European Commission
Directorate-General for Research and Innovation
Research Fund for Coal and Steel

Summaries of RFCS Projects 2003 – 2014

Full list of projects co-financed by the Research Fund for Coal and Steel of the European Commission

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Technical Group Coal 1

Coal mining operation, mine infrastructure and management, unconventional use of coal deposits

The scope of TGC1 includes:

- Modern techniques for surveying deposits
- Integrated mine planning
- Highly efficient, largely automated excavation and mining technologies corresponding to the geological characteristics of EU hard coal deposits
- Appropriate support technologies
- Transport systems
- Power supply services, communication and information, transmission, monitoring and process control system
- Health and safety in mines, gas control, ventilation and air conditioning, occupational health safety
- Reduction of green house emissions from coal deposits
- Return to the mine of mining waste, fly ash, desulphurization, other forms of waste
- Refurbishment of waste heaps and the industrial use of residues from coal production and consumption
- Protection of water tables and the purification of mine drainage water
- Protection of surface installation against the effects of subsidence in the short and long term
- CO_2 geological storage
- Upgrading coal deposits; coal bed methane, enhanced coal bed methane, underground gasification, others

RFCR-CT-2003-00003 EPCWCMS

Enhancing the performance of mine communication, warning and condition monitoring systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2236231 €	Start Date	1/09/2003
	EU Contribution	1341739 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23196:EN			

Final Abstract This project investigated improvements in power line communications (PLC), condition monitoring techniques and diagnostic aids, together with improving audible communication systems underground. The work on PLC investigated narrow-band, low data rate technologies and high data bandwidth broadband PLC technologies. It is concluded that broadband PLC technologies cannot currently meet the requirements of providing backbone communications in mining and that fibre-optic methods offer better performance. However, short range broadband applications are feasible and an innovative voice and data transmission system, including remote control features, has been developed for coalface communications, using radiofrequency and digital voice technologies not previously used for this application. This system accommodates all the new digital interfaces: Bluetooth, PLC, twisted pair cables, etc. The condition monitoring research has led to a suite of new specialised ATEX-certified sensors together with the development of new vibration signature tracking and classification devices and methods, which provide an early indication of incipient failure. Particular value of these methods is anticipated with coalface equipment. A further component of the work examined the practicability of implementing noise reduction techniques in mining communications systems and noisy workplaces by means of active noise cancellation (ANC). Whilst ANC-based techniques would not be currently cost-effective, several other practical communication improvements are worth considering further. These include new hearing protector technologies and a simple but effective 'waveshape compressor' to improve speech dynamic range in communication systems. A final component of the project examined the issue of mining alerts and alarms, where significant advances in signal design tools have been made.

		Country	*Scientific person in charge*
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RFCR-CT-2003-00006 WATERCHEM

Optim. of mine water discharge by monitoring & modelling of geochemical processes & develop. of measures to protect acquifers & active mining areas from mine water contamination

Info	Type of Project	Research	Duration (months)	42
	Total Budget	3421209 €	Start Date	1/09/2003
	EU Contribution	2052726 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23456:EN			

Final Abstract The aim of the project was to improve the competitiveness of coal production by improving the quality of the mine water raised and monitoring the substances it contains, making the cost effectiveness of different methods of dam construction calculable, increasing the safety of mining by determining the flow paths and optimising the construction of dams between areas that are still being worked and those that have been closed down and minimising the costs incurred for draining the mines while taking the measures necessary for environmental protection into account. The different objectives have in general been reached. The box model, integrating a geochemical reaction model, has proved to be a very appropriate tool in simulating mine water rebound effects in large coal mine fields. Empirical analytical solutions can easily and for a number of applications adequately describe the development of mine water quality after flooding. Equipment and methods for monitoring mine water flows and compositions have been successfully tested and applied. Data transmission units have been developed as well. Several coal mine areas have been monitored and investigated. All results led to improved quality of modelling as well as to improved parameters for mine water management. In order to optimise mine closure and subsequent effects the results of the study have highlighted several key points linked to rebound of both the aquifer and the mine water and the type of hydraulic connections between the aquifer and the mine workings. The optimisation of dam construction has been achieved.

Partners		*Country*	*Scientific person in charge*
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RFCR-CT-2003-00010 SAFETECH

Optimisation of surveillance,technical equipment & procedures to prevent workers from danger attribute to fire, hazardous or toxic gases, firedamp or climatic conditions

Info	Type of Project	Research	Duration (months)	42
	Total Budget	3267686 €	Start Date	1/09/2003
	EU Contribution	1960611 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23353:EN			

Final Abstract In underground coal mines, controlling and surveillance of firedamp or toxic gases, ventilation, climate control and early fire indication are some of the major problems facing miners and mining companies. The aim of this project was to improve safety, taking into account the competitiveness of coal production by: - Improving the quality of surveillance of underground ambient air, to detect as early as possible hazardous gas concentrations and/or concealed fires. - Increasing the safety of miners and mining by determining the flow characteristics of firedamp in the rock mass and optimising the drainage volume in high-production rate faces. - Technical solutions to reduce the thermal strain for workers and the development of thermal risk assessment methodology. - Developing technical methods and equipment for a permanent controlling and/or diagnosis of sensitive electrical equipment. The research has successfully shown how mine safety can be enhanced by using optimum methods of methane drainage, achieved for standard long wall and sub-level caving methods. Allied to this work was the successful development and certification of equipment that can be used for surveillance in mine atmospheres containing methane. In terms of working, emergency and rescue situations in mines subjected to high heat stress conditions, a range of protective measures have been successfully identified. Finally, a highly sensitive system for measuring, analysing and early detection of gases especially with respect to combustion products has been developed, which is of paramount importance due to the continued occurrences of mine fires.

Partners		*Country*	*Scientific person in charge*
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RFCR-CT-2003-00011 GEOMOD

Geotechnical modelling, classification & exploration for safe & efficient mine layout & tunnel support design

Info

Type of Project	Research	Duration (months)	36
Total Budget	2545614 €	Start Date	1/09/2003
EU Contribution	1527368 €	End Date	31/08/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22964:EN

Final Abstract Developments and improvements in geotechnical modelling, classification and exploration for safe and efficient mine layout and tunnel support design were achieved through rock mass classification, rock testing, underground measurements, seismic system development, improved numerical modelling techniques and application at field study sites. In geotechnical modelling, new constitutive models were proposed for rock creep and stiffness properties. Further advances in rock property representation were achieved for rock mass deformability, definition of the susceptibility of a rock to bursting failure and the strength of ground that has failed and then been reconsolidated by grout injection. Approaches were developed to reduce the time necessary to construct 3D models and to represent pre-tensioning of reinforcement elements and the placement of trusses in roadway reinforcement designs. These improvements were applied within the numerical codes FLAC, FLAC3D and MAP3D. A practical rock mass classification system was developed using data from exploratory drilling and face mapping incorporating the effects of faulting. Using this rock mass classification and measured gate road deformations, a methodology was developed for the prediction of roadway deformation. Tests with a 3D laser scanner showed the technology was applicable to recording roadway deformation and geotechnical rock mass classification data although use was restricted as it was not intrinsically safe. A practical seismic system was developed to detect geological disturbances up to 50m ahead of an advancing roadway. At the case study site where exploratory drilling ahead of the face was undertaken the seismic results correlated well with the location of water-filled disturbances encountered.

Partners

	Country	*Scientific person in charge*
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RFCR-CT-2004-00001 IAMTECH

Increasing the efficiency of roadway drivages through the application of advanced information, automation and maintenance technologies

Info	Type of Project	Research	Duration (months)	40
	Total Budget	3029283 €	Start Date	1/07/2004
	EU Contribution	1817569 €	End Date	31/10/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23881:EN			

Final Abstract The main goal of the IAMTECH project was increasing the efficiency of road-heading by applying advanced information, automation and maintenance technologies. Some of its results will allow for increasing the availability of the machinery through the decrease of both programmed maintenance time and medium time to repair. Other results are related to the adoption of new types (in coal mining) of support considered promising from a productivity increase perspective, such as concrete spraying. Research topics addressed in the project could be classified roughly in two groups: horizontal (underlying common technologies) and vertical (related to the actual implementation of devices, software and systems). Among the results for horizontal activities, those that deserve special mention are the development of an Atex 3D laser scanner, Atex WLAN (WiFi) access points, cameras and PDA, as well as methods for storing and representing in 3D machinery components, subassemblies and complete machines. Amid results of vertical activities is the implementation of a central maintenance control room (CMCR), in which the information and expertise on maintenance and repairing of mining machinery is concentrated. Engineers in charge of CMCR have online access to all machinery-related information, including direct access to manufacturers' databases. Images, voice and data flowing from the underground, and diagrams and advice flowing from the surface are transmitted and displayed using the technologies developed during horizontal activities. Other important results are the development of methods for assessing the quality of execution of roadway support when using sprayed concrete for this purpose, also using technologies (such as laser scanning) developed within the horizontal activities.

		Country	*Scientific person in charge*
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RFCR-CT-2005-00001 ADEMA

Advances in exploration methods and applications

Info

Type of Project	Research	Duration (months)	36
Total Budget	3228216 €	Start Date	1/07/2005
EU Contribution	1936930 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24217:EN

Final Abstract

The ADEMA project comprised a programme of integrated research seeking to enhance mining exploration and planning capability. The main topics studied were seismic processing, radio imaging, drilling parameter analysis, micro-seismic activity and predictive analysis. Oil industry techniques have been adapted to the coal environment. 3D seismic data have been reprocessed for inversion and modelling projects and refined for lithology classification schemes. Additionally, a new seismic inversion method, known as ADAPS, which uses pattern recognition to extract the seismic wavelet, has been developed and applied. The AVP inversion method has been developed enabling derivation of rock properties. Software has been developed to generate impedance data which, when correlated with boreholes, provide a lithology indicator. Radio imaging methods have been analysed. An extensive appraisal of electromagnetic propagation in coal seams has been completed, prototype transmitting equipment built and the parameters of the coal seam medium measured, using several different types of equipment. Drilling parameters have been defined from drilling equipment. They have been combined to obtain a specific energy and drilling exponent, which can be correlated with mechanical properties of the rock mass. An increase in specific energy with the rock quality was observed. A 64-channel, flameproof seismic observation system, incorporating new low-frequency geophones, has been installed in a Polish coalmine. Evolutionary tomographic algorithms have allowed the construction of velocity images for the surrounding rocks, providing a method for the location of seismic hazard zones in coalmines. A programme of cored underground boreholes, samples and geological observations has been undertaken to validate the sedimentary model generated from the re-processed seismic volume.

Partners

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HERIOT-WATT UNIVERSITY	UNITED KINGDOM	Brian SMART
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SEISMIC IMAGE PROCESSING LTD	UNITED KINGDOM	Beatrice McGLEN
TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	Henk PAGNIER

Patents

Radio imaging of underground structures: elimination of need for synchronisation channel. Applicant: Mines Rescue Service Limited. Application No.:GB0620563.7. Date of Filing: 17 Oct 2006. Publication No.:GB 2443019, Publication Date: 23 April 2008

Electrodes for resistivity tomography in coal mines. Applicant/ Mines Rescue Service Limited. Application No.: GB0620860.7. Date of Filing: 20 Oct 2006. Publication No.: GB 2443246. Publication Date: 30 April 2008

Detection of anomalies within a stratum, structure or seam. Applicant/ Heriot Watt University. Application No.: GB0802778.1. Date of Filing: 15 Feb 2008. This application replaces GB0702831.9, which was reported earlier in the project.

Selected Publications

Sangster A J, Lavu S, McHugh R, Westerman R. Modal Formation of Electromagnetic Fields in a Geological Stratum with Loss Tangent Greater Than Unity, submitted to the Journal of Applied Geophysics, June 2008.

Gibson, D. Novel Cave Radio Antenna uses Small Ceramic Tiles. Published in the British Cave Research Association's Cave Radio and Electronics Group Journal (ISSN 1361-4800), June 2008 (CREGJ 71, pp14-15).

Mutke G., Lurka A., Dubinski J. 2009: Seismic monitoring and rock burst hazard assessment in Deep Polish Coal Mines – Case study of rock burst on April 16, 2008 in Wujek-Slask Coal Mine. Seventh International Symposium on Rockburst and Seismicity in Mines - RASiM 7: Controlling Seismic Hazard and Sustainable Development of Deep Mines. Chun'an Tang (ed.). Vol. 2. Rinton Press. pp. 1413-1424.

RFCR-CT-2005-00002 MONSUPPORT

Development of more economical innovative support systems for gateroads under the influence of rock stresses

Info

Type of Project	Research	Duration (months)	36
Total Budget	2882817 €	Start Date	1/07/2005
EU Contribution	1729690 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24461:EN

Final Abstract

Based on the developments and results achieved during this project, several monitoring systems could be newly developed or improved and ATEX certified, so that additional tools can be provided for the underground coal mining industry. The measuring values recorded with these tools increase theinformation density of the support system considerably. By these data the interaction of the geotechnical rock conditions and the support systems could be documented in greater detail. Especially the remote reading online support monitoring systems increase the measuring grid density. The newlydeveloped methods, monitoring tools and software applications and the acquired geotechnical data contribute to the understanding about the optimisation of the support techniques.

Partners

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UK COAL MINING LTD	UNITED KINGDOM	David MOORE

RFCR-CT-2005-00003 RAINOW

Researching the applications of innovative open wireless technologies

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3275993 €	Start Date	1/07/2005
	EU Contribution	1965597 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24182:EN			

Final Abstract By basic research the IEEE 802.15.4/Zigbee standard was identified as the key technology for a wireless sensor network (WSN) and Bluetooth for the wireless mines rescue communication system link. Additionally, alternative power supply technologies have been examined. Wireless sensor network equipment have been developed, like sensors, interfaces and RFID devices, capable of operating in harsh mining environments, at underground propagation conditions and with ultra-low power consumption. Innovative technologies such as wideband chirp transmission schemes, ultra-low power microcontrollers and advanced networking protocols were necessary. By using standard-based interfaces, compatibility of different systems was achieved. Several applications were developed, where the WSN equipment could demonstrate its capabilities. These were for example temperature monitoring at belt drives, rock stress monitoring and material tracking. Additionally, a solution has been developed to make the information of WSNs directly available on site by a wireless linked PDA. Important enhancements of wireless technologies for personal sensor networks (PAN) were achieved. Small size wireless sensors capable of being worn by underground personnel provide continuous monitoring of health and environmental parameters. Localisation within the mine is possible as well. Portable devices for wireless voice communications have also been developed. Operational trials have been carried out in several underground locations around Europe using the different developed technologies, i.e. WSN and PAN equipment and applications. The operational capability of the systems has been proven up to different levels. Some products are ready for marketing, for others firstly ATEX-approval or larger scale demonstration trails are intended.

Partners	*Country*	*Scientific person in charge*
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RFCR-CT-2006-00001 NEMAEQ

New mechanisation and automation of longwall and drivage equipment

Info

Type of Project	Research	Duration (months)	36
Total Budget	3809157 €	Start Date	1/07/2006
EU Contribution	2285493 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24974:EN

Final Abstract

A fully automated coal shearer was developed with load-dependent regulation and coal/rock distinction through infra red and impact sound sensors. Collision avoidance is obtained through radar and video technologies. The development comprises appropriate control technologies and software for sensor data processing and a reliable integration of the onboard networks into the mine network. The efficiency of cutting drums can be improved through FLAC3D numerical modelling to simulate the process of cutting, which can replace laboratory testing, and aid drum design. Specifically written CAD software can generate drum lacings to reduce pick wear and vibration-caused machine downtime. For determining the cause of poorly performing drums the software can be used as part of an iterative problem diagnosis process. A novel monitoring and visualisation system provides analysis of longwall operations and equipment condition monitoring. Diagnostic devices developed include:• a portable thermal imaging camera,• wireless diagnostic sensors for online monitoring of triaxial vibrations, temperatures, leak detection and water in oil content.A maintainability and human factors assessment software package was developed that will help to avoid or minimise practical difficulties and reveal options for maintainability improvement. A fiber optic communication system was developed for 'the last mile', tolerant to the harsh underground environment. The flexible high bandwidth network provides support to any kind of mining monitoring and control system. It includes interfaces to integrate both new devices and legacy equipment. A dedicated software tool was developed for easy management of the network.

Partners

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RFCR-CT-2007-00001 PROSAFECOAL

Increased productivity and safety of European coalmines by advanced techniques and planning tools enabling an improved strata control of the face-roadway junction

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3293615 €	Start Date	1/07/2007
	EU Contribution	1976170 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25090:EN			

Final Abstract By reviews and examinations, basic data on current face end support design practices, experiences with cable-bolting, 2D-modelling and mine layouts were compiled and evaluated. They vary widely across Europe. A wide range of improved and new support systems were tested and the results incorporated into the NIOSH STOP programme and a handbook. A triaxial test cell for a new cable bolt testing bench was built and used. Geotechnical investigations were carried out, such as load and stress measurements, surveys of geological and geotechnical characteristics (especially joints and fractures) and gob reconsolidation, over a wide range of European mines. Interactions were evaluated (geology, joints systems and properties, seam structure, excavation methods, support design), methodologies developed concerning gob reconsolidation and support under caving gobs, and a shear test apparatus was built and used. Through these results, novel numerical 3D-modelling tools (FLAC-3D) for support elements and mine layouts' inclusive face-roadway junctions could be developed, calibrated, applied and validated. This complex and highly automated model is universally applicable for all roadway types usual in Europe and for a large number of support elements. Due to short modelling and calculation times, it is now possible to use 3D-modelling as a standard feature for underground mine planning. A logical tree was developed in which improved support management systems from German, Polish and British coal mine types were integrated. This could enable users to define a methodology tailored to the actual conditions of a mine. Improved support design and management was developed and successfully tested, including at multi-slice longwall extraction.

Partners		*Country*	*Scientific person in charge*
	RAG Aktiengesellschaft	DEUTSCHLAND	Frank LÜTTIG (Pr. Coord.)
	ASS. POUR LA RECHERCHE ET LE DEV. DES METHODES ET PROC. IND., ARMINES	FRANCE	Faouzi HADJ HASSEN
	DMT GmbH & Co KG	DEUTSCHLAND	Andreas K.M. HUCKE
	GEOCONTROL S.A.	ESPAÑA	Agustín MUÑOZ NIHARRA
	GLOWNY INSTYTUT GORNICTWA	POLAND	Stanislaw PRUSEK
	GOLDER ASSOCIATES (UK) Ltd	UNITED KINGDOM	David Norman BIGBY
	KOMPANIA WEGLOWA S.A.	POLAND	Janusz IMIELA
	ROCK MECHANICS TECHNOLOGY Ltd	UNITED KINGDOM	Lorraine KENT
	UK COAL MINING LTD	UNITED KINGDOM	David MOORE

Selected Publications

Studeny A., Scior C..: Advanced numerical solutions for strata control in mining. Mining Reporter 3-2009

Bock S., Prusek S., Masny W. (2010): Calculation with the help of numerical modeling of the load of roadway workings localized under goafs (in Polish). III Second Scientific-Training Conference „Problems of Contemporary Mining", Scientific Works of GIG, Quarterly Mining and Environment, No 1/1/2010, p. 17-28.

Blanco Martín. L., M. Tijani, and F. Hadj-Hassen. 2010. A New Analytical Solution to the Mechanical Behaviour of Fully Grouted Rockbolts Subjected to Pull-out Tests. Construction and Building Materials. 25: 749-755

Bowler J., Robinson G., Altounyan P. "Rib support innovation at Daw Mill colliery." 28th Int. Conf. Ground Control in Mining. Morgantown 2009.

Prusek S., Bock S., Masny W. (2009): New method of assessment of the reconsolidation degree of caving debris from the aspect of support selection of roadway workings (in Polish). II Second Scientific-Training Conference „Problems of Contemporary Mining", Scientific Works of GIG, Quarterly Mining and Environment, No 2/1/2009, p. 203-210,

RFCR-CT-2007-00002 ADRIS

Advanced drivage and roadheading intelligent systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3612890 €	Start Date	1/07/2007
	EU Contribution	2167734 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25077:EN

Project web page http://www.aitemin.es/adris/

Final Abstract

ADRIS was a three year research project whose main target was to develop technologies to increase the efficiency of the preparatory works needed to open new exploitation areas in underground coal mines. The project was intended to identify the main automation needs for coal mining roadheading process in both horizontal and vertical seam mines. For horizontal seams, the development of these technologies involved the fully automation of roadheaders, which included the development of automated cutting simulation software using gathered information from real operational procedures, the analysis and simulation of path planning algorithms, strategies for self adaptation to geological conditions and the real time detection of the coal/rock interface using laser scanners. For vertical seams, the need for the implementation of an automated roof support installation system and the development of a cutting process avoiding drilling and blasting generated the design and development of a newly designed multi tool arm manipulator. Additionally the study of some blue skies technologies were included inside the scope of the project like the design of roof support and cutting sequences using geological simulation tools, a thorough study of New Rock Fragmentation Technologies (NRFT) using electrofracture mechanisms or a self advancing support system.

Partners	*Country*	*Scientific person in charge*
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Samir NABULSI (Pr. Coord.)
DMT GmbH & Co KG	DEUTSCHLAND	Dietmar PLUM
GOLDER ASSOCIATES (UK) Ltd	UNITED KINGDOM	David Norman BIGBY
HULLERAS DEL NORTE, S.A.	ESPAÑA	César CORDERO ESCOSURA
INSTYTUT TECHNIKI GORNICZEJ KOMAG	POLAND	Dariusz PROSTANSKI
MINES RESCUE SERVICE LTD	UNITED KINGDOM	John FORD
RAG Aktiengesellschaft	DEUTSCHLAND	Peter ACHILLES
ROCK MECHANICS TECHNOLOGY Ltd	UNITED KINGDOM	Lorraine KENT
TALLERES ZITRÓN SA	ESPAÑA	Roberto ARIAS

RFCR-CT-2007-00003 MINTOS

Improving mining transport reliability

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2413736 €	Start Date	1/07/2007
	EU Contribution	1448242 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25098:EN			

Final Abstract The project addresses improvements to mine transport management, safety and health. Fuel cells have the potential to provide clean efficient power underground, but significant further development is required before they meet the safety and power requirements of coal mine transport systems. However, a range of alternative fuel cell applications were identified. Bio-fuels could be used as blends in underground diesel engines to reduce exhaust particulates. Alternatively, wet scrubbing of the exhaust using water mists will also reduce particulates. Advanced wireless sensors and software were developed to form an improved system for underground vehicle transport logistics and diagnostics. The incorporation of novel data transmission and distributed sensor power supply systems provides a highperformance, low-cost wireless monitoring system. A scheme of an automatic fire alarm system for vehicle operators was devised, which can be expanded to other safety monitoring systems. A novel onboard fire fighting system, which can be periodically tested and still maintain its operational capability, was designed and a fully functional operational prototype produced. A comprehensive joint open access WEB-based platform was developed for use by transport system designers and specialists in transport health and safety. A prototype augmented reality system was developed to enable operational mine staff to radically improve logistics management and maintenance. Whole body vibration levels encountered by vehicle operators exceed legal limits in many cases due to the impulsive nature of the vibration. A database of transportrelated vibration exposure profiles was produced and recommended minimum vibration measurement times derived.

		Country	*Scientific person in charge*
Partners	**MINES RESCUE SERVICE LTD**	UNITED KINGDOM	Stuart C. BENNETT (Pr. Coord.)
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Pedro MORILLO
	INSTYTUT TECHNIK INNOWACYJNYCH EMAG	POLAND	Przemyslaw WISZNIOWSKI
	GLOWNY INSTYTUT GORNICTWA	POLAND	Stanislaw PRUSEK
	INSTYTUT TECHNIKI GORNICZEJ KOMAG	POLAND	Teodor WINKLER
	KOMPANIA WEGLOWA S.A.	POLAND	Andrzej PAKURA
	RITTAL GMBH & CO KG	DEUTSCHLAND	Martin ROSSMANN

Selected Publications

Winkler T., Dudek M., Chuchnowski W., Tokarczyk J.: Internet tools supporting planning of underground mining transport. Aachen International Mining Symposia. Mineral Resources and Mine Development. RWTH Aachen, 26th and 27th May 2010.

Wiszniowski, Przemyslaw. 'WLSS Bezprzewodowy System Wspierania Logistyki dla Transportu Podziemnego' conference „Innowacyjne Maszyny i Technologie – Bezpieczenstwo" Szczyrk 2011.

Madera, J., Morillo, P. Riesgo por Vibraciones en la Industria Extractiva: Situación del Sector Respecto a las Exigencias Legales. Published in scientific journal "Canteras y Explotaciones". Nº 498, pp. 21-25. July 2008.

RFCR-CT-2007-00004 PRESIDENCE

Prediction and monitoring of subsidence hazards above coal mines

Info

Type of Project	Research	Duration (months)	36
Total Budget	4366865 €	Start Date	1/07/2007
EU Contribution	2620118 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25097:EN

Final Abstract

"Mining subsidence engineering is one of the most important topics in relation to coal mining. Although its occurrence, prediction and control are well known, this project will apply various innovative techniques to an old problem (photogrammetry, InSAR, GPS, seismic tools, SFS). Geology is a major factor in surface subsidence. Empirical predictions are inaccurate where experience is lacking and geology unusual. Geomechanical subsidence modelling can account for geology but requires anisotropic solutions to reproduce subsidence profiles. Four items have been developed in relation to the prediction of subsidence caused by underground infrastructures: two in relation to shafts (telemetry and instrumentation for fill stability, and the laser-scanner techniques for surveys); another in relation to a survey methodology using numerical modelling for infrastructure roadway, and the last one in relation to the effect of mine water on concrete and other materials. A 4D database, called GeoMond-DB has been developed to manage subsidence hazards on the surface, working with data from Germany, Poland and Spain. A methodology based on geomechanical models to establish a prevision of surface and subsidence was carried out and validated. Specially, the consistency of FLAC 3D was checked to evaluate subsidence and the tensile strain on the surface. In conclusion, the techniques employed in this research represent a significant advance on the current situation in forecasting and control of subsidence. Therefore, although some of the investigated techniques must still be refined, it can be said that the results of this research project will have a positive effect in the monitoring of the subsidence in the coal basins of the EU and some outcomes, such as the technique of monitoring the movements of the ground with a GPS and vibrating sensors, could be exported outside the EU."

Partners

	Country	*Scientific person in charge*
GEOCONTROL S.A.	ESPAÑA	Carlos HERRERO GARCÍA (Pr. Coord.)
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Juan Carlos CATALINA
ASS. POUR LA RECHERCHE ET LE DEV. DES METHODES ET PROC. IND., ARMINES	FRANCE	Faouzi HADJ HASSEN
DMT GmbH & Co KG	DEUTSCHLAND	Rainer KUCHENBECKER
INSTYTUT TECHNIK INNOWACYJNYCH EMAG	POLAND	Jacek JUZWA
GOLDER ASSOCIATES (UK) Ltd	UNITED KINGDOM	David Norman BIGBY
MINES RESCUE SERVICE LTD	UNITED KINGDOM	Robert R. JOZEFOWICZ
RAG Aktiengesellschaft	DEUTSCHLAND	Volker SPRECKELS
ROCK MECHANICS TECHNOLOGY Ltd	UNITED KINGDOM	Lorraine KENT
UK COAL MINING LTD	UNITED KINGDOM	David MOORE

Selected Publications

Kamphans, K., Walter, D., Hannemann, W., Busch, W., Spreckels, V., Vosen, P. GIS-Einsatz im Monitoring bergbaubedingter Oberflaechenbewegungen.In: Angewandte Geoinformatik 2008. Beitraege zum 20. AGIT-Symposium Salzburg, Oesterreich, 02.-04.07.2008 . Hrsg.: J. Strobl, Th. Blaschke, G. Griesebner. H. Wichmann Verlag, Heidelberg. pp 572 - 577.

Spreckels V., Walter D., Wegmueller U., Deutschmann J., Busch, W. Nutzung der Radarinterferometrie im Steinkohlenbergbau.In: Allgemeine Vermessungs-Nachrichten, AVN 7/2008, Wichmann Verlag, Heidelberg, ISSN 0002-5968. pp. 253 - 261.

"Presentation at the annual seminars 2008 (November 6th) and contribution to the annual report of Gisos http//www.gisos.org on ""Surface movements after closing and flooding coal mines"" , in French"

"Presentation at the annual seminars 2009 (November 10th) and contribution to the annual report of Gisos http//www.gisos.org on ""Surface movements after closing and flooding coal mines"" , in French (progress of the work)"

Software

J.C. Catalina. Prototype of a new remote monitoring system (photogrammetry-theodolite). Deliverable 2.1

VIPLEF implantation in the finite element code of a new constitutive law describing anisotropic creep and swelling of schistose rocks without and under (constitutive model developed during the project). URL:http://www.geosciences.mines-paristech.fr/fr/recherche/bibliotheque-de-logiciels/viplef/view

RFCR-CT-2008-00001 IMPREX

Improved extraction ratios for deep coal mines

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2399428 €	Start Date	1/07/2008
	EU Contribution	1439656 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25914:EN			

Final Abstract The objective of this Project is to research, identify and develop practical means by which coal recovery ratios in European deep mines can be improved significantly in a safe and efficient manner. Currently, large volumes of valuable coal are being left in-situ and effectively sterilised, against a background of dwindling indigenous reserves, rising energy prices and increasing dependency upon imported energy. This situation has become exacerbated by the adoption of highly cost efficient retreat longwalling as the main means of coal recovery in European deep coal mines, which has produced enormous improvements in productivity, but has had detrimental consequences on extraction ratios. It is therefore necessary to devise means of efficiently extracting significant tonnages of the extensive areas of coal which are left around and between longwalls and in old shaft pillars and of improving the deep mined coal industry's ability to maximise its extraction of the reserves of thick coal seams, large tonnages of which are currently abandoned in the goaf.

		Country	*Scientific person in charge*
Partners	**GOLDER ASSOCIATES (UK) Ltd**	UNITED KINGDOM	David Norman BIGBY (Pr. Coord.)
	DMT GmbH & Co KG	DEUTSCHLAND	Juergen te KOOK
	GLOWNY INSTYTUT GORNICTWA	POLAND	Stanislaw PRUSEK
	KATOWICKI HOLDING WEGLOWY S.A.	POLAND	Janusz CZARNECKI
	ROCK MECHANICS TECHNOLOGY Ltd	UNITED KINGDOM	David Norman BIGBY
	TECHNISCHE UNIVERSITAET CLAUSTHAL	DEUTSCHLAND	Elisabeth CLAUSEN
	UK COAL MINING LTD	UNITED KINGDOM	David MOORE
	THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Rodney STACE

RFCR-CT-2008-00002 EDAFFIC

Early detection and fighting of fires in belt conveyors

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2204019 €	Start Date	1/07/2008
	EU Contribution	1322412 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25364:EN

Project web page http://www.aitemin.es/edaffic/

Final Abstract Edaffic was a 3-year research project, the main target of which was minimising the risk of initiation and spreading of conveyor belt fires, acting on all control points of the fire ignition and propagation process. The fundamental mechanisms behind the initiation and propagation of conveyor belt fires were established. The characterisation of the combustion process (including an estimation of fire load and characteristics of combustion products), the evaluation of the effect of these combustion products on persons (including workers and local population) as well as the impact on the environment allowed the manufacturers of conveyor belts to use the results to reduce development costs. The results obtained from the tests showed that the belts with the current material composition will seriously pollute the environment in case of fire.

		Country	*Scientific person in charge*
Partners	**ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.**	ESPAÑA	Angel RODRIGUEZ LÓPEZ (Pr. Coord.)
	CENTRUM BADAN I DOZORU GORNICTWA PODZIEMNEGO SP Z.O.O.	POLAND	Malgorzata RYSZKA
	DMT GmbH & Co KG	DEUTSCHLAND	Heinrich PETERSMANN
	INSTYTUT TECHNIK INNOWACYJNYCH EMAG	POLAND	Wladyslaw MIRONOWICZ
	HULLERAS DEL NORTE, S.A.	ESPAÑA	César CORDERO ESCOSURA
	MINES RESCUE SERVICE LTD	UNITED KINGDOM	John FORD
	UK COAL MINING LTD	UNITED KINGDOM	Stewart JOBLING

RFCR-CT-2008-00003 EMTECH

Mine emergency support technologies

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3665712 €	Start Date	1/07/2008
	EU Contribution	2199428 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25917:EN			

Final Abstract

"The major objectives of this project have been to provide a resilient network infrastructure which meets the dual requirements of operational day-to-day and emergency management needs, together with researching and introducing a range of new support technologies for mine evacuation and rescue. The research consortium involved three EU coal operators, two mine rescue services and five research institutes/manufacturers. The project was highly application focused and a number of innovations and prototypes have been produced; including resilient networked communications, emergency refuges, evacuation modelling tools, and evacuation support technologies together with knowledge on their application. It is considered that there are excellent prospects for a successful technology transfer process and subsequent take-up of the research outputs by industry."

Partners

	Country	*Scientific person in charge*
MINES RESCUE SERVICE LTD	UNITED KINGDOM	David BRENKLEY (Pr. Coord.)
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Pedro MORILLO
CENTRALNA STACJA RATOWNICTWA GORNICZEGO SA	POLAND	Miroslaw BAGINSKI
DMT GmbH & Co KG	DEUTSCHLAND	Rainer RELLECKE
INSTYTUT TECHNIK INNOWACYJNYCH EMAG	POLAND	Wladyslaw MIRONOWICZ
EMBIGENCE GMBH	DEUTSCHLAND	Christoph MÜLLER
GEOCONTROL S.A.	ESPAÑA	Fernando PORTUGUES SALGADO
HULLERAS DEL NORTE, S.A.	ESPAÑA	Juan José FERNANDEZ DIAZ
MINETRONICS GMBH	DEUTSCHLAND	Christoph MÜLLER
RAG Aktiengesellschaft	DEUTSCHLAND	Ulrich KIMMIT
UK COAL MINING LTD	UNITED KINGDOM	Stewart JOBLING

Patents

Müller C, Kommunikationsnetzwerk und Verfahren zur sicherheitsgerichteten Kommunikation in Tunnel- und Bergwerksstrukturen, Patent application PCT/EP 2010/056825, Ladbergen: MineTronics GmbH, 2010

Selected Publications

Müller C, Noack A, Szekely I (2010) Ethernet communication for detection of emergency locations and dynamic evacuation in underground infrastructures, Proceedings of IEEE 12th International Conference on Optimisation of Electrical and Electronic Equipment (OPTIM), 20-22 May 2010, Uni. of Transylvania, Brasov, Romania

Müller C, Noack A (2011) Network-based communication for mine and tunnel constructions, 17th Colloquium “Bohr- und Sprengtechnik”, 21-22 January 2011, Clausthal, Germany

Müller C, Noack A (2011) Safety support functions for underground network communications, In Proceedings 35th Application of Computers and Operations Research in the Minerals Industry Symposium (APCOM 2011), 27-29 September 2011, Wollongong, Australia

Müller C, Szekely I (2012) Emergency switching and network functions for enhanced safety in underground networks, In Proceedings 11th International Conference on Development and Application Systems, Suceava 2012, University of Suceava, Suceava, Romania

Wiszniowski P and Babecki D (2010), Nowoczesne technologie wspieraj_ce prowadzenie akcji ratowniczych (tranls.: New emergency support technologies), Industry seminar hosted by EMAG Scientific & Industrial Centre, 23 November 2010, Katowice, Poland

RFCR-CT-2008-00004 COALSWAD

Investigation of adsorption and swelling behaviour of coal to determine the feasibility of CO2 sequestration and CH4 production enhancement

Info

Type of Project	Research	Duration (months)	36
Total Budget	1764112 €	Start Date	1/07/2008
EU Contribution	1058467 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25895:EN

Project web page http://www.coalswad.eu, http://www.coalswad.de

Final Abstract

In Coalswad, Czech, Spanish and German coal samples were examined concerning their adsorption and swelling behaviour. It is seen that the origin of coal has no influence on the adsorption properties. Only the rank is an important parameter. The adsorption of different adsorptives was examined. For all samples, a strong enrichment of the molar fraction of CO2 in the adsorbed phase was observed. In the investigated pressure range no methane excess isotherms show maxima, whereas CO2 excess isotherms show maxima. These maxima are caused by buoyancy effects during the experiments. To obtain absolute data, respective corrections were implemented. Furthermore the influence of structural changes during sorption has to be considered. Structural changes due to coal swelling were investigated by NMR and SAXS measurements. The NMR results concerning rank are consistent with our results of proximate and petrographic analysis. Comparison of untreated and treated (CO2 sorption) coal does not indicate changes at a molecular level. SAXS investigations showed that sorption effects are minor in the micropore region and highest in the mesopore region. Pressure-scanning experiments between 1 and 50 bar showed some minor and reversible changes at microand mesopore length scale. Both methods underline the elastic reaction of coal on CO2 sorption in the investigated pressure range. We have shown that CO2 sequestration in coal is feasible even if CO2 is injected in diluted form. As the adsorption affinity of coal towards CO2 is much greater than towards CH4, the injection of CO2 can be used for an increased recovery of CH4.

Partners

	Country	*Scientific person in charge*
FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG e.V.	DEUTSCHLAND	Eva SCHIEFERSTEIN (Pr. Coord.)
DMT GmbH & Co KG	DEUTSCHLAND	Ralph SCHLÜTER
GREEN GAS DPB a.s.	CZECH REPUBLIC	Petr HEMZA
INSTITUT FÜR NICHTKLASSISCHE CHEMIE e.V.	DEUTSCHLAND	Reiner STAUDT
ÖSTERREICHISCHE AKADEMIE DER WISSENSCHAFTEN	OESTERREICH	Peter LAGGNER
UNIVERSITEIT LEIDEN	NEDERLAND	Jörg MATYSIK

Selected Publications

P. Hemza, E. Schieferstein. Report on sample characterisation. COALSWAD deliverable-3. http://www.coalswad.eu

R. Staudt. Gravimetric and Volumetric Measurements of Adsorption equilibria of pure gases and binary and multicomponent mixtures on different Coals. COALSWAD project deliverable -4. URL http://www.coalswad.eu

Manfred Kriechbaum, Maria Schmuck, Peter Laggner. Investigation of Swelling Behavior (SAXS Method). COALSWAD project deliverable-5. URL http://www.coalswad.eu

Fu Chen, Bela Bode, Ben Anger and Jörg Matysik. NMR Investigations of CO2 Sorption in European Coals. COALSWAD project deliverable-6. URL http://www.coalswad.eu

E. Schieferstein. Report on determined fractal parameters, proceeding adsorption mechanisms and calculated CO2 adsorption isotherms. COALSWAD project deliverable-7. URL http://www.coalswad.eu

RFCR-CT-2008-00005 FLOMINET

Flooding management for underground coal mines considering regional mining networks

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1925484 €	Start Date	1/07/2008
	EU Contribution	1155291 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25905:EN			

Final Abstract The Boxmodel has been enhanced for innovative processes like coupled gaswater flow, energy production, turbulent flow and heat transport. Coupling of mine water and surface water models allows now for examination of closed water balances. All site models have been supplied with the required functionalities. The model calculations have been used for prognosis calculations and planning. An Optimisation software tool has been developed and the programming includes data exchange with the site-Boxmodels. Therefore the impact of strategic options of mine water management on costs and environment can be better predicted an evaluated. It has to be highlighted the realisation of the geothermal pilot project by the Spanish partners. This activity adds a new example for use of mine water for production of renewable energy in Europe. Feasibility checks show however that in spite of general cost benefits of the recoverable mine-related energy sources site specific development costs might compensate the cost advantage. Model calculations for hydrothermal energy use have proved the importance of correct design of the hydrothermal regime for stable temperature conditions. The laboratory experiments on gas sorption on coal have provided coal specific data which can be used for gas transport calculation in the flooded mine now. The gas transport model has been developed for small scale realistic settings and is under preparation for a larger scale. Therefore two models describing the gas history starting with active mining, flooding up to the after flooding phase are available now.

		Country	*Scientific person in charge*
Partners	**DMT GmbH & Co KG**	DEUTSCHLAND	Christoph KLINGER (Pr. Coord.)
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Jesus Maria SUSO LLAMAS
	GLOWNY INSTYTUT GORNICTWA	POLAND	Grzegorz GZYL
	HULLERAS DEL NORTE, S.A.	ESPAÑA	María Belén GARZON SUCAR
	INSTITUT NATIONAL DE L'ENVIRONNEMENT INDUSTRIEL ET DES RISQUES	FRANCE	Arnaud CHARMOILLE

Selected Publications

KLINGER, C., CHARMOILLE, A., BUENO. J., GZYL, G., GARZON SÚCAR, B. (2010): Strategies for follow-up care and utilisation of closing and flooding in European hard coal mining areas.- In: Hoppe, A., Röhling, H.-G., Schüth, C. (eds.): GeoDarmstadt2010 – Geowissenschaften sichern Zukunft, SDGG (Schriftenreihe der Deutschen Gesellschaft für Geowissenschaften), 68, S. 316 – 317, Stuttgart, Schweizerbart, ISBN 978-3-510-49219-0

KLINGER, C., CHARMOILLE, A., BUENO. J., GZYL, G., GARZON SÚCAR, B. (2012): Strategies for follow-up care and utilisation of closing and flooding in European hard coal mining areas.- International Journal of Coal Geology, 89, Special Issue European Coal Conference 2010, 51 – 61, ISSN 0166-5162, DOI:10.1016/j.coal.2011.11.008.

LE GAL, N., LAGNEAU, V., CHARMOILLE, A. (2010): Mechanisms of gas migration in flooding post-mining context. – In: Wolkersdorfer, Ch. & Freund, A.: Mine Water & Innovative Thinking. – p.483 – 487. Sydney, Nova Scotia (CBU Press), http://www.imwa.info/docs/imwa_2010/IMWA2010_LeGal_440.pdf

LE GAL N., LAGNEAU V., CHARMOILLE A. (2012): Experimental characterization of CH4 release from coal at high hydrostatic pressure. - International Journal of Coal Geology, 96-97, pp. 82 – 92, DOI : 10.1016/j.coal.2012.04.001.

LE GAL, N. (2012): Libération et migration du méthane depuis le charbon dans un contexte hydrogéologique post-minier Développement d'un protocole expérimental et approche numérique. - PhD, Ecole supérieur des mines de Paris, http://pastel.archives-ouvertes.fr/docs/00/73/46/86/PDF/2012ENMP0021.pdf

Software

Boxmodel The "Boxmodel" is a 3D finite volume program for modelling flow of groundwater and mine water, heat transport and multi-component mass transport with chemical reactions. A special feature is the highly flexible discretisation to model geological structures such as layers and faults as well as structural mining elements and mine excavations. www.dmt.de

RFCR-CT-2009-00001 CARBOLAB

Improving the knowledge of carbon storage and coal bed methane production by "in situ" underground tests

Info

Type of Project	Research	Duration (months)	54
Total Budget	4122752 €	Start Date	1/07/2009
EU Contribution	2473652 €	End Date	31/12/2013

State Project completed, final report not published yet

Project web page http://www.carbolab.eu/default.aspx

Provisional Abstract

The proposal aims to improve the practical knowledge of the physical and chemical processes involved in the Enhanced Coal Bed Methane (ECBM) technique, by means of a series of “in situ” tests of CO2 injection and CBM production, in a specially conditioned test area in a underground coal mine, in order to obtain high-quality data for:
− Development of improved models that simulate the mechanical, physical and chemical behaviour of coal and gases,
− Identification and sizing of the physical parameters to be monitored during and after the injection experiments.
− Long term risk assessment of the CO2 storage

Partners

	Country	*Scientific person in charge*
HULLERAS DEL NORTE, S.A.	ESPAÑA	Noel CANTO TOIMIL (Pr. Coord.)
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	José Luis GARCIA-SIÑERIZ MARTÍNEZ
BRGM	FRANCE	Isabelle CZERNICHOWSKI-LAURIOL
GLOWNY INSTYTUT GORNICTWA	POLAND	Jacek SKIBA
INSTITUT NATIONAL DE L'ENVIRONNEMENT INDUSTRIEL ET DES RISQUES	FRANCE	Zbigniew POKRYSZKA

RFCR-CT-2009-00002 EMIMSAR

Enhanced miner-information interaction to improve maintenance and safety with augmented reality technologies and new sensors

Info

Type of Project	Research	Duration (months)	36
Total Budget	3347542 €	Start Date	1/07/2009
EU Contribution	2008526 €	End Date	30/06/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26172:EN

Final Abstract

Emimsar was a research project whose main objective was to facilitate the work and to improve the safety of underground miners by providing them with enhanced means to access essential computer-stored information when and where they need it most. The technology selected to ease this interaction is called 'Augmented Reality', and consists of the visual superimposition of computer-generated data or images of virtual objects over images of the real scene viewed by the user. Additionally, the project has developed a condition-oriented preventive maintenance based on novel sensors on heavy duty gears of conveyors and ploughs and on drive systems with high performance chains and sprockets in AFC and plough systems, implementing an online monitoring system that provides valuable indicators of machine condition at the operational and control centre. Suitable radio-based positioning technologies were identified and evaluated to act as navigational aids in underground mines, and prototype systems were constructed. Equipment for local tracking and identification was also developed, making use of display systems and augmented-reality goggles developed within the project. A data acquisition system for plough and AFC drives was developed and put into operation. A pick force sensor for road header cutter heads has been built, tested in a coal mine and patented. Resources of KBMS dealing with the support of processes of mining machine's maintenance were developed. A diversity of software has been developed for positioning and navigation aids, for AR tools providing assistance in maintenance, repair and operator training activities, and for many other tasks

Partners

	Country	*Scientific person in charge*
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Juan Carlos CATALINA (Pr. Coord.)
DMT GmbH & Co KG	DEUTSCHLAND	Dietmar PLUM
INSTYTUT TECHNIK INNOWACYJNYCH EMAG	POLAND	Przemyslaw WISZNIOWSKI
INSTYTUT TECHNIKI GORNICZEJ KOMAG	POLAND	Teodor WINKLER
MINES RESCUE SERVICE LTD	UNITED KINGDOM	David GIBSON
RAG Aktiengesellschaft	DEUTSCHLAND	Johannes QUINKENSTEIN
RITTAL GMBH & CO KG	DEUTSCHLAND	Martin ROSSMANN
SANDVIK MINING AND CONSTRUCTION GMBH	OESTERREICH	Egmont LAMMER

Patents "Patent application: on April 23, 2013, Sandvik Mining and Construction was granted patent application ""Anordnung zum Erfassen der Belastung eines Meissels von Schrämmaschinen"" in Austria, with number A 454/2010, AT 509644"

Selected Publications

M.D. Bedford and G.A. Kennedy. Evaluation of ZigBee (IEEE 802.15.4) Time-of-Flight-Based Distance Measurement for Application in Emergency Underground Navigation. IEEE Transactions on Antennas and Propagation, Volume 60, Issue 5, pages 2502-2510 (2012). DOI: 10.1109/TAP.2012.2189731

P. Wojtas and P. Wiszniowski. GPS-less Positioning, Tracking and Navigation Services for Underground Mining Applications. Proceedings of the 5th WSEAS International Conference on Sensors and Signals (SENSIG'12) Sliema, Malta, September 7-9, 2012. URL: http://www.wseas.us/e-library/conferences/2012/Sliema/SENVIS/SENVIS-22.pdf

RFCR-CT-2010-00001 GEOSOFT

Geomechanics and control of soft mine floors and sides

Info

Type of Project	Research	Duration (months)	36
Total Budget	3269320 €	Start Date	1/07/2010
EU Contribution	1961593 €	End Date	30/06/2013

State Project completed, final report not published yet

Provisional Abstract

European collieries suffer from severe floor and side deformation due to depth, tectonic stress and the soft strata around the seams, which are vulnerable to degradation over time, particularly when wet. This has major economic and safety implications for the industry. The project will develop and apply improved means of measuring, representing and analysing this behaviour and its interaction with mine support, both in the laboratory and in the field. Its objectives are to improve our understanding of the phenomena and develop enhanced design and construction solutions utilising stress control, sprayed linings, improved cuttable reinforcement and/or closed support structural sections.

Partners

	Country	*Scientific person in charge*
GOLDER ASSOCIATES (UK) Ltd	UNITED KINGDOM	Lorraine KENT (Pr. Coord.)
BECKER-WARKOP Sp. Z.o.o.	POLAND	Leszek ZYREK
GEOCONTROL S.A.	ESPAÑA	Mario FERNÁNDEZ PÉREZ
GLOWNY INSTYTUT GORNICTWA	POLAND	Sylwester RAJWA
POLUDNIOWY KONCERN WEGLOWY SA	POLAND	Wojciech KAMINSKI
UK COAL MINING LTD	UNITED KINGDOM	David MOORE
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Rodney STACE

RFCR-CT-2010-00002 COGASOUT

Development of novel technologies for predicting and combating gas outbursts and uncontrolled emissions in thick seam coal mining

Info

Type of Project	Research	Duration (months)	36
Total Budget	3641260 €	Start Date	1/07/2010
EU Contribution	2184756 €	End Date	30/06/2013

State Project completed, final report not published yet

Provisional Abstract The objective of this project is to develop and test novel technologies for the prediction and combating of gas outbursts and uncontrollable gas emissions in coal mines which operate in thick and/or steeply dipping thick seams. This in turn will significantly enhance the potential to recover thick seam reserves within the EU. The objectives will be achieved through a programme of field experimentation, monitoring and theoretical development combined with numerical simulation methods. Coal mine Velenje and Hullera Vasco-Leonesa will host fieldwork and research will lead to the development of a risk assessment methodology which can be implemented worldwide.

Partners

	Country	*Scientific person in charge*
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Sevket DURUCAN (Pr. Coord.)
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Pedro MORILLO
PREMOGOVNIK VELENJE, d.d.	SLOVENIJA	Simon ZAVSEK
DMT GmbH & Co KG	DEUTSCHLAND	Joachim BRANDT
GLOWNY INSTYTUT GORNICTWA	POLAND	Adam LURKA
HORNONITRIANSKE BANE PRIEVIDZA A.S.	SLOVAKIA	Stanislav PAULIK
S.A. HULLERA VASCO-LEONESA	ESPAÑA	Concepcion CASADO SULE
K-UTEC AG SALT TECHNOLOGIES	DEUTSCHLAND	Volkmar SCHMIDT
MINES RESCUE SERVICE LTD	UNITED KINGDOM	Stuart C. BENNETT

RFCR-CT-2010-00003 UCG & CO2 STORAGE

Study of deep underground coal gasification and the permanent storage of CO^2 in the affected areas

Info	Type of Project	Research	Duration (months)	30
	Total Budget	3067971 €	Start Date	1/07/2010
	EU Contribution	1840783 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26420:EN

Project web page www.ucg-co2.eu

Final Abstract This Final Report is an assessment of the entire UCG&CO2 STORAGE project (the project). It describes the scientific and technical work during the 2.5-year study, the objectives under the grant agreement and results obtained during the period 1 July 2010 to 31 December 2012. The main subject of the Project was to evaluate the potential of deep lying coal seams (>1200m) for the development of UCG and subsequent storage of CO2 in the affected areas by using the same boreholes with technical modifications for CO2 injection. The key objectives were to investigate the factors determining the technical suitability and environmental, and economic feasibility of the scheme, and demonstrate that the deep lying coal fields of the target area - the Bulgarian Dobrudzha Coal Deposit (DCD), and elsewhere, have the potential for deep UCG and are suitable for both energy production and CO2 storage, using the same drilling infrastructure. State-of-the-art geological, geo-mechanical, hydro-geological, and UCG cavity growth models were developed promoting the better understanding of the UCG-CO2 storage processes and determining site selection requirements for evaluation of deep coal locations in Bulgaria and elsewhere as potential sites for UCG-CO2 storage. The practical engineering requirements for developing the scheme and its environmental and economic benefits were also assessed. This research has prepared the groundwork for a potential pilot test. A successful demonstration of UCG-CCS in the DCD would be a step forward in the maturity of the technology and provide a low-cost competitor to imported natural gas thus increasing Europe's security of supply

Partners		*Country*	*Scientific person in charge*
	OVERGAS INC. AD	BULGARIA	Nikolay HRISTOV (Pr. Coord.)
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Nikolaos KOUKOUZAS
	DMT GmbH & Co KG	DEUTSCHLAND	Ralph SCHLÜTER
	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHES GEOFORSCHUNGSZENTRUM GFZ	DEUTSCHLAND	Thomas KEMPKA
	GEOLOGICAL INSTITUTE - BULGARIAN ACADEMY OF SCIENCES	BULGARIA	Aleksey BENDEREV
	INSTITUTO SUPERIOR TECNICO	PORTUGAL	Vidal NAVARRO TORRES
	UNIVERSITY OF LEEDS	UNITED KINGDOM	Yong SHENG

Selected Publications

Y. Sheng, A. Benderev, D. Bukolska, K. Eshiet, C. Dinis da Gama, T. Gorka, M. Green, N. Hristov, I. Katsimpardi, T. Kempka, J. Kortenski, N. Koukouzas, N. Nakaten, V. Sarhosis, R. Schlueter, V. Navarro Torres, A. Carina Veríssimo, V. Vesselinov, D. Yang. Interdisciplinary Studies on the Technical and Economic Feasibility of Deep Underground Coal Gasification with CO2 Storage in Bulgaria. Journal of Mitigation and Adaptation Strategies for Global Change, 2013.

D. Yang, V. Sarhosis, Y. Sheng. Computational Modelling of the Cavity Growth in UCG. Proc. of the 1st UK-Pakistan Coal Conference (2012), University of Leeds, UK.

N. Nakaten, R. Schlüter, R. Azzam, T. Kempka. Development of a techno-economic model for dynamic calculation of COE, energy demand and CO2 emissions of an integrated UCG-CCS process. Energy Education Science & Technology, Part A: Energy Science and Research (2012).

Michael Green, Nikolay Hristov, Donka Bukolska. Prospectus for the Project UCG and CO2 Storage. UCG&CO2 STORAGE project milestone 8.3. URL - https://docs.google.com/file/d/0B9cdz8eFflpGWVZXSnZnTkZsVDQ/edit?usp=sharing

Anatoli Angelov, Michael Green. Report on the implications of the developing framework regulations for CCS for UCG-CCS opportunities. UCG&CO2 STORAGE project deliverable 7.2. URL - https://docs.google.com/file/d/0B9cdz8eFflpGSmZNeURELWFDeTQ/edit?usp=sharing

RFCR-CT-2010-00004 LOWCARB

Low carbon mine site energy initiatives

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3876689 €	Start Date	1/07/2010
	EU Contribution	2326014 €	End Date	30/06/2013
State	Project completed, final report not published yet			

Project web page www.lowcarbonmining.eu

Provisional Abstract Carbon emissions caused by mining-related activities has never been more topical with increasing environmental, social and political awareness of climate change. Reducing CO2 and methane (CH4) emissions are equally important issues. Coal mining contributes to 8% of global anthropogenic methane emissions, and CH4 is 21 times more potent than CO2 in trapping heat. This project is designed to investigate and develop modern technologies and techniques that can significantly reduce the coal mining industry's carbon footprint in terms of both emissions (CO2, CH4), operational energy consumption (CO2), whilst remaining technically and commercially competitive.

		Country	*Scientific person in charge*
Partners	**UNIVERSITY OF EXETER**	UNITED KINGDOM	Gareth KENNEDY (Pr. Coord.)
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	José Luis GARCIA-SIÑERIZ MARTÍNEZ
	PREMOGOVNIK VELENJE, d.d.	SLOVENIJA	Matjaz KAMENIK
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	HULLERAS DEL NORTE, S.A.	ESPAÑA	César CORDERO ESCOSURA
	KOMPANIA WEGLOWA S.A.	POLAND	Grzegorz LAGODZINSKI
	MINES RESCUE SERVICE LTD	UNITED KINGDOM	Malcom PURVIS
	THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Rodney STACE
	UNIVERSIDAD DE OVIEDO	ESPAÑA	Salvador ORDONEZ GARCIA

Selected Publications

Díaz E, Fernández J, Ordóñez S, Canto N, González A (2012). Carbon and ecological footprints as tools for evaluating the environmental impact of coal mine ventilation air. Ecological Indicators. 18, 126. DOI 10.1016/j.ecolind.2011.11.009

Bukowska M, Sanetra U, Wadas M (2012). Chronostratigraphic and Depth Variability of Porosity and Strength of Hard Coals of the Upper Silesian Basin. Mineral Resources Management, Vol. 28, no. 4. DOI 10.2478/v10269-012-0029-8

Thomson C, Marin P, Diez F V, Ordóñez S. Evaluation of the use of ceramic foams as catalyst supports for reverse-flow combustors. Chemical Engineering Journal (in press, DOI 10.1016/j.cej.2013.01.080)

Gutiérrez I, Díaz E, Vega A, Ordóñez S (2013). Consequences of cavity size and chemical environment on the adsorption properties of isoreticular metal-organic frameworks: An inverse gas chromatography study. Journal of Chromatography A 1274, 173-180. DOI 10.1016/j.chroma.2012.12.006

Gutiérrez I, Díaz E, Ordóñez S (2013). Consequences of cavity size and palladium addition on the selective hydrogen adsorption in isoreticular metal-organic frameworks. Thermochimica Acta. DOI 10.1016/j.tca.2013.01.007

RFCR-CT-2010-00005 MINFIREX

Minimising risk for and reducing impact of fire and explosion hazards in underground coal mining

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2554212 €	Start Date	1/07/2010
	EU Contribution	1532528 €	End Date	30/06/2013
State	Project completed, final report not published yet			

Provisional Abstract

Fires and explosions are still major cause of injuries and even fatalities in underground coal mining although the safety in European coal mines has reached a fairly high standard. But also operation downtimes and productions losses are caused by fires and thus affect competitiveness of the coal mining companies. MINFIREX aims at minimising the risks for fires and explosions by developing strategies to prevent fires and explosions and developing innovative detection measures and fire fighting methods especially for hidden fires as well as
developing an innovative active extinguishing system ensuring effective protection against propagation of fires or explosions.

Partners		*Country*	*Scientific person in charge*
	DMT GmbH & Co KG	DEUTSCHLAND	Harald SCHILLEGGER (Pr. Coord.)
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	José Luis GARCIA-SIÑERIZ MARTÍNEZ
	INSTYTUT TECHNIK INNOWACYJNYCH EMAG	POLAND	Stanislaw TRENCZEK
	HULLERAS DEL NORTE, S.A.	ESPAÑA	Albino GONZALEZ GARCIA
	INSTYTUT TECHNIKI GORNICZEJ KOMAG	POLAND	Zbigniew SZKUDLAREK
	MINES RESCUE SERVICE LTD	UNITED KINGDOM	Colin TALBOT
	UK COAL PRODUCTION LTD	UNITED KINGDOM	Stewart JOBLING

RFCR-CT-2010-00014 MISSTER

Mine shafts: improving security and new tools for the evaluation of risks

Info

Type of Project	Research	Duration (months)	36
Total Budget	3006853 €	Start Date	1/07/2010
EU Contribution	1804111 €	End Date	30/06/2013

State Project completed, final report not published yet

Project web page http://www.misster.eu

Provisional Abstract

Mine shafts consitute a key element of mining by being:
- crucial for access to underground workings;
- necessary for the proper functioning of mining operations;
- a remaining trace of former mining activity on surface

Therefore, the safety of the whole "mine shaft life cycle" must be ensured (from design to closure), for active mining activity, staff and public safety and land use reasons.
The project aims to develop innovative cost-effective tools to:
- enhance the understanding of hazards that may affect mining shafts;
- optimize safety conditions for active shafts maintenance and disused shafts treatments.

Partners

	Country	*Scientific person in charge*
INSTITUT NATIONAL DE L'ENVIRONNEMENT INDUSTRIEL ET DES RISQUES	FRANCE	Romuald SALMON (Pr. Coord.)
DMT GmbH & Co KG	DEUTSCHLAND	Rainer KUCHENBECKER
GEOCONTROL S.A.	ESPAÑA	Virginia PORTAL CABEZUELO
GLOWNY INSTYTUT GORNICTWA	POLAND	Stanislaw PRUSEK
KOMPANIA WEGLOWA S.A.	POLAND	Grzegorz LAGODZINSKI
MINES RESCUE SERVICE LTD	UNITED KINGDOM	Malcom PURVIS
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Rodney STACE

Selected Publications

S. RAPP. Guideline for continuous shaft measurement system, visualization software. MISSTER project deliverable 2.2. URL http://www.misster.eu/sites/default/files/MISSTER_DELIVERABLE_D2_2.pdf

S. Bock, L. Cauvin. Design and construction of the probe and field tests. MISSTER project deliverable 2.3. URL http://www.misster.eu/sites/default/files/MISSTER_DELIVERABLE_D2_3.pdf

A. Lecomte, A. Muñoz. Handbook to best practices for mine shaft protection. MISSTER project deliverable 4. URL http://www.misster.eu/sites/default/files/MISSTER_DELIVERABLE_D4.pdf

S. Prusek, S. Bock, J. Dziura. Evaluation of new materials and techniques for shaft filling or consolidation. MISSTER project deliverable 2.1 URL http://www.misster.eu/sites/default/files/Deliverables_02-WP31.pdf

A. Gullón, A. Muñoz, J. Vaca, M.Purvis, S. Prusek, S. Bock, J. Dziura, A. Marshall, W. Yang, Y. Jia, R. Stace, D. Wanatowski. Numerical modelling of critical mine shaft constitutive elements - including characterization of materials and static and time dependent numerical analyses for the evaluation of treatment effectiveness. MISSTER project deliverable 3.2. URL http://www.misster.eu/sites/default/files/MISSTER%20DELIVERABLE%20D3.2%20DRAFT.pdf

RFCP-CT-2011-00001 OPTI-MINE

Demonstration of process optimization for increasing the efficiency and safety by integrating leading edge electronic information and communication technologies (ICT) in coal mines

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	4590053 €	Start Date	1/07/2011
	EU Contribution	2295028 €	End Date	30/06/2014
State	Running project			

Project web page www.opti-mine.eu

Provisional Abstract

Increasing cost pressure requires optimized operation processes in coal mining. OPTI-MINE integrates and demonstrates newest ICT developments, many originating from earlier RFCS projects, to increase efficiency of mining operations and safety by holistic process optimisation:
Five European mines in five different countries, two ICT system integrators and two universities demonstrate and assess the reliability and the impact on cost effectiveness, safety and environment within industrial scale demonstrations of different focus. The scientifically proven results and a strong dissemination programme will boost the use of these integrated ICT systems in European mines and strengthen European mining technology on global markets.

Partners	*Country*	*Scientific person in charge*
RAG ANTHRAZIT IBBENBÜREN GMBH	DEUTSCHLAND	Thomas MISZ (Pr. Coord.)
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Angel RODRIGUEZ LÓPEZ
PREMOGOVNIK VELENJE, d.d.	SLOVENIJA	Bostjan SKARJA
DMT-GESELLSCHAFT FÜR LEHRE UND BILDUNG MBH	DEUTSCHLAND	Christoph DAUBER
HULLERAS DEL NORTE, S.A.	ESPAÑA	José Raul GONZALEZ RUIZSANCHEZ
KOMPANIA WEGLOWA S.A.	POLAND	Marek SZARAFINSKI
MINETRONICS GMBH	DEUTSCHLAND	Christoph MÜLLER
OKD, A.S.	CZECH REPUBLIC	Richard PAVLIK
SILESIAN UNIVERSITY OF TECHNOLOGY - POLITECHNIKA SLASKA	POLAND	Jan PALARSKI

Selected Publications

Andreas Papamichalis. Documentation of 1st OPTI-MINE Industry Forum (27-28 November 2012, Ostrava, Czech Republic). URL http://www.opti-mine.eu/downloads.php

Klaus Vogt. Presentation of OPTI-MINE at the Moscow State Mining University, Mining Week, 28-31 January 2013. URL http://www.opti-mine.eu/downloads.php

RFCR-CT-2012-00001 FEATureFACE

Electromagnetic coal face environmental observation and recognition for feats in process optimization and occupational health and safety

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3585251 €	Start Date	1/07/2012
	EU Contribution	2151151 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

Positioning of mining machines under harsh conditions while enabling safety for the Miners costs considerably time and money. Observation of complete machine environments using simultaneously several electromagnetic technologies enables for the first time reliable and accurate object-localization underground. Combined with Information and Communication Technology (ICT) it increases the efficiency of mine production and development and contributes to process optimization. Productivity enhancement is achieved by high accuracy and reliable geometric environmental scanning for machine positioning and movement sequences, leading to less waste, energy consumption, wear, downtimes, coal preparation effort, fire hazard and cost and higher coal yield. Safety enhancement is achieved by introducing a human localization device for proximity detection and collision avoidance with machinery reducing accidents and fatalities. FEATureFACE additionally complies with the upcoming EU-machinery-directive regarding the required functional safety, which can currently not be fulfilled with state-of-the-art technologies. The full-range consortium involves two coal producers and will develop, test and implement the world's first failsafe machine environment detection solution for roadheaders, loaders and shearers. FEATureFACE aims at a breakthrough by combining strengths and compensating weaknesses of each single technology.

Partners		*Country*	*Scientific person in charge*
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Karl NIENHAUS (Pr. Coord.)
	AUSTRIAN CENTER OF COMPETENCE IN MECHATRONICS GMBH	OESTERREICH	Reimar PFEIL
	BECKER MINING SYSTEMS AG	DEUTSCHLAND	Andreas SEELIGER
	EICKHOFF BERGBAUTECHNIK GMBH	DEUTSCHLAND	Thomas HUERMANN
	INDURAD GMBH	DEUTSCHLAND	Reik WINKEL
	LINZ CENTER OF MECHATRONICS GMBH	OESTERREICH	Thomas BUCHEGGER
	OKD, A.S.	CZECH REPUBLIC	Richard PAVLIK
	RAG Aktiengesellschaft	DEUTSCHLAND	Armin MOZAR
	SANDVIK MINING AND CONSTRUCTION GMBH	OESTERREICH	Egmont LAMMER

RFCR-CT-2012-00002 INREQ

Enhanced effectiveness and safety of rescuers involved in high risk activities by designing innovative rescue equipment systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3312628 €	Start Date	1/07/2012
	EU Contribution	1987577 €	End Date	30/06/2015
State	Running project			

Project web page http://inreq.komag.eu

Provisional Abstract

The INREQ project addresses directly the safety and operational efficiency of mine rescue teams. It will develop special prototype and experimental rescue equipment to increase their safety, work comfort and effectiveness. This includes several new tools and a system for monitoring biometric and working conditions, with data transfer via a dedicated communication system to the rescue centre. Special attention will be paid to exposure of rescuers to hyperthermia. This will include comprehensive body temperature measurement, transfer of information and providing local air conditioning. The rescue equipment to be developed within INREQ will be directly applicable in a wide variety of rescue actions; for example where miners are cut off from evacuation routes as a result of infrastructure damage and rock falls. One outcome of the project will be a development of effective rescue equipment for rescue tunneling through rock fall debris. The rescue equipment will consist of carefully designed, but inter-related sub-systems, including; an improved lightweight rescue conveyor, equipped with a self-propelled platform to facilitate its forward relocation as the rescue proceeds, an improved rescue support system, and a mobile air conditioner to deliver vital cooled air to the rescuers' working zone. Also a device for driving the rescue tunnels in solid rock is planned to be designed. In this case two types of devices will be developed. One of them will be based on hydro cutting technology, which will be a prototype device and the other one using low energy will be developed as an experimental device.

Partners	*Country*	*Scientific person in charge*
INSTYTUT TECHNIKI GORNICZEJ KOMAG	POLAND	Andrzej DRWIEGA (Pr. Coord.)
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Samir NABULSI
CENTRALNA STACJA RATOWNICTWA GORNICZEGO SA	POLAND	Adam NOWAK
DMT GmbH & Co KG	DEUTSCHLAND	Rainer RELLECKE
GEOCONTROL S.A.	ESPAÑA	Fernando PORTUGUES SALGADO
GOLDER ASSOCIATES (UK) Ltd	UNITED KINGDOM	Lorraine KENT
I.CO.P. SpA	ITALIA	Enzo RIZZI

Selected Publications

Andrzej Drwiega, Fernando Portugues: Acceptance of 3D models for equipment covered by T1.1 and required for further processing. Data. INREQ project deliverable 1.2

Rainer Rellecke: Specification of the climate measuring device. Data. INREQ project deliverable 1.5.

RFCR-CT-2012-00003 COMEX

Complex mining exploitation : optimizing mine design and reducing the impact on human environment

Info

Type of Project	Research	Duration (months)	36
Total Budget	3787333 €	Start Date	1/07/2012
EU Contribution	2272400 €	End Date	30/06/2015

State Running project

Project web page http://www.comex-rfcs.eu

Provisional Abstract

This project focuses on:
-mine exploitation with over- or under-lying old mine and the potential resulting hazards
-the reduction of the impact of mining exploitation on human environment in such conditions
For mining in subsided coal seams, work begun under the Presidence RFCS Project. A draft methodology was developed to design mine layouts in these cases. The work under this Project will:
-apply this methodology to the workings at the target mines
-closely monitor their condition on drivage and face retreat
-improve the methodology based on the experience gained
The Project will need to develop improved geotechnical numerical modelling techniques to better represent the condition of subsided rock and to couple large scale stress distribution modelling with small scale support system modelling to predict roadway support behaviour in these complex conditions. Secondly, stress and strain caused by deep exploitation may affect old shallow mines. The Upper Silesia Basin is largely concerned. Mining seismicity is a specific case. The problem with mining seismicity is worldwide, in EU it is still occurring in Upper Silesia Coal Basin and in German mines. Ground vibration resulting from mining seismic events can be dangerous according to reactivation of old shallow exploitation. It can cause discontinuous effect in near surface soils or even land collapses. Moreover, it can trigger slope instabilities in open pits, like in Belchatow lignite mine in Poland were mining seismic events have reached magnitude greater than 4. To protect in an efficient manner the building assets, we need to be able to predict the effect of ground movements on building assets. Recent works (Burland 97, Deck 06, Caudron 08) show that the transfer mechanism of the strains from the ground to the building is dependent of some complex and non-linear soilstructure interactions. This project will answer the need to evaluate and reduce the vulnerability of buildings subjected to those hazards.

Partners

	Country	*Scientific person in charge*
INSTITUT NATIONAL DE L'ENVIRONNEMENT INDUSTRIEL ET DES RISQUES	FRANCE	Marwan AL HEIB (Pr. Coord.)
CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Nikolaos KOUKOUZAS
DMT GmbH & Co KG	DEUTSCHLAND	Paul ALTHAUS
GEOCONTROL S.A.	ESPAÑA	Mario FERNÁNDEZ PÉREZ
GLOWNY INSTYTUT GORNICTWA	POLAND	Grzegorz MUTKE
GOLDER ASSOCIATES (UK) Ltd	UNITED KINGDOM	Lorraine KENT
UK COAL MINING LTD	UNITED KINGDOM	David MOORE
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Alec MARSHALL

RFCR-CT-2012-00004 AVENTO

Advance tools for ventilation and methane emmissions control

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3268736 €	Start Date	1/07/2012
	EU Contribution	1961242 €	End Date	30/06/2015
State	Running project			

Project web page http://www.aventoproject.com/

Provisional Abstract

European coal mines are in general deeper than other mines, which increase the risks of high methane emissions and outbursts, having also higher rock temperature. For both reasons, ventilation air flows are considerably higher in European mines, this being an important cost factor that affects the overall competitiveness of the European coal industry: the energy requirement for these ventilation needs is estimated in about 200 billion kWh per year, only in the main surface fans. The situation is worsening, as most coal fields to be mined in the next years are located at greater depths. Some of the fatal accidents registered in European mines in the last years are connected with the new and increased risks being found as the mines go deeper. Usual practice in most European mines is to provide a large air flow excess in order to guarantee safe conditions. This flow is maintained continuously, although it is only required in very specific points and at certain moments, depending in any case on the specific conditions and working procedures of each mine. The project has two basic aims: i) To develop new concepts on ventilation monitoring systems, taking into account the new risks appearing in the current and future production fields, in order to improve the safety and climatic conditions at the working areas, with special attention to the actions to be taken after severe methane incidents. ii) To reduce the costs involved in ventilation, analysing different aspects such as the dynamic regulation of air flow (”Ventilation On Demand”), and new systems of fan control for better efficiency and reliability. The activities planned in the project represent a new approach to the problems of ventilation and methane control at European level, when compared to the current practices. The participation of a balanced consortium of organizations from five different countries -including Romania for first time in theprogram- enables to cover a variety of mining conditions across Europe.

Partners		*Country*	*Scientific person in charge*
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Marta FERNANDEZ ORDAS (Pr. Coord.)
	DMT GmbH & Co KG	DEUTSCHLAND	Rainer RELLECKE
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	GLOWNY INSTYTUT GORNICTWA	POLAND	Henryk KOPTON
	HULLERAS DEL NORTE, S.A.	ESPAÑA	Albino GONZALEZ GARCIA
	INST.NAT.DE CERC- DEZVOLTARE PENTRU SEC.MINIERA SI PROT. ANTIEXPLOZIVA	ROMANIA	George-Artur GĂMAN
	KOMPANIA WEGLOWA S.A.	POLAND	Marek SZARAFINSKI
	THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Ian Stuart LOWNDES

RFCR-CT-2013-00001 AMSSTED

Advancing Mining Support Systems to Enhance the Control of Highly Stressed Ground

Info	Type of Project	Research	Duration (months)	36
	Total Budget	4294628 €	Start Date	1/07/2013
	EU Contribution	2576776 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

Roadway support techniques need to keep pace with the demands of safer and more productive mining in ever deeper and more highly stressed mining environments. The advances in support techniques proposed address a variety of issues surrounding existing Support Management Systems for gateroads below 1000m, face salvage and wide openings. The issues cover geotechnical investigations, numerical modelling, quality and support behaviour including optimisation of bolting system, support cost reduction. Laboratory and field trials of developed support systems will be also undertaken to determine Risk Reduction Systems/Options for gateroads below 1000 m, roadways up to 1500 m, face salvage operations up to 1000 m and wide excavations (> 8.0m).

		Country	*Scientific person in charge*
Partners	**GLOWNY INSTYTUT GORNICTWA**	POLAND	Zbigniew LUBOSIK (Pr. Coord.)
	ASS. POUR LA RECHERCHE ET LE DEV. DES METHODES ET PROC. IND., ARMINES	FRANCE	Faouzi HADJ HASSEN
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	GOLDER ASSOCIATES (UK) Ltd	UNITED KINGDOM	Lorraine KENT
	JASTRZEBSKA SPOLKA WEGLOWA S.A.	POLAND	Kazimierz KOLINSKI
	OKD, A.S.	CZECH REPUBLIC	Petr DVORSKY
	UK COAL PRODUCTION LTD	UNITED KINGDOM	David MOORE
	THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Rodney STACE

RFCR-CT-2013-00002 COGAR

Underground Coal Gasification in operating mine and areas of high vulnerability

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2839866 €	Start Date	1/07/2013
	EU Contribution	1703920 €	End Date	30/06/2016
State	Running project			

Provisional Abstract The project is focused on risk assessment of underground coal gasification in operating mines and in areas of high vulnerability. In the Project the large number of underground and laboratory measurements will be performed and monitoring data will be collected during two underground trials, one under RFCS project HUGE2 and second under project financed by Polish Government. The most important aspects related the impact of UCG on environment (ie. parameters of rock strata, water and air, underground workings, surface) will be investigated and included into Risk Assessment Methodology. The recommendations for mine management and mining authorities will be also developed.

		Country	*Scientific person in charge*
Partners	**GLOWNY INSTYTUT GORNICTWA**	POLAND	Sylwester RAJWA (Pr. Coord.)
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Francisco José ESPADA
	DMT GmbH & Co KG	DEUTSCHLAND	Ralph SCHLÜTER
	INSTITUT NATIONAL DE L'ENVIRONNEMENT INDUSTRIEL ET DES RISQUES	FRANCE	Régis FARRET
	KATOWICKI HOLDING WEGLOWY S.A.	POLAND	Boguslaw SYREK
	SUBTERRA INGENIERIA S.L.	ESPAÑA	José Miguel GALERA
	TECHNICKA UNIVERZITA V KOSICIACH - TECHNICAL UNIVERSITY OF KOSICE	SLOVAKIA	Juraj DUROVE
	THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Dariusz WANATOWSKI

RFCR-CT-2013-00004 M-SMARTGRID

Mining Smart Electrical Grids

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2798888 €	Start Date	1/07/2013
	EU Contribution	1679334 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

Energy consumption is a major cost component in all mining operations. Furthermore, the considerable distances underground, coupled with high power requirements impose increasing strains on the power network. In response, a number of individual system developments have been introduced over the years with an objective of decreasing the cost of energy used, mainly in the fields of mine ventilation and pumping etc. However it is increasingly recognised that if significant gains are going to be made in this area, then it is necessary to fundamentally address the grid system as a whole, applying smartgird technologies (A smart grid is an electrical grid that uses Information and Communications Technology to gather and act on information, such as information about the behaviours of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity) The proposed research will develop and implement a radical approach to mine power engineering involving smart grid systems, together with the use of engineered boreholes to provide direct power connections from the surface. The approach will take full advantage of current data transmission systems and wireless networks to ensure effective implementation at minimum cost, while enabling additional features including mining safety and automation.

Partners		*Country*	*Scientific person in charge*
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Angel RODRIGUEZ LÓPEZ (Pr. Coord.)
	PREMOGOVNIK VELENJE, d.d.	SLOVENIJA	Bostjan SKARJA
	DMT GmbH & Co KG	DEUTSCHLAND	Rainer RELLECKE
	HULLERAS DEL NORTE, S.A.	ESPAÑA	Miguel ALONSO CAMARA
	INSTYTUT TECHNIKI GORNICZEJ KOMAG	POLAND	Krzysztof STANKIEWICZ
	KOMPANIA WEGLOWA S.A.	POLAND	Jacek DLUGOSZ
	UNIVERSITY OF EXETER	UNITED KINGDOM	Patrick FOSTER

RFCR-CT-2013-00005 MANAGER

Management of mine water discharges to mitigate environmental risks for post-mining period

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2845595 €	Start Date	1/07/2013
	EU Contribution	1707358 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

Global changes in mining led to the closure of many long-operating deep mines in many industrialized countries. Discharges of contaminated water from operating as well as abandoned mines are reason of water resources degradation. The mine water treatment is a basic component of overall mine water management during mine operations and in post-closure period. The MANAGER project aims to mitigate environmental risk connected with mine water discharge through innovative and advanced approach combining: (a) identification of priority substances of concern in mine waters based on local conditions, long-term forecast, risk assessment and the Water Framework Directive objectives, (b) development of innovative, cost-effective and sustainable passive and active treatment technologies taking into consideration the results of field tests (pilot sites) and cost-benefits analysis, (c) identification of forward-looking technical possibilities of mine water reuse and metals recovery, (d) development of innovative management approaches to mine water discharge and treatment. The realisation of pilot schemes in different European countries allows to assess technical and economic feasibilities of analysed technologies, what will guarantee their application not only for partner countries, but also on EU level.

		Country	*Scientific person in charge*
Partners	**GLOWNY INSTYTUT GORNICTWA**	POLAND	Jan BONDARUK (Pr. Coord.)
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Gaspar BALERIOLA SANCHEZ
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	DMT GmbH & Co KG	DEUTSCHLAND	Christoph KLINGER
	HULLERAS DEL NORTE, S.A.	ESPAÑA	María Belén GARZON SUCAR
	INSTITUT NATIONAL DE L'ENVIRONNEMENT INDUSTRIEL ET DES RISQUES	FRANCE	Philippe GOMBERT
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RFCR-CT-2013-00003 RTRO-Coal

Real-Time Reconciliation and Optimization in large open pit coal mines

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1447283 €	Start Date	1/10/2013
	EU Contribution	761967 €	End Date	30/09/2017
State	Running project			

Provisional Abstract

The project “Real-Time Reconciliation and Optimization in large open pit coal mines” (RTRO-Coal) aims to develop an innovative and integrated framework for real-time-process reconciliation and optimization in large open pit coal mines along the whole value chain. By changing the process management in open pit mines from the current practice of periodical to a near continuous process, an increased process performance is expected in terms of coal recovery and financial measures. The intended stochastic approach of quantifying uncertainty of process influencing factors will lead to more robust decisions in short- and long term mine planning. These factors include incomplete knowledge about the spatial distribution of key attributes in the deposit, in-situ variability and actual loss and dilution, uncertainty in demand for different products and equipment performance in different material types, Based on the state-of-the-art in process planning and ICT-based process monitoring the project will develop new methods in stochastic mine system simulation, intelligent process data analysis, back-propagation combined with real-time-planning-model-updating and decision support methods in short- and long term mine planning under uncertain mining conditions. The applicability and the expected benefits of the frameworks will be assessed in industrial scale field tests. RTRO-coal is expected to significantly increase production efficiency and decrease environmental impact while maintaining a high quality of different products.

		Country	*Scientific person in charge*
Partners	**TECHNISCHE UNIVERSITEIT DELFT**	NEDERLAND	Mike W N BUXTON (Pr. Coord.)
	AKADEMIA GORNICZO-HUTNICZA IM. STANISLAWA STASZICA W KRAKOWIE AGH	POLAND	Wojciech NAWORYTA
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	RWE POWER AG	DEUTSCHLAND	Heinrich ROSENBERG
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Anton SROKA

RFCR-CT-2014-00001 LoCAL

Low-Carbon After-Life (LoCAL): sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure environmental risks

Info

Type of Project	Research	Duration (months)	36
Total Budget	1621998 €	Start Date	1/07/2014
EU Contribution	973195 €	End Date	30/06/2017

State Running project

Provisional Abstract

In pursuit of the RFCS priority 1.1. (managing environmental risks after mine closure), LoCAL seeks to deliver an effective low-carbon after-life for flooded coal mine workings, fully harmonised with wider environmental protection goals, by unlocking the commercially viable potential of mine waters as a thermal energy resource; addressing (i) remaining technical barriers to implementation (i.e. corrosion and incrustation prevention in ferruginous mine waters) (ii) thermal mixing phenomena in flooded workings (iii) pathways to market and maximisation of socio-economic benefits. In contrast to previous projects, LoCAL will fully integrates private sector interests, testing its new tools on real systems in development.

Partners

	Country	*Scientific person in charge*
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ALKANE ENERGY UK LIMITED	UNITED KINGDOM	Anup ATHRESH
ARMADA DEVELOPMENT SPÓŁKA AKCYJNA	POLAND	Anna HYRIA
HULLERAS DEL NORTE, S.A.	ESPAÑA	Albino GONZALEZ GARCIA
THE UNIVERSITY OF GLASGOW	UNITED KINGDOM	Paul YOUNGER
UNIVERSIDAD DE OVIEDO	ESPAÑA	Jorge LOREDO PEREZ

RFCR-CT-2014-00002 TeleRescuer

System for virtual TELEportation of RESCUER for inspecting coal mine areas affected by catastrophic events

Info

Type of Project	Research	Duration (months)	36
Total Budget	2142007 €	Start Date	1/07/2014
EU Contribution	1285203 €	End Date	30/06/2017

State Running project

Provisional Abstract

The goal is to develop a system for virtual teleportation of rescuers to subterranean areas of a coal mine that have been closed due to a catastrophic event that has been occurred within the area. Nowadays, human rescuers are inspecting such an area. The activity of rescuers is extremely dangerous. Moreover, human rescuers are allowed to enter the restricted area if values of several critical parameters achieve acceptable levels, that often requires long waiting times. To overcome these problems and improve efficiency of operation of human rescuers a TeleRescuer system will be developed. It will take advantage of a special unmanned vehicle (UV) capable of moving within the area affected by the catastrophic event, i.e. with many obstacles such as parts of destroyed machinery and equipment, rocks fallen at the soil, damaged installations etc. The UV will be equipped with sensors and cameras (VCR and IR). A breakthrough in the operation of such UVs will depend on the true possibility to virtually teleport the rescuer to the direct area of operation, which will be achieved threefold. First, particular attention will be paid to the interface rescuer/UV, whose goal is to make possible direct acting in the inspected area while the operator is remaining in a safe place. To this end, Virtual and Augmented Reality will be widely applied. Second, to allow this virtual teleportation, a very powerful communication system will be developed to allow broadband broadcasting of videos, results of measurements, and virtually direct control of the UV and its sensors and effectors. Third, a very realistic simulator will be developed to allow testing the interface and to train the rescuers in controlling and using the UV during the rescue operations in a true environment. Finally, the general approach and the system itself will undergo extensive tests in an environment very similar to operating conditions of the rescuers in a real coal mine, supervised by the Mining Rescuers Station.

Partners

	Country	*Scientific person in charge*
SILESIAN UNIVERSITY OF TECHNOLOGY - POLITECHNIKA SLASKA	POLAND	Anna TIMOFIEJCZUK (Pr. Coord.)
ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	Angel RODRIGUEZ LÓPEZ
SIMMERSION GMBH	OESTERREICH	Arkadiusz PATRYAS
SKYTECH RESEARCH SP. Z O.O.	POLAND	Krzysztof CYRAN
VYSOKA SKOLA BANSKA - TECHNICKA UNIVERZITA OSTRAVA	CZECH REPUBLIC	Petr NOVAK

RFCR-CT-2014-00003 COAL2GAS

Enhanced Coal Exploitation through UCG Implementation in European Lignite Mines

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2208195 €	Start Date	1/07/2014
	EU Contribution	1324915 €	End Date	30/06/2017
State	Running project			

Provisional Abstract Tests of gasifying lignite at relatively shallow depths are quite rare even though many underground lignite mines have been abandoned with vast resources remaining. While the general feasibility of gasifying these resources has been proven, it has to be confirmed whether the technology could be implemented under EU standards. This proposal is focusing on a representative deposit in Romania and will address geological and mining related issues. A future pilot will be prepared focussing on environmental protection. Chances are assessed for other European deposits. The results obtained will help evaluating the potential and risks of UCG in shallow mining environments.

		Country	*Scientific person in charge*
Partners	**INSTITUTUL DE STUDII SI PROIECTARI ENERGETICE SA**	ROMANIA	Carmencita CONSTANTIN (Pr. Coord.)
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Nikolaos KOUKOUZAS
	PREMOGOVNIK VELENJE, d.d.	SLOVENIJA	Simon ZAVSEK
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	DMT GmbH & Co KG	DEUTSCHLAND	Ralph SCHLÜTER
	GLOWNY INSTYTUT GORNICTWA	POLAND	Krzysztof STANCZYK
	MOST COAL ENGINEERING SPRL	BELGIQUE	Marc MOSTADE
	TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	Ton WILDENBORG

RFCR-CT-2014-00004 GasDrain

Development of Improved Methane Drainage Technologies by Stimulating Coal Seams for Major Risks Prevention and Increased Coal Output

Info	Type of Project	Research	Duration (months)	42
	Total Budget	3818294 €	Start Date	1/07/2014
	EU Contribution	2290975 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

Coal mining in EU is extending to deeper and deeper levels, facing ever increasing coal seam methane contents and much higher methane emissions at production districts. The increased release of methane observed with increasing depth is not only a serious safety risk, but also represents a problem for coal production, as it limits the advance rates of both headings and longwalls. Current drainage and pre-drainage methods applied in EU coal mines are not sufficiently effective to combat the growing risks caused by the increasing depth. Therefore, in order to improve safety and achieve increased production rate in the coal mines of most European coalfields, it is essential that new and innovative gas control and drainage techniques are developed. The primary objective of the proposed project is to “investigate and research into borehole stimulation techniques and develop novel and improved methane drainage technologies, which will break the existing technological barriers and help increase safety and productivity in coal mines”. It must be emphasised, however, that it is not possible to develop a universal solution, that could be directly applicable to all coal seams and mining conditions. Therefore, the project aims to investigate the potential for the application of following borehole stimulation techniques: hydraulic fracturing, successfully applied in the conventional and unconventional hydrocarbons industry, novel stimulation techniques such as open or cased hole cavitation, which has been very successful in CBM well stimulations when applied to low cohesion and soft coals of the USA, high pressure water jet slotting, already tested and found effective in combatting gas outbursts in some Chinese coalfields, and the use of explosives to stimulate coal seams and the surrounding rock strata, through lab. experiments, numerical modelling and extensive field testing of the developed techniques at different mining conditions in order to achieve the project objectives.

		Country	*Scientific person in charge*
Partners	**GLOWNY INSTYTUT GORNICTWA**	POLAND	Janusz MAKOWKA (Pr. Coord.)
	ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.	ESPAÑA	José Luis FUENTES-CANTILLANA
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	INSTYTUT NAFTY I GAZU - PANSTWOWY INSTYTUT BADAWCZY	POLAND	Wieslaw SZOTT
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	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Ralf LITTKE

RFCR-CT-2014-00005 EXPRO

Prediction and mitigation of methane explosion effects for improved protection of mine infrastructure and critical equipment

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2402465 €	Start Date	1/07/2014
	EU Contribution	1365851 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

The project aims the development of tools and means that can help to adopt measures for mitigating the damages of underground methane explosions in the mine infrastructure and in particular in critical equipment, and to investigate the causes of the explosions once they have occurred. The work is focused in three specific and complementary areas: 1) Developing numerical models of methane explosions in different scenarios that represent different types of mine geometries and explosion hipothesis. The models will be also validated with real scale explosion tests that will be carried out in different experimental facilities, in order to improve the confidence on their predictions. These models will help to estimate the potential distribution of the effects of potential underground explosions, and will help to make decisions about the most convenient geometries and the optimal location of critical equipment, and in particular of those associated to safety systems (gas monitoring, ventilation, alarm systems, etc.) 2) Development of a new air pressure monitoring system that is capable to detect and record fast changes in the static and dynamic air pressure in the face area, that could be an indication of unexpected methane releases or the initiation of an explosion. This information will be helpful for the investigation of the location of the ignition point of explosions, once they have ocurred. This particular aspect has been a request of the post-incident investigation commissions after the last explosions in the Polish mining industry. 3) Investigation of the potential application of existing triggered barriers for the mitigation of the explosion effects and the prevention of secondary methane and dust explosions. Two different systems being currently used in Ukraine will be analyzed and validated, in order to identify the applicability of these systems in the EU countries and the potential changes or improvements required to increase their effectiveness.

		Country	*Scientific person in charge*
Partners	**ASOCIACION PARA LA INVEST. Y EL DESAR. INDUSTRIAL DE LOS RECURSOS NAT.**	ESPAÑA	Susana TUÑON (Pr. Coord.)
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Technical Group Coal 2

Coal preparation, conversion and upgrading

The scope of TGC2 includes:

- Coal beneficiation
- Cokemaking
- Coal derived carbon materials
- Coal gasification (hydrogen, syngas, synthetic natural gas), including chemical and process aspects of underground coal gasification
- Coal liquefaction
- Environmental issues associated with coal upgrading processes

RFCR-CT-2003-00005 INFERENCE

On-line measurement of coal quality parameters by inference of sensor information

Info	Type of Project	Research	Duration (months)	52
	Total Budget	2062262 €	Start Date	1/09/2003
	EU Contribution	1237357 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23897:EN			

Final Abstract The aim of this project was to improve the availability of information about coal quality parameters. Signals from existing instrumentation were evaluated in soft sensors and particle size sensors were further developed. The investigation of part products of the preparation process gave valuable findings regarding their contribution to handleabiiity. So it was possible to focus the preparation plant work on the finest products. For the flotation process, a dynamic model of the feed circuit was developed and implemented into the PLC system of a preparation plant. So the control of the flotation process was greatly improved and expensive measuring equipment was replaced by cheap software. Work on particle size sensors was done with different methods for different ranges of particle size. In the measurement of particle size above 1 mm by image analysis, a breakthrough on the segmentation of individual objects (particles) in an image was reached through the application of multi-flash imaging (MFI), here in the form of multi-wavelength imaging (MWI). Electrostatic measurements below 1 mm were applied. The method developed in this project makes it possible to calculate a mean particle size in a power station where the feeding rate to each mill is known using the existing ABB Pf meter. Pulverised fuel was analysed through laser scattering. The objective of the work was to validate an online coal fineness device at full scale in power plants. This objective was reached and allows a technical and economically feasible use of the results.

		Country	*Scientific person in charge*
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RFCR-CT-2003-00009 C2H UPGRADE

Upgrading of high moisture, low rank coals to hydrogen and methane

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2792444 €	Start Date	1/09/2003
	EU Contribution	1675468 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23584:EN			

Final Abstract The C2H upgrade project developed a new process for upgrading high moisture low rank brown coals yielding two valuable products: - a H2-rich fuel gas which can be used for high efficient power generation in a combined cycle or as a natural gas substitute, - a pre-calcined feed for a cement clinker kiln consisting of CaO, CaSO4 and coal ash. The C2H upgrade process consists of two core reactors: (i) a steam gasifer with in situ CO2 capture by CaO, and (ii) a sorbent regenerator with the possibility to produce a separate CO2 stream. The project evaluated the necessary aspects of process development. Characterisation of coals and CaO-based sorbents: A European geological survey produced suitable locations for a C2H plant. A methodology for evaluation of calcium-based sorbents was developed. Pilot scale gasification: Testing on three different reactor types was successfully completed (ABFB, PBFB, Rotary Kiln). A H2-rich (>85 vol. %) and CO2-lean gas with low tar content (< 2 g/Nm3) was generated. Two continuous C2H pilot plants were designed for small-scale applications and large-scale power generation. IGCC simulation: The C2H-based IGCC plant has a net electric efficiency of 45.0 %. With CO2 capture, the base efficiency decreases to 37.5 %. Utilisation of the pre-calcined feed in a cement plant yields savings in fuel (66 %) and CO2 emissions (88 %). Life-cycle analysis: The C2H-based IGCC process is economically competitive compared with conventional IGCC systems, especially for CO2 capture: the specific investment cost is estimated at < 1 500 €/kWe and the CO2 mitigation cost is < 20 €/ tonne CO2 avoided.

Partners		*Country*	*Scientific person in charge*
	UNIVERSITAET STUTTGART	DEUTSCHLAND	Roland BERGER (Pr. Coord.)
	BRANDENBURGISCHE TECHNISCHE UNIVERSITÄT COTTBUS	DEUTSCHLAND	Hans-Joachim KRAUTZ
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Emmanuel KAKARAS
	INGENIEURBURO THOMAS WEIMER	DEUTSCHLAND	Thomas WEIMER
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	George ANDROUTSOPOULOS
	PUBLIC POWER CORPORATION S.A.	HELLAS	Abraham MIZAN
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	VATTENFALL EUROPE MINING AG	DEUTSCHLAND	Ralf MASSOW
	ZENTRUM FÜR SONNENENERGIE- UND WASSERSTOFF-FORSCHUNG BW	DEUTSCHLAND	Michael SPECHT

RFCR-CT-2004-00004 IMPECABL

Improving environmental control and battery life through integrated monitoring systems

Info

Type of Project	Research	Duration (months)	48
Total Budget	1479333 €	Start Date	1/07/2004
EU Contribution	887600 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24226:EN

Final Abstract

"An integrated package of coke oven monitoring systems was developed to assist oven life extension, minimise environmental emissions, and maintain consistency of battery operations, productivity and coke quality. The chamber wall observation system developed by CPM and Arcelor Research was tested successfully in Dillingen and Carling Coke Plants. Good quality images were processed with specially developed image analysis software. The final version of the software can generate a picture of each wall from the chamber wall inspection video. Using polarised light microscopy, a classification system was devised by Nottingham University to characterise the nature of coke oven wall and roof carbon. The development of such deposits was determined by scanning electron microscopy, X-ray diffraction and carbon deposits from a laboratory-scale rig specifically designed for this study. DMT developed a flexible mirror/video camera and pressurised air nozzle system for optical inspection and cleaning of the regenerator brickwork. The new systems were tested successfully in plant trials at a German coke plant for inspection and cleaning of the lower sections of the regenerator. Corus developed an automated flue temperature and vision monitor to measure temperature profiles and record the condition of flue refractories. Load cells on battery top tie-bars provided continuous monitoring of the forces acting on the tie-bar springs, and evaluation of battery steelwork stress and movement. A battery top deflection measurement system provided regular assessment of the oven top brickwork profile. After successful plant trials, these monitoring systems can be applied on other batteries."

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Ruth POULTNEY (Pr. Coord.)
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THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	John W. PATRICK

Selected Publications

F. Nivoix and J-P. Gaillet. Development of a coke oven chamber wall observation device, Steelmaking Days, Paris, 13-14 December 2007. Revue de Métallurgie, Vol 104 (Issue 10), 2007, pp 443 – 492. URL http://dx.doi.org/10.1051/metal/20071002 http://www.ats-ffa.org/Pages/Rubriques/manifestations/1_JSI/Programme/Definitif_programme2007.pdf

R.M. Poultney, T.J. Walker, S.K. Williams, P.H. Griffiths, R.H. Bewick. Coke Oven Monitoring Techniques for Battery Life Prolongation, The Year-Book of the Oven Managers' Association 2011, 124-134. URL http://www.coke-oven-managers.org/techyb.html

R. Barranco, J.W. Patrick, C.E. Snape, T. Wu, R.M. Poultney, C. Barriocanal, A. Diez. Optical Microscopy and SEM Study of Pyrolytic Carbon Deposits from Coke ovens, Proc. International Conference on Coal Science and Technology, 2007, ISBN 92-9029-437-X.

R. Barranco, J.W. Patrick, T. Wu. Characterisation of Pyrolytic Carbon by Optical Microscopy and Image Analysis', 7th European Conference on Coal Research and its Applications, Cardiff, 2008.

J. Patrick, R. Barranco. Carbon Deposits: Formation, Nature and Characterisation', The Year-Book of the Coke Oven Managers' Association 2007, 122-135. URL http://www.coke-oven-managers.org/techyb.html

RFCR-CT-2005-00004 ECOPITCH

Development of a new generation of coal-derived environmentally-friendly pitches

Info

Type of Project	Research	Duration (months)	36
Total Budget	2015084 €	Start Date	1/07/2005
EU Contribution	1209050 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24193:EN

Final Abstract A new process for preparing pitches from anthracene oil has been developed. Named the 'ecopitch process', it involved four sequential cycles each of which included a thermal oxidative condensation step followed by thermal treatment and distillation. The unreacted anthracene oil obtained in each cycle was used as the feedstock for the next cycle. It was observed that the unreactive anthracene oil required severer operational conditions (i.e. temperature) for being polymerised as the number of processing cycles increased. After four cycles, the polymerisation capability of the anthracene oil was depleted. Bulk samples and their fractions from all stages of the process were characterised in terms of their molecular mass distribution and structural features. These samples were used to develop and validate methods based on laser desorption mass spectroscopy and nuclear magnetic resonance. The pyrolysis behaviour and the capacity of the anthracene oil derivatives to generate carbon materials were also investigated. The feasibility of using anthracene oil derivatives as impregnation and binder agents in the production of graphite electrodes was studied. Preliminary results suggest that these pitches are suitable for use as impregnation agents. However, their application as binders requires further study. One of the most important goals attained in this project is the excellent capacity of anthracene oil derivatives to develop mesophase, and, consequently, to produce advanced carbon materials (e.g. carbon fibres, graphitic carbons and activated carbons for application in energy storage). Modelling of the anthracene oil polymerisation was performed as a base for the scaling-up of the process. Tests in batch mode involved the study of the main parameters that affected the final properties and quality of the pitch obtained from the anthracene oil. A computational model was also developed and tested in order to simulate the experimental conditions inside a pitch production reactor. This model showed that the critical point in the reacting system is the injector which corresponded to the zone of largest energy release.

Partners

	Country	*Scientific person in charge*
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Selected Publications

P. Alvarez, M. Granda, J. Suti, R. Menendez, J.J. Fernandez, J.A. Viña, T.J. Morgan, M. Millan, A.A. Herod, R. Kandiyoti. Characterization and pyrolysis behaviour of novel anthracene oil derivatives. Energy & Fuels 22 (2008), 4077-4086. DOI 10.1021/ef800537a. URL http://dx.doi.org/10.1021/ef800537a

P. Alvarez, J. Sutil, R. Santamaria, C. Blanco, R. Menendez, M. Granda. Mesophase from anthracene oil-based pitches. Energy & Fuels 22 (2008), 4146-4150. DOI 10.1021/ef800499x. URL http://dx.doi.org/10.1021/ef800499x

E. Frackowiak, K. Kierzek, G. Lota, J. Machnikowski. Lithium insertion/deinsertion of boron doped graphitic carbons synthesized by different procedure. J. Phys. Chem. Solids 69 (2008), 1179-1181. DOI 10.1016/j.jpcs.2007.10.091. URL http://dx.doi.org/10.1016/j.jpcs.2007.10.091

T.J. Morgan, A. George, P. Alvarez, M. Millan, A.A. Herod, R. Kandiyoti. Characterization of molecular mass ranges of two coal tar distillate fractions (creosote and anthracene oils) and aromatic standards by LD-MS, GC-MS, probe-MS & size exclusion chromatography. Energy & Fuels, 22 (2008), 3275-3292. DOI 10.1021/ef800333v. URL http://dx.doi.org/10.1021/ef800333v

P. Alvarez, J. Sutil, R. Menendez, M. Granda. Matriz-iron interactions in carbon-embedded iron oxide nanoparticles. Journal of Nanoscience and Nanotechnology 9 (2009), 4098-4102. DOI 10.1166/jnn.2009.M16. URL http://dx.doi.org/10.1166/jnn.2009.M16

RFCR-CT-2005-00005 REDPAH

Reduction of polycyclic aromatic hydrocarbon (PAH) emissions from coking plants

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1930920 €	Start Date	1/09/2005
	EU Contribution	1158552 €	End Date	28/02/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24965:EN			

Final Abstract This project has developed a number of approaches to understand and reduce polycyclic aromatic hydrocarbon (PAH) and particulate matter (PM) emissions from coking plants. Ammonia water spraying in the gooseneck at the beginning of the coking cycle has indicated that coke oven pressure can be regulated during the whole coking time by two simple water sprayers.Comparisons were made between the content of PAHs in Gray-King tars of several commercial coals and blends and the PAHs emitted in a 250 kg coking oven to predict and reduce the emissions for actual plants. The 250 kg oven trials have identified how marked reductions in PAH emissions can be achieved for the Maltby coal used through blending with low volatile coking coals.An innovative procedure for the measurement of non-stack PAH emissions from coke oven batteries has been developed, together with an integrated system for battery evaluation. PM10 and PAH samples taken in two different locations of ArcelorMittal's coking plant in Gijon (Spain), before and after the implantation of a new charging car, revealed the significant reductions achieved with this new equipment. The stable carbon isotopic values (?13C) of PAHs in tars are fairly constant for all the major coking coals investigated and this has enabled non-coal tar inputs into environment samples to be identified in the vicinity of the Gijon and Monckton plants.

		Country	*Scientific person in charge*
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RFCR-CT-2006-00002 MAXICARB

Maximising carbon utilisation through improved raw material selection and process control

Info	Type of Project	Research	Duration (months)	42
	Total Budget	3071461 €	Start Date	1/07/2006
	EU Contribution	1842876 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25047:EN			

Final Abstract Coke strength in single coals depends on bubble nucleation, growth and coalescence, and an equation to predict I20 values from rheological properties has been proposed. Indices calculated from FTIR, GC-FID and TGA helped to explain modifications in coal thermoplastic properties due to additives. The maximum content of additives in blends is sensitive to their properties. Up to 20 % of semi-coking coals can be included in carbonisation blends. LV (anthracite and petroleum coke) and HV additives (biomass, shredder fluff and waste plastics) have also been tested, but their use is limited by reductions in coke yield or quality or adverse emissions. Test devices for stamping and cake strength measurements have been developed and suitable blends assessed. Non-destructive monitoring of stamp cake homogeneity was successful with a Georadar. Other process investigations included coal moisture control and a system for maintaining consistent, high blend moisture on plant. Crushing tests showed that finer grain size exerted positive effects on mechanical strength, if bulk density is kept constant by oiling. TGA parameters were introduced into models to predict coke quality, replacing traditional variables. New and improved mathematical models to facilitate coke quality prediction have been developed from laboratory and pilot tests. The volatile matter content of the additive and of the base coal was fundamental in determining emissions during carbonisation. Tests have demonstrated the possibilities of replacing good quality coals by high carbon additives. There are environmental and economic limits in utilising additives, which control their value in use.

		Country	*Scientific person in charge*
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Selected Publications

H.Z. Kuyumcu, J. Rosenkranz, F. Abel. Stamped Coal Cakes in Coke Making Technology - Part I: A Parameter Study on the Stampability, Ironmaking and Steelmaking: Processes, Products and Applications, 36, issue 5, 2009, 321-326. http://www.ingentaconnect.com/content/maney/ias/2009/00000036/00000005/art00001

H.Z. Kuyumcu, J. Rosenkranz, F. Abel. Stamped Coal Cakes in Coke Making Technology - Part II: The Investigation of Cake Strength, Ironmaking and Steelmaking: Processes, Products and Applications, 36, issue 5, 2009, 327-332. http://www.ingentaconnect.com/content/maney/ias/2009/00000036/00000005/art00002

A.M. Fernaandez, C. Barriocanal, M.A. Diiez, R. Alvarez. Influence of additives of various origins on thermoplastic properties of coal. Fuel 88 (2009)2365-2372. doi:10.1016/j.fuel.2008.11.029

A.M. Fernaandez, C. Barriocanal, M.A. Diez, R. Importance of the textural characteristics of inert additives in the reduction of coal thermoplastic properties. Fuel 89 (2010) 3388–3392. doi:10.1016/j.fuel.2010.03.006.

K.M. Steel, M. Castro Diaz, J.J. Duffy, and C.E. Snape. Use of oscillatory shear rheometry and thermogravimetric analysis to examine the microstructural changes during coal pyrolysis/carbonization for the prediction of IRSID strength indices. Energy and Fuels, 2009, 23, 2111-2117. DOI: 10.1021/ef800977q URL: http://pubs.acs.org/doi/pdf/10.1021/ef800977q

RFCR-CT-2006-00003 HYDROSEP

Hydrogen separation in advanced gasification processes

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2515813 €	Start Date	1/07/2006
	EU Contribution	1509487 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25071:EN			

Final Abstract The project concentrated on the development of high-capacity carbon-based adsorbents to capture CO2, and thin-film metal and composite membranes for hydrogen separation with polymer gas-liquid contact membranes for cold removal of CO2 and other acid gases. Also, an evaluation of integrating hydrogen production units into an IGCC power plant was undertaken to facilitate the future utilisation of the adsorbents and membranes developed. On the laboratory scale, high capacity carbon-based sorbents were developed and optimised for their CO2 adsorption efficiency at both low and high pressures. Larger (kilogram) quantities of the best performers were prepared and similarly tested. Ceramic membranes were studied and means to improve their selectivity in hydrogen separation investigated. Novel thin-film metallic membranes were deposited on porous supports to assess their efficacy in hydrogen separation and in catalytic conversion via the water–gas shift reaction, and were tested in a novel reactor. Polymer membranes were also tested for their ability to remove CO2 from syngas by liquid contact, thereby resulting in a higher purity fuel gas. Design for integration scale of some of these technologies on an industrial into an existing IGCC plant at Puertollano, Spain, were developed.

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RFCR-CT-2006-00004 COOL

Coke oven operating limits

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1595507 €	Start Date	1/07/2006
	EU Contribution	957304 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24972:EN			

Final Abstract

To define safe limits of coke oven operating conditions it is necessary to understand the thermo-mechanical behaviour of the heating walls. Sources of stresses on oven walls must be controlled: thermal load, swelling pressure, friction force during pushing. It was carried out on these main factors.Modelling of the heating wall with a method of brick work periodic homogenisation was successful. A 3D model of the full heating wall was established with ABAQUS software. Results show that tall ovens do not stand 10 kPa average swelling pressure: cracks appear in masonry.Sensors installed on the new battery 3 of ArcelorMittal Fos-sur-Mer coking plant and temperature measurements in the flues gave inputs to the model.To predict swelling pressure of coals in the oven, a wide range of coals have been tested at laboratory scale by ICHPW. A first model of swelling pressure development is proposed.Measurement of wall pressure developed by coal was carried out in the ILVA pilot oven. Effect of oiling is different on dry coal and on wet coal. Partial briquetting was investigated by ILVA as this technique allows using more slight coking coals in the blend.Industrial trials at Ruukki Raahe coke plant confirmed that bulk density increases by oil addition. Techniques to measure the actual pushing force transmitted to the coke cake were tested at ArcelorMittal Florange coking plant. Both machines in Florange are now equipped with torque sensors.

Partners		*Country*	*Scientific person in charge*
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	RAUTARUUKKI OYJ	FINLAND	Olavi KERKKONEN
	UNIVERSITE D'ORLEANS	FRANCE	Alain GASSER

Selected Publications

M. Landreau. Modélisation thermomécanique d'un piédroit de four à coke. PhD thesis, University of Orléans, France. 04/12/2009

M. Sciazko, B. Mertas, Z. Bebenek, G. Czerski. Coal grains swelling in plasticity range and expansion pressure development. Cokemaking 2007 Poland., Ksiaz. October 10-12, 2007

D. Kroh, D. Isler, Y Hergalant, D. Dumay, F. Entringer. Pushing force measurement and transmission. La Revue de Métallurgie, CIT. November 2009. p. 499-507

M. Landreau, E. Blond, A. Gasser, D. Isler. Modelling of a coke oven heating wall. Unitecr'09. Salvador, Brazil. October 13-16, 2009

RFCR-CT-2007-00005 FLEXGAS

Near zero emission advanced fluidised bed gasification

Info

Type of Project	Research	Duration (months)	36
Total Budget	2536420 €	Start Date	1/07/2007
EU Contribution	1521852 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25125:EN

Project web page http://www.flexgas.cnr.it/

Final Abstract

The Flexgas project deals with the co-gasification of coal and biomass/waste in fluidised beds. The research consortium was comprised of nine industrial partners and public research institutes from seven EU Member States. This report covers the activities of the project from 1 July 2007 to 30 June 2010.Complex schemes of gasification based on the concept of the oxy-fuel process as well as the internal circulating fluidised bed (ICFB) were studied. These schemes were able to produce nitrogen-free and hydrogen-rich syngas. Thus, a CO2 sequestration postprocess is relatively easy to implement, although out of the scope of Flexgas. On the whole, the project was successfully completed. 31 deliverables were produced during the project, 23 of which have a technical/scientific content. All milestones were achieved, some of which with a reasonable delay. Flexgas demonstrates that the fluidised bed co-gasification of coal and biomass/waste is viable even on a relatively small scale as well as with advanced process schemes. A syngas very rich in H2 and compatible with CO2 sequestration can be produced. The adoption of catalytic materials for in-bed/ex-bed processes allows a series of problems related to FB gasification to be overcome. Under certain conditions, the studied process can be economically attractive. The research had a noticeable impact on the scientific community, thanks to a large number of publications coming from the consortium. A moderate impact was registered on the social, industrial and economic worlds. Further R & D actions were individuated to overcome the main barriers to gasification on the basis of the knowledge acquired through Flexgas.

Partners

	Country	*Scientific person in charge*
CONSIGLIO NAZIONALE DELLE RICERCHE	ITALIA	Francesco MICCIO (Pr. Coord.)
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TECHNISCHE UNIVERSITAET WIEN	OESTERREICH	Hermann HOFBAUER

Selected Publications

Francesco Miccio, Giovanna Ruoppolo. Procedure for the determination of the fuel behaviour under more realistic conditions of Gasification. FLEXGAS project deliverable 2.4. URL http://www.flexgas.cnr.it/Deliverables/DL2 4.pdf

M. Millan. Comparison between oxy-fuel gasification at different pressure. FLEXGAS project deliverable 3.2. URL http://www.flexgas.cnr.it/Deliverables/DL3 2.pdf

C. Pfeifer, M. Koch. Results of co-gasification in the 8 MWth demonstration plant. FLEXGAS project deliverable 5.2. URL http://www.flexgas.cnr.it/Deliverables/DLS 2.pdf

K. Svoboda. Selection/ranking of methods to assure dust abatement. FLEXGAS project deliverable 6.3 URL. http://www.flexgas.cnr.it/Deliverables/DL6 3.pdf

J.M. Sanchez, M. Marano. Optimisation of shift reactor operating conditions to maximise the production of hydrogen and catalyst life FLEX GAS project deliverable 6.5 URL http://www.flexgas.cnr.it/Deliverables/DL6 5.pdf

RFCR-CT-2007-00006 HUGE

Hydrogen oriented underground coal gasification for Europe

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3139846 €	Start Date	1/07/2007
	EU Contribution	1853308 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25044:EN

Project web page http://huge.gig.eu/pl.html

Final Abstract

An analysis of various options of coal gasification technologies with different gasification media, process parameters and coal types, as well as mathematical and thermodynamic modelling of the planned trials, have been conducted. Moreover, a pseudo-homogeneous mathematical model for the adsorption of CO2 on the CaO-rich minerals was developed. For the purpose of the experiments an ex situ reactor was constructed. The reactor was used for the simulation of real underground conditions in respect to both the coal seamsand the surrounding rock layers. Large blocks of coal were prepared for the reactor by the industrial partner of the project. In total, six experiments were performed. The experiments demonstrated the possibility of coal gasification in hard coal block and lignite, and tested the methodology of the experiment. Tests with smaller coal blocks in a pressurised reactor were also performed. Moreover, tests on the migration of heavy metals to water during the gasification process, as well as tests of the behaviour of the strata, have been conducted. The concept of the underground georeactor at a process developmen unit scale was elaborated. The location of the georeactor was chosen and an analysis of the surrounding space was carried out. The process design, together with the technical design of the generator and the monitoring system, has been carried out. After all the necessary infrastructure had been built, an underground trial in the in situ reactor in the experimental mine was conducted. The trial lasted 16 days. The underground experiment enabled the identification of potential problems related to the operation of the UCG process.After the in situ trial, the impact of the UCG process on the natural environment was analysed, as well as the impact of the UCG process on life standards, and the implementation criteria for the selected UCG technological option were elaborated. The results of the project were presented during 17 international conferences, in 15 publications in journals and one patent application.

Partners

	Country	*Scientific person in charge*
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Selected Publications

A. Mikelic, H. Bruining. Analysis of model equations for stress-enhanced diffusion in coal layers. Part I: Existence of a weak solution, SIAM Journal of Applied Mathematics 40 (2008) 1671-1691. http://dx.doi.org/10.1137/070710172.

O. Šolcová, K. Soukup, J. Rogut, K. Stanczyk, P. Schneider. Gas transport through porous strata from underground reaction source. The influence of the gas kind, temperature and transport-pore size. Fuel Processing Technology 90 (2009) 1495-1501. doi:10.1016/j.fuproc.2009.07.015. URL http://vls1.icm.edu.pl/pdflinks/13052709034225458.pdf.

"M. Wiatowski, K. Stanczyk, J. Swiadrowski, K. Kapusta, K. Cybulski, E. Krause, J. Grabowski, J. Rogut, N. Howaniec, A. Smolinski. Semi-technical underground coal gasification (UCG) using the shaft method in Experimental Mine ""Barbara"". Fuel 99 (2012) 170-179. http://dx.doi.org/10.1016/j.fuel.2012.04.017. URL http://vls1.icm.edu.pl/pdflinks/13052709065225713.pdf."

K. Kapusta, K. Stanczyk. Pollution of water during underground coal gasification of hard coal and lignite. Fuel 90 (2011) 1927-1934. doi:10.1016/j.fuel.2010.11.025. http://vls1.icm.edu.pl/pdflinks/13052709095625943.pdf.

K. Stanczyk, K. Kapusta, M. Wiatowski, J. Swiadrowski, A. Smolinski, J. Rogut, A. Kotyrba. Experimental simulation of hard coal underground gasification for hydrogen production. Fuel 91 (2012) 40-50. doi:10.1016/j.fuel.2011.08.024. http://vls1.icm.edu.pl/pdflinks/13052709142726555.pdf.

RFC2-CT-2008-00006 CTLEUROPE

Promotion of European coal to liquids R&D activities

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	326927 €	Start Date	1/07/2008
	EU Contribution	196156 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25002:EN			

Final Abstract This project has been undertaken by IEA Coal Research Limited (IEACCC), FuelConsult GmbH, Glowny Instytut Gornictwa (GIG), Tallinn University of Technology (TUT) and Stredisko Pro Efektivni Vyuzivani Energie O.P.S. (SEVEn). It provided an assessment of Coal to Liquids (CTL) R, D & D activities worldwide. This included a critical technical and economic assessment of the technology competitiveness together with comment on environmental issues. It further provided an impact assessment of current CTL R & D capabilities within European industry, institutes and academia, together with comments and recommendations regarding the need to recommence such activities withina European context. The information was specifically promoted and disseminated by the project partners in the major coal- and oil shale-using newer Member States of the European Union (EU), namely Poland, Estonia and the Czech Republic. This included circulation of the review to national stakeholders, including government officials, fuel processing companies, equipment manufacturers and developers, other interested industries, research institutes and universities. The review was also posted on the websitesof IEACCC, GIG, TUT and SEVEn. Workshops to present the findings of the project and seek feedback were held in Poland, Estonia and the Czech Republic. A separate short report on the findings from these workshops was prepared and disseminated. This included contact details for each project partner to better facilitate contact between R, D & D organisations within Europe. To complete the promotion and dissemination activities, the two documents were circulated to comparable stakeholders in the EU-15 countries and other newer Members States of the EU via various networks and associations.

		Country	*Scientific person in charge*
Partners	**IEA COAL RESEARCH LIMITED**	UNITED KINGDOM	Andrew MINCHENER (Pr. Coord.)
	FUELCONSULT GMBH	DEUTSCHLAND	Bernhard BONN
	GLOWNY INSTYTUT GORNICTWA	POLAND	Krzysztof STANCZYK
	SEVEN - STREDISKO PRO EFEKTIVNI VYUZIVANI ENERGIE o.p.s.	CZECH REPUBLIC	Bohuslav MALEK
	TALLINNA TEHNIKAULIKOOL*TALLINN UNIVERSITY OF TECHNOLOGY	ESTONIA	Andres SIIRDE

RFCR-CT-2008-00007 ECOCARB

Reduction of emissions and energy utilisation of coke oven underfiring heating systems through advanced diagnostics and control

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2490112 €	Start Date	1/07/2008
	EU Contribution	1494068 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25902:EN			

Final Abstract The project aims are to reduce emissions and maximise the energy efficiency of coke oven heating using intelligent diagnostics and individual wall heating control. A new understanding of the combustion characteristics under abnormal conditions caused by through-wall leakage, combustion inefficiency and regenerator malfunctioning has been obtained using plant trials, physical modelling and analysis. The information and data from these investigations have enabled a data-driven real-time diagnostic system to be developed for detecting and identifying heating faults at early stages of occurrence. Waste gas analysis, plant data and process knowledge have helped in the identification of the main parameters for detection and location of heating faults (Tata Steel), required for the development of a diagnostic system. This system was further extended into a real-time advisory system (UNEW), which was implemented on-line at DLCO to provide feedback on heating faults to plant personnel. A regenerator inspection robot was developed and applied under real coke oven conditions as part of a complete evaluation of combustion efficiency, with guidelines to identify combustion problems (AMMR/CPM).An experimental heating flue was constructed to investigate the effects of through-wall leakage and nozzle blockage (BFI), and along with CFD modelling, it was shown that flue gas dust, CO, H2 and O2 contents can be used as indicators of heating faults. An individual wall heating control system was designed and implemented to counteract the effects from heating faults (Uhde), with no detrimental effect on NOX emissions or heat distribution.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Mansour SAIEPOUR (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Daniel ISLER
	UHDE GmbH	DEUTSCHLAND	Ulrich KOCHANSKI
	UNIVERSITY OF NEWCASTLE UPON TYNE	UNITED KINGDOM	Anthony Julian MORRIS
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Frank MINTUS

Patents EU Patent filing number: 10015884. Method and device for assessing through-wall leakage of a heating wall of a coke oven. The coke oven wall emissions tester (COWET) has been developed for undertaking measurements on both walls of a coke oven simultaneously, to assess for leakage quickly and conveniently.

Selected Publications

Saiepour M et al: 'Assessment of Coke Oven Through-wall Leakage using Waste Gas Analysis', InSteelCon 2011, 27th June- 1st July, Dusseldorf, Germany

Saiepour M et al: 'Detection of Coke Oven Through-wall Leakage Using Data Driven Techniques', International Conference on Clean Technologies in the Steel Industry, 26th-28th September 2011, Budapest, Hungary.

Yi G, Zhang J et al: 'Intelligent Process Condition Monitoring in Large Scale Materials Processing', 24th International Congress on Condition Monitoring and Diagnostics Engineering Management (COMADEM2011), 30th May-1st June, Stavanger, Norway

Yi G, Zhang J et al: 'Intelligent Process Monitoring in Large Scale Processing', 2nd Conference European Process Analytics and Control Technology, 26th April 2011, Glasgow, UK.

RFCR-CT-2009-00003 CO2freeSNG

Substitute natural gas from coal with internal sequestration of CO2

Info

Type of Project	Research	Duration (months)	36
Total Budget	1661353 €	Start Date	1/07/2009
EU Contribution	996812 €	End Date	30/06/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26209:EN

Project web page www.co2freesng.eu

Final Abstract

This report summarises the achievements during the project runtime from 01.07.2009–30.06.2012 of the RFCS-project RFCR-CT-2009-00003 'Substitute natural gas from coal with internal sequestration of CO2' (CO2freeSNG). The project focused on the design and feasibility of medium-scale plants for the production of Substitute Natural Gas from coal based on an innovative indirect gasification technology, the so-called Heatpipe Reformer. Indirect gasification improves the process efficiency and reduces inherently the CO2 production of the process

Partners

	Country	*Scientific person in charge*
FRIEDRICH-ALEXANDER UNIVERSITAT ERLANGEN NURNBERG	DEUTSCHLAND	Jürgen KARL (Pr. Coord.)
DVGW DEUTSCHE VER. DES GAS-UND WASSERFACHES-TEC.-WISSENSCHAF. VEREIN	DEUTSCHLAND	Frank GRAF
HIGHTERM RESEARCH GMBH	DEUTSCHLAND	Markus ZANKL
NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Emmanouil KAKARAS
TECHNISCHE UNIVERSITAET GRAZ	OESTERREICH	Jürgen KARL

Selected Publications

Sotirios Karellas, et. Al. An evaluation of substitute natural gas production from different coal gasification processes based on modelling, Energy, Volume 45, 2012. http://dx.doi.org/10.1016/j.energy.2012.03.075

Jacobus van den Berg, Andreas Schweiger. Gasifier raw gas composition, Deliverable Report D11 CO2freeSNG, 2011

Christoph Baumhakl, Thomas Kienberger, Jürgen Karl. Substitute Natural Gas (SNG) from Coal and Lignite – Methanation of synthesis gas from allothermal gasification. Conference proceedings Clearwater Clean Coal Conference 2012, Clearwater Beach, USA

Sotirios Karellas, et. Al. Synthetic natural gas production from coal, Submitted for publication, Energy, 2013

Baumhakl C., Karl J., Kienberger T.: Substitute Natural Gas (SNG) aus Kohle - Methanierung von Synthesegas aus der allothermen Kohlevergasung. Tagungsband zum 25. VDI-Flammentag, Karlsruhe, 2011

RFCR-CT-2009-00004 EUROFIBRES

Development of carbon precursors from anthracene oil-based pitches for carbon fibre preparation

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1879655 €	Start Date	1/07/2009
	EU Contribution	1127793 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26211:EN			

Final Abstract Pitches differing in their properties (e.g. softening point) were produced from anthracene oil by thermal oxidative condensation. These pitches, their fractions and thermally treated products, were characterised by various techniques and their mass ranges, chemical structures and pyrolysis behaviour were compared. The viscosity of the pitches was studied at various shear rates and temperatures by means of capillary rheometry. The information obtained was used to define the subsequent processing conditions of the pitches for producing carbon fibres. Some selected pitches were spun, stabilised and carbonised to produce carbon fibres, which were subsequently characterised in terms of structure and mechanical behaviour. Intermediate products (i.e. green and stabilised fibres) were also characterised in order to obtain information about their subsequent behaviour during processing. Carbon fibres with a diameter of ~ 15-20 ?m and a tensile strength of > 1 000 MPa were obtained. Porous materials, including nitrogen and cobalt doped activated carbon fibres, were prepared by physical and chemical activation procedures, from a selection of stabilised and carbonised anthracene oil-based powders and fibres. Their textural properties and surface chemistry were evaluated with a view to defining their possible applications. The materials showed a high efficiency as selective adsorbents of gases (i.e. CO2) and water contaminants (i.e. phenol). They were also tested as both catalyst (SO2 oxidation) and catalyst support (unsaturated aldehyde hydrogenation). Electrochemical studies revealed the advantage of activated carbon fibres over activated particulates when used as electrodes in supercapacitors

Partners		*Country*	*Scientific person in charge*
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Marcos GRANDA (Pr. Coord.)
	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Marcos MILLAN
	INDUSTRIAL QUIMICA DEL NALON S.A.	ESPAÑA	Juan José FERNANDEZ-RODRIGUEZ
	UNIVERSITY OF LEEDS	UNITED KINGDOM	Aidan WESTWOOD
	POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Jacek MACHNIKOWSKI

Selected Publications

P. Alvarez, M. Granda, J. Sutil, R. Santamaria, C. Blanco, R. Menendez. A unified process for preparing mesophase and isotropic material from anthracene oil-based pitch. Fuel Processing Technology 92 (2011), 421-427. DOI 10.1016/j.fuproc.2010.10.004. URL http://dx.doi.org/10.1016/j.fuproc.2010.10.004

N. Diez, P. Alvarez, R. Santamaria, C. Blanco, R. Menendez and M. Granda. Optimization of the melt-spinning of anthracene oil-based pitch for isotropic carbon fibre preparation. Fuel Processing Technology 93 (2012) 99-104. DOI 10.1016/j.fuproc.2011.09.016. URL http://dx.doi.org/10.1016/j.fuproc.2011.09.016

P. Alvarez, N. Diez, R. Santamaria, C. Blanco, R. Menendez, M. Granda. Novel coal-based precursors for cokes with highly oriented microstructures. Fuel 95 (2012), 400-406. DOI 10.1016/j.fuel.2011.09.023. URL http://dx.doi.org/10.1016/j.fuel.2011.09.023

P. Alvarez, N. Diez, R. Santamaria, C. Blanco, R. Menendez, M. Granda. Novel coal-based precursors for cokes with highly oriented microstructures. Fuel 95 (2012), 400-406. DOI 10.1016/j.fuel.2011.09.023. URL http://dx.doi.org/10.1016/j.fuel.2011.09.023

P. Alvarez, N. Diez, C. Blanco, R. Santamaria, R. Menendez, M. Granda. An insight into the polymerization of anthracene oil to produce pitch using nuclear magnetic resonance. Fuel 105 (2013), 471-476. DOI 10.1016/j.fuel.2012.09.047. URL http://dx.doi.org/10.1016/j.fuel.2012.09.047

RFCR-CT-2010-00006 SPRITCO

Generation of swelling pressure in a coke, transmission on oven walls and consequences on wall degradation

Info

Type of Project	Research	Duration (months)	42
Total Budget	1942334 €	Start Date	1/07/2010
EU Contribution	1165400 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract

Coal swelling pressure is one of the major causes of coke oven degradation. The aim of the present project is to progress in the knowledge of the swelling pressure generation phenomena, to develop advanced methodologies to measure phenomena and their consequences on ovens, and to develop a prediction model of wall pressure.
A global approach from gas pressure generation in the plastic coal to the resulting stress on the oven walls is proposed. Coupling of pressure development in the oven chamber and thermo mechanical behaviour of heating walls will allow quantifying the effect of swelling pressure on oven walls degradation.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Daniel ISLER (Pr. Coord.)
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Ramon ALVAREZ
INSTYTUT CHEMICZNEJ PRZEROBKI WEGLA - INST. FOR CHEMICAL PROC. OF COAL	POLAND	Aleksander SOBOLEWSKI
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Colin E. SNAPE
UNIVERSITE D'ORLEANS	FRANCE	Alain GASSER

Selected Publications

E. Díaz-Faes, C. Barriocanal, R. Alvarez. Influence of residual volatile matter in semi-cokes on coking pressure. ICCS&T 2011. Oviedo.

AM. Fernandez, E. Diaz-Faes, C. Barriocanal, R. Alvarez., Thermal decomposition of semicokes obtained at resolidification temperature. 19th international symposium on analytical and applied pyrolysis. Linz, Austria. 21-25 May 2012

S. Kokonya, M. Castro-Diaz, C. Snape. Predicting wall pressures generated for low volatile coking coals during carbonisation from coal characteristics and laboratory tests including rheometry. 9th European conference on coal research and its application (ECCRIA 9). University of Nottingham. 10-12 September 2012

B. Mertas, A. Sobolewski, G. Rozycki. Plastic layer gas permeability as an influential factor on coking pressure generation. Polish conference on coking coal and cokemaking industry (Cokemaking 2012). Szczyrk. 3-5 October 2012

N. Gallienne, M. Landreau, E. Blond, A. Gasser, D. Isler. Modelling of a brick-mortar masonry using periodic homogenisation and submodelling. Journées spécialisées sur les céramiques réfractaires. Mons, Belgium. 28-29 November 2012

RFCR-CT-2010-00007 DENSICHARGE

Improving the use of alternative raw materials in coking blends through charge densification

Info

Type of Project	Research	Duration (months)	36
Total Budget	2872353 €	Start Date	1/07/2010
EU Contribution	1723413 €	End Date	30/06/2013

State Project completed, final report not published yet

Provisional Abstract

The principal aim is to improve use of alternative materials in coking coal blends by delivering technological solutions to increase oven charge bulk density for European plants, through an integrated series of trials supported by process development and mathematical modelling to:
• Investigate charge pre-treatment/densification methods to increase use of alternative materials in coking blends at existing plants.
• Evaluate the influence of alternative raw materials, blends and pre-treatment processes on charge bulk density, carbonisation, coke oven operating conditions, coke quality and yield.
• Assess the economic and environmental feasibility of alternative materials and pre-treatment technologies for industrial coke production.

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Ruth POULTNEY (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Daniel ISLER
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Ramon ALVAREZ
DMT GmbH & Co KG	DEUTSCHLAND	Erwin PILARCZYK
INSTYTUT CHEMICZNEJ PRZEROBKI WEGLA - INST. FOR CHEMICAL PROC. OF COAL	POLAND	Aleksander SOBOLEWSKI
TECHNISCHE UNIVERSITÄT BERLIN	DEUTSCHLAND	Halit Z. KUYUMCU
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Colin E. SNAPE
VOESTALPINE STAHL GMBH	OESTERREICH	Karl PILZ

Selected Publications

H.Z. Kuyumcu, S. Sander. Compacting coking coals by stamping and by pressing, Proc. XXVI International Mineral Processing Congress, ISBN: 81-901714-3-7, New Delhi/India 2012, 2634-2645. http://www.impc2012.org/DownloadFiles/IMPC_Book_of_Abstracts_2012_Volume_2.pdf

M.G. Montiano, C. Barriocanal, R. Alvarez. Effect of the addition of waste sawdust on thermoplastic properties of a coal, Fuel 106, 537-543 (2013), http://dx.doi.org/10.1016/j.fuel.2012.10.062

S. Kokonya, M. Castro Diaz, C. Barriocanal, and C.E. Snape. An investigation into the effect of fast heating on fluidity development and coke quality for blends of coal and biomass, Biomass and Bioenergy, 2013, 56, 295-306. DOI: 10.1016/j.biombioe.2013.05.026. URL: http://www.sciencedirect.com/science/article/pii/S0961953413002833#

M. Castro Diaz, H. Zhao, S. Kokonya, A. Dufour, C.E. Snape. The effect of biomass on fluidity development in coking blends using high-temperature SAOS rheometry, Energy and Fuels, 2012, 26, 1767-1775. DOI: 10.1021/ef2018463. URL: http://pubs.acs.org/doi/pdf/10.1021/ef2018463

RFCR-CT-2010-00008 RATIO-COAL

Improvement of coal carbonization through the optimization of fuel in coking coal blends

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2014497 €	Start Date	1/07/2010
	EU Contribution	1089501 €	End Date	30/06/2013
State	Running project			

Project web page http://ratio-coal.eu

Provisional Abstract The main objective of the project is an improvement of coal carbonization process through the optimization of fuel in coking coal blends. The dependence between petrographic properties of coal, alternative fuels addition and coke quality will be determined. New method of prognosis of metallurgical coke quality based on reactive/inert ratio of coal fuel blends will be proposed. An innovative monitoring, control and optimization system for preparation of coking fuel blends will be designed and implemented. A number of tests demonstrating the system feasibility and effectiveness at full scale industrial process will be provided.

		Country	*Scientific person in charge*
Partners	**UNIWERSYTET SLASKI**	POLAND	Iwona JELONEK (Pr. Coord.)
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Angeles BORREGO
	KOMBINAT KOKSOCHEMICZNY ZABRZE SA	POLAND	Stella ROSIAK
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Heike EICKHOFF
	TRINECKE ZELEZARNY a.s.	CZECH REPUBLIC	Stanislav CZUDEK
	USTAV GEONIKY AV CR, V.V.I.	CZECH REPUBLIC	Alena KOZUSNIKOVA

Selected Publications

Czudek S., Herman R., Jelonek I., Kruszewska K.. 2011. Research of Relationship between Petrographic Coal Constitution and Corresponding CSR/CRI Parameters of Coke. Metallurgical Journal, vol. LXIV- 5/2011, 3-6. URL http://www.hutnickelisty.cz/en/images/dokumenty/obsah_hl_5_2011_en.pdf

Guerrero A., Diez M.A., Borrego. A.G.. 2012. Effect of volatile matter release on optical properties of macerals from different rank coals. Fuel (accepted for publication) DOI 10.1016/j.bbr.2011.03.031.URL http://www.sciencedirect.com/science/article/pii/S0016236112003663

Guerrero A., Diez M.A., Borrego, A.G., 2012, Evaluation of Coke Structure by Raman Spectroscopy in Relation to Its Optical Texture. Proc. Of the 64th Annual Meeting of ICCP. 15-24 September, Beijing, China , 2012

Krystyna Kruszewska, Iwona Jelonek, Stanislav Czudek, Radek Herman. Coke Strength and Reactivity Prediction – A New Approach. ICCS&T 2013 September Penn State.

Kruszewska K., Jelonek I., Czudek S., Hermann R. 2013. Interrelation between petrographic and coking properties of coal. Metallurgical Journal, vol. LXVI- 1/2013, 5-12. URL http://www.hutnickelisty.cz/en/images/dokumenty/obsah_hl_1_2013_en.pdf

RFCR-CT-2010-00009 FECUNDUS

Advanced concepts and process schemes for CO^2 free fluidised and entrained bed co-gasification of coals

Info

Type of Project	Research	Duration (months)	36
Total Budget	2877029 €	Start Date	1/07/2010
EU Contribution	1726218 €	End Date	30/06/2013

State Project completed, final report not published yet

Project web page http://www.fecundus.cnr.it

Provisional Abstract

The need to efficiently convert/upgrade coal and renewable fuels and to drastically reduce CO2 emissions calls for research in improving technologies of solid fuels to energy conversion.
The project aims at integrating gasification schemes for the co-gasification of coal, biomass and wastes with processes for CO2 separation and capture. Fluidised bed and entrained flow gasification processes will be considered thanks to their flexibility and effectiveness for carrying out thermal conversion of different feedstock.
Seven work-packages are foreseen dealing with management, outcomes dissemination, tailoring gasification schemes for integration with CO2 separation, development of materials for gas cleaning, char upgrading, and CO2 separation.

Partners

	Country	*Scientific person in charge*
CONSIGLIO NAZIONALE DELLE RICERCHE	ITALIA	Francesco MICCIO (Pr. Coord.)
CENTRO DE INVESTIGACIONES ENERGÉTICAS MEDIOAMBIENTALES Y TECNOLÓGICAS	ESPAÑA	José Maria SANCHEZ HERVAS
ELCOGAS SA	ESPAÑA	Pilar COCA LLANO
INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS ACAD. OF SCIENCES OF CZ	CZECH REPUBLIC	Karel SVOBODA
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Marcos MILLAN
LABORATORIO NACIONAL DE ENERGIA E GEOLOGIA IP	PORTUGAL	Ibrahim GULYURTLU
UNIVERSITA DEGLI STUDI DI SALERNO	ITALIA	Diego BARLETTA
TECHNISCHE UNIVERSITAET WIEN	OESTERREICH	Hermann HOFBAUER

Patents

"Izak, P., Poloncarzova, M., Vejrazka, J., Czech head, Czech Republic. ""Zpusob separace plynu a zarfzeni k jeho obohaceni"" (Czech). Method of gas separation and equipment for the process, Czech Patent No. CZ303107, 2012."

Pohorely M., Kamenikova P., Svoboda K., Skoblia S., Jeremias M., Syc M., Puncochar M., Hartman M.: Zarizeni pro fluidni zplynovani tuhych paliv. (Czech) The Facility for the Fluidized-Bed Gasification of Solid Fuels., Czech Patent Application No. PV 2012-516. Applied 27.7.2012.

Svoboda K., Smetana J., Stojdl J., Sulc J., Vacek J.: Zpusob zplynovani upravene biomasy a zarizeni k jeho provadeni. (Czech) Method and Apparatus/Equipment for Gasification of Adapted/ Adjusted Biomass. Czech Pat. No. CZ303367, Patented: 07.09.2012.

Selected Publications

Stefan Kern. Report on fuel tests with the dual fluidised bed pilot plant. FECUNDUS project deliverable 2.2

Stefan Kern. Report on tests in pilot scale ICFB. FECUNDUS project deliverable 2.4

Diego Barletta. Report on results of flowability evaluation of coal-alternative fuels. FECUNDUS project deliverable 3.3

Giavanna Ruoppolo, Francesco Miccio. Report on new catalyst performance during co-gasification. FECUNDUS project deliverable 4.1

Pavellzcik, Karel Svodoba. Report on possible separation of C02 and H2Sby membrane technique. FECUNDUS project deliverable 4.4

RFCR-CT-2011-00002 HUGE2

Hydrogen oriented underground coal gasification for Europe - Environmental and Safety Aspects

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2074641 €	Start Date	1/07/2011
	EU Contribution	1244785 €	End Date	30/06/2014
State	Running project			

Project web page http://huge.gig.eu/pl.html

Provisional Abstract

The project is focused on safety and environmental aspects of underground coal gasification. Underground trial will be performed in mine testing two borehole system and reactive barriers usage. The most serious environmental concerns related to UCG will be investigated that is contamination of underground aquifers and potential leakage of poisonous and explosive gases into the surrounding strata. The work will be focused on finding practical solutions of possible leakages prevention by use of reactive barriers. Complex system of environmental telemetric monitoring will be built and tested. Also technical and ecological risk assessment will be performed.

Partners	*Country*	*Scientific person in charge*
GLOWNY INSTYTUT GORNICTWA	POLAND	Krzysztof STANCZYK (Pr. Coord.)
LUBELSKI WEGIEL "BOGDANKA" SA	POLAND	Boleslaw KOZEK
INSTITUTE OF CHEMICAL PROCESS FUNDAMENTALS ACAD. OF SCIENCES OF CZ	CZECH REPUBLIC	Olga SOLCOVA
INSTITUT NATIONAL DE L'ENVIRONNEMENT INDUSTRIEL ET DES RISQUES	FRANCE	Régis FARRET
KOMPANIA WEGLOWA S.A.	POLAND	Marek SZARAFINSKI
SILESIAN UNIVERSITY OF TECHNOLOGY - POLITECHNIKA SLASKA	POLAND	Jan PALARSKI
UCG ENGINEERING LTD	UNITED KINGDOM	Michael GREEN

Selected Publications

A.Smolinski, K. Stanczyk, K. Kapusta, N. Howaniec, Chemometric study of the ex-situ underground coal gasification wastewater experimental data. Water, Air and Soil Pollution 223 (2012) 5745-5758. DOI 10.1007/s11270-012-1311-5. http://link.springer.com/article/10.1007%2Fs11270-012-1311-5#page-1.

Stanczyk K., Dubinski J., Kapusta K., European Underground Coal Gasification Projects: HUGE and HUGE2. IEA Workshop, Banff., Alberta, 22-23 August 2012.

Kapusta K., Stanczyk K., Dubinski J., Underground Coal Gasification in Poland. Experience, results and prospects. 12th Polish-American Conference on Science and Technology", 20-22 May 2012, Ohio State University, Columbus, USA

RFCR-CT-2012-00005 NOEMI

Nitrogen oxides emissions minimization through improvement of vertical heat distribution inside heating flues

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1231394 €	Start Date	1/07/2012
	EU Contribution	738836 €	End Date	31/12/2015
State	Running project			

Provisional Abstract The primary sources of NOx emissions in coke plants are waste heat gases. These emissions depend on underfiring gas and heating pattern. New heating designs with multi-stage heating and waste gas recirculation allow reducing NOx formation but can only be applied in new constructions. Improvement of existing batteries in terms of heat distribution and NOx emissions will be proposed. Coke oven gas dilution and possible design modifications will be studied. Mathematical and physical models will be used to determine the best possible ways to improve the heating pattern before implementation at industrial scale. Benefits will be assessed by performing industrial measurements.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Matthieu LANDREAU (Pr. Coord.)
	BIURO PROJEKTOW KOKSOPROJEKT Sp. Z.O.O.	POLAND	Wiktor HUMMER

RFCR-CT-2013-00006 COALPHENES

Coal liquid-based high crystalline carbons for the synthesis of graphene-based composites

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1896144 €	Start Date	1/07/2013
	EU Contribution	1137686 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

This proposal deals with the transformation of coal liquids (eg., anthracene oil, coal-tars) into cokes and graphites with a tailored structure for use in the production of graphene materials. The development of this type of coke/graphite using a coking liquid phase process will provide an innovative product for making high-tech materials with a good marketing potential. High crystalline coke/graphites with different structures and properties will be used as precursors for the preparation of graphenes. Graphenes will be prepared via graphene oxide (GO) by two different methods followed by GO reduction using different approaches. The enrichment of graphene/GO in nitrogen will be also studied. Graphene will be tested as: (i) filler in polymer-graphene composites for themal interface materials (TIMs), using rubbery epoxy and silicone as matrix precursors and (ii) advanced graphene-based hybrid materials with a hierarchical structure, including carbon nanofibres/graphene and MnO2/GO, will be designed and synthesized and then be tested as electrode in supercapacitors.

		Country	*Scientific person in charge*
Partners	**AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS**	ESPAÑA	Marcos GRANDA (Pr. Coord.)
	INDUSTRIAL QUIMICA DEL NALON S.A.	ESPAÑA	Juan José FERNANDEZ-RODRIGUEZ
	UNIVERSITY OF LEEDS	UNITED KINGDOM	Aidan WESTWOOD
	POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Grazyna GRYGLEWICZ

RFCR-CT-2013-00007 COWEST

Coal weathering study to predict oxidation, improve coke properties and protect coke oven operation

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2045947 €	Start Date	1/07/2013
	EU Contribution	1227568 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

The exposure of coal to mild weathering decreases the thermoplastic capability of coking coals and this modifies their behaviour during the coking process, affecting coke structure and properties. There are incidences where coking coal properties have changed markedly during shipping and storage. Although reduced fluidity and volatile matter can be detrimental, particularly with regard to the possibility of increasing wall pressures, controlled oxidation to reduce volatile matter content can potentially increase the quality of the coke produced. This provides an opportunity for mildly oxidised mid to high-volatile European coking coals to displace imported low volatile matter premium coking coals in blends, given increased competition from Asian markets for these coals. The objectives of the proposed research are to ascertain how prime coking coals can be affected by weathering and the extent to which mild oxidation can be favourable for improving coking properties of mid to high volatile European coking coals. This will involve understanding the mechanisms involved in coal oxidation through a systematic study of a wide range of weathered and oxidised coals and blends using the novel characterisation techniques of high-temperature 1H NMR and rheometry in combination with other traditional characterisation techniques, including TGA, together with pilot oven tests. This knowledge will be used for the introduction of alternative raw materials or additives with plasticising properties that can reverse any detrimental effects arising from coal weathering. These include waste plastics and biomass fractions, the latter offering beneficial environmental effects as they are carbon neutral. In addition, novel reliable tests based on the parameters derived from the analytical techniques will be developed to predict the extent of coal oxidation in order to replace the not always sensitive to oxidation ASTM D5263 method.

		Country	*Scientific person in charge*
Partners	**THE UNIVERSITY OF NOTTINGHAM**	UNITED KINGDOM	Miguel CASTRO DIAZ (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Tatiana ROZHKOVA
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Carmen BARRIO CANAL
	DMT GmbH & Co KG	DEUTSCHLAND	Drazen GAJIC
	INSTYTUT CHEMICZNEJ PRZEROBKI WEGLA - INST. FOR CHEMICAL PROC. OF COAL	POLAND	Aleksander SOBOLEWSKI

RFCR-CT-2013-00008 CO2freeSNG2.0

Advanced Substitute Natural Gas from Coal with Internal Sequestration of CO2

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1834169 €	Start Date	1/07/2013
	EU Contribution	1100502 €	End Date	30/06/2016
State	Running project			

Provisional Abstract The proposed project shall continue a previous RFCS project which focused on the conversion of coal into Substitute Natural Gas (SNG) by means of methanation of coal derived syngas. The follow-up project targets at the complete process chain demonstration of an innovative process design developed within the previous project with European coal and lignites. The new process comprises a substantially simplified gas cleaning based on carbonate scrubbing. It allows to simultaneously remove CO2, sulphur and tar components by means of a single pressurized water/ carbonate scrubbing process and will substantially increase process efficiency in comparison to state-of-the-art systems.

		Country	*Scientific person in charge*
Partners	**FRIEDRICH-ALEXANDER UNIVERSITAT ERLANGEN NURNBERG**	DEUTSCHLAND	Jürgen KARL (Pr. Coord.)
	AIR LIQUIDE FORSCHUNG UND ENTWICKLUNG GmbH	DEUTSCHLAND	Claudia KRIER
	DVGW DEUTSCHER VEREIN DES GAS- UND WASSERFACHES - TECH.-WIS. VEREIN EV	DEUTSCHLAND	Dominic BUCHHOLZ
	GLOWNY INSTYTUT GORNICTWA	POLAND	Leokadia ROG
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Sotirios KARELLAS

RFCR-CT-2014-00006 ALTERAMA

Developing uses of alternative raw materials in cokemaking

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1976512 €	Start Date	1/07/2014
	EU Contribution	1185906 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

In the current volatile global economic situation, it is essential that optimum use is made of alternative raw materials to increase the viability and competitiveness of European coke plants. Since approximately 70% of the coke production cost is for raw materials, the European cokemaking industry is interested in saving raw material costs through including alternative materials in blends, improving the coking process and productivity with higher charge bulk densities, and improving the health of plant operators and the environment by using more environmentally-friendly materials. In order to substitute higher proportions of expensive coking coals with alternative raw materials and maintain coke quality and safe oven operation, suitable pre-carbonisation technologies need developing to increase oven charge density, and the feasibility of using them in existing coke oven plants needs to be assessed. Hence, ALTERAMA has been created as a complex European R&D project whose principal aims are: • To develop a novel methodology based on hydrous pyrolysis to maximise the introduction of biomass in coking blends and minimise non-renewable carbon emissions. • To understand the mechanisms by which novel alternative raw materials affect coal properties during carbonisation. • To beneficiate poor coking coals with plasticising raw materials in order to produce good coking blends. • To maximise the use of alternative raw materials in the coke oven charge by briquetting optimisation. • To evaluate their influence on charge density, coke oven operation, coke quality and yield, cost and emissions. By application of this research, coke plant operators will gain increased productivity and improved coke quality or cost savings from alternative raw materials. The investigated techniques provide possibilities to increase coke production at the existing coke oven plants and to reduce the purchase and transport of coal from outside the EU.

		Country	*Scientific person in charge*
Partners	**THE UNIVERSITY OF NOTTINGHAM**	UNITED KINGDOM	Miguel CASTRO DIAZ (Pr. Coord.)
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Carmen BARRIO CANAL
	INSTYTUT CHEMICZNEJ PRZEROBKI WEGLA - INST. FOR CHEMICAL PROC. OF COAL	POLAND	Rafal BIGDA
	TATA STEEL UK LIMITED	UNITED KINGDOM	Ruth POULTNEY
	VOESTALPINE STAHL GMBH	OESTERREICH	Karl PILZ

Technical Group Coal 3

Coal combustion, clean and efficient coal technologies, CO_2 capture

The scope of TGC3 includes:

- Clean and efficient coal combustion
- Integration of the coal chain, from mining to the final product (electricity, heat, hydrogen, coke)
- Carbon management strategy
- Reduction of the environmental impact of installations using EU coal, lignite and oil shave
- Reduction in emissions from coal utilization
- Clean and efficient coal technologies
- CO2 capture
- Co-combustion of coal with solid waste or biomass
- Zero emissions and high efficient power generation
- CHP from coal
- Coal contribution to global energy security

RFCP-CT-2003-00002 LIGPOWER

More efficient cleaning concepts for stepping up availability of lignite-fired power plants

Info	Type of Project	Pilot&Demonstration	Duration (months)	52
	Total Budget	2312896 €	Start Date	1/09/2003
	EU Contribution	925158 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23869:EN			

Final Abstract The quality of lignite extracted in various deposits differs considerably in part. The impact of changed major coal quality parameters on steam generator operation became evident in the form of increased deposit formation on the boilers' heating surfaces. Successful countermeasures were launched, but the bottleneck of the problem continues to be the cleaning of the first convection heating surfaces downstream of the furnace. As the cleaning facilities available so far (soot blowers) have not proved sufficient for these areas of application despite all optimisation efforts made, new processes have to be developed. In contrast to the methods applied so far, these processes do not use the common cleaning medium steam but work on the basis of alternative cleaning media. Within the scope of the Ligpower project, such alternative cleaning methods were selected and subjected to extensive testing on commercial utility boilers. Since a more intensive cleaning of superheater tubes involves increased stress of the tube material, we developed new, more resistant, superheater designs and installed these in a 600 MW unit. The transferability of the findings made was ensured by a comparison of the lignites used. To permit the cleaning device to be controlled as needed, we developed a programme that analyses the degree of fouling of the boiler and generates suggestions for its cleaning. In addition, a tube-fin superheater design was calculated and optimised in terms of fluid dynamics. The extensive tests showed which cleaning methods have suitable approaches to cleaning. By testing them over several years, we gained important information about equipment design. The superheater design could be tested only to a limited degree. Thus, we obtained additional findings in tests using a test heating surface that was mounted on a 300 MW boiler.

		Country	*Scientific person in charge*
Partners	**RWE POWER AG**	DEUTSCHLAND	Georg WIECHERS (Pr. Coord.)
	ALSTOM POWER SYSTEMS GmbH	DEUTSCHLAND	Georg-Nikolaus STAMATELOPOULOS
	PUBLIC POWER CORPORATION S.A.	HELLAS	Abraham MIZAN
	RWE NPOWER PLC	UNITED KINGDOM	Gerry RILEY

RFCR-CT-2003-00001 CLEFCO

Advanced CFB for clean and efficient coal power

Info	Type of Project	Research	Duration (months)	40
	Total Budget	2231760 €	Start Date	1/09/2003
	EU Contribution	1339056 €	End Date	31/12/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23875:EN			

Final Abstract

The European Union's Clefco project (2004-06) aimed to promote the development of once through steam cycle (OTSC) CFB technology. This was carried out by increasing the process knowledge that is essential for successful boiler design and demonstration of the multi-fuel flexibility of the process. To fulfil the development needs of OTSC CFB technology, a comprehensive understanding of CFB combustion processes needed to be achieved. Intensive research in laboratory, pilot and full-scale combustors was required to fulfil the abovementioned objectives. In the project, each partner worked in its own field of research. Cooperation between partners enabled the best-possible understanding of the process. In order to study different process characteristics and verify measurements and simulations, experiments were carried out with different size reactors — VTT's laboratory scale CFB reactor, VTT's 50 kW pilot CFB reactor, Chalmers' 12 MW CFB boiler, cold rig and several commercial boilers. To find out possibilities for end-use of ash, national legislations and standards were studied. Knowledge was applied to ash management possibilities for coal combustion and co-combustion of coal and biomass. The studies were based on the ash characterisation, which was carried out for ash samples collected during the projects' combustion tests.

		Country	*Scientific person in charge*
Partners	**TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND**	FINLAND	Jouni HAMALAINEN (Pr. Coord.)
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Emmanuel KAKARAS
	CHALMERS TEKNISKA HÖGSKOLA AB	SVERIGE	Filip JOHNSSON
	FOSTER WHEELER ENERGIA OY	FINLAND	Timo HYPPÄNEN

RFCR-CT-2003-00004 MINORTOP

Minimisation of impact of nitrogen oxide reduction technologies on operation and performance

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2115359 €	Start Date	1/09/2003
	EU Contribution	1269214 €	End Date	31/08/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23861:EN			

Final Abstract This project investigates the impact of the application of advanced NOX reduction technologies, such as deep furnace staging, on practical operating issues for coal-fired power plant. Programmes of laboratory-, pilot and full-scale tests have been undertaken and numerical simulation models have been extended to predict the effects of fuel selection and the firing of coal and coal/biomass blends when applying staging and overfire air conditions. Carbon in ash levels have been predicted for full scale plant and an existing carbon in ash notification (CARNO) system was extended to incorporate overfire air applications. Deposition assessments were carried out at pilot- and laboratory-scale using modelling studies to define test conditions and identify locations where slagging and fouling could be a problem under staged conditions. Furnace corrosion and metal loss rates were identified for different fuel compositions and staging conditions. Corrosion probes installed in a full scale plant were used to monitor local corrosion problems. The findings from these work programmes were used to develop a series of guidelines that will advise operators on operational factors to be considered when using advanced NOX reduction technologies. Factors identified include advice on fuel selection, coal blends and co-firing coal with biomass, particle milling requirements, particle residence times needed in different zones, optimum furnace stoichiometry and injection velocities, risk areas for and operational measures to combat slagging, measures for minimising problem corrosion conditions (including tube material selection) and ways of minimising cost penalties resulting from SRC catalyst deactivation when co-firing biomass.

		Country	*Scientific person in charge*
Partners	**RWE NPOWER PLC**	UNITED KINGDOM	Michael WHITEHOUSE (Pr. Coord.)
	ENERGY RESEARCH CENTRE OF THE NETHERLANDS	NEDERLAND	Rob KORBEE
	EMC ENVIRONMENT ENGINEERING LTD	UNITED KINGDOM	Michael WHITEHOUSE
	INSTITUTO SUPERIOR TECNICO	PORTUGAL	Mario COSTA
	KEMA NEDERLAND BV	NEDERLAND	Kees GAST
	RUHR-UNIVERSITÄT BOCHUM	DEUTSCHLAND	Viktor SCHERER
	UNIVERSITY OF LEEDS	UNITED KINGDOM	Bernard GIBBS

RFCR-CT-2003-00007 ADMONI

Development of advanced monitoring methodes to improve boiler availability and performance

Info	Type of Project	Research	Duration (months)	40
	Total Budget	1698392 €	Start Date	1/09/2003
	EU Contribution	1019035 €	End Date	31/12/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22994:EN			

Final Abstract Environmental constraints, emission regulations and market competition have led to efficient use of coal in power plants. Introduction of biomass in the feedstock of a coal-fired utility boiler is a cost-effective method to reduce CO2 emissions in energy generation, but it can affect combustion and heat transfer and enhance fouling inside the boiler. The necessity to monitor the operation and performance of a co-fired boiler online is obvious as it can lead to both financial and technical benefits. Development of online monitoring tools is a key activity in the supervision, diagnosis and control of the impact of ash fouling on the efficiency and operation of large co-fired boilers. These monitoring tools have to be based both on the design of new measurement practices and on the mathematical modelling of the physical processes, aiming at the accurate determination of the deposition rates. The Admoni project (Development of advanced monitoring methods to improve boiler availability and performance) aimed to study the effects of biomass co-firing on power plant availability by pilot and power plant measurements. For this purpose different types of fouling and corrosion probes were developed. The aim was also to develop online plant performance-based deposition formation monitoring methods and simulation software. This included both steady state and dynamic process simulations and boiler performance calculations which enable the quantification of the deposits and of the implications they have for boiler operation. Combustion kinetics and reactivity characteristics for selected project fuels were also determined.

		Country	*Scientific person in charge*
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	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Emmanuel KAKARAS
	FUNDACION CIRCE- CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERG.	ESPAÑA	Cristobal CORTES GRACIA
	EVN AG	OESTERREICH	Alois OTTER
	FORTUM POWER AND HEAT OY	FINLAND	Pertti MIELONEN
	TECHNISCHE UNIVERSITEIT DELFT	NEDERLAND	Hartmut SPLIETHOFF
	CRANFIELD UNIVERSITY	UNITED KINGDOM	John OAKEY

RFCR-CT-2003-00008 ASSOCOGS

Assessment of options for CO2 capture and geological sequestration

Info	Type of Project	Research	Duration (months)	45
	Total Budget	2941793 €	Start Date	1/09/2003
	EU Contribution	1765076 €	End Date	31/05/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23873:EN			

Final Abstract This project carried out research on a number of technologies which may be deployed for carbon capture and examined the possibility of using CO2 to enhance production of methane from disused coal mines. Parametric studies of oxyfuel coal combustion were completed under atmospheric conditions at 40 kW and 1 MW scale and at pressures up to 7.5 bar. A series of implications were drawn for the design and operation of a full-scale plant. Ceramic membranes were developed for CO2/H2 separation in gasification systems with catalytic destruction of NH3/H2S. Various techniques were employed to improve selectivities but achieving defect-free surfaces proved difficult. An apparatus was developed and also used to assess commercial Pd-Cu-Ag/V membranes. Reactor models were devised and concepts invented to allow effective use of membranes with low selectivities. Gas-liquid contact membranes were tested and proved to be a very promising alternative to conventional scrubbers. They offer high mass transfer area and modularity, with major reduction in device volume. A range of solid adsorbents for CO2 removal from post-combustion flue gas were developed and tested, with adsorption capacities >10 wt%. Regeneration strategies, both thermal swing with inert stripping gas were explored. Large-scale testing of adsorbent demonstrated that gas residence time is a key factor in determining adsorption performance. The programme established scientific and economic models of the methane production potential of CO2 injection into remnant coal-seams and validated the scientific model against commercial projects. Implications for the application to a full-scale plant of all the technologies have been reviewed.

Partners		*Country*	*Scientific person in charge*
	E.ON UK plc	UNITED KINGDOM	Robin IRONS (Pr. Coord.)
	ARTISTOTLE UNIVERSITY OF THESSALONIKI	HELLAS	George SAKELLAROPOULOS
	CERAMICS & REFRACTORIES TECHNOLOGICAL DEVELOPMENT COMPANY	HELLAS	Christos DEDELOUDIS
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	George SKODRAS
	IMC GEOPHYSICS LTD	UNITED KINGDOM	Peter JACKSON
	THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Colin E. SNAPE
	UNIVERSITAET STUTTGART	DEUTSCHLAND	Klaus R.G. HEIN

RFCP-CT-2004-00003 COMTES700

Component test facility for a 700 °C power plant

Info	Type of Project	Pilot&Demonstration	Duration (months)	90
	Total Budget	15189984 €	Start Date	1/07/2004
	EU Contribution	6075994 €	End Date	31/12/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25921:EN

Project web page http://www.comtes700.org/index.xhtml

Final Abstract The objective of Comtes700 was a test of components for the 700 °C power plant technology. A test facility of steam generator components up to a wall thickness of 50 mm was erected in an existing power plant. A partial steam flow from the host plant was heated up to 700 °C and operated for 22 400 hours. Compared to ferritic components, machining of nickel-based components lasted a minimum of four times longer. Maximum grain sizes in semi-finished products were achieved by a modified heat treatment. After adjustment of testing technology, overlaps of alloy 617B tubes were avoided. Evaporator materials functioned satisfactorily during operation. Updated material properties and reduced mechanical loads restricted the reliability statement. Superheater materials only failed once in a dissimilar weld. Some superheater materials may not reach a lifetime of 200 000 hours due to fireside corrosion. Thick-walled components from 30 to 50 mm in wall thickness displayed a susceptibility to stress relaxation cracking in welds. Additional stresses were caused by two-phase flow and insufficient design of spray attemperator. A solution for the workshop and repair welds was to conduct different heat treatment procedures. Valves functioned satisfactorily but after dismantling some internal cracks were found which could be avoided by design changes. Steam parameter measurements were proved. Non-destructive testing for initial and periodic inspection was developed during the project, but without having a relevant acceptance criterion. The component test was designed, manufactured, erected and operated, but it revealed challenges which were partly solved. Additional research activities are necessary before construction and operation of a 700 °C power plant in the near future.

		Country	*Scientific person in charge*
Partners	**VGB POWERTECH e.V.**	DEUTSCHLAND	Christian STOLZENBERGER (Pr. Coord.)
	ALSTOM POWER SYSTEMS GmbH	DEUTSCHLAND	Georg-Nikolaus STAMATELOPOULOS
	BURMEISTER & WAIN ENERGY A/S	DANMARK	Oluf KROGH
	DONG ENERGY THERMAL POWER AS	DANMARK	Joergen BUGGE
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	SIEMENS AG	DEUTSCHLAND	Heiner EDELMANN

RFCP-CT-2004-00002 DRYCOAL

Commercial-scale testing of a fluidized-bed drying plant for highly efficient lignite-fired power plants

Info	Type of Project	Pilot&Demonstration	Duration (months)	54
	Total Budget	6184654 €	Start Date	1/10/2004
	EU Contribution	2473862 €	End Date	31/03/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25912:EN			

Final Abstract Lignite plays an important role in Europe's power sector and contributes about 12 % on average to power generation in the EU-15 and the accession countries. In some countries like Greece, the Czech Republic, Germany and Poland the shares of lignite range between 35 and 70 %. In all cases, lignite as a domestic resource ensures security of supply and calculability, an aspect of growing importance to future energy supplies. Today, modern lignite-based power plant technology attains net efficiencies of over 43 %. Preventive climate protection by further reduction of CO2, the preservation of resources and further improvements in economy are major incentives for additional efficiency increases. In particular the very moist lignite offers the option of pre-drying to achieve further efficiency increases. Against this background, RWE Power started development work on a drying process suitable for power plants. From 1993 to 2003 a demonstration plant and an optimised, simplified and cost-effective test plant were successfully operated. On this positive basis, RWE Power is testing a commercial-scale drying module in a final development step with a dry lignite output of 110 t/h which is co-combusted in a modern lignite-fired power plant. The major results of the DRYCOAL project are: determination of all design data for a commercial-scale drier and its associated dry lignite-fired boiler, demonstration of the operational viability of a commercial-scale drying module and the dry lignite firing system, determination of the potential application of the pre-drying concept in other power plants.

		Country	*Scientific person in charge*
Partners	**RWE POWER AG**	DEUTSCHLAND	Claus MOSER (Pr. Coord.)
	ALSTOM POWER SYSTEMS GmbH	DEUTSCHLAND	Georg-Nikolaus STAMATELOPOULOS
	BOT ELEKTROWNIA BELCHATOW SPOLSKA AK	POLAND	Krzysztof PRZEGALINSKI
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Emmanuel KAKARAS
	PUBLIC POWER CORPORATION S.A.	HELLAS	Constantin CHALOULOS
	VATTENFALL EUROPE GENERATION AG & CO. KG	DEUTSCHLAND	Thomas BRUNNE

RFCR-CT-2004-00005 GEOASH

Understanding and mastering coal fired ashes geopolymerization process in order to turn potential into profit

Info

Type of Project	Research	Duration (months)	36
Total Budget	1203141 €	Start Date	1/11/2004
EU Contribution	721884 €	End Date	31/10/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23891:EN

Final Abstract

The EU regulations are restrictive with regard to solid residues and waste management. Research efforts to develop satisfying solutions are thus necessary. The GEOASH project aims, on one hand, at producing new geopolymeric matrixes using the advantageous properties of fine particles extracted from (co)-combustion fly ashes for the long-term stabilisation of inorganic hazardous wastes and, on the other, at predicting technologies for the recycling of coal ashes into added-value products which could be integrated in manufacture processes, allowing a reduction of primary resources consumption. The new geopolymer matrixes produced at room temperature in moderate alkaline conditions display a compressive strength of 60-80 MPa that is not affected by the particle size of the starting fly ashes. High content of unburned carbon (10 %) in the fly ash inhibits the reactions. The higher the amorphous phases content in fly ashes the higher the polymerisation degree typical of the geopolymer framework. Additionally, fly ashes with a high SiO2/Al2O3 ratio require less chemical reagents to reach high compressive strength, reducing significantly the cost of the geopolymerisation. Considering the pilot plant tests performed with a semi-industrial mixer, it appears that the amounts of water and chemical reagents may be reduced at pilot plant scale without an appreciable sacrifice in the properties of the geopolymer solids. Despite the rather satisfying results obtained by the leaching tests applied to two multimetal wastes that are difficult to stabilise, such as the MSWI residues and arc furnace dust solidified/stabilised in fly ash-based geopolymer matrixes, further research is still needed.

Partners

	Country	*Scientific person in charge*
INSTITUT SCIENTIFIQUE DE SERVICE PUBLIC	BELGIQUE	Diano ANTENUCCI (Pr. Coord.)
ASOCIACION DE INVESTIGACION Y COOPERACION IND. ANDALUCIA	ESPAÑA	Constantino PEREIRA
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UNIVERSIDAD DE SEVILLA	ESPAÑA	Constantino FERNANDEZ PEREIRA

Patents

O. Font, N. Moreno, X. Querol, M. Izquierdo, E. Alvarez, S. Diez, J. Elvira, D. Antenucci, H. Nugteren, F. Plana, A. Lopez, P. Coca, F.G. Pena. X-ray powder diffraction-based method for the determination of the glass content and mineralogy of coal (co)-combustion fly ashes. Fuel (2010), p. 2971 – 2976. doi.org/10.1016/j.fuel.2009.11.024.

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M. Izquierdo, N. Moreno, O. Font, X. Querol, E. Alvarez, D. Antenucci, H. Nugteren, Y. Luna, C. Fernandez-Pereira. Influence of the co-firing on the leaching of trace pollutants from coal fly ash. Fuel (2008), p. 1958-1966. DOI: 10.1016/j.fuel.2007.11.002. ISSN: 0016-2361.

E Alvarez-Ayuso, X Querol, F Plana, A Alastuey, N Moreno, M Izquierdo, O Font, T Moreno, S Diez, E Vázquez, M Barra. Environmental, physical and structural characterisation of geopolymer matrixes synthesised from coal (co-)combustion fly ashes. Journal of Hazardous Materials (2008), 175-83. DOI:10.1016/j.jhazmat.2007.10.00

M. Izquierdo, X. Querol, J. Davidovits, D. Antenucci, H. Nugteren, C. Fernandez-Pereira. Coal fly ash-slag-based geopolymers: Microstructure and metal leaching. Journal of Hazardous Materials (2009), pp 561 – 566. DOI: 10.1016/j.jhazmat.2008.11.063. ISSN: 0304-3894.

M. Izquierdo, X. Querol, C. Philippart, D. Antenucci, M. Towler. The role of open and closed curing conditions on the leaching properties of fly ash-slag-based geopolymers. Journal of Hazardous Materials (2010) pp 623-628. doi.org/10.1016/j.jhazmat.2009.11.075.

RFCR-CT-2004-00006 AGAPUTE

Advanced gas purification techn. for co-gasification of coal,refinery by-products,biomass & waste,targeted to clean power produced from gas & steam turbine generator set fuel cells

Info

Type of Project	Research	Duration (months)	42
Total Budget	2569812 €	Start Date	1/12/2004
EU Contribution	1541887 €	End Date	31/05/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24967:EN

Final Abstract

The objective of the project was to improve cleaning technologies, to be modelled, validated, interlinked in optimised processes and economically assessed for application to syngas, considering the enlargement of the fuel panorama. The work was organised in two main lines. The first line focused on the improvement of purification technologies, carried out at two levels :(a) development of better performing models, (b) scientific advancement on improved and innovative technologies. Level (a) activities carried out in WP3, interlinked with WP1–2 and WP13–16, produced a repository containing relevant techno-economic details about various gasification process scenarios. Level (b) activities were the subject of WP4–12.Although valuable scientific advancements have been reached, as demonstrated by published material in archived journals, their techno-economic impact in actual gasification processes has been achieved in only a few cases, mainly because this advanced knowledge could only be tested at the laboratory scale.The second line refers to the modelling, validation and techno-economic evaluation of optimised process schemes for gas cleaning, targeted at enhancing the industrial design of gasification processes at a preliminary stage. WP13 created and validated an innovative superstructure for modelling and simulating gasification processes that is supported by a modular software toolset (WP13–16), open to new features, standards-compliant, interoperable and allows for future development. A versatile simulation and optimisation toolkit was carried out for the first time for the preliminary design of new process alternatives, the redesign of existing ones and improvement of the operating conditions of real plants. However, further development is needed for commercial use.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Antonello DI DONATO (Pr. Coord.)
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Ana Maria MASTRAL
ELCOGAS SA	ESPAÑA	Pilar COCA LLANO
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Rafael KANDIYOTI
INSTITUTO NACIONAL DE ENGENHARIA, TECNOLOGIA E INOVACAO	PORTUGAL	Ibrahim GULYURTLU
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Colin E. SNAPE
UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)	ESPAÑA	Luis PUIGJANER
UNIVERSIDAD POLITECNICA DE MADRID	ESPAÑA	Carmen CLEMENTE

Selected Publications

Puigjaner, Luis (Ed.). Syngas from waste: Emerging Technologies, ISBN 978-0-85729-539-2, Springer-Verlag, London, Limited (2011). DOI 10.1007/978-0-85729-540-8.

"Muñoz, E.,Capón-García, E., Laínez, Espuña, A. Puigjaner, L., ""Considering environmental assessment in an ontological framework for enterprise sustanability"". Renewable Energy Global Innovations, ISSN: 2291-2460 (http://reginnovations.org/) 17 April 2013. Key Scientific article. In Journal of Cleaner Production, Available online 4 December 2012 (2013)."

"Puigjaner, L., Laínez, JM, Reklaitis, GV. "" Process Systems Engineering, 8. Plant Operation, Integration, Planning, Scheduling, and Supply Chain"" In ULLMANN'S Encyclopedia of Industrial Chemistry. © Wiley-VCH Verlag GmbH, 01/2013: pages 1-83, ISBN: 9783527306732."

Filomena Pinto, Helena Lopes, Rui Neto André, I. Gulyurtlu, I. Cabrita, Effect of Catalysts in the Quality of Syngas and By-Products Obtained by Co- Gasification of Coal and Wastes. 2. Heavy Metals, Sulphur and Halogen Compounds Abatement, Fuel 87 (2008) 1050–1062.

4.O. Font, X. Querol, M. Izquierdo, E. Alvarez, N. Moreno, S. Diez, R. Álvarez-Rodríguez, C. Clemente-Jul, P.Coca, F Garcia-Peña.Partitioning of trace elements in a entrained flow IGCC plant: Influence of selected operational conditions .Fuel 89 (2010), 3250-3261. doi:10.1016/j.fuel.2010.03.044. http://dx.doi.org/10.1016/j.fuel.2010.03.044

RFCR-CT-2004-00007 NODIOXCOMB

Zero "dioxin" releases in coal combustion and coal/organic waste co-combustion processes

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2868020 €	Start Date	1/12/2004
	EU Contribution	1720811 €	End Date	30/11/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25059:EN			

Final Abstract Basic technological developments aim at indirectly hindering dioxin/furan formation by greatly decreasing free hydrochloric acid and by neutralising catalytic effects of heavy metals swept along inside fly ash-loaded gases at combustor output. Addition of lime, potassium hydroxide and sodium carbonate (10 w %) decreases both dioxins/furans and heavy metals (Cu, Mn, Co, Cr, etc.) during lignite/RDF co-combustion. Gaseous ammoniainjected into the raw gases after the combustion bed within a temperature range of 400–450 °C induces a decrease of PCDD/DFs released in flue gases (varying from 50 % to 90 %). Other end-of-pipe processing treatments are targeted to trap multi-pollutants in flue gases. Extruded ceramic composite clay/activated carbon (with AC content of up to 75 w %) can be successfully produced in various geometries (honeycomb, hollow tubes, etc.) and are potential PCDD/DFs adsorbers. Composite bag filters (P84/AC/P84) exhibit good dust filtration efficiency (higher than 99 w %) and high dioxin/furan adsorption capacity (a few hours, depending on the flue gas contamination level). Both of them can be regenerated by PCDD/DFs thermal desorption and destruction into the combustion unit. HyColl industrial technology (> 99.9 % particulate and > 99 % heavy metals collection efficiency) is a suitable best available technology candidate for coal power plants and could be an appropriate and low-cost add-on retrofit technology to existing plants withelectrostatic precipitators (HyColl investment is about 50 % of fabric filters investment).

		Country	*Scientific person in charge*
Partners	**INSTITUT SCIENTIFIQUE DE SERVICE PUBLIC**	BELGIQUE	Pierre LANDUYT (Pr. Coord.)
	ASOCIACION DE INVESTIGACION Y COOPERACION IND. ANDALUCIA	ESPAÑA	Luis SALVADOR MARTINEZ
	ARTISTOTLE UNIVERSITY OF THESSALONIKI	HELLAS	George SAKELLAROPOULOS
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	George SKODRAS
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Jesus BLANCO
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Eros Luciano FARACI
	ENDESA GENERACION SA	ESPAÑA	Antonio GIMENEZ ALONSO
	ENERVAC-FLUTEC Ltd	HELLAS	Athanasios KATSANEVAKIS
	INGENIERIA ENERGETICA Y DE CONTAMINACION S.A.	ESPAÑA	Francisco RODRIGUEZ BAREA
	SIOEN-NORDIFA S.A.	BELGIQUE	Bernard COLSON
	UNIVERSITY OF NEWCASTLE UPON TYNE	UNITED KINGDOM	Keith Mark THOMAS

RFCR-CT-2005-00010 FLOX-COAL

Development of a pilot-scale flameless oxidation burner for ultra low NOx combustion of pulverised coal

Info

Type of Project	Research	Duration (months)	36
Total Budget	2996203 €	Start Date	1/06/2005
EU Contribution	1797722 €	End Date	31/05/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24188:EN

Final Abstract

This project aims to develop new flameless oxidation (FLOX) burners for lignite and bituminous coals combustion. Development of the coal FLOX burners is supported by experimental investigation and by CFD modelling. Based on the results obtained, the most promising design will be scaled up to pilot-scale and tested. The burner has to meet the following challenging measurable objectives: - NOx emissions inferior 200 mg/Nm3 (at 6 % 02), - CO emissions inferior 100 mg/Nm3 (at 6 % 02), - C in ash inferior 5 %. The project evaluated the necessary aspects of coal FLOX burner development and up-scaling: Coal FLOX burner design: It became apparent from experimental data obtained from different burner designs and different coal types that a single FLOX burner design would be capable of firing the full range of coals specified. Experimental investigation: Testing on bench and pilot-scale was successfully completed. Experiments showed an overall NOx reduction capability with the current burner design of about 20-50 % depending on coal type and burner excess air ratio. Coal FLOX burner up-scaling: Designs for a 2 MWt and a 40 MWt coal-fired FLOX burner were developed. The impact of FLOX combustion with the 40 MWt design burners installed on wall-fired and tangentially-fired plant was investigated using engineering performance models and CFD. In all cases the impact on furnace performance was moderate. The full-scale testing of a 40 MWt coal FLOX burner was shown to be feasible.

Partners

	Country	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Anja SCHUSTER (Pr. Coord.)
ELECTRICITE DE France	FRANCE	Pierre PLION
ELEKTROWNIA OPOLE SA	POLAND	Edward KINAL
INSTYTUT ENERGETYKI	POLAND	Tomasz GOLEC
INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE ROUEN	FRANCE	David HONORE
DOOSAN BABCOCK ENERGY LTD	UNITED KINGDOM	Gerard HESSELMANN
NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Emmanouil KAKARAS
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Reinhold KNEER
WS WÄRMEPROZESSTECHNIK GmbH	DEUTSCHLAND	Joachim G. WÜNNING

RFCR-CT-2005-00006 OXYMOD

Development and experimental validation of a mathematical modelling methodology for oxy-fuel combustion for CO2 capture in large power plants

Info	Type of Project	Research	Duration (months)	40
	Total Budget	2156685 €	Start Date	1/07/2005
	EU Contribution	1294011 €	End Date	31/10/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24248:EN			

Final Abstract "Mathematical modelling has in recent years proven to be a useful and cost-reducing tool for design and improvement of conventional pulverised coal-fired power plants. The OxyMod project has strived to extend existing combustion modelling capabilities to oxyfuel combustion conditions, the primary intended output being upgraded CFD codes that include oxy-fuel-modelling capability for industry and research. A unique consortium suitable for the task including CFD model developer and user (Vattenfall Research and Development AB, IVD Stuttgart, National Technical University of Athens), experimental test rig operators (Chalmers, IVD Stuttgart), one of the leading manufacturer of power boilers (Doosan Babcock Energy Limited) and commercial code developer and manufacturer (Ansys UK Limited). The project has combined experimental work in the largest existing oxy-fuel test rigs in Europe, model development and implementation, and initial validation through comparisons to experimental data. An extensive database of oxy-fuel (and air) combustion trials in gas- and coal-fired test rigs has been compiled. Improved sub-models have been developed and implemented in the CFD codes Aiolos and Fluent, and in the engineering performance model BWHOT. Initial validation in 20kW, ""lOOkW and 500kW test rigs has proved that the combustion models developed are principally capable of predicting the more moderate combustion under oxy-fuel conditions. Space for further model development and evaluation work was, however, also identified. Final application of the developed models to a reference 600MWe coal fired once through supercritical boiler design showed that the impact of introducing oxy-fuel was not excessive, thereby confirming the initial design intent. The results and the further development of the CFD codes are expected to be used in the upcoming (2009-12) pre-engineering of oxy-fuel demonstration plants/combustors in Europe."

		Country	*Scientific person in charge*
Partners	**VATTENFALL RESEARCH AND DEVELOPMENT AB**	SVERIGE	Leif BRANDELS (Pr. Coord.)
	CHALMERS TEKNISKA HÖGSKOLA AB	SVERIGE	Filip JOHNSSON
	FLUENT EUROPE LIMITED	UNITED KINGDOM	Christopher CAREY
	DOOSAN BABCOCK ENERGY LTD	UNITED KINGDOM	Ragi PANESAR
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Emmanouil KAKARAS
	UNIVERSITAET STUTTGART	DEUTSCHLAND	Uwe SCHNELL

RFCR-CT-2005-00007 CLYCARGAS

Clean syngas from carbonaceous materials gasification for highly efficient electric energy generation

Info

Type of Project	Research	Duration (months)	36
Total Budget	2500804 €	Start Date	1/07/2005
EU Contribution	1500482 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25055:EN

Final Abstract

The project was focused on the production of tar-free gas obtained from gasification of coal mixed with low-grade coal and co-fuels, to be directly used for highly efficient electric energy production in gas turbine-operated plants or in fuel cells. The aim is to identify appropriate conditions inside the gasifier and operating conditions for separated downstream units, to minimise tar formation and to establish control systems and criteria for the industrial application of the identified technological solutions.The work steps were the following.• Characterisation of fuels/co-fuels at laboratory scale to give an indication of the quality/quantity of tar expected in the syngas.• Development of gasification models for designing process conditions.• Preparation, characterisation and evaluation of catalyst performance for tar destruction and investigation of catalyst regeneration strategy.• Experimentation with tar removal techniques in the pilot plant using different technological options and reactor configurations.• Development of expert systems and scaling-up criteria.Main results of the project.• Characterisation of fuels and co-fuels was performed, using chemical methods, thermogravimetric techniques and microscopic analysis. Reactivity tests were performed to gather information on temperature ignition of coal/biomass blends.• Models of gasification in fixed and fluidised beds were developed to predict syngas quality and tar formation.• The influence of the characteristics of the catalysts on their efficiency was defined and suitable conditions to be applied in tar abatement units were individuated.• Pilot plant scale testing gave an indication on the parameters responsible for tar content, on suitable gasification conditions and plant configurations, also integrating the gasifier with downstream tar abatement units.• Control systems and logic for process control logic were developed and criteria for industrial application of the results of pilot plants were defined.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Antonello DI DONATO (Pr. Coord.)
ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Claudio ZEPPI
TECHNIP K.T.I. SPA	ITALIA	Gaetano IAQUANIELLO
LABORATORIO NACIONAL DE ENERGIA E GEOLOGIA IP	PORTUGAL	Ibrahim GULYURTLU
SOCIETÀ TECNOLOGIE AVANZATE CARBONE S.P.A. - SOTACARBO	ITALIA	Enrico MAGGIO
TECNATOM S.A.	ESPAÑA	Andrés SANCHEZ BIEZMA
UNIVERSITY OF NEWCASTLE UPON TYNE	UNITED KINGDOM	Keith Mark THOMAS
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Edward LESTER

Selected Publications

Filomena Pinto, M. Helena Lopes, A. Teresa Crujeira, Rui André, Mário Dias, Ibrahim Gulyurtlu, Isabel Cabrita, Environmental impact of wastes valorisation through co-gasification with coal, oral communication in 7th European Conf. on Industrial Furnaces and Boilers, Porto, Portugal, April, 2006.

I. Gulyurtlu, Filomena Pinto, Helena Lopes, Rui Neto André, Mário Dias, I. Cabrita, S, Cl and N gas/solid partition during co-gasification of coal mixed with cardoon, oral communication in CCT 2007 – 3rd International Conf. on Clean Coal Technologies for our Future, Sardinia, Italy, May, 2007.

Rui Neto André, I. Gulyurtlu, Filomena Pinto, Helena Lopes, Mário Dias, I. Cabrita, Analysis of the Potentialities of Gasification of Different Species of Biomass for Energy Production, oral communication in Bioenergy: Challenges and Opportunities - International Conference and Exhibition on Bioenergy, Guimarães, Portugal, April, 2008.

Filomena Pinto, C. Franco, R. André, Helena Lopes, I. Gulyurtlu, I. Cabrita, Co-Gasification of Coal and Wastes in a Pilot-Scale Installation. 1. Effect of catalysts in syngas treatment to achieve tar abatement, Fuel 88 (2009) 2392–2402.

RFCR-CT-2005-00008 CO.CA.CO.R.K.

Coal catalytic co-gasification in an innovative rotary Kiln gasifier

Info				
	Type of Project	Research	Duration (months)	36
	Total Budget	2098332 €	Start Date	1/07/2005
	EU Contribution	1259000 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25043:EN

Final Abstract The project aimed at developing a new gasification process by the use of an innovative gasifier named DIRK (differentiated injection rotary kiln), based upon CSM technology (patent 0001352001, 19 January 2009), fed by coals and co-fuels (i.e. waste/biomass) in order to produce a syngas suitable for micro gas turbines, internal combustion engines or fuel cells (after the extraction of hydrogen), for distributed power generation.The main activities of this project consisted of :• creation of a data bank in the Internet environment, in which all the data collected regarding the coals and waste/biomass characterised have been classified. • designing, building and setting up of a pilot-scale innovative DIRK gasifier. • gasification tests carried out on the DIRK and on traditional reactors (i.e. fluidised bed) to compare their performance. • analysis of different syngas clean-up options to determine their suitability to treat the syngas produced by the DIRK. • analysis of the possible markets for the DIRK and investigation of the economic aspects related to the DIRK operation.The results indicate that the DIRK gasifier, in comparison with traditional technologies, is characterised by flexible use with different types of coal and co-fuels feedstocks, without significant preliminary preparation and with easy control of the process, at competitive cost, in terms of syngas clean-up and management of the plant. These characteristics make the DIRK a suitable technology for distributed power generation for local applications that can self-produce energy from their by-products, such as agriculture residues, wood residue and wastes at relatively high calorific values.

Partners		*Country*	*Scientific person in charge*
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Claudio LEPORATI (Pr. Coord.)
	ANSALDO ENERGIA S.p.A.	ITALIA	Maria Luisa PELIZZA
	ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Claudio ZEPPI
	LABORATORIO NACIONAL DE ENERGIA E GEOLOGIA IP	PORTUGAL	Ibrahim GULYURTLU
	SOCIETÀ TECNOLOGIE AVANZATE CARBONE S.P.A. - SOTACARBO	ITALIA	Alberto PETTINAU
	THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Colin E. SNAPE
	UNIVERSIDAD DE ZARAGOZA	ESPAÑA	Jesus ARAUZO PÉREZ

Patents

EP1612482 A3 - Waste disposal apparatus - Medardo Pinti, Maria Ilaria Pistelli, Giuseppe Rosario Todarello (URL http://www.google.com/patents/EP1612482A3?cl=en)

EP 2454349 A2 - Process and apparatus for the thermal treatment of refinery sludge - Michelangelo D'Abbieri, Felicia Massetti, Medardo Pinti, Maria Ilaria Pistelli, Giacomo Fernando Rispoli (URL http://www.google.com/patents/EP2454349A2?cl=en)

Selected Publications

G. Garcia, J. Arauzo, A. Gonzalo, J.L. Sanchez, J. Abrego, Influence of feedstock composition in fluidised bed co-gasification of mixtures of lignite, bituminous coal and sewage sludge, CHEMICAL ENGINEERING JOURNAL Volume: 222 Pages: 345-352 DOI: 10.1016/j.cej.2013.02.073 Published: APR 15 2013

G. Garcia, E. Cascarosa, J. Abrego, A. Gonzalo, J.L. Sanchez, Use of different residues for high temperature desulphurisation of gasification gas, CHEMICAL ENGINEERING JOURNAL Volume: 174 Issue: 2-3 Pages: 644-651 DOI: 10.1016/j.cej.2011.09.085

G. García, E. Campos, I. Fonts, J. L. Sánchez, and J. Herguido, Gas Catalytic Upgrading in a Two-Zone Fluidized Bed Reactor Coupled to a Cogasification Plant , pp 2835–2845 Publication Date (Web): April 18, 2013 (Article) DOI: 10.1021/ef400227z

F. Pinto, H. Lopes, A. Rui Neto, M. Dias, I. Gulyurtlu, I. Cabrita, Effect of Experimental Conditions on Gas Quality and Solids Produced by Sewage Sludge Cogasification. 1. Sewage Sludge Mixed with Coal, Energy & Fuels 2007, 21, 2737-2745.

F. Pinto, A. Rui Neto, C. Franco, H. Lopes, C. Carolino, R. Costa,I. Gulyurtlu, Co-gasification of coal and wastes in a pilot-scale installation. 2: Effect of catalysts in syngas treatment to achieve sulphur and nitrogen compounds abatement, Fuel 89 (2010) 3340–3351

RFCR-CT-2005-00009 CFB800

Utility scale CFB for competitive coal power

Info	Type of Project	Research	Duration (months)	36
	Total Budget	3396235 €	Start Date	1/09/2005
	EU Contribution	2037743 €	End Date	31/08/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24357:EN			

Final Abstract technology to 800 MWe size. Scaling up the technology to 'real' utility scale (600-800 MWe) with a net efficiency of 45 % or more was needed to fulfil the future requirements of utility operators. The character of CFB technology with fuel and operational flexibility and multifuel capability can provide economic and environmental advantages also in utility scale and can thereby improve operators' competitiveness in deregulated energy markets. During the project a viable CFB plant design of 800 MWe was developed. The calculated net plant efficiency of the CFB800 was 45 % (600 °C/300 bar). The design resulted in a furnace cross-section of 40 x 12 m, and a furnace height of 50 m. The furnace dimensions are clearly larger than those found in existing units. The water and steam side of the design is based on low mass flux Benson once-through technology. This technology is ideal for CFB conditions, as it utilises vertical furnace tubes rather than the spiral-wound tubing used in many other once-through designs. A cost structure of the CFB800 concept was determined for the complete power plant. The investment costs of the plant are on the same level as pulverised coal plants, and the slightly higher operating costs can be offset against the possible use of cheaper fuels (e.g. low-grade coals). The electricity price shows a competitive value for CFB800 compared with other generation technologies, especially when opportunity fuels are used.

		Country	*Scientific person in charge*
Partners	**TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND**	FINLAND	Jouni HAMALAINEN (Pr. Coord.)
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Nikolaos KOUKOUZAS
	FUNDACION CIRCE- CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERG.	ESPAÑA	Cristobal CORTES GRACIA
	ENDESA GENERACION SA	ESPAÑA	Juan Carlos BALLESTEROS APARICIO
	FOSTER WHEELER ENERGIA OY	FINLAND	Timo HYPPÄNEN
	SIEMENS AG	DEUTSCHLAND	Andre SCHRIEF

RFC2-CT-2006-00005 CCTPROM

Clean coal technology R, D&D promotion and dissemination

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	290353 €	Start Date	1/07/2006
	EU Contribution	186902 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23583:EN			

Final Abstract This project has provided a means to valorise the technical achievements of the CCT power generation RD&D activities arising from the ECSC and RFCS coal utilisation programmes. The focus has been on promotion and dissemination of such results to major coal-using Member States that have recently joined the European Union, namely Poland, the Czech Republic and Romania. A comprehensive review of the scope and achievements of the ECSC and RFCS projects on coal-fired power generation RD&D has been prepared and posted on the IEACCC website. This document has been translated by the partners in the three designated States and disseminated to their respective national stakeholders. Workshops have been held successfully in each country to promote the findings of the review and to determine their respective primary interests in future RD&D. The attendees have included representatives of major power plant operators, equipment manufacturers and developers, research institutes and universities. Very positive feedback was received from those stakeholders. The project has been completed with the circulation of the report and associated information to comparable stakeholders in the EU-15 countries and other newer members of the European Union via various networks and associations.

		Country	*Scientific person in charge*
Partners	**IEA COAL RESEARCH LIMITED**	UNITED KINGDOM	Andrew MINCHENER (Pr. Coord.)
	INSTITUTUL DE STUDII SI PROIECTARI ENERGETICE SA	ROMANIA	Carmencita CONSTANTIN
	SEVEN - STREDISKO PRO EFEKTIVNI VYUZIVANI ENERGIE o.p.s.	CZECH REPUBLIC	Bohuslav MALEK
	SILESIAN UNIVERSITY OF TECHNOLOGY - POLITECHNIKA SLASKA	POLAND	Andrzej SZLEK

RFCP-CT-2006-00011 CERCOT

CO2 emission reduction through combustion optimisation technologies at coal-fired power plants

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	3250225 €	Start Date	1/07/2006
	EU Contribution	1300090 €	End Date	30/06/2009
State	Project suspended, no final report published			

Provisional Abstract

This project is devoted to the development and full-scale validation of technologies for reducing CO2 emissions in pulverised coal power plants, by means of increased efficiency and fuel flexibility strategies.
The approach to be used relies on the following complementary scopes:
- Adaptation and industrial application of a novel combustion control based on in-furnace monitoring, which was successfully developed in a previous ECSC project for Nox optimisation.
- Development of a novel burner with higher fuel flexibility capabilities.
Fuel scenarios to be considered include combustion of different types of coals and coal/biomass cofiring.

		Country	*Scientific person in charge*
Partners	**ENDESA GENERACION SA**	ESPAÑA	Juan Carlos BALLESTEROS APARICIO (Pr. Coord.)
	ANSALDO CALDAIE S.p.A.	ITALIA	Alessandro SAPONARO
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Panagiotis GRAMMELIS
	ECOENERGIA Sp ZOO	POLAND	Jan SIWINKSI
	INGENIERIA ENERGETICA Y DE CONTAMINACION S.A.	ESPAÑA	Francisco RODRIGUEZ BAREA

RFCR-CT-2006-00006 ABETRAP

Abatement of emissions of trace pollutants by FGD from co-combustion and environmental characteristics of by-products

Info

Type of Project	Research	Duration (months)	36
Total Budget	2324489 €	Start Date	1/07/2006
EU Contribution	1394693 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25083:EN

Final Abstract

Abetrapproject has studied the influence of co-firing coal and alternative fuels (29 % biomass, 4–26 % pet-coke) on speciation, partitioning, leachability and FGD abatement capacity for trace pollutants. The identification of major problems and the development of remediation measures have also been investigated, as well as the potential commercial uses of by-products. An intensive characterisation programme has been executed, including seven sampling campaigns at six European power plants feeding different fuels and with different FGD designs. Generally, co-firing is of low relevance on the aforementioned issues, being those controlled by plant and environmental equipment operational conditions. The co-firing of high percentages of pet-coke (26 %) may be of relevance when using a pet-coke rich in metals (resulting in hazardous PFA for landfilling). All the emissions are below the limits established by the LCP directive, although a 29 % biomass co-firing ratio produces Cl and F emissions slightly higher than the PRTR threshold limits. In view of that, it can be stated that up to 26–30 % co-firing of biomass and pet-coke may be applied to power plants equipped with wet FGD systems without significant environmental concerns. Fluorine has been the only element in gypsum exceeding the leachable limits established for non-hazardous waste landfilling without a clear influence of co-firing. High environmental quality gypsum may be produced by preventive addition of Al-sulphate in the scrubber or by corrective measures. Gypsum fire panels have been manufactured using some FGD-gypsum studied, having shown comparable and even better results respecting products commercially available.

Partners

	Country	*Scientific person in charge*
ENDESA GENERACION SA	ESPAÑA	Juan Carlos BALLESTEROS APARICIO (Pr. Coord.)
CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Nikolaos KOUKOUZAS
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Xavier QUEROL
KEMA NEDERLAND BV	NEDERLAND	Rudolf MEIJ
THE UNIVERSITY OF NOTTINGHAM	UNITED KINGDOM	Mercedes MAROTO-VALER
UNIVERSIDAD DE SEVILLA	ESPAÑA	Constantino FERNANDEZ PEREIRA

Selected Publications

Córdoba P, Font O, Izquierdo M, Querol X, Leiva C, López-Antón MA, Díaz-Somoano M, Martinez-Tarazona MR, Gómez P. Role of the operational conditions co-combustion power plant on the retention capacity for trace inorganic species by the flue gas desulphurisation system. Fuel, 102 (2012) 773–788.

Córdoba P, ,Font O. Izquierdo M, Querol X, Leiva C, López-Antón MA, Díaz-Somoano M, Martinez-Tarazona MR, Fernandez C, Tomás, A. Partitioning of trace inorganic elements in a coal-fired power plant equipped with a wet Flue Gas Desulphurisation system. Fuel, 2012, 92 (1):145-157. DOI: 10.1016/j.fuel.2011.07.025.

Córdoba P, Font O, Izquierdo M, Querol X, Tobías A, López-Antón MA, Ochoa-Gonzalez R, Díaz-Somoano M, Martínez-Tarazona MR, Ayora C, Leiva C, Fernández C, Giménez A. Enrichment of inorganic trace pollutants in re-circulated water streams from a wet limestone flue gas desulphurisation system in two coal power plants. Fuel Processing Technology, 2011, 92 (9): 1764-1775. http://dx.doi.org/10.1016/j.fuproc.2011.04.025

Ochoa-González R, Córdoba, P, Díaz-Somoano M, Font O, López-Antón MA, Leiva C, Martínez-Tarazona MR, Querol X, Fernández-Pereira C, Tomás A, Gómez P, Mesado P. Differential partitioning and speciation of Hg in wet FGD facilities of two Spanish PCC power plants, Chemosphere, 2011, 85 (4): 565-570. http://dx.doi.org/10.1016/j.chemosphere.2011.06.081

IJA-CSIC with the collaboration of USEV, KEMA, CERTH/ISFA and ENDESA. INTEGRATION OF THE RESULTS AND RECOMMENDATIONS. Data: Abetrap project deliverable 6.

RFCR-CT-2006-00007 FriendlyCoal

Cost effective and environmental friendly oxyfuel combustion of hard coals

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2364382 €	Start Date	1/07/2006
	EU Contribution	1418630 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25000:EN

Project web page http://www.es.mw.tum.de/index.php?id=102

Final Abstract

The design of today's oxyfuel steam boilers in development aims at a similar heat transfer distribution to the water-steam cycle as a conventional air fired boiler. With this approach the existing experiences from air fired plants can be used for the new technology. The Friendly Coal project compared this approach with a new approach to oxyfuel combustion, which allows a reduction of the necessary recirculation rate and promises an optimised oxyfuel boiler of the second generation. Both concepts were looked at in detail. The new concept of Controlled Staging with Non-stoichiometric Burners (CSNB) with low recirculation and the common concept with high recirculation were validated with experiments and simulations in pilot and medium scale experiments. Based on the gained knowledge and validated simulation models two 300 MWth steam boilers were designed with high and low recirculation rate. An economical evaluation of both approaches finalised the comparison.Both experimental campaigns showed successfully the viability of the combustion processes. The design of the high recirculation boiler was possible with only slight changes to a design for an air fired case. A more compact low recirculation boiler design with the CSNB concept was developed with a recirculation rate of 57 %. The lower bound for the recirculation rate was due to heat transfer efficiency in the convective boiler part, not due to inadmissible high flame temperatures. The net efficiency of the reduced recirculation concept was 0.23 % better. The specific investment costs decrease 6 % and the electricity costs 3 % compared to the high recirculation concept.

Partners

	Country	*Scientific person in charge*
TECHNISCHE UNIVERSITAET MUENCHEN	DEUTSCHLAND	Hartmut SPLIETHOFF (Pr. Coord.)
ANDRITZ ENERGY & ENVIRONMENT GmbH	OESTERREICH	Paul RENETZEDER
DANMARKS TEKNISKE UNIVERSITET	DANMARK	Anker DEGN JENSEN
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SIEMENS AG	DEUTSCHLAND	Joachim FRANKE
TECHNISCHE UNIVERSITAET GRAZ	OESTERREICH	Ulrich HOHENWARTER

Selected Publications

A combustion concept for oxyfuel processes with low recirculation rate – Experimental validation. Combustion and Flame, Volume 158, Issue 8, August 2011, Pages 1542–1552. http://dx.doi.org/10.1016/j.combustflame.2010.12.029

Validation of spectral gas radiation models under oxyfuel conditions—Part B: Natural gas flame experiments. http://dx.doi.org/10.1016/j.ijggc.2011.05.006. International Journal of Greenhouse Gas Control, Volume 5, Supplement 1, July 2011, Pages S66–S75.

Validation of spectral gas radiation models under oxyfuel conditions – Part C: Validation of simplified models. http://dx.doi.org/10.1016/j.ijggc.2012.07.011. International Journal of Greenhouse Gas Control,Volume 11, November 2012, Pages 34–51 .

Validation of spectral gas radiation models under oxyfuel conditions. Part A: Gas cell experiments. http://dx.doi.org/10.1016/j.ijggc.2011.05.005. International Journal of Greenhouse Gas Control, Volume 5, Supplement 1, July 2011, Pages S76–S99.

Coal devolatilization and char conversion under suspension fired conditions in O2/N2 and O2/CO2 atmospheres. http://dx.doi.org/10.1016/j.fuel.2010.03.019. Fuel, Volume 89, Issue 11, November 2010, Pages 3373–3380.

RFCR-CT-2006-00008 CLEAN SELECTIVE

Intelligent monitoring and selective cleaning control of deposits in pulverised coal boilers

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2073614 €	Start Date	1/07/2006
	EU Contribution	1244169 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25084:EN			

Final Abstract

Within the EU-funded project 'Clean selective', software and hardware sensors have been developed and used to monitor the ash deposition in the Teruel plant. As hardware sensors in the convective section, strain gauges were applied to the hanger rods of a superheater for the first time. Heat flux sensors were used in the furnace area to observe deposition evolution. Additionally, 3D-CFD calculations were performed for the boiler and results were used as input for the Ash Deposition Predictor developed, which monitors the ash deposition on the surfaces as maps. The sensor signals are used to decide when and where soot-blowers should be activated to effectively clean the heat exchangers. In the furnace section, heat flux sensor signals do not indicate the effectiveness of soot-blowing on deposition removal. Therefore, neural network models have been developed to decide on the activation of a soot-blower. These models are trained on historical data of soot-blowing in the furnace. In addition, the heat flux signals are compared to the depositions maps. In the convective section, the hardware sensor indicates deposition evolution without the location on the observed superheater. Therefore, historical data have been used to identify areas of heavy deposition, which are compared to the maps from the ash deposition calculations. Thus a predictive tool for the detection of ash deposition in a boiler has been developed combining hardware and software sensors. This system has been successfully tested for a two month period, where an efficiency rise could be predicted.

Partners		*Country*	*Scientific person in charge*
	TECHNISCHE UNIVERSITAET MUENCHEN	DEUTSCHLAND	Hartmut SPLIETHOFF (Pr. Coord.)
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	FUNDACION CIRCE- CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERG.	ESPAÑA	Cristobal CORTES GRACIA
	CLYDE BERGEMANN GmbH MASCHINEN UND APPARATEBAU	DEUTSCHLAND	Stephan SIMON
	ENERGY RESEARCH CENTRE OF THE NETHERLANDS	NEDERLAND	Rob KORBEE
	ENDESA GENERACION SA	ESPAÑA	Juan Carlos BALLESTEROS APARICIO

Selected Publications

Spliethoff, H., Ballesteros, J.C., Bertrand, C., Cortes, C., Diez, L. I., Martinez, P. F. et al. Increase of boiler efficiency by means of targeted onload cleaning utilizing information based on mathematical modelling and advanced measurement techniques. Power-Gen Europe (2009), Pennwell

Mazuque G., Peña B., Díez L. I., Cortés C., Teruel E. On-line Thermal Simulation of Pulverized Coal Utility Boilers for Optimized Soot-blowing Control. European Conference on industrial furnaces and boilers (2008)

van de Kamp, W.L., Cieplik, M.K., Kalivodová J., Zagórski, T.J.: In-boiler diagnostics of Slagging and Fouling Propensity for Pulverised Coals and Biomass/Waste Fuels at Laboratory and Full Scale. European Conference on industrial furnaces and boilers (2008)

RFCR-CT-2006-00009 OxyBurner

Development of advanced large scale low NOx oxy-fuel burner for PF combustion

Info

Type of Project	Research	Duration (months)	36
Total Budget	1444391 €	Start Date	1/07/2006
EU Contribution	866634 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25333:EN

Final Abstract

The new oxy-fuel process offers and also requires R & D activities along the whole process chain. Still, one key component in a highly efficient and environment-friendly combustion system is the burner. In the past, much efforts was spent to develop low-NOX burners for all ranks of coal and to efficiently integrate such burners into advanced firing concepts such as furnace air staging or fuel reburning. The project focuses on the development and testing of an efficient, clean, large scale low-NOX oxy-fuel burner concept for lignite and sub-bituminous coals. In this context substantial firing system and burner parameters were investigated in order to gather a complete evaluation of a single component (burner) and the overall potential of this new process. Some of these parameters are listed below: • testing of an advanced low-NOx oxy-burner design (up/down scaling). • oxygen injection method (pre-mixing, direct injection). • operational issues like switching from air to oxy-fuel mode and vice versa. • burner performance evaluation by using different CFD models. • process evaluation by investigating different cooling concepts. The project has combined experimental work, CFD modelling and cross validation through experimental data. The generated up/downscaling results of a 500 kW and the 30 MWth produces results that are fruitful for commercial application. Furthermore, in-flame measurements and operational experience regarding burner testing from a 30 MWth lignite-fired oxy-fuel plant are presented. Two individual large-scale advanced low-NOx burner designs (swirl and jet burner) are worked out as being applicable for lignite and medium- to high-volatility sub-bituminous coals.

Partners

	Country	*Scientific person in charge*
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NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Emmanouil KAKARAS
VATTENFALL EUROPE GENERATION AG & CO. KG	DEUTSCHLAND	Norbert JENTSCH

RFCR-CT-2006-00010 BOFCom

Application of the biomass, oxyfuel and flameless combustion for the utilisation of pulverised coals for electricity generation

Info

Type of Project	Research	Duration (months)	42
Total Budget	1622372 €	Start Date	1/07/2006
EU Contribution	973423 €	End Date	31/12/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25128:EN

Final Abstract

This project aimed to develop efficient, low-carbon options for coal use in coal-fired power plants by integrating three technologies: coal-biomass co-firing, oxyfuel and flameless combustion. A novel concept was developed by using: (a) lab-scale experiments to assess the behaviour of fuels and blends under oxyfuel conditions, (b) pilot scale tests to evaluate optimised configurations, and (c) mathematical models to study the application of the combined configuration for existing and new-build applications. The lab-scale tests assessed deposit formation phenomena using selected coals and biomass blends. The pilot-scale trials provided information on radiative and convective heat transfer and flame characteristics for different recirculation ratios, giving an indication of the likely behaviour of full-scale boilers. Finally, CFD simulations were used to assess the overall effect of retrofitting conventional full-scale power plants, making use of data generated in the experimental tasks. The results indicate clear changes in heat transfer patterns when retrofitting oxy-fuel technology, giving rise to specific implications for flame stability and ash deposition. These properties were measured for different coal and biomass fuels. The combination with flameless combustion gave an indication of the effects of mixing and the impact of high CO2 levels when designing retrofit and new-build installations. ASPENplus calculations demonstrated the increased possibilities of heat integration for retrofit boilers, due to the higher oxyfuel combustion temperatures and the increased cooling requirements of the air and CO2 compressors. Techno-economic studies compared the available state-of-the-art of the involved technologies and assessed the economic viability of the combined BOFCom concept.

Partners

	Country	*Scientific person in charge*
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RFCR-CT-2007-00008 DENOPT

Optimisation of SCR-DeNOx catalyst performance related to deactivation and mercury oxidation

Info

Type of Project	Research	Duration (months)	36
Total Budget	1887164 €	Start Date	1/07/2007
EU Contribution	1061839 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25331:EN

Final Abstract

The Denopt project aimed at optimising existing and developing new SCRDeNOx catalysts applied at coal fired power plants. Special emphasis was put on catalyst deactivation and mercury oxidation, but nevertheless NOx reduction and SO2–SO3 conversion were considered, too. New catalysts for high dust application were produced and tested in extensive tests in lab-scale and bench-scale reactors. New promising materials like copper, manganese, iron and cerium were introduced into the catalyst material and their effects on mercury oxidation, DeNOx activity and SO2–SO3 conversion were determined. Some of the materials showed a mercury oxidation level almost twice as high at only slightly increased SO2–SO3 conversion compared to a commercial catalyst. As important parameters, the flue gas HCl content was identified. Furthermore, the interaction of DeNOx reaction and mercury oxidation was shown with a strong influence of flue gas ammonia concentration on mercury oxidation. A new approach of low temperature mercury oxidation catalysts with noble metal impregnation was tested and economically analysed, showing that noble metal catalysts are powerful mercury oxidation catalysts at high cost. The effect of deactivation was evaluated by mass balances of mercury, arsenic and phosphorous in power plants and showed the major effect and sinks of these materials, leading to a better understanding of measures against deactivation. A 3D CFD model was developed, implemented and calibrated, which includes relevant descriptions and their interactions for NOx-reduction, mercury oxidation and SO2–SO3 conversion. The model showed good correlation at validation with measurement data of full scale power plants and forms a good tool for power plant optimisation in the section boiler until downstream of the DeNOx catalyst.

Partners

	Country	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Kevin BRECHTEL (Pr. Coord.)
ENBW ERNEUERBARE UND KONVENTIONELLE ERZEUGUNG AG	DEUTSCHLAND	Sven UNTERBERGER
ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Gennaro DE MICHELE
E.ON NEW BUILD & TECHNOLOGY GmbH	DEUTSCHLAND	Jürgen BRANDENSTEIN
IBIDEN PORZELLANFABRIK FRAUENTHAL GMBH	OESTERREICH	Kurt OREHOVSKY
RECOM SERVICES GMBH	DEUTSCHLAND	Xiaohai HAN
REACTION ENGINEERING INTERNATIONAL	USA	Constance SENIOR

Selected Publications

Klatt, A.: “Facts of modern SCR-catalysts: mercury oxidation and low conversion rate”, VDI-Seminar “Measurement and Reduction of mercury emissions”, 6./7. May 2009, Düsseldorf, Germany

Schwaemmle, T., Heidel, B., Brechtel, K., Scheffknecht, G.: Study of the effect of newly developed mercury oxidation catalysts on the DeNOx-activity and SO2–SO3- conversion, Fuel, Volume 101, November 2012, Pages 179-186, ISSN 0016-2361. DOI: 10.1016/j.fuel.2010.11.043

Brechtel, K., Stack-Lara, V. Scheffknecht, G.: Einfluss der Zusammensetzung von SCR-DeNOx-Katalysatoren auf die Quecksilberoxidation (Influence of catalyst composition on mercury oxidation). VGB conference „chemistry in power plants, 28.-30.10.2008, Friedrichshafen, Germany

Thorwarth H., Risio B., Brechtel K. “Einflüsse auf die Hg-Oxidation an SCR-Katalysatoren” (“Influence on mercury oxidation at SCR-catalysts”), VDI-Seminar Measurement and Reduction of mercury emissions”, 6./7. May 2009, Düsseldorf, Germany

Brechtel, K., Stack-Lara, V., Scheffknecht, G.: Mercury Behaviour and SO2-SO3-Conversion over New Developed high-dust SCR-Catalysts by Investigations in a 500kWth Test Facility. VGB conference „chemistry in power plants“, 27.-29.10.2009, Dresden, Germany

RFCR-CT-2007-00009 ECO-Scrub

Enhanced capture with oxygen for scrubbing of CO2

Info	Type of Project	Research	Duration (months)	39
	Total Budget	2591775 €	Start Date	1/07/2007
	EU Contribution	1555064 €	End Date	30/09/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25319:EN			

Final Abstract The project aims to develop a low-cost option for carbon capture in existing modern coal-fired power plants. The concept, known as ECO-Scrub, uses a novel combination of techniques employed in CO2 capture, such as oxygen enrichment and post-combustion solvent scrubbing, together with measures to increase efficiency, reduce steam consumption and generate power requirements. The project work involved development of the process, module integration and optimisation for lignite- and coal-fired power plants through programmes of laboratory- and pilot-scale tests, simulation modelling studies, literature reviews and collation of power plant performance data. The ECO-Scrub system was shown to be technically and economically feasible for retrofitting existing power plants for CO2 capture and sequestration. Optimising the oxygen enrichment level and the rate at which the flue gas is recycled were key parameters for achieving satisfactory combustion characteristics, low NOX emissions and improved heat transfer characteristics, and avoiding ash deposition problems. Preferentially enriching the staged air system with oxygen was an effective option for NOX control. A pilot-scale combustion test facility with oxyfuel capability, simulated flue gas recycling and equipped with a pilot-scale amine solvent scrubbing plant was used to evaluate the flexibility of the ECO-Scrub process and solvent performance. Membrane separation systems were shown to be promising alternatives to conventional CO2 capture methods for enriched CO2 flue gas. The cost and efficiency penalties for the ECO-Scrub process were comparable to those for post-combustion capture and oxyfuel combustion, however ECO-Scrub was shown to be more attractive as a retrofit option.

Partners		*Country*	*Scientific person in charge*
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	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Panagiotis GRAMMELIS
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	ENERGY RESEARCH CENTRE OF THE NETHERLANDS	NEDERLAND	Willem VAN DE KAMP
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	RWE POWER AG	DEUTSCHLAND	Matthias KRUMBECK
	UNIVERSITY OF LEEDS	UNITED KINGDOM	Bernard GIBBS

RFCR-CT-2007-00007 MERCURYCAP

High capacity sorbents and optimization of existing pollution control technologies for mercury capture in industrial combustion systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2479480 €	Start Date	1/10/2007
	EU Contribution	1487687 €	End Date	30/09/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25318:EN			

Final Abstract

The MERCURYCAP project addressed the global problem of mercury emissions from coal-fired plants and the current position of conventional air pollution control devices, providing a partial solution for mercury capture. Two different routes were proposed and investigated for mercury capture and oxidation: (1) promising mercury sorbents, and (2) oxidation catalyst materials. Extensive injection testing programmes for mercury sorbents at pulverised fuel and fluidised bed combustion facilities were conducted to evaluate the performance of the developed materials. The HGC15-Lancaster and HGC03- Centre sorbents developed from gasification of mixed paper and plastic wastes were promising sorbents and could offer an alternative to commercial activated carbon sorbents. Moreover, HGC02-Berks sorbent, a char sorbent from clean wood gasification, showed very good performance in the full-scale tests. The preliminary evaluation of the potential commercialisation of the proposed sorbents suggested that the sorbent costs should be evaluated by analysing the sorbent consumption, capital and operating/maintenance costs and by-product management and disposal. Characterisation and evaluation of selective catalytic reduction (SCR) and manganese oxide modified SCR catalysts were undertaken to understand the effect of the addition of a mercury oxidation component on the catalyst and their performance for mercury oxidation/adsorption. Manganese-impregnated samples presented higher mercury adsorption than their undoped precursors and enhanced mercury adsorption of SCR catalysts. Commercial SCR catalysts coated with different active metals were produced and their performance tested in a pilot-scale unit. The optimal temperature for a high mercury conversion rate ranged between 300 and 350 °C and increasing SO2 concentrations slightly enhanced the mercury conversion rate.

		Country	*Scientific person in charge*
Partners	**THE UNIVERSITY OF NOTTINGHAM**	UNITED KINGDOM	Mercedes MAROTO-VALER (Pr. Coord.)
	CENTRO DE INVESTIGACIONES ENERGÉTICAS MEDIOAMBIENTALES Y TECNOLÓGICAS	ESPAÑA	Alberto BAHILLO
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	M. Rosa MARTINEZ-TARAZONA
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	UNIVERSITAET STUTTGART	DEUTSCHLAND	Kevin BRECHTEL

Selected Publications

M. Rallo, B. Heidel, K. Brechtel, M. M. Maroto-Valer, Effect of SCR operation variables on mercury speciation, Chemical Engineering Journal, 2012, 198-199, 87–94 DOI: 10.1016/j.cej.2012.05.080.

P. Abad-Valle, M.A. Lopez-Anton, M. Diaz-Somoano, R. Juan, B. Rubio, J.R. Garcia, S.A. Khainakov, M.R. Martínez-Tarazona, Influence of iron species present in fly ashes on mercury retention and oxidation, FUEL Volume: 90 Issue: 8, 2808-2811 DOI: 10.1016/j.fuel.2011.04.031

A. Fuente-Cuesta, M.A. Lopez-Anton, M. Diaz-Somoano, A.van Zomeren, M. Cieplik, M.R. Martínez-Tarazona, Leaching of major and trace elements from paper–plastic gasification chars:An experimental and modelling study, Journal of Hazardous Materials, Volume: 244, 70-76 DOI: 10.1016/j.jhazmat.2012.11.026.

A. Fuente-Cuesta, M. Diaz-Somoano, M.A. Lopez-Anton, M. Cieplik, J.L.G. Fierro, M.R. Martínez-Tarazona, Biomass gasification chars for mercury capture from a simulated flue gas of coal combustion, Journal of Environmental Management, Volume: 98, 23-28 DOI: 10.1016/j.jenvman.2011.12.013

B. Lobato, M.A. Lopez-Anton, M. Diaz-Somoano, L. Diaz and R. Martinez-Tarazona, 2009. The behaviour of mercury in a CFBC plant. 9th International Conference on Mercury as a Global pollutant, Guiyang, China

RFCP-CT-2008-00008 ECLAIR

Emission free chemical looping coal combustion process

Info	Type of Project	Pilot&Demonstration	Duration (months)	54
	Total Budget	6421724 €	Start Date	1/07/2008
	EU Contribution	2270771 €	End Date	31/12/2012
State	Project completed, final report not published yet			

Provisional Abstract

Chemical-looping combustion (CLC) for coal is a zero-emission technology, combining very low efficiency penalty (2-3%) and low CO2 capture cost, about 10€/ton CO2. Key issues for coal-CLC are: adequate technical solutions to reactors/surrounding systems; oxygen-carrier performance/behaviour and interaction with fuel; actual demonstration of technology.
The proposal involves scale-up to 1-MWth pilot and experimental/theoretical work to provide basis for design and optimization. This includes investigation of oxygen-carrier interaction with fuel and long-term stabilility; development of tools/models to identify best reactor design and process layout; solutions for emission control; testing in 1-MWth plant and technical, environmental and economical assessment including 450-MW unit.

Partners		*Country*	*Scientific person in charge*
	ALSTOM BOILER France	FRANCE	Corinne BEAL (Pr. Coord.)
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	VATTENFALL RESEARCH AND DEVELOPMENT AB	SVERIGE	Marie ANHEDEN

Selected Publications

Linderholm, C., Lyngfelt, A., Cuadrat, A., and Jerndal, E., Chemical-looping combustion of solid fuels – operation in 10 kW unit with two fuels, above-bed and in-bed fuel feed and two oxygen carriers, manganese ore and ilmenite, Fuel 102 (2012) 808–822

Performance of CLOU process in the combustion of different types of coal with CO2 capture. I. Adánez-Rubio, A. Abad?, P. Gayán, L.F. de Diego, F. García-Labiano, J. Adánez. International Journal of Greenhouse Gas Control 12 (2013) 430–440.

Markström, P., Linderholm, C., and Lyngfelt, A., Chemical-looping combustion of solid fuels - Design and operation of a 100 kW unit with bituminous coal, Int. Journal of Greenhouse Gas Control 15 (2013) 150-162

M. Orth, J. Ströhle, B. Epple: Design and operation of a coal-fired 1 MWth chemical looping pilot plant, 2nd Int. Conf. on Chemical Looping, Darmstadt, 2012

Beal C. and al, Development of Metal Oxides Chemical Looping Process for Coal-Fired Power Plants , 2nd Int.Conf. on Chemical Looping, Darmstadt, 2012

RFCR-CT-2008-00009 SMARTBURN

Intelligent control and optimisation of power station boilers firing pulverised coal and coal/biomass blends

Info

Type of Project	Research	Duration (months)	36
Total Budget	1467226 €	Start Date	1/07/2008
EU Contribution	880337 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25860:EN

Final Abstract

The Smartburn project was designed to increase the amount of biomass used in utility power stations. The project enabled this by focussing on the problem of combustion instability which can occur during the co-firing of coal and biomass and in its severest form can lead to flame extinction. As a result of poor combustion high emissions of CO or NOx may emanate from the burner. In order to co-fire higher concentrations of biomass a system was required that could provide warning of these conditions. The objective of the Smart burn project was the development of an innovative 'intelligent' monitoring, control and optimisation system to control coal/biomass fired burners. The system developed is based on the remote monitoring of individual flames using sensors that detect the spectral emissions of the combustion flame in the ultra-violet (UV), infra-red (IR) and visible (VIS) bands and the application of thermo-acoustic sensors was also investigated. Advanced signal processing was applied based on joint time-frequency methods and an Artificial Neural Network (ANN) was used to identify characteristics that could be related to operational parameters such as local air/fuel ratio, NOx emissions, and flame stability. The developed system was successfully tested at pilot scale (500 kWt) and on a full scale power plant (burner 20 MWt) where the ability of the system to monitor and optimise the combustion for a variety of unseen coal/biomass blends was demonstrated. It was also demonstrated how the system could be applied to balance air/fuel supply to multi-burner applications and detect potential flame out conditions.

Partners

	Country	*Scientific person in charge*
UNIVERSITY OF GLAMORGAN	UNITED KINGDOM	Steven WILCOX (Pr. Coord.)
GAS NATURAL SDG	ESPAÑA	Jesús María GONZALEZ GARCÍA
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Selected Publications

Paliappan, V. and Wilcox S.J. 'Controlling Utility Boiler Burners Co-Firing Biomass'. Presented at the ASME IDETC/CIE Conference, August 2012, Chicago, USA.

Paliappan, V., Wilcox S.J. and Jagiello, K. The Monitoring and Control of Burners Co-firing Coal and Biomass using Joint Time-Frequency Methods. Presented at the British Flame Research Committee in Collaboration with the Coal Research Forum and the University of Kent, Technical Meeting on Combustion Diagnostics, Control, Computational Methods & Process Optimisation at the University of Kent at Canterbury, Thursday 2nd May 2013.

Wilcox S.J. Invited Presentation at the 24th Annual Meeting and Meeting of the Environment Division held in Collaboration with the Royal Society of Chemistry Energy Sector, 10th April 2013 at Cranfield University.

Garcia-Armingol T., Ballester J., Smolarz A. Chemiluminescence-based sensing of flame stoichiometry: Influence of the measurement method Measurement' (accepted) http://dx.doi.org/10.1016/j.measurement.2013.06.008

Smolarz A., Kotyra A., Wójcik W., Ballester J. 'Advanced diagnostics of industrial pulverized coal burner using optical methods and artificial intelligence', Experimental Thermal and Fluid Science, Vol. 43, pp82-89, 2012. http://dx.doi.org/10.1016/j.expthermflusci.2012.04.001

RFCR-CT-2009-00005 OXYCORR

Boiler corrosion under oxy-fuel conditions

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1956218 €	Start Date	1/09/2009
	EU Contribution	1173730 €	End Date	31/08/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26413:EN

Project web page http://oxycorr.eu-projects.de/

Final Abstract

The OxyCorr project was run from 1 September 2009 to 31 August 2012 in the frame of the grant (RFCR-CT-2009-00005) obtained from the Research Fund for Coal and Steel of the European Commission. The consortium encompassed four industrial partners: alloy and tube manufacturer Outokumpu, power plant vendor Alstom, two utilities: Vattenfall and Enel as well as two research entities: University of Stuttgart Institute of Combustion and Power Plant Technology (IFK) and Swerea KIMAB. IFK was co-ordinating the OxyCorr project. The primary objective of the OxyCorr project is the evaluation of deposit and material-related limitations on the boiler performance and lifetime of highly efficient, CO2-lean, oxyfuel operated power plants in order to determine the usability of advanced and conventional boiler materials. Highly dedicated experimental and theoretical investigations have focused on the evaluation and assessment of high and low temperature related deposit and corrosion problems as well as influence on flue gas cleaning appliances such as ESP. The impact of varying combustion parameters on the flue gas composition and their further effect on the corrosion process were studied and evaluated. Two bituminous coals and three various lignite qualities were tested in a 3MW and a 0.5MW test rig respectively. More than 60 material rings were exposed using corrosion probes in combustion chambers of both test rigs and more than 20 metal coupons were positioned in the flue gas ducts. Simultaneous long-term corrosion tests were run in four independent laboratories, generating almost 200 specimens. Both oxidising and reducing conditions were considered. The chosen parameters should depict operation in a USC-steam regime. Additionally, tests simulating behaviour of 12 alloys and a coating in the cold end of a power plant were performed resulting in more than 100 specimens. The results obtained in the project are aimed at use in the development and assessment of advanced process layout and boiler design strategies that should enhance plant efficiency and reduce maintenance costs of oxyfuel power stations

		Country	*Scientific person in charge*
Partners	**UNIVERSITAET STUTTGART**	DEUTSCHLAND	Jörg MAIER (Pr. Coord.)
	ALSTOM BOILER DEUTSCHLAND GmbH	DEUTSCHLAND	Frank KLUGER
	ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Nicola ROSSI
	SWEREA KIMAB AB	SVERIGE	Peter VIKLUND
	OUTOKUMPU STAINLESS AB	SVERIGE	Rachel PETTERSSON
	VATTENFALL RESEARCH AND DEVELOPMENT AB	SVERIGE	Pamela HENDERSON

Selected Publications

G. Stein-Brzozowska, R. Norling, P. Viklund, J. Maier, G. Scheffknecht. Fireside corrosion during oxyfuel combustion considering various SO2 contents. Proceedings: The 7th Trondheim CCS Conference (TCCS-7), June 4-6, 2013. Paper under revision to be published by Energy Procedia. http://tccs-7.exordo.com/data/paper_attachments/94/final_draft/20130410_Abstract_IFK_KIMAB_as_uploaded_rev.pdf

G. Stein-Brzozowska, J. Maier, G. Scheffknecht, D. Cumbo, S. Masci, E. Tosi, G. Corraggio, M. Faleni, L. Biasci. Fireside Corrosion of Applied and Modern Superheater- Alloys under Oxy-Fuel Conditions. Proceedings: 11th International Conference on Greenhouse Gas Control Technologies GHGT-11, 18. - 22.11.2012, Kyoto, Japan, 2012. Paper under revision to be published by Energy Procedia. http://www.ghgt.info/index.php/Content-GHGT11/session-6-tues-20th.html

D. Cumbo, N. Rossi, E. Tosi, G. Stein-Brzozowska, E. Miller, J. Maier, G. Scheffknecht, P. Viklund. Corrosion of candidate superheater materials during oxy-fuel conditions - Pilot plant and laboratory investigations. Conference proceedings: 2nd Oxy-fuel Combustion Conference, September 12 - 16, 2011, Yeppoon, Australia, 2011

G. Stein-Brzozowska, S. Babat, J. Maier, G. Scheffknecht. Influence of oxy-coal on fly ash transformations and corrosion behaviour of heat exchangers. Conference proceedings: 2nd Oxy-fuel Combustion Conference, September 12 - 16, 2011, Yeppoon, Australia. 2011

G. Stein-Brzozowska, S. Babat, J. Maier, G. Scheffknecht. Deposition Behavior and Superheater Corrosion under Coal Fired Oxyfuel Conditions. Conference proceedings: Special Workshop on Oxyfuel Combustion Addressing SO2/SO3/Hg and Corrosion Issues. January 25 – 26, 2011. London. http://sacccs.org.za/wp-content/uploads/2013members/Special%20Workshop%20Oxyfuel%20Combustiuon%20-%20Addressing%20SO2-SO3-Hg%20Corrosion%20Issues%20in%20Oxyfuel%20Combustion%20Boiler%20and%20Flue%20Gas%20processing%20Units%20-%202011-18.pdf

RFCR-CT-2010-00011 CARINA

Carbon capture by means of indirectly heated carbonate looping process

Info	Type of Project	Research	Duration (months)	51
	Total Budget	2458416 €	Start Date	1/07/2010
	EU Contribution	1475050 €	End Date	30/09/2014
State	Running project			

Project web page www.est.tu-darmstadt.de/RFCS-CARINA

Provisional Abstract Standard carbonate looping promises low energy penalties for post-combustion CO2-capture and is particularly suited for retrofitting existing power plants. The heat for calcination can be provided by supplementary coal firing with oxygen leading to energy penalties and additional investment costs for air separation. The objective of this project is to investigate and test a new concept with an indirectly heated calciner using heat pipes, offering even higher plant efficiency and lower CO2 avoidance costs than the oxy-fired standard carbonate looping process. The work programme includes design of the heat exchanger system with heat pipes, process cycle calculations, testing in 1MWth scale, and up-scaling studies for real plants.

Partners	*Country*	*Scientific person in charge*
TECHNISCHE UNIVERSITÄT DARMSTADT	DEUTSCHLAND	Bernd EPPLE (Pr. Coord.)
FISIA-BABCOCK ENVIRONMENT GMBH	DEUTSCHLAND	Ulrich PRIESMEIER
GROSSKRAFTWERK MANNHEIM AG	DEUTSCHLAND	Karl-Heinz CZYCHON
HIGHTERM RESEARCH GMBH	DEUTSCHLAND	Andreas SCHWEIGER
LHOIST RECHERCHE ET DEVELOPPEMENT SA	BELGIQUE	Thierry CHOPIN
TECHNISCHE UNIVERSITAET GRAZ	OESTERREICH	Christoph BAUMHAKL
FRIEDRICH-ALEXANDER UNIVERSITAT ERLANGEN NURNBERG	DEUTSCHLAND	Jürgen KARL

Selected Publications

D. Höftberger, J. Karl : Self-Fluidization in an Indirectly Heated Calciner, Chemical Engineering & Technology, Volume 36, Issue 8, August, 2013, DOI: 10.1002/ceat.201300111

M. Junk, M. Reitz, J. Ströhle, B. Epple : Thermodynamic evaluation and cold flow model testing of an indirectly heated carbonate looping process, Chemical Engineering & Technology, Volume 36, Issue 8, August, 2013, DOI: 10.1002/ceat.201300019

RFCR-CT-2010-00012 DEVCAT

Development of high performance SCR-catalysts related to different fuel types

Info

Type of Project	Research	Duration (months)	36
Total Budget	2359856 €	Start Date	1/07/2010
EU Contribution	1415913 €	End Date	30/06/2013

State Project completed, final report not published yet

Project web page http://devcat.eu-projects.de

Provisional Abstract

The DEVCAT proposal addresses the topic of “technological improvements targeting enhanced efficiency of coal fired power plants” related to an efficient reduction of NOx-, SO3- and Hgemissions.
The goal of the project is to develop special SCR-DeNOx-catalysts for coal, bio-fuel
and co-combustion with respect on efficient NOx-reduction, high mercury oxidation and low SO2- SO3-conversion. Therefore based on the further development of existing catalyst technology, innovative catalyst designs for bio-fuel applications or the use of nano-technology is applied. With respect to modified SCR-technology, also the effect on downstream air pollution control devices like FGD systems is investigated. Furthermore a 3D-CFD model is used and improved for the modelling of the SCR-system.

Partners

	Country	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Barna HEIDEL (Pr. Coord.)
ENBW ERNEUERBARE UND KONVENTIONELLE ERZEUGUNG AG	DEUTSCHLAND	Harald THORWARTH
ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Sauro PASINI
E.ON NEW BUILD & TECHNOLOGY GmbH	DEUTSCHLAND	Jürgen BRANDENSTEIN
IBIDEN PORZELLANFABRIK FRAUENTHAL GMBH	OESTERREICH	Kurt OREHOVSKY
RECOM SERVICES GMBH	DEUTSCHLAND	Xiaohai HAN

Selected Publications

Schwaemmle, T., Bertsche, F., Hartung, A., Brandenstein, J., Heidel, B., Scheffknecht, G.: Influence of geometrical parameters of honeycomb commercial SCR-DeNOx-catalysts on DeNOx-activity, mercury oxidation and SO2/SO3-conversion, Chemical Engineering Journal, 222, 2013, p. 274-281 (DOI: 10.1016/j.cej.2013.02.057)

B. Risio, X. Han, M. Hilber, H. Thorwarth: “Industrial scale assessment of the predictive quality of a 3D-CFD model for SCR DeNOx-catalysts, VGB Powertech, 10, 2012, p. 74-79

"""Quecksilberoxidation in Kraftwerksabgasen mittels Katalysatoren (Mercury oxidation in flue gasese of power plants by catalysts)"", VDI Emissionsminderung 2012, 19th – 20th June 2012, Nürnberg, Germany (presentation and paper)"

“SCR-DeNOx-catalyst development towards high-performance catalysts related to different fuel types”, 9th mercury emission from coal, 22nd – 23rd May 2012, St. Petersburg, Russia (presentation)

“Synergie bestehender Rauchgasreinigungsanlagen bei der Quecksilberabscheidung (Synergies of existing air pollution control devices related to mercury retention)“, VDI Wissensforum „Messung und Minderung von Quecksilber-Emissionen“, April 2013 (presentation and paper)

RFCR-CT-2010-00013 CAL-MOD

Modelling and experimental validation of calcium looping CO^2-capture process for near-zero CO^2-emission power plants

Info

Type of Project	Research	Duration (months)	36
Total Budget	2007454 €	Start Date	1/10/2010
EU Contribution	1204473 €	End Date	30/09/2013

State Project completed, final report not published yet

Project web page http://cal-mod.eu-projects.de

Provisional Abstract

The Calcium Looping (CaL) process is a post-combustion CO2 capture route. This project aims to develop advanced simulation tools for industrial process application. Issues of sorbent attrition, sulphation and reactivation are assessed. Kinetic parameters are incorporated to a sorbent model, providing the basis for the CFD carbonator, regenerator models. CFD models are validated against bench-scale experimentation results. Their input will be used for a process and steam cycle model regarding reference plants and leading to design rules. Synergy with the cement industry is beneficial. A techno-economic analysis and basic engineering of such systems will bring the process close to commercialization.

Partners

	Country	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Heiko DIETER (Pr. Coord.)
ANDRITZ ENERGY & ENVIRONMENT GmbH	OESTERREICH	Günter GRONALD
CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Panagiotis GRAMMELIS
CONSIGLIO NAZIONALE DELLE RICERCHE	ITALIA	Riccardo CHIRONE
ENBW ERNEUERBARE UND KONVENTIONELLE ERZEUGUNG AG	DEUTSCHLAND	Sven UNTERBERGER
ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Cristiana LA MARCA
TITAN CEMENT COMPANY AE	HELLAS	Emmanuel CHANIOTAKIS
POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Halina PAWLAK KRUCZEK

Selected Publications

A. Coppola, F. Montagnaro, P. Salatino, F. Scala. Attrition of limestone during fluidized bed calcium looping cycles for CO2 capture. Combustion Science & Technology, 184 (2012) 929-941. DOI 10.1080/00102202.2012.663986. URL http://www.tandfonline.com/doi/abs/10.1080/00102202.2012.663986

A. Coppola, F. Montagnaro, P. Salatino, F. Scala. Fluidized bed calcium looping: the effect of SO2 on sorbent attrition and CO2 capture capacity. Chemical Engineering Journal, 207-208 (2012) 445-449. DOI 10.1016/j.cej.2012.06.149. URL http://www.sciencedirect.com/science/article/pii/S1385894712008893

K. Atsonios, A. Nikolopoulos, S. Karellas, N. Nikolopoulos, P. Grammelis, E. Kakaras. Numerical investigation of the grid spatial resolution and the anisotropic character of EMMS in CFB multiphase flow., Chemical Engineering Science (2011), 66 (17), 3979-3990 DOIi: 10.1016/j.ces.2011.05.024 URL http://www.sciencedirect.com/science/article/pii/S0009250911003332

Nikolopoulos, N. Nikolopoulos, A. Charitos, P. Grammelis, E. Kakaras, A.R. Bidwe, G. Varela. High resolution 3-D full-loop simulation of a CFB carbonator cold model. Chemical Engineering Science 90 (2013) 137–150 DOI 10.1016/j.ces.2012.12.007 URL http://www.sciencedirect.com/science/article/pii/S0009250912006987

Vorrias, K. Atsonios, A. Nikolopoulos, N. Nikolopoulos, P. Grammelis, E. Kakaras. Calcium looping for CO2 capture from a lignite fired power plant. Fuel (2013). DOI 10.1016/j.fuel.2012.12.087 URL http://www.sciencedirect.com/science/article/pii/S0016236113000033

RFCP-CT-2011-00003 ENCIO

European network for component integration and optimisation

Info	Type of Project	Pilot&Demonstration	Duration (months)	72
	Total Budget	23886488 €	Start Date	1/07/2011
	EU Contribution	9554596 €	End Date	30/06/2017
State	Running project			

Project web page http://www.encio.eu/

Provisional Abstract The key goal of ENCIO is to concentrate all scientific and technological efforts to make the 700°C technology ready for deployment in coal fired power plants. ENCIO is an important step before the erection of a 700°C power plant can start. This step consists of the installation of a test facility in Fusina, at an ENEL power plant in Italy. The project will focus on practical investigations, aiming at proving manufacturing, welding, repair and life-time concepts for thickwalled components. ENCIO can be seen as perfect transition from pilot towards demo features.

		Country	*Scientific person in charge*
Partners	**VGB POWERTECH e.V.**	DEUTSCHLAND	Christian STOLZENBERGER (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Paolo FOLGARAIT
	ENEL PRODUZIONE S.p.A.	ITALIA	Leonardo ARRIGHI
	ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Sauro PASINI
	MITSHUBISHI HITACHI POWER SYSTEMS EUROPE GmbH	DEUTSCHLAND	Marc JEDAMZIK

RFCR-CT-2011-00004 DCFC

Efficient conversion of coal to electricity - direct coal fuel cells

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2030301 €	Start Date	1/07/2011
	EU Contribution	1218181 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

Direct electrochemical conversion of coal to electricity offers very significant increases in efficiency with consequent reductions in CO2 emissions coupled with facilitated sequestration possibilities. Our recent laboratory tests have shown that Direct Carbon Fuel Cells (DCFC) can exceed commercial MCFC performance levels. Here we seek to apply DCFC technologies to coal conversion. We will develop these coal DCFCs increasing scale, improving cell design, seeking new active and conductive structure and surface promoted catalysts, addressing durability, investigating coal source and optimising coal processing for this application. Performance will be evaluated throughout the project and recommendations
made for a commercial-scale demonstrator.

		Country	*Scientific person in charge*
Partners	**THE UNIVERSITY COURT OF THE UNIVERSITY OF ST ANDREWS**	UNITED KINGDOM	John IRVINE (Pr. Coord.)
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Ana ARENILLAS
	DANMARKS TEKNISKE UNIVERSITET	DANMARK	Peter HOLTAPPELS
	PANEPISTIMIO DYTIKIS MAKEDONIAS - UNIVERSITY OF WESTERN MACEDONIA	HELLAS	George MARNELLOS

RFCR-CT-2011-00005 FLOX-COAL-II

Development of scale-up methodology and simulation tools for the demonstration of PC-FLOX burner technology in full-scale utility boilers

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2690872 €	Start Date	1/07/2011
	EU Contribution	1614524 €	End Date	30/06/2014
State	Running project			

Project web page http://floxcoal2.eu-projects.de

Provisional Abstract

This project aims to develop a scale-up methodology and simulation tools which are required for the implementation of Pulverised-Coal Flameless Oxidation (PC-FLOX) burners in utility plants. Substantial pilot (0.5 MWth) experimental investigation will be the backbone in order to support the development and validation of scale-up methodology and CFD FLOX-specific sub-models.

To develop simulation tools, these CFD FLOX-specific sub-models will be integrated into commercial CFD codes. A CFD modelling, experimental results and industrial partners' expertise will lead to the development of the scale-up methodology for full-scale PC-FLOX burners. A CFD study and techno-economic analysis of utility plants operated with PC-FLOX burners will be carried out.

		Country	*Scientific person in charge*
Partners	**UNIVERSITAET STUTTGART**	DEUTSCHLAND	Max. WEIDMANN (Pr. Coord.)
	DOOSAN BABCOCK LIMITED	UNITED KINGDOM	Greg SIMS
	ENBW ERNEUERBARE UND KONVENTIONELLE ERZEUGUNG AG	DEUTSCHLAND	Sven UNTERBERGER
	INSTYTUT ENERGETYKI	POLAND	Bartosz SWIATKOWSKI
	INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE ROUEN	FRANCE	David HONORE
	PGE GORNICTWO I ENERGETYKA KONWENCJONALNA SA	POLAND	Krzysztof FUZOWSKI
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Reinhold KNEER
	WS WÄRMEPROZESSTECHNIK GmbH	DEUTSCHLAND	Joachim G. WÜNNING

RFCP-CT-2012-00006 ACCLAIM

Advanced coal chemical-looping combustion, aiming at highest performance

Info	Type of Project	Pilot&Demonstration	Duration (months)	30
	Total Budget	3200765 €	Start Date	1/07/2012
	EU Contribution	1591434 €	End Date	31/12/2014
State	Running project			

Project web page www.sintef.no/acclaim

Provisional Abstract

Chemical-looping combustion (CLC) for coal is a zero-emission technology, combining very low efficiency penalty (2-3%) and low CO2 capture cost, potentially as low as 10 €/ton CO2. Key issues for coal-CLC are: adequate technical solutions to reactors/surrounding systems; oxygen-carrier performance/behaviour and interaction with fuel; actual demonstration of technology. The proposal builds on the great advances made in the ÉCLAIR project and the unique CLC solid fuel pilots developed and built. ÉCLAIR has clearly demonstrated the feasibility of the technology, but also that it would be an important advantage if process performance could be further improved. Such improvement primarily concerns the incomplete gas conversion and the corresponding need for oxypolishing of CO2 product gas. The proposal focuses on options to improve gas conversion with either new oxygen carriers, or with more advanced fuel reactor design. A number of oxygen carrier materials expected to give radical improvements in performance are known, but have not been sufficiently tested. The programme involves prequalification tests of such materials under sustained continuous operation in smaller chemical-looping combustors, 1-10 kW. Best candidates will be further tested in 100 kW and 1 MW pilots. Advanced fuel reactor designs will be investigated in cold flow model experiments combined with use of validated models in order to assess options to improve gas conversion. Proposal also involves update and review of downstream gas treatment and full-scale power plant design, as well as studies of the fate and influence of sulphur and nitrogen in the fuel, depending on oxygen carrier. The project is expected to have very great impact because it aims at demonstrating significant advances of the chemical-looping technology for solid fuel. Thus, it is expected to demonstrate how the potential for very fundamental reductions of energy penalty and CO2 capture costs can be realized.

		Country	*Scientific person in charge*
Partners	**CHALMERS TEKNISKA HÖGSKOLA AB**	SVERIGE	Anders LYNGFELT (Pr. Coord.)
	ALSTOM BOILER France	FRANCE	Corinne BEAL
	BASF SE	DEUTSCHLAND	Philipp GRUENE
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Juan ADANEZ
	STIFTELSEN SINTEF	NORGE	Rune BREDESEN
	TECHNISCHE UNIVERSITÄT DARMSTADT	DEUTSCHLAND	Bernd EPPLE
	TECHNISCHE UNIVERSITAET WIEN	OESTERREICH	Tobias PRÖLL

Selected Publications

T. Mendiara, L. F. de Diego, F. García-Labiano, P. Gayán, A. Abad , J. Adánez , Behaviour of a bauxite waste material as oxygen carrier in a 500Wth CLC unit with coal, submitted for publication

P. Gayán, Alberto Abad, L.F. de Diego, F. García-Labiano, J. Adánez , Assessment of technological solutions for improving Chemical Looping Combustion of solid fuels with CO2 capture, submitted for publication

D. Guío-Pérez , T. Pröll, H. Hofbauer, Solids residence time distribution in the secondary reactor of a dual circulating fluidized bed system, submitted for publication

T. Mendiara, A. Abad, L. F. de Diego, F. García-Labiano, P. Gayán, J. Adánez, Biomass combustion in a CLC system using an iron ore as oxygen carrier, submitted for publication

I. Adánez-Rubio, A. Abad, P. Gayán, L. F. de Diego, F. García-Labiano, J. Adánez, Biomass combustion with CO2 capture by Chemical Looping with Oxygen Uncoupling (CLOU) , submitted for publication

RFCR-CT-2012-00008 RECaL

Novel calcium looping CO2 capture process incorporating sorbent reactivation by recarbonation

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2697943 €	Start Date	1/07/2012
	EU Contribution	1618765 €	End Date	30/06/2015
State	Running project			

Project web page www.recal-project.eu

Provisional Abstract This project will develop a new sorbent regeneration technique for postcombustion Calcium Looping CO2 capture systems, that could reduce to near zero the net sorbent requirements and further reduce operating cost and energy penalties. The novel method (patent application in 2011) is based on the re- carbonation of carbonated particles with pure CO2, and the use of solids purges for flue gas desulfurization. An intense R&D programme is proposed to close existing gaps of knowledge, design, build and test the concept in an existing large calcium looping pilot (1.7MWt) as well as to conduct process simulation and economic estimations at large scale.

		Country	*Scientific person in charge*
Partners	**ENDESA GENERACION SA**	ESPAÑA	Andrés SANCHEZ-BIEZMA SACRISTAN (Pr. Coord.)
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Juan Carlos ABANADES GARCIA
	HULLERAS DEL NORTE, S.A.	ESPAÑA	Luis DIAZ FERNANDEZ
	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	UNITED KINGDOM	John DENNIS
	UNIVERSITAET STUTTGART	DEUTSCHLAND	Mariusz ZIEBA

Patents Patent application ES1641.854

Selected Publications Diego ME, Arias B, M. Alonso, Abanades JC. The impact of calcium sulfate and inert solids accumulation in post-combustion calcium looping systems. Fuel (in press, http://dx.doi.org/10.1016/j.fuel.2012.11.062 , 2013)

RFCP-CT-2013-00009 ASC2

Amine-impregnated Alumina Solid Sorbent for CO2 Capture

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	3093261 €	Start Date	1/07/2013
	EU Contribution	1546630 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

The present proposal focuses on several of the most important recommendations of the Zero Emission Platform´s (ZEP) report for the deployment of CCS in the European Union (EU) and contribute to increase the experience of pilot plant operation with power plant flue gases, reduce the energy demand for regeneration (improving the efficiency of power plants with CCS), through full process integration, power plant optimization and sorbent performance including improved degradation characteristics under different flue gas conditions (including other pollutants and oxygen content). The project objective is to demonstrate, through pilot plant operational validation, that the use of alumina impregnated-amine solid sorbent is a suitable option to increase CO2 capture efficiency and reduce by 3-4 points the efficiency penalty caused by capture system in the power plant. This objective requires the development and demonstration of new and innovative solid sorbents. New porous materials will be developed in order to obtain the best performances for amine deposition on solid support and for CO2 absorption-desorption cycle. The most effective solution, selected by screening in laboratory tests, will be produced in a suitable quantity (about a ton) and tested in a pilot plant with coal fired power station flue gases. The project has a holistic approach from the laboratory solid sorbent development to the preparation of sorbent for pilot plant operation (modified to fit the sorbent performance), pilot plant testing and also includes the scale-up of the concept to commercial coal power plants for both existing and new applications. The proposed technology is of main interest for retrofitting existing plants without dramatic changes to the existing boiler and power cycle.

		Country	*Scientific person in charge*
Partners	**FUNDACION CIRCE- CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERG.**	ESPAÑA	Luis M. ROMEO (Pr. Coord.)
	CIUDEN - FUNDACION CIUDAD DE LA ENERGIA	ESPAÑA	Ruth DIEGO GARCIA
	INDUSTRIE BITOSSI S.p.A.	ITALIA	Carlo TERRENI
	RICERCA SUL SISTEMA ENERGETICO - RSE SPA	ITALIA	Maurizio NOTARO
	UNIVERSITA DEL SALENTO	ITALIA	Antonio LICCIULLI

RFCR-CT-2013-00010 BiOxySorb

Economic low carbon power production and emissions control for future and flexible biomass co-fired power stations

Info

Type of Project	Research	Duration (months)	36
Total Budget	2105362 €	Start Date	1/07/2013
EU Contribution	1263217 €	End Date	30/06/2016

State Running project

Provisional Abstract

Coal-fired plants are under pressure to reduce their carbon-intensity. Available options include biomass co-combustion, CCS or, a combination of both, giving a CO2-negative power plant. Oxy-fuel combustion with CO2 storage (or utilization) is one of the leading and most cost-effective CCS technologies that approved its potential for industrial scale power production and for retrofitting existing power stations for CCS recently at the coal-fired 30MWel Callide oxy-fuel plant in Australia. The BiOxySorb project will investigate 1st and 2nd generation biomass co-combustion under air- and oxy-fuel conditions at various co-combustion ratios. BiOxySorb's results will help large scale coal-fired power stations to reduce their carbon intensity in the short term by implementing or increasing energy- and cost-efficient biomass co-combustion in conventional air-fired systems. Particularly, the focus on new 2nd generation biomasses that can be handled and milled much easier than 1st generation biofuels is important in that respect. The project will also generate novel, highly valuable information on the co-combustion of biomass under oxy-fuel conditions and will allow for a highly efficient utilization of biofuels in CO2-negative oxy-fuel power plants in near future. The second main objective of BiOxySorb is an investigation of highly flexible, low cost SOx, HCl and Hg emission control by sorbent injection in air and oxy-fuel biomass co-combustion. Sorbent injection systems can be installed relatively cheaply at existing or newly built power plants, to backup or replace existing gas cleaning systems that cannot fully cope with increasingly flexible plant operation. In oxy-fuel combustion, a reduction of SOx, HCl and Hg by sorbents has a great potential to reduce emissions energy- and cost-efficiently and to allow a minimisation of problems arising from corrosion by those species in hot and cold parts of the power plant and of CO2 processing and transportation facilities.

Partners

	Country	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Jörg MAIER (Pr. Coord.)
CIUDEN - FUNDACION CIUDAD DE LA ENERGIA	ESPAÑA	Ruth DIEGO GARCIA
E.ON NEW BUILD & TECHNOLOGY LTD	UNITED KINGDOM	David COULING
GESTAMP BIOMASS SOLUTIONS	ESPAÑA	Pablo LEAL FORERO
LHOIST RECHERCHE ET DEVELOPPEMENT SA	BELGIQUE	Johan HEISZWOLF

RFCR-CT-2013-00011 CRAMUFAT24

Crack Mechanism Understanding and Failure Avoiding Treatment of T24 Tube Material in Advanced Super Critical Coal Fired Steam Generators

Info	Type of Project	Research	Duration (months)	24
	Total Budget	2138151 €	Start Date	1/07/2013
	EU Contribution	1282891 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

In order to further increase the efficiency of hard coal fired power plants up to 46 % and lignite-fired plants up to 43 % life steam temperatures and pressures need to be elevated. New materials are required in order to achieve supercritical live steam temperatures of 600 °C. T23 and T24 material is used for boiler tubes in such supercritical power plants. Recent failures in welded joints in evaporator water walls made of material T24 of newly built and commissioned steam generators, caused by preferably intergranular cracks, demonstrate there is a need in understanding possible failure mechanisms in the context with: - Welding procedures and their parameters like heat control - Post weld heat treatment - Cleaning of welded components before commissioning - Medium (steam, water, conductivity/pH, O2-content) - Temperature - Residual stresses - Critical strains caused by construction and operation. Overall project objective is to identify parameters that are critical to crack formation and to provide a general basis of knowledge in order to understand the material behavior during welding and the reactions with medium during the set of operation phase.

		Country	*Scientific person in charge*
Partners	**UNIVERSITAET STUTTGART**	DEUTSCHLAND	Jürgen BÖSE (Pr. Coord.)
	ALSTOM BOILER DEUTSCHLAND GmbH	DEUTSCHLAND	Andreas HELMRICH
	CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Panagiotis GRAMMELIS
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Alessio SACCOCCI
	ENBW ERNEUERBARE UND KONVENTIONELLE ERZEUGUNG AG	DEUTSCHLAND	Jörg BAREISS
	GROSSKRAFTWERK MANNHEIM AG	DEUTSCHLAND	Klaus METZGER

RFCP-CT-2014-00007 CaO2

Calcium looping CO2 capture technology with extreme oxy-coal combustion conditions in the calciner

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	3166109 €	Start Date	1/06/2014
	EU Contribution	1583054 €	End Date	31/05/2017
State	Running project			

Provisional Abstract The proposal intends to demonstrate in a large pilot (rated at 2-3 MWth in the O2-fired calciner) an energy efficient process variant of the CO2 capture postcombustion Calcium Looping system for coal based power plants. The optimised process scheme is intended to minimize, or even avoid, the need of a CO2 recycle to the oxyfired CFB calciner, by exploiting the endothermic nature of the calcination and the large solid circulation flows . Capital cost and energy consumption are reduced significantly due to smaller calciner, ASU and O2 and fuel requirements, thereby improving the competitiveness of the CaL system..

		Country	*Scientific person in charge*
Partners	**ENDESA GENERACION SA**	ESPAÑA	Andrés SANCHEZ-BIEZMA SACRISTAN (Pr. Coord.)
	CARMEUSE RESEARCH & TECHNOLOGY SA	BELGIQUE	Jean-Yves TILQUIN
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Juan Carlos ABANADES GARCIA
	FOSTER WHEELER ENERGIA S.L.	ESPAÑA	Francisco Javier ALVAREZ RUIZ
	HULLERAS DEL NORTE, S.A.	ESPAÑA	Luis DIAZ FERNANDEZ
	CRANFIELD UNIVERSITY	UNITED KINGDOM	Edward J. ANTHONY
	LAPPEENRANTA UNIVERSITY OF TECHNOLOGY - LAPPEENRANNAN TEKNILLINEN YL.	FINLAND	Timo HYPPÄNEN

RFCR-CT-2014-00008 CERUBIS

Corrosion and Emission Reduction of Utility Boilers through Intelligent Systems

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2768186 €	Start Date	1/07/2014
	EU Contribution	1660911 €	End Date	30/06/2018
State	Running project			

Provisional Abstract

Coal-fired power plants have traditionally been operated in a continuous mode, i.e. as close as possible to the design full load for as long an operating time as possible. However recent times, energy policy, emission standards and fuels portfolio enforced the dramatic change of boilers operating conditions. This very often leads to maintenance problems like corrosion, slagging/fouling and faults of boilers heat exchangers and water wall. Ideally the boilers operators and specialist would like to be able to follow the extent of corrosion and ash-related phenomena in the boiler in real-time and plan the maintenance schedule. CERUBIS proposal focuses on the development and testing of an intelligent, on-line diagnostic systems. The CERUBIS objective is to reduce the extent of the corrosion and slagging/fouling of boiler evaporators and heat exchangers. This should improve the reliability and the efficiency of utility boilers. Also, by improved controls of the boiler, should make it more easy to meet the newly-imposed stringent emission directives. This envisaged overall goal shall be met by joined development of a multitude of sensors, data handling and intelligent software systems which will be subsequently deployed in real-life boiler environment. Hereby, much attention will be paid to using as much as possible common data handling and software interface as well as, wherever applicable, the same material and technological base for the sensors. Care will be taken to use systems in a way to minimize the data overlap and a the same time, a maximise the complimentary nature of the obtained information. The phased approach envisages joint development, tests and validation on the laboratory- and pilot- scale test facilities (up to 0.5 MW). The developed systems will then be installed at two full-scale, commercial, 380 MWe, hard coal- and lignite-fired boilers at Opole and Bełchatów Power Plants. The systems will be tested and validated through one year of operation.

		Country	*Scientific person in charge*
Partners	**INSTYTUT ENERGETYKI**	POLAND	Slawomir KAKIETEK (Pr. Coord.)
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	HUKSEFLUX THERMAL SENSORS BV	NEDERLAND	Kees VAN DEN BOS
	PGE GORNICTWO I ENERGETYKA KONWENCJONALNA SA	POLAND	Czeslaw ANDRYJOWICZ
	UNIVERSITAET STUTTGART	DEUTSCHLAND	Jörg MAIER

RFCR-CT-2014-00009 DRYLIG

Competitive pre-drying technologies and firing concepts for flexible and efficient lignite utilisation

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2207633 €	Start Date	1/07/2014
	EU Contribution	1295047 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

Main scope of the proposal is the development of new and innovative retrofitting concepts for lignite pre-drying and pre-dried lignite co-firing. The proposed concepts are intended for existing lignite power plant (increase of flexibility, improved operational and environmental performance under low loads), hard coal plants (as start up/co-firing fuel) and, finally, the enlargement of pre-dried lignite applications in other industrial applications. In order to meet the abovementioned objectives, the following actions will be be performed within this project: • Evaluation and comparison of currently applicable pre-drying technologies (fluidized beds, tubular dryers, air/gas drying)and firing systems according to appropriate techno-economic criteria. Identification of potential pre-dried lignite end-users in other industrial sectors. • Pilot tests at pilot scale/prototype dryers for different lignite types. • Combustion tests of pre-dried lignite as co-firing and/or ignition fuel at lab, pilot and industrial scale facilities at different thermal shares and firing arrangements. • CFD simulations of specific boiler retrofitting cases for optimization of firing arrangement and thermal cycle calculations for integration of pre-drying technologies, aiming towards increased flexibility at load load operation. • Development of plant design concepts for retrofit cases and initial engineering study for pre-dried lignite application in green-field plants. • Techno-economic evaluation of proposed concepts and drafting of Guidebook. The project consortium includes the two main lignite boiler manufacturers, European utilities and leading institutes with a long experience in lignite utilisation.

Partners	*Country*	*Scientific person in charge*
CENTRE FOR RESEARCH AND TECHNOLOGY HELLAS	HELLAS	Panagiotis GRAMMELIS (Pr. Coord.)
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INSTITUTUL DE STUDII SI PROIECTARI ENERGETICE SA	ROMANIA	Ion Eduard CHITESCU
MITSUBISHI HITACHI POWER SYSTEMS EUROPE GMBH	DEUTSCHLAND	Michalis AGRANIOTIS
MONASH UNIVERSITY	AUSTRALIA	Sankar BHATTACHARYA
PUBLIC POWER CORPORATION S.A.	HELLAS	Charalampos PAPAPAVLOU
UNIVERSITAET STUTTGART	DEUTSCHLAND	Jörg MAIER
POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Halina PAWLAK KRUCZEK

RFCR-CT-2014-00010 OnCord

Online corrosion monitoring for the combined combustion of coal and chlorine-rich biomasses in pulverised fuel and circulating fluidised bed systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2918723 €	Start Date	1/07/2014
	EU Contribution	1751232 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

The emerging trend towards renewable energy sources leads to an increased share of biomass used in solid fuel fired power plants. This development and the demand for increasing live steam temperatures result in severe operational problems, such as high temperature corrosion which can lead to unscheduled power plant shut downs and a decreased boiler availability. Co-firing biomass is often limited to high quality wood materials in order to ensure safe combustion without the risk of corrosion. It has been observed that the proper combination of coal and chlorine-rich biomass significantly reduces corrosive deposits and thus accelerated metal wastage. Often, these observations could not be explained properly and further research was recommended. Within the present proposal co-firing of chlorine-rich biomasses at high shares and with elevated steam temperatures is enabled by using coal and its ash as a protective agent. Coal and its inorganic constituents such as sulphur and alumina-silicates are able to prevent the formation of alkali chlorides, and consequently chlorine-rich deposits. Two online corrosion sensors are developed and used in combination with online measurement techniques yielding gaseous and solid phase composition to monitor corrosion. Both sensors are tested under aggressive conditions and long-term exposure tests in pulverised fuel and fluidised bed systems of varying size and in combination with material loss probes. Experiments will start in small scale and proceed with increasing plant size. By this approach corrosion rates can be correlated to the fuel composition and process conditions in order to understand observed phenomena. Modelling will support the understanding of corrosion attack and its mechanisms. The project will provide strategies for setting up fuel blends and strengthen the position of solid fuel fired boilers, particularly the position of coal since it enables the use of low grade biomass in highly efficient combustion systems.

		Country	*Scientific person in charge*
Partners	**TECHNISCHE UNIVERSITAET MUENCHEN**	DEUTSCHLAND	Hartmut SPLIETHOFF (Pr. Coord.)
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	CORRMORAN GmbH	DEUTSCHLAND	Christian DEUERLING
	DOOSAN BABCOCK LIMITED	UNITED KINGDOM	William LIVINGSTON
	ENEL INGEGNERIA E RICERCA S.p.A.	ITALIA	Nicola ROSSI
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	UNIVERSITÄT AUGSBURG	DEUTSCHLAND	Ferdinand HAIDER
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	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Martti AHO

Technical Group Steel 1

Ore agglomeration and ironmaking

The scope of TGS1 includes:

- Ore agglomeration, sintering and pelletising processes
- New and improved iron-ore reduction processes (including DRI & C-free reduction)
- Ironmaking processes and operations including slag treatment
- Standardisation of testing and evaluation methods
- Maintenance and reliability of production lines
- Reduction of emissions, energy consumption and improvement of the environmental impact
- Instrumentation, modelling and control of processes

RFSR-CT-2003-00013 ENHANCED BF OPERATION

Enhanced blast furnace operation and service life by improved monitoring and control of the hearth and uniformity

Info

Type of Project	Research	Duration (months)	42
Total Budget	2315055 €	Start Date	1/09/2003
EU Contribution	1389033 €	End Date	28/02/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23455:EN

Final Abstract The competitiveness and productivity of the iron-making industry relies significantly on the operational lifetime of the blast furnace. Specific attention has to be paid to the hearth, since its refractory wear is often decisive for campaign length. Wear and skulling of the hearth are closely related to internal hearth and dead man conditions, which are known to play an extremely important role for iron and slag flow, hot metal composition and temperature. Non-uniform operation can lead to excessive wear and, as a result, expensive repairs — even if other areas of the blast furnace may still be in good condition. A more uniform operation improves hot metal quality, lowers the fuel rate and increases hearth and stave life. The wear profile of different blast furnaces across Europe was documented and samples of refractory were analysed. Based on these results, hearth supervision was improved to monitor refractory decay which up to now cannot be detected. Several campaigns of tap hole pressure measurement were carried out. Average void fractions of the dead man were determined and correlation with EMF was found. A new tapping management system, based on CCD-cameras and a suitable software platform was tested. Internal hearth conditions were investigated with hearth supervision systems, CFD-simulation, tuyere drillings and additional measurement data. An acoustic measurement technique to indicate charging irregularities and combustion problems was successfully tested. Subsequent countermeasures improve blast furnace uniformity. The results described increase blast furnace life, stability and security. Given that higher productivity and lower fuel consumption can be expected, this research clearly contributes to the sustainable development of the European Steel Industry.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Günter HARP (Pr. Coord.)
ABO AKADEMI UNIVERSITY	FINLAND	Henrik SAXEN
AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Rongshan LIN
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Dominique SERT
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RAUTARUUKKI OYJ	FINLAND	Päivi MANNILA
TATA STEEL UK LIMITED	UNITED KINGDOM	George CLIXBY

Patents Verfahren und Meßvorrichtung zur Ermittlung der Wärmeleitfähigkeit des Feuerfestmaterials einer Ofenauskleidung. German patent application 10 2006 011 816.2.

Selected Publications

Höfer O., Klima R., Lin R., Rausch H. Hearth Monitoring at the end of a blast furnace campaign. 27es Journées Sidérurgiques Internationales, Paris Dec. 14th-15th 2006, pp. 4-5.

Brännbacka, J., Model Analysis of Dead-man Floating State and Liquid Levels in the Blast Furnace Hearth, Doctoral dissertation, Åbo Akademi University, Finland, 2004.

Helle, M. and H. Saxén, `"Data-driven analysis of sulfur flows and behavior in the blast furnace", the 4th International Conference on the Science and Technology of Ironmaking (ICSTI), November 2006, Osaka, Japan, (Ed. Usui, T.), pp. 573-576, ISIJ, Japan, 2006.

Björkholm, F., "A Study of Thermal Cycles in a Blast Furnace", M.Sc. thesis, Heat Engineering Laboratory, Åbo Akademi University, Finland, 2006.

Mannevaara, M., "Model of Erosion and Build-up Formation in the Blast Furnace Hearth", M.Sc. thesis, Heat Engineering Laboratory, Åbo Akademi University, Finland, 2004.

RFSR-CT-2004-00001 MEMORACE

Improvement of the raceway monitoring under modern blast furnace operating conditions

Info	Type of Project	Research	Duration (months)	45
	Total Budget	1256925 €	Start Date	1/07/2004
	EU Contribution	754155 €	End Date	31/03/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24388:EN			

Final Abstract "Microwave technique was developed for the online determination of raceway depth at industrial installations. It is validated, not influenced by coal injection and reliable. The CARS technique, for gas composition and temperature determination on a very short time scale, was for the first time adapted for metallurgy. It is suitable for fundamentals studies. The Ground Penetrating Radar (Georadar) technique could not give reliable results on hot pilot. Industrial raceway depth presents smooth time evolution and the relation with blast volume is confirmed. Indications of collapse are found at occasions of hot stove changes, unlike in laboratory studies. On a time scale of few days, the cut of coal injection on one tuyere produces an increase in raceway size and the converse. The same effect is obtained in the laboratory when the coke size is decreased. Some recommendations for operating blast furnaces at coal injection rates are given: optimisation of coal size using a small rate of fine particles; tuyere design with an additional lance to deliver oxygen in the front of the PC lance tip; decreasing of constraints on flame temperature in some cases when injecting auxiliary reducing agents; focused attention on productivity and the height of the position of the reserve zone when flame temperature is changed. A new coal distribution practice — consisting in adjusting constant flame temperaturefor all tuyeres by adjusting locally the coal mass flow to actual local blast volume — was tested and approved. It is estimated to save more than 1kg/tHM of coke at constant PCI rate."

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Eric LECTARD (Pr. Coord.)
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Alberto ISIDRO
	SWEREA MEFOS AB	SVERIGE	Pär HAHLIN
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK

RFSR-CT-2004-00002 COKARAC

New characterisation test of the coke behaviour at high temperatures

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1250249 €	Start Date	1/07/2004
	EU Contribution	750150 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23748:EN			

Final Abstract behaviour at high temperature under conditions similar to those encountered in the blast furnace, especially in terms of gasification degree. The CRM Cokarac test characterises the evolution of coke size distribution under mechanical, chemical and thermal stresses during increasing residence time under gasification conditions prevailing in the blast furnace. Two Corus tests characterise the resistance of coke submitted to the actions of liquid iron and slag. A CPM test characterises the strength of coke after a constant weight loss. The validity of these new tests has been demonstrated by comparing the modifications of the coke grain size and microscopic texture resulting from the tests with those undergone by coke in the blast furnace. The latter have been measured by comparing cokes sampled by a tuyere probe with cokes sampled before charging into the blast furnace. Industrial cokes from a wide variety of sources have been tested. Moreover, to highlight the sensitivity of the new tests and their innovative content, cokes differing greatly by their CRI and CSR indices have been produced in the pilot coke oven plant of CPM. The results of the new tests showed only little correlation with the classical coke characterisation indices (I10, I40) and with the standard CRI-CSR indices, which indicates that they really bring new information on coke properties. The applicability of these new tests on a routine basis has been evaluated in order to allow the ironmaking industry to better characterise coke quality.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Gérard DANLOY (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Eric HESS
	TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Bart van der VELDEN
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Klaus MÜLHEIMS

RFSR-CT-2004-00003 ECONOSOX

Modelling the pollutants formation and behaviour during sintering of iron ores

Info	Type of Project	Research	Duration (months)	42
	Total Budget	868384 €	Start Date	1/07/2004
	EU Contribution	521031 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24221:EN			

Final Abstract

"At the project start, the CRM mathematical model of the sintering process was able to simulate the emission of CO, but not of NOx. Concerning SOx emissions, the shape of the emission profile was correctly simulated but not the amplitude, because the latter depends on the sulphur input and also on its retention in the sinter cake, which was not explicitly simulated. Within the scope of this project, the model has been adapted and completed so that it can calculate CO, NOx and SOx emissions in different sintering conditions and also different layouts (conventional sintering, various waste gas recycling layouts, top layer sintering). It has been calibrated/validated at sinter pot scale and industrially (at ArcelorMittal Gent and VASD). Its predictions turn out to give mostly satisfactory results in relative terms (trends) whereas the absolute values of pollutant emissions are not always perfectly predicted, due to the influence of parameters that are not measurable or not explicitly simulated (catalytic effects of trace elements, effect of volatile matter on NOx formation mechanisms, etc.). The new model version has been used for a sensitivity analysis giving the trends to be expected in terms of environmental performance when modifying some sintering conditions (suction, mean size of solid fuel, vertical segregation of solid fuel concentration). Other simulations have been carried out to assess different waste gas recycling layouts if they were applied to the two sinter strands of one ArcelorMittal plant; this exercise has shown how the model can be used to get some initial insight about the effect of the amount of recycled gas and the zone where it is collected/recycled on the pollutant emissions as well as on the sintering speed and the potential energy savings. The main deliverable of this project is a modelling tool, to be considered as complementary to sinter pot trials or industrial tests, useful for the environmental optimisation of sintering conditions or for a first evaluation of different waste gas recycling techniques when applied to the local features and operating conditions prevailing in any specific sinter plant."

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Bernard VANDERHEYDEN (Pr. Coord.)
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	VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Wolfgang SCHWEIGER

RFSR-CT-2004-00004 MEORU

Minimising environmental emissions by optimised reductant utilisation

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1796006 €	Start Date	1/07/2004
	EU Contribution	1077603 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24995:EN			

Final Abstract "The temperature profile at tuyere level is probably the most important parameter for influencing blast furnace performance because it has an effect at every step of physical and chemical reaction. This is seen especially as increased abrasion of coke, caused by carbon graphitisation and silicate reduction in the hottest flame zone, and as alkali attack on the coke in the colder deadman. The Raman analysis technique has proved to be a sensitive method for differentiation of carbon structure within BF dusts, coke and different chars related to BF operation. Results of the Raman analyses indicate that BF dust is a mixture of tuyere carbon (from high temperature zones of the BF) and coke formed by abrasion in the upper BF shaft. For BF dusts, a roughly linear relationship of the FWHM values from Raman analysis to the percentage of tuyere carbon is revealed. This relationship enables the quantification of tuyere carbon within the BF dust. The technique is useful for semi-continuousmonitoring of the efficiency of reductant consumption during BF injection. Increasing amounts of tuyere carbon in the BF dust means lower efficiency of reductant consumption. Different injection modes (oil injection; PCI) lead to a characteristic content of tuyere carbon in the BF top gas dust. With oil injection a lower content of tuyere carbon is observed than with PCI. A lower tuyere carbon content with oil injection means improved reductant utilisation compared to PCI operation. However, this advantage is associated with higher costs for the injected reductant. The theoretical maximum decrease of reductant utilisation for PCI operation amounts to 0.6 % of the total carbon input (which is the amount of tuyere carbon in the top gas dust). A realistic assumption is that 50 % of the tuyere carbon emissions may be reduced, which means that 0.3 % of total carbon consumption is potentially saved byoptimised injection practice. The new Raman analysis technique would be capable of assisting blast furnace operators in optimising furnace operation conditions by maximising reductant injection rates while maintaining best efficiency of reductant consumption."

		Country	*Scientific person in charge*
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	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Günter HARP

Selected Publications

Dong S., Wu L., Paterson N., Herod A.A., Dugwell D.R., Kandiyoti R., “Investigating the Fate of Injectant Coal in Blast Furnaces by Size Exclusion Chromatography”, Energy Fuels, 2007, 21 (2), pp. 1062-1070. DOI: 10.1021/ef060472k.

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S. Dong, P. Alvarez, N. Paterson, D. R. Dugwell and R. Kandiyoti, “Investigating the Formation Mechanism of Soot-like Materials Present in Blast Furnace Coke Samples”, Energy Fuels, 2008, 22 (5), pp. 3317-3325. DOI: 10.1021/ef800466h

RFSR-CT-2004-00005 ULCOS

ULCOS New Blast Furnace Process

Info	Type of Project	Research	Duration (months)	60
	Total Budget	8551812 €	Start Date	1/07/2004
	EU Contribution	5131088 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25085:EN

Project web page www.ulcos.org/

Final Abstract

"Within this project a new blast furnace process route able to operate with very low CO2 emissions has been developed. This can be achieved by using oxygen instead of air, facilitating CO2 capture from the top gas and recycling of the reducing gas. Starting from the first concepts, mathematical models were used to calculate several process configurations in order to evaluate the impact of the new parameters on the process. These calculations led to the selection of three promising versions: version 1, where the decarbonated top gas is recycled cold at the normal tuyeres and hot in the lower shaft; version 3, where the gas is recycled hot at the normal tuyeres only; and version 4, where the gas is recycled hot at the tuyeres and hot in the lower shaft. To estimate the impact of the decarbonated top gas recycling on the burden reduction and disintegration, several laboratory tests were performed using different burden compositions. The lab tests showed that a mixture of sinter and pellets would be the best burden composition to be used for the EBF campaign. Regarding the injection coal, laboratory trials were performed to give a recommendation of a suitable coal for the trials. Due to the fact that version 1 is running with cold gas injection, a prototype of a three component (O2, PCI and DTG) tuyere burner has been tested at a single tuyere rig to compare the raceway conditions with the conditions of a conventional blast furnace raceway. To avoid carbon deposition when heating up the decarbonated top gas, an extensive study has been performed to find suitable materials that are resistant against soot formation. Furthermore, several recuperative and regenerative systems have been compared to give a recommendation on which way of heating up the gas is best. To prove the capability of the new process, version 3 and version 4 were at the experimental blast furnace in Luleå, Sweden. The EBF was prepared and modified to be able to run under ULCOS BF conditions, defined by the version 3 and 4 circumstances. To remove the CO2 from the top gas a VPSA plant was erected. To guarantee safe operation strategies were defined for the startup and shutdown phases, but unplanned events were also considered. All important safety issues were considered in a HAZOP study and risk assessment. The first ULCOS BF trial was performed in autumn 2007 in a 6-week campaign. It could be proven that it is possible to operate the EBF very smoothly under the new process conditions. The carbon savings were in the range of 15 % for version 3 and 24 % for version 4. With the VPSA it was possible to reach recycling ratios up to 90 %. Though these first results showed that the process could be successfully tested at the EBF some technological aspects still had to be more closely observed before transferring this technology to an industrial scale. Together with engineering companies some technological points were identified and possible solutions were shown."

		Country	*Scientific person in charge*
Partners	**THYSSENKRUPP STEEL EUROPE AG**	DEUTSCHLAND	Alexandra HIRSCH (Pr. Coord.)
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	L'AIR LIQUIDE SA	FRANCE	Michel DEVAUX
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	François HANROT
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Olivier ANSSEAU
	ILVA S.P.A.	ITALIA	Vincenzo DIMASTROMATTEO
	KÜTTNER GmbH & Co. KG	DEUTSCHLAND	Wolfram KÜTTNER
	LUOSSAVAARA-KIIRUNAVAARA AB (LKAB)	SVERIGE	Mats HALLIN
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	SIEMENS VAI TECHNOLOGIES LTD	UNITED KINGDOM	Michael EDEN
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Günter HARP
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RFSR-CT-2005-00001 SHOCOM

Short term CO^2 mitigation for steelmaking

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2402677 €	Start Date	1/07/2005
	EU Contribution	1441605 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24989:EN			

Final Abstract "Decreasing the coke gasification threshold temperature by 100 °C brings a 9 % CO2 saving. This can be achieved either by incorporating 6 % of charcoal into coal blend, if the blend is fluid enough, or by charging charcoal (20–50 kg/thm) mixed with coke. The latter is more efficient. The reduction kinetics is not impaired by a threshold temperature of 850 °C. Charcoal injection into BF tuyeres was studied, especially charcoal reactivity in and outside the raceway. Charcoals from three wood types were produced and characterised. Reactivity of charcoals, coals and coal-charcoal mixtures was studied. Injection testswere conducted at pilot scale. Secondary utilisation of charcoal outside the raceway was investigated. The reducing gas generation from waste/secondary raw material for iron ore reduction in Midrex or BF was evaluated. The quality requirements and sources of secondary raw material were evaluated. Plastics have higher contents of trace elements like Pb, Zn, Cd and Hg than conventional BF (and DR) reductants. The feasibility of using plastic wastes of various compositions as additives to coal blends for the production of blast-furnace coke was studied, paying special attention to the effects of plastic wastes on: coal thermal behaviour; coking pressure ; and quality of cokes produced in movable wall ovens at two scales. The CO2 emission and the cost of every route proposed have been calculated. The potential of CO2 mitigation ranges between 2 % and 35 %. The maximum increase of cost is 7 %, the routes using a large extent of charcoal being more expensive than thereference."

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	François HANROT (Pr. Coord.)
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Miguel FERNANDEZ
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Günter HARP
	VOESTALPINE STAHL GMBH	OESTERREICH	Thomas BÜRGLER

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M.A. Díez, R. Alvarez, C. Barriocanal, S. Melendi. Possibilities of the Coking Process for the Recycling of Plastic Wastes. EuroCoke Summit 2007. Intertech Pira, Nice-France. URL: http://www.ceska-koksarenska.cz/download/eurocoke.pdf

F. Hanrot, D. Sert, J. Delinchant, R. Pietruck, T. Bürgler, A. Babich, M. Fernández, R. Álvarez, M.A. Diez. CO2 Mitigation for Steelmaking using Charcoal and Plastics Wastes as Reducing Agents and Secondary Raw Materials. Proceedings of the 1st Spanish National Conference on Advances in Materials Recycling and Eco – Energy Madrid, Spain, November 12-13, 2009. Paper S05-4. ISBN: 978-84-7292-3980-0. URL: http://digital.csic.es/handle/10261/18433.

M.A. Diez, R. Alvarez. Advances in the Recycling of Plastic Wastes for Metallurgical Coke Production. Journal of Material Cycles and Waste Management, Published on line: 07 December 2012. DOI: 10.1007/s10163-012-0103-8. URL: http://link.springer.com/article/10.1007%2Fs10163-012-0103-8#

RFSR-CT-2005-00002 DEMPOLIFE

Determination of factors influencing dead man position and evaluation of its impact on blast furnace life time

Info

Type of Project	Research	Duration (months)	42
Total Budget	1991409 €	Start Date	1/07/2005
EU Contribution	1194846 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24976:EN

Final Abstract

The reline of a blast furnace at the end of its campaign life is a very costly affair, due to both the costs of the actual relining and the costs of the production loss. The campaign life of a blast furnace is currently limited by the lifespan of its hearth refractory. An EMF-based, online hearth monitoring system with early detection of process disturbances related to the blast furnace hearth have been developed and implemented. A measuring installation based on strain gauges has been designed and has been installed on the shell of the hearth, which has proved to be an efficient sensor to determine the liquid levels inside the hearth. Several model studies have been carried out to investigate the fluid and solid flow in the hearth. Also a model that calculates the deadman position, based on both finite element modelling and industrial measurements, has been developed. The dissections of both an industrial blast furnace hearth and the hearth of the experimental blast furnace have been used to improve the understanding of the processes' interaction on the hearth wear and processes. All models have been validated and used to improve the hearth lifetime and to detect process disturbances.

Partners

	Country	*Scientific person in charge*
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RFSP-CT-2006-00001 IDEOGAS

Industrial demonstration of hot gas injection at the blast furnace

Info	Type of Project	Pilot&Demonstration	Duration (months)	64
	Total Budget	4511967 €	Start Date	1/03/2006
	EU Contribution	1359570 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25865:EN			

Final Abstract The Ideogas project started in March 2006 with the aim of simulating and investigating the recycling of decarbonated top gas (DTG) in the shaft of the blast furnace. Unfortunately, the burner technology foreseen to produce reducing a gas simulating DTG from natural gas did not work and had to be given up. As no effective alternative to produce reducing gas could be found, the Ideogas project was focused on the development of the oxygen tuyere technology for the most difficult configuration of the ULCOS-BF process (Version 1). The on-paper design of these trials was validated by the ULCOS steering committee in May 2008 and the decision was made to go to the second stage of the project, a technological test of the O2-tuyere technology at industrial scale during 15 days. However, the preparation of this test was severely slowed down by the economic crisis and further disturbed by successive stoppages of the pilot BF1 of ArcelorMittalEisenhüttenstadt linked to the market situation. The technological test finally took place in June 2011. The O2-tuyere jointly developed by ArcelorMittal and BFI passed this test successfully. From a process point of view, the tuyere has been operated during about 11 days at an adiabatic flame temperature over 2 300 °C without problem, while the PCI rate was kept above 160 kg/thm, with peaks at 180 kg/thm. The project thus reached the goal of developing a tuyere technology suitable for Version 1 of the ULCOS-BF process.

		Country	*Scientific person in charge*
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	ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Jörg HUNGER
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RFSR-CT-2006-00039 Sinter efficiency

Enhanced sinter efficiency by optimised quality control

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1751893 €	Start Date	1/07/2006
	EU Contribution	1051136 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25086:EN			

Final Abstract A PGNAA test device was developed and installed to measure the sinter raw mixture composition in situ at TKSE. Based on the results of the measurement a limestone dosing control (LDSC) was implemented into the sinter process control. PGNAA and LSDC are working very well and the basicity level is much more homogeneous. The evaluation of long-term trials has shown that a great benefit of EUR 0.11/tsinter can be expected by using the new devices. A XRF in situ measurement and a basicity controller were implemented into the control system at the VASD sinter plant. Very good results were achieved. Since September 2009 the basicity controller based on the XRF measurement system has been more or less in continuous operation. The result of the control interventions is a much more uniform basicity of the sinter. BFI and TKSE investigated the on-strand (cold) permeability. A device for continuous measurement of the on-strand permeability was enhanced with respect to accuracy and long-time stability. Sinter mix moisture, bulk density and BTP fluctuations were investigated by operational trials with different sinter mix compositions. A software tool was developed and implemented to optimise the permeability by automatic detection of the optimum moisture. Corus demonstrated the contribution of cold permeability to the post-ignition gas flow rate (hot permeability). Mechanisms by which hot permeability and/or flame front affect sinter productivity were also studied through sinter pot tests. In addition, a method to monitor the on-line bed permeability has been developed at strand No 2 of the IJmuiden sinter plant.

		Country	*Scientific person in charge*
Partners	**THYSSENKRUPP STEEL EUROPE AG**	DEUTSCHLAND	Stefan WIENSTRÖER (Pr. Coord.)
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	VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Manfred ZAHN
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Thorsten HAUCK

Selected Publications

A. Klein, G. Ma, R. Mayerhofer, M.Zahn, J. Zirngast , Online Bestimmung der Basizität der Sintermischung mittels RöntgenfluoreszenzLecture at PRORA 2007 - Fachtagung Prozessnahe Röntgenanalytik, 15. - 16. November 2007 WISTA – Wissenschafts und Wirtschaftsstandort Berlin-Adlershof, 12489 Berlin, Germany

Christoph Delwig, Hans Fettweis, Thomas Schnitzler, Stefan Wienströer, Sinter process optimisation by prompt gamma neutron activation analysis (PGNAA) based basicity control system, Congress report, 6th European Coke and Ironmaking Congress 2011, Düsseldorf, Germany, ECIC-54

RFSR-CT-2007-00001 Hearth efficiency

Improvement of hearth drainage efficiency and refractory life for high BF productivity and a well adjusted reductant injection rate at varying coke quality

Info	Type of Project	Research	Duration (months)	42
	Total Budget	3558656 €	Start Date	1/07/2007
	EU Contribution	2135194 €	End Date	31/12/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25121:EN			

Final Abstract A new deadman (DM) porosity and position criterion was developed using bottom temperature and tapping data. This was established online at industrial plants. The ultrasound technique AU-E seems promising to assist with conventional wear determination. Copper was successfully established for hearth tracing tests to replace radioactive materials. Refractory samples from industrial BFs at campaign end were analysed. The aging influences depend on BF operation and refractory. Feed coke and DM core-drill coke symplex were analysed with various methods. The differences were assigned to BF charging and way of operation. Hearth samples from industrial and experimental BFs at campaign ends were analysed. The correlation between BF operation and brittle layer formation was determined using historic BF data. The influence of DM permeability on the hearth drainage was studied via simulation models. Different hearth drainage and tapping conditions were studied experimentally, numerically and by comparison with industrial tracing test results. EBF simulations were performed to investigate raceway combustion and hearth flow. Tapping models were developed based on image processing, EMF, data classification or two-phase flow. They show the effect of hearth and liquid states on drainage. New techniques were developed for the online measurement of HM temperature in runners and accurate hearth liquid level prediction. Temperature and mechanical stresses of BF hearth refractory were modelled using FEM. Approaches with different commercial FEM tools were compared and consistent results were obtained. The influences of different model assumptions were determined. New concepts were introduced to reduce stresses, brittle zones and wear.

		Country	*Scientific person in charge*
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	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Sami-Alex ZAÏMI
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	LUCCHINI S.p.A.	ITALIA	Antonio GRANATA
	SWEREA MEFOS AB	SVERIGE	Dong Yuan SHENG
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Selected Publications

Helle, M., H. Saxén and O. Kerkkonen, “Assessment of the State of the Blast Furnace High Temperature Region by Tuyere Core Drilling”, ISIJ International 49 (2009) 203-209

Shao, L. and H. Saxén, “A simulation study of blast furnace hearth drainage using a two-phase flow model of the taphole”, ISIJ International 51 (2011) 228-235

Shao, L. and H. Saxén, “Investigation of pressure drop in the blast furnace hearth with a sitting dead man”, draft manuscript

Kaymak Y., “A Simplified Approach to the Contact in Thermo-mechanical Analysis of Refractory Linings”, Comsol Conference Stuttgart 2011

Rongshan L., Mernitz J., Kaymak Y., Hauck T.: New Dead man criterion for porosity and position of the dead man. Project deliverable.

RFSR-CT-2007-00002 Consistent BF

Consistent blast furnace operation whilst using low cost raw materials

Info	Type of Project	Research	Duration (months)	54
	Total Budget	2685901 €	Start Date	1/07/2007
	EU Contribution	1611540 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25868:EN			

Final Abstract Solutions which enable the extended use of low cost raw materials, but conserve blast furnace operation consistent, will contribute to economical hot metal production. The industrial experience with regard to using nut coke, ferrous fines and injected coals as important low cost raw materials was raised from test campaigns and operational modifications at five blast furnace plants. All plants preferred charging the complete screened nut coke. This was possible without loss of process efficiency in cases of satisfactory coke quality. If high screened nut coke rates were resulting from low coke cold strength, negative effects towards permeability and coke size at tuyere level were found. To avoid decreased permeability during ferrous fines charging, the rate of ferrous fines plus low grade ores shall not exceed 8 % of the burden. To achieve more flexibility in the use of ferrous burden, modified sinter distributions among two ore layers located upon each other were successfully tested. Gas flow was investigated with the tracing method. A laser distance measuring unit was installed at one tuyere and determined raceway depth, raceway shape and coke particles sizes. Basing on scientific evaluations rules were developed to achieve consistent operation. This was supported by the calculation of composite nut and coarse coke size after direct reduction and further new numerical methods. A software system for rules-based operation was installed in the control room and provides advices and warnings for shaft and hearth wear protection, hot metal homogeneity and optimised coal rates. Less frequent rules were provided by traditional documentation.

		Country	*Scientific person in charge*
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	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Javier MOCHON MUÑOZ
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
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	TATA STEEL UK LIMITED	UNITED KINGDOM	George CLIXBY
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Carl Ulrich WIETERS

RFSR-CT-2007-00003 ACASOS

Alternate carbon sources for sintering of iron ore

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1548822 €	Start Date	1/07/2007
	EU Contribution	929293 €	End Date	31/12/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25151:EN			

Final Abstract In the RFCS project 'Acasos', alternative carbon sources, for example olive pits, sunflower husks, blast furnace (BF) dust and sludge, anthracite and pet coke, were analysed, pre-treated and evaluated by sinter pot tests and industrial sinter plant trials. It was found that pre-treatment is essential for the utilisation of alternate carbon sources. The crushing of the evaluated biomass to a particle size smaller than the optimal coke breeze size improved thermal utilisation at sintering, although productivity and quality could not reach the level of carbon breeze. At the industrial scale it was shown that the pelletising of carbon-rich BF dust and sludge led to the increased utilisation of their carbon content without negative effects on productivity. The substitution of coke breeze with 60 % anthracite at the industrial scale led to a slight reduction in sinter productivity. Environmental aspects were considered, especially concerning emissions of SO2 and volatile organic carbon (VOC). SO2 can be a limitation criterion for pet coke, anthracite, and BF dust and sludge if the sulphur/carbon ratio is significantly higher than that of coke breeze. On the other hand, VOC emission is a strong limiting criterion for the utilisation of all kinds of biomass, although biomass Acasos has advantages over SO2 emissions and CO2 balance due to regenerative resources.

		Country	*Scientific person in charge*
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Selected Publications M. Zandi, M. Martinez-Pacheco, T.A.T. Fray. Biomass for iron ore sintering, Minerals Engineering, Volume 23 (14) Elsevier – Nov 1, 2010

RFSR-CT-2008-00001 FLEXINJECT

Flexible injection of alternative carbon material into the blast furnace

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1875402 €	Start Date	1/07/2008
	EU Contribution	1125242 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25909:EN			

Final Abstract Aiming at increased flexibility and use of alternative carbon materials (ACM) and sustainable use of carbon resources by reaching high injection levels of ACM (plastics, dusts, sludge etc.) and at decreasing the demand for coke and coal, physical and chemical characterisation, pre-treatment of materials in the Tornado process, fluidisation and conveying, operational injection tests at experimental and industrial BF, theoretical calculations and CFD modelling have been conducted. Return of BF dust increases the efficiency of charged materials as the off-gas dust mainly contains fines of coke and ferrous materials. The Tornado process can make wet materials suitable for injection by efficient drying. The injection of ACM in mixtures with PC using the PCI plant or separately using separate injection facilities are both feasible methods for implementation on an industrial scale. The efficiency in the use of injected C is high and C in BF flue dust can be used as efficiently as C included in PC and coke, according to pilot-scale trials. Tornado-treated BF sludge did not result in any savings of C in coke and coal due process disturbance by segregation causing a lower C input than expected. Injection should be possible to use also for recycling of BF sludge under controlled conditions. Operational data, raceway core evaluation and CFD modelling results indicate that there is an upper limit of BF flue dust injection and stable operation, both dependent on conversion rate and accumulation of elements such as Zn and alkalis.

Partners	*Country*	*Scientific person in charge*
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Selected Publications

"L Sundqvist Ökvist, M. Lundgren, G. Hyllander, M. Hensmann, E. Olsson, O. Antila and S. Schuster; ""Injection of Alternative Carbon Containing Materials into the Blast Furnace"", TMS 2012 141st Annual Meeting & Exhibition, Orlando, Florida, USA, March 2012"

S. Hällsten, J Larsson, E. Olsson, O Antila, L Sundqvist Ökvist, Green initiative at the blast furnace department in SSAB EMEA oxelösund, SCANMETIV, Vol 1, MEFOS, Luleå, Sweden, June 2012

L. Sundqvist Ökvist, Gunilla Hyllander, E. T. Olsson, J-O. Wikström, M. Lundgren, Injection of pulverized materials into the blast furnace raceway 6th ICSTI, Rio de Janerio, October, 2012

G. Hyllander, L. Sundqvist Ökvist, D. Malmberg, J. Eriksson, E. Olsson, E. Zetterberg, Oleksandr Tarasenko, Innovative measurement technicque for raceway monitoring, 6th ICSTI, Rio de Janerio, October, 2012

Jordan C., Harasek M., El-Gohari A., Feilmayr C., Schuster S, “Combined Injection of Plastic Particles and Heavy Fuel Oil into a Blast Furnace Raceway – Detailed CFD Analysis” 5th European Conference on Computational Fluid Dynamics ECCOMAS CFD 2010, 978-989-96778-1-4 (CDROM) & 978-989-96778-0-7 (Book of Abstracts)

RFSR-CT-2009-00002 ULCOS TGRBF

ULCOS top gas recycling blast furnace process

Info	Type of Project	Research	Duration (months)	46
	Total Budget	8029041 €	Start Date	1/03/2009
	EU Contribution	4817425 €	End Date	31/12/2012
State	Project completed			

Project web page www.ulcos.org/

Provisional Abstract

The objective of this project is the next step in the development of a new blast furnace route to operate with very low CO2 emissions. The project is the succession of the ULCOS New Blast Furnace process RFCS project launched in 2005 and aims at preparing this process for industrial application.
After the design of the experiments and the engineering, three options of the new technology will be tested and/or optimised at the experimental blast furnace and evaluated. The results will allow selecting the best process and technology options for an industrial size demonstration unit, which will be the object of a future project.

Partners	*Country*	*Scientific person in charge*
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RFSR-CT-2009-00001 TOSICO

New measurement and control techniques for total control in iron ore sinter plants

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2409197 €	Start Date	1/07/2009
	EU Contribution	1445518 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26414:EN			

Final Abstract The current blast furnaces are efficient and highly optimised and the scope for further lowering the carbon usage (and thus CO2 emissions) in these furnaces is approaching its limits. A possible breakthrough solution is to recycle the remaining CO and H2 in blast furnace top gas back into the process, effectively lowering the coke requirements. The CO and H2 can be recovered with a CO2 separation step. However, to avoid N2 build-up, the blast furnace needs to operate on pure O2 instead of hot blast. The objective of this project was to determine and optimise the best configuration for a Top Gas Recycling Blast Furnace. The project has shown that it is possible to operate a blast furnace in a closed loop with a CO2 separation unit in an effective way. The obtained C-savings are consistent with the model predictions. The tests also proved that conventional burden material sinter, pellet and coke can be used. The VPSA plant was able to remove the CO2 efficiently from the blast furnace top gas and up to 90% of the top gas could be treated and recycled. It was possible to operate the blast furnace process and the VPSA gas separation plant in a closed loop. The optimum configuration for an industrial scale furnace was found to be the injection of hot decarbonated top gas in both the hearth tuyeres and the tuyeres in the shaft. These three EBF campaigns in the ULCOS BF mode can be considered as a great success

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Thorsten HAUCK (Pr. Coord.)
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Selected Publications

Dr. Ir. F. Laksmana, Dr. Eng. M. Martinez-Pacheco, Dr. R. Jonckbloedt, Ir. E. Schoonbergen, Dr. Ir. T. Peeters, Dr. Ir. W. H. Husslage. Paper presented at the ECIC Conference, Düsseldorf, Germany, June 2011

Piero Pulito (ILVA), Javier Mochón Muñoz (CENIM): Quantification of fuel efficiency of anthracite, BF dust and char coal in the sinter process. Project Deliverable.

Tim Peeters (TATA): Onstrand flame front characterisation method. Project Deliverable.

RFSR-CT-2010-00001 INNOCARB

Innovative carbon products for substituting coke on BF operation

Info

Type of Project	Research	Duration (months)	42
Total Budget	2575225 €	Start Date	1/07/2010
EU Contribution	1545136 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract Based on positive experiences with charging self reducing iron oxide carbon briquettes into a blast furnace, carbon briquettes shall be developed for coke substitution. To get reasonable mechanical briquette strength, undersized BF coke fractions as base material shall be used together with alternative carbon fines like e.g. low volatile coal or lignite coke together with a binder. For further decrease in coke consumtion activated carbon material shall be charged into the ferrous layer. Due to high reactivity against CO^2 that carbon will participate in the solution loss reaction producing CO and decrease the thermal reserve zone temperature in the blast furnace. The expected benefits are increased indirect reduction and decreased direct reduction as well as reduced energy consumption. Here two different technologies for application to blast furnace operation are traced: the activation of nut coke and the agglomeration of active pet coke.

Partners

	Country	*Scientific person in charge*
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DK RECYCLING & ROHEISEN GmbH	DEUTSCHLAND	Carsten HILLMANN
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RFSR-CT-2010-00002 IERO

Iron production by electrochemical reduction of its oxide for high CO^2 mitigation

Info	Type of Project	Research	Duration (months)	48
	Total Budget	3962766 €	Start Date	1/07/2010
	EU Contribution	1834616 €	End Date	30/06/2014
State	Running project			

Project web page www.ulcos.org/

Provisional Abstract

The present proposal aims at developing a breakthrough technology to produce steel without any direct CO2 emissions. The solution consists in using electricity directly to decompose iron oxide into metal and oxygen. The proposal is following up on the ULCOS program, during which the key phenomena controlling the efficiency of the electrochemical reaction have been identified. The work packages are focused on understanding the physics and chemistry of these phenomena in order to propose the design at the scale of an industrial individual cell of an optimised technology demonstrating a very high level of CO2 mitigation.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Hervé LAVELAINE DE MAUBEUGE (Pr. Coord.)
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Selected Publications

J.F. Monteiro, J.C. Waerenborgh, A.V. Kovalevsky, A.A. Yaremchenko, J.R. Frade, Synthesis of Sr0.9K0.1FeO3-d electrocatalysts by mechanical activation, Journal of Solid State Chemistry 198 (2013) 169–175. DOI 10.1016/j.jssc.2012.10.009.

H. Lavelaine de Maubeuge: Influence of geometric variables on the current distribution uniformity at the edge of parallel plate electrodes, Electrochimica Acta 56 (2011) 10603– 10611. DOI 0.1016/j.electacta.2011.06.074.

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J.F. Monteiro, A.A.L. Ferreira, I. Antunes, D.P. Fagg, J.R. Frade, Thermodynamic restrictions on mechano synthesis of strontium titanate, Journal of Solid State Chemistry 185 (2012) 143–149. DOI 10.1016/j.jssc.2011.10.044.

E.M. Domingues, E.V. Tsipis, A.A. Yaremchenko , F.M. Figueiredo, J.C. Waerenborgh, A.V. Kovalevsky, J.R. Frade, Redox stability and electrical conductivity of Fe2.3Mg0.7O4±d, spinel prepared by mechanochemical activation. Journal of the European Ceramic Society 33 (2013) 1307–1315. DOI 10.1016/j.jeurceramsoc.2012.12.014.

RFSR-CT-2011-00001 EXTUL

Investigations of measures for extension of BF tuyere life time

Info

Type of Project	Research	Duration (months)	42
Total Budget	1354331 €	Start Date	1/07/2011
EU Contribution	812599 €	End Date	31/12/2014

State Running project

Provisional Abstract The damage of blast furnace tuyeres happens up to 80 times a year at normal BF operation. Each single tuyere damage effect a stoppage of the whole BF for several hours. Energy and money is spent without any benefit in form of HM production.
To ensure its competitiveness and sustainability, the European steel industry must reduce those unplanned BF stoppages.
The objective is to define practical measure for BF operators for the extension of tuyere life time.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Jörg ADAM (Pr. Coord.)
	ISD DUNAFERR DUNAI VASMU Zrt.	HUNGARY	Imre TITZ
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Andrej JOHNEN
	VOESTALPINE STAHL GMBH	OESTERREICH	Stefan SCHUSTER

RFSR-CT-2011-00002 HISARNA B and C

Hisarna experimental campaigns B and C

Info	Type of Project	Research	Duration (months)	42
	Total Budget	11212004 €	Start Date	1/07/2011
	EU Contribution	6727202 €	End Date	31/12/2014
State	Running project			

Project web page www.ulcos.org/

Provisional Abstract HIsarna is a new Ironmaking concept developed under FP6-ULCOS, characterised by very low CO2 emissions and direct use of coal and ore. It combines previous developments known as CCF and HIsmelt.
The main objective within the proposed project is to gain a detailed understanding of the process principles and hardware performance and thus knowledge towards the robustness of the process concept.
After design of experiments and related engineering, trials are to be performed in the Hisarna experimental plant in IJmuiden. These trials should eventually provide information for a next scale up of the process.

		Country	*Scientific person in charge*
Partners	**TATA STEEL NEDERLAND TECHNOLOGY BV**	NEDERLAND	Koen MEIJER (Pr. Coord.)
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	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Jean Pierre BIRAT
	ILVA S.P.A.	ITALIA	Michele ZAGARIA
	KÜTTNER GmbH & Co. KG	DEUTSCHLAND	Wolfram KÜTTNER
	LUOSSAVAARA-KIIRUNAVAARA AB (LKAB)	SVERIGE	Peter SIKSTRÖM
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	SAARSTAHL AG	DEUTSCHLAND	Christian GÜNTHER
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Patents Smelt cyclone and apparatus provided with such a smelt cyclone, Patent application WO2013/091847, H.K.A. Meijer, C. Zeilstra

Selected Publications Developments in Alternative Ironmaking, Koen Meijer, Christiaan Zeilstra, Cornelis Teerhuis, Maarten Ouwehand, Jan van der Stel, Transactions of the Indian Institute of Metals, July 2013, http://www.springerlink.com/openurl.asp?genre=article&id=doi:10.1007/s12666-013-0309-z

HIsarna - the ecologically sustainable iron making process, Koen Meijer, Minerals and Metals review April 2012, Page 40 – 43.

RFSR-CT-2011-00003 IMSIMI

Improved sinter mix preparation while using challenging raw materials

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2494056 €	Start Date	1/07/2011
	EU Contribution	1496434 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

Iron ores show a downward trend of their quality (finer particles, broader size distribution, lower grades and higher fluctuation of properties).
To ensure its competitiveness and sustainability, the European steel industry must use such ores together with recycled materials at the sinter plant, while improving sinter quality and productivity at lowest possible environmental impact and energy consumption.
The objective of this project is to allow an optimal use of challenging input materials in such a difficult context, by an advanced control of all preparation phases (mixing, granulation, etc.) and a better understanding of their impact on the sintering process.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Frédéric VAN LOO (Pr. Coord.)
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	UNIVERSITE DE LIEGE	BELGIQUE	Eric PIRARD
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Roland PIETRUCK
	VOESTALPINE STAHL GMBH	OESTERREICH	Herbert SCHMID

RFSR-CT-2012-00001 SUSTAINTAP

Blast furnace sustained tapping practice

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2877812 €	Start Date	1/07/2012
	EU Contribution	1726687 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

The key objective of this proposal is to optimise the blast furnace tapping practice.
The innovative approach is the combination of direct liquid level and flow measurements and the characterisation of drainage regimes.
This will result in a better understanding of the hearth processes and in improved casting rules based on actual measurements.
The proposed applications will contribute to a stable and thus more efficient blast furnace process in terms of operational safety, energy consumption and economy.

		Country	*Scientific person in charge*
Partners	**TATA STEEL NEDERLAND TECHNOLOGY B.V.**	NEDERLAND	Jan van der STEL (Pr. Coord.)
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RFSR-CT-2012-00002 IMPCO

Improved coal combustion under variable blast furnace conditions

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2481011 €	Start Date	1/07/2012
	EU Contribution	1488607 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

High pulverised coal injection (PCI) rates for minimisation of coke consumption are state of the art in blast furnace (BF) operation. Increasing need for flexible production rate with changing operational conditions and limited availability of matching coal types causes constraints for high PCI rates and results in higher total carbon © consumption. The overall project objective is to reduce the coke consumption also under these difficult new conditions by increased injection of conventional PC or new carbon products at the same time as the total rate of reducing agents is minimised. Additionally, some plants are restricted not only in supply of coals of stable and desirable quality, but also in oxygen capacity or injection system layout.
The project will contribute to improved competiveness of European steel industry by reduced costs and ecological footprint of carbon with respect to air. The flexibility will be improved by customizing new carbon products for injection available on the market at the same time as need for high rank coking coals can be decreased.
The objectives are reached by implementation of monitoring methods for injection-material quality, which improves BF heat level control and stability. The injection lances are modified for enhanced blast oxygen supply to coal plume, increasing the conversion efficiency of injected carbon material, minimising fines accumulation in lower zone of the BF and allowing minimum coke rates. Modification of lance design and necessary adjustments of blast parameters shall be carried out with the restriction at the actual BF plant in mind, without demands for major investments in the injection facilities.
Decreased use of metallurgical coke and high rank coking coals by replacing them with low rank coals or new carbon materials harmonize with ESTEP priorities of adaptation of the ironmaking process to lower quality materials.

		Country	*Scientific person in charge*
Partners	**SWEREA MEFOS AB**	SVERIGE	Lena SUNDQVIST ÖQVIST (Pr. Coord.)
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	VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Hugo STOCKER
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Michael HENSMANN

RFSR-CT-2012-00003 OPTISTOVE

Optimisation of blast furnace hot stove operation

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1916301 €	Start Date	1/07/2012
	EU Contribution	1149781 €	End Date	31/12/2015
State	Running project			

Provisional Abstract European steelmaking rely on relatively old plant that often experience problems with hot stove performance and operation. This project aims at developing and optimising techniques that makes the operation more efficient and stable thus reducing emissions, cost and energy demand. Stove oxygen enrichment , preheating of fuel/air, automated stove control concept and general guidelines for characterisation and optimisation of hot stoves will be developed to help European steelmakers improve its operations and increase its competitiveness. All techniques will be developed through a combination of theoretical work, pilot scale trials and industrial scale trials. A proper evaluation of the different techniques are ensured by thoroughly analysing the effect on the whole steelmaking production system. The results will be delivered as general guidelines and can in practice be applied by all European steel plants.

		Country	*Scientific person in charge*
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	SSAB EMEA AB	SVERIGE	Erik OLSSON
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Sebastian KOTZICH

RFSR-CT-2012-00004 OPTIPER

Optimisation of permeability bars to customise sinter plants on changing demands

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1560357 €	Start Date	1/07/2012
	EU Contribution	936214 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

Most sinter plants use permeability bars (rakes) to effectively raise productivity. However, still very few knowledge exists about their influences on the process. Consequently, they can hardly be adapted to changing conditions.
Aim of „OptiPer“ is to completely understand the influences of permeability bars on the local processes, productivity and quality. A unique set of well-coordinated operational trials at several plants will be performed and analysed by measurements and innovative models. A generally applicable optimisation strategy will be developed and guidelines for adaption to changing conditions/demands (raw materials, production, quality). Special attention will be paid on vertical permeability bars.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Michael HILLERS (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Javier RODRIGUEZ SOMOANO
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RFSR-CT-2013-00001 FLEXCOKE

Flexible production of coke using alternative coals - effects on coke properties under blast furnace conditions

Info

Type of Project	Research	Duration (months)	42
Total Budget	4955167 €	Start Date	1/07/2013
EU Contribution	2973100 €	End Date	31/12/2016

State Running project

Provisional Abstract

Limited availability and high costs for high quality cokemaking coals on the global market leads to importance of using alternative coal and carbon containing material. FLEXCOKE will increase the flexibility for selecting alterative carbon sources for cokemaking and produce coke of a quality that meets the requirements for stable blast furnace (BF) operation. This contributes to reduced costs for hot metal production with similar or lower carbon input and CO2 emission. The uniqueness of the proposed research is to link alternative raw material for cokemaking to BF coke properties and BF behaviour. Coke will be produced from alternative blends suitable for cokemaking plants and tested for BF requirements in innovative laboratory tests and in a BF, both on pilot and industrial scale. Development and use of innovative test methods in combination with samples from BF testing will improve the classification of coke quality relative BF conditions. Activities in the work program will contribute to the overall objective and includes characterisation and selection of coal/carbon-containing materials to be added to the coal blend, production of test coke in laboratory, pilot and full scale for metallurgical testing in the laboratory using standard equipment and a new test developed in the project, in a tuyere rig creating raceway realistic conditions, in an experimental BF and in full scale. The partners contribute complementary experience and facilities that in combination with tests at external laboratories forms a unique research structure. Combining standard methods with specific ones as methods for microstructure determination (isotropy/anistropy, graphitisation), microscopic gasification studies and particle shape determination the treated samples can be efficiently explored. Combining operational data with solid sample evaluation the impact of properties of alternative materials on coke quality and BF operation can be stated and the requirement for BF partly deduced.

Partners	*Country*	*Scientific person in charge*
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SSAB EMEA AB	SVERIGE	Dan HEDKVIST
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RFSR-CT-2014-00001 CharFoCo

Char formation, transportation and consumption in the blast furnace and its impact on coke rate

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2004743 €	Start Date	1/07/2014
	EU Contribution	1202844 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

The quality of usable raw materials for blast furnace ironmaking decreases. Coal quality can vary in a wide range, making it difficult to keep minimum coke rate and stable blast furnace conditions. Additional demand of production flexibility increases problems regarding process stability. With the decreasing iron ore qualities, maintaining high productivity and in economically harder situations, maintaining low specific coke rate becomes problematic. To investigate the appropriateness of coals or coal blends for injection, it is important to investigate the correlations between coal characteristics, impact on raceway conditions and impact on overall blast furnace characteristics, also including impact on melting, smelting and permeability of the burden. At industrial plants, high PCI operation seems to be sometime limited by the intrinsic nature of the coal. It might be relatively easy to reach coal rates above 200 kg/thm with one coal and difficult to inject more than 170 kg/thm with another one. For a minimisation of the coal rate, not only the conversion of coals in the raceway, but also the conversion and behaviour of the un-burnt coal char in the blast furnace are of importance. The reactions on the inside of the blast furnace are hardly predictable especially without special measurement equipment. Interpretation of typical, available plant data to draw conclusions on the inside of the furnace is difficult and shall be part of this project.

		Country	*Scientific person in charge*
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	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Dominique SERT
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Technical Group Steel 2

Steelmaking Processes

The scope of TGS2 includes:

- Electric arc furnace processes
- Physico-chemical metallurgy of liquid steel and slag
- Recycling of steel scrap
- Secondary metallurgy techniques
- Standardisation of testing and evaluation methods
- Maintenance and reliability of production lines
- Reduction of emissions, energy consumption and improvement of the environmental impact
- Instrumentation, modelling and control of processes

RFSP-CT-2003-00007 FULL-REC 2

Hydrometallurgical continuous treatment of ZnO enriched powders for metal zinc production

Info	Type of Project	Pilot&Demonstration	Duration (months)	24
	Total Budget	1460000 €	Start Date	1/09/2003
	EU Contribution	584000 €	End Date	31/08/2005
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22989:EN			

Final Abstract

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Loredana DI SANTE (Pr. Coord.)
	ASO SIDERURGICA S.R.L.	ITALIA	Silvano PANZA
	ACCIAI SPECIALI TERNI SpA	ITALIA	Daniele MORONI
	TECHINTSpA	ITALIA	Marcello POZZI

RFSR-CT-2003-00008 IMSTEELLAD

Investigations and measures to reduce emissions and energy consumption during preheating of steel ladles

Info

Type of Project	Research	Duration (months)	40
Total Budget	1775447 €	Start Date	1/09/2003
EU Contribution	1065268 €	End Date	31/12/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23175:EN

Final Abstract

The goal of this research project was to optimise the ladle preheating procedure for emissions and energy consumption. The project began with a detailed analysis of the present situation of ladle heating at the different steel plants (including on-site measurements). The ladles investigated differ in size, in heating procedure and refractory lining. The outgassing behaviour of eight typical refractory products was tested in newly developed (material and combustion) test facilities. The highest amount of outgassing volatile components occurs at a brick temperature of 450°C. A thermo-kinetic model was developed, based on experimental results and CFD simulations of the ladle flow field (including the burner flame), to describe the interaction of fluid flow, heat transfer, evaporation rate (outgassing behaviour) of the volatile components and their combustion. A simplified version of this model was produced for use as a 'ladle temperature control model' at the participating plants. The optimisation of the ladle flow field led to a new suction hood design for the heating system. The main features are the 'U'-shaped flow inside the ladle and a heat recovery in the exhaust channel, which led to a complete burnout of the volatile components and enabled the change from an oxygen/natural-gas combustion to an air/natural-gas combustion. These heating systems were installed in the participating plants. The energy consumption was reduced by approximately 20 %, NOx by 90 % and PAH down to around 10 ppm. When in operation the ladle temperature control model is successful.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Wolfgang ADLER (Pr. Coord.)
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CENTRO SVILUPPO MATERIALI SPA	ITALIA	Mario TONELLI
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THYSSENKRUPP NIROSTA GMBH	DEUTSCHLAND	Uwe de FRIES

RFSR-CT-2003-00016 PROMS

Cost efficient metallurgy for the production of novel ultra high strength deep drawable steel grades with high Mn contents from 10 to 25 wt.-%

Info	Type of Project	Research	Duration (months)	36
	Total Budget	934489 €	Start Date	1/09/2003
	EU Contribution	560693 €	End Date	31/12/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22991:EN			

Final Abstract The presented project addresses a current need for novel ultra-high strength deep-draw-able steels with high manganese contents with extremely improved properties for lightweight construction. The aim of the work was the selection and development of suitable technologies of primary and secondary metallurgy for the production of these steels with an emphasis on the BOF route. A combination of theoretical investigations, laboratory development and pilot-scale trials was used. Various fundamental aspects related to the production of these steel grades have been investigated like metal/slag reaction and melt refining, decarburization of the melt, reactions with the refractory and so on. This was done by laboratory scale experiments and theoretical modelling. Based on these fundamental investigations, pilot scale trials in an experimental BOF have been performed which have proven the possibilities to alloy crude steel (produced in the same vessel by LD process) up to 20% wt. Mn. Small-scale trials have demonstrated possibilities and limitations of secondary metallurgical treatments. A kinetic process model to investigate the principles of different process routes for the production of high Mn steels was set up and was applied to three principle production routes (BOF based, VOD and an EAF based route). The role of tramp elements for the considered production routes has been regarded. Their influence on the technological steel properties has been investigated as a prerequisite to define allowable contents to be fulfilled by the metallurgical process. The costs for production have been calculated for the regarded routes. Special aspects of the specific route and alloy are discussed.

		Country	*Scientific person in charge*
Partners	**SALZGITTER MANNESMANN FORSCHUNG GmbH**	DEUTSCHLAND	Christian REDEKER (Pr. Coord.)
	SWEREA MEFOS AB	SVERIGE	Ralph NYSTRÖM
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RFSR-CT-2003-00024 REC DC EAF

Monitoring system for controlling and reducing the electrode consumption in DC EAF plants

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1050400 €	Start Date	1/09/2003
	EU Contribution	630240 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23889:EN			

Final Abstract The general aim of this project was to reduce graphite electrode consumption at DC EAF plants. Camera-based systems allowing for monitoring of the state of the electrode after the melting of each scrap basket were installed in the steel plants of ArcelorMittal Esch-Belval and Differdange. Dedicated image analysis software and logging systems were developed to follow up the electrode wear. Three industrial measurement campaigns were carried out. Electrode consumption was calculated on a basket-by-basket basis and the accuracy of the measurement method was evaluated. Industrial results were studied in detail, splitting electrode consumption into three main mechanisms: continuous consumption, crack losses and stub-end losses. Statistical analyses were then carried out, and the main operating parameters influencing the different modes of consumption identified. An extended version of the BFI electrode consumption model was proposed and validated. Additional investigations (using X-ray scanning and metallographic analyses) were carried out on industrial electrode samples to study the generation and propagation of cracks in the electrode material. CSM carried out dedicated pilot-scale tests in order to evaluate the influence of several process parameters on electrode consumption and to study the behaviour of artificially cracked electrodes. Guidelines to reduce the electrode consumption in DC plants were proposed. Four such camera-based electrode-monitoring systems have now been installed in industrial EAF plants and more are envisaged. The system is used both online by furnace operators and offline by plant managers to negotiate with electrode suppliers and to support the development of new electrode solutions.

		Country	*Scientific person in charge*
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	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT

RFSR-CT-2003-00031 EAFDYNCON

Dynamic control of EAF burners and injectors for oxygen and carbon for improved and reproducible furnace opertion and slag foaming

Info

Type of Project	Research	Duration (months)	42
Total Budget	1545849 €	Start Date	1/09/2003
EU Contribution	927509 €	End Date	28/02/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23920:EN

Final Abstract

The objective of the project was the development of techniques to improve the control of the energy input by natural gas burners and of the wall mounted oxygen and carbon injectors of the electric arc furnace (EAF). Process data acquisition and measurement systems for foamy slag detection were implemented at the EAFs of ArcelorMittal Belval (DC), Sidenor (AC) and GMH (DC). Plant trials with different carbon and oxygen injector configurations and operation regimes were evaluated to derive control strategies for carbon and oxygen injectors regarding foamy slag control and adjustment of final carbon and oxygen content of the melt. A laser-based distance sensor was developed, tested and installed inside a natural gas burner, to detect the distance to the actual scrap load in front of the burner during scrap preheating. A tentative control algorithm for the burner operation was derived from industrial trials at the ArcelorMittal Belval EAF. A comparison with the water-cooled panel overheating proved the ability of the sensor to predict the blow-back phenomenon and thus to avoid burner damage. Control concepts for carbon and oxygen injection were developed on the basis of carbon and oxygen content measurements, signals for foamy slag detection, off-gas analysis values and dynamic model calculations. The online implementation of an automatic injector control at the Sidenor EAF led to a reduction of the main EAF parameters, like power-on and power-off times, and electrical energy consumption. Furthermore, the foamy slag performance was improved. Results of plant trials showed that similar results can be expected when dynamic control concepts are implemented online at the EAFs of ArcelorMittal Belval and GMH.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT (Pr. Coord.)
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Pierre NYSSEN
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Santiago LANDA LAZCANO
GEORGSMARIENHÜTTE GmbH	DEUTSCHLAND	Ingo KOLM
ProfilARBED S.A.	LUXEMBOURG	Jean-Claude BAUMERT

Patents Device and process for the dynamic combustion control of a burner of an electric arc furnace. P. Nyssen, C. Mathy, M. Schyns. Patent EP1703241 - 20060920

Selected Publications

Kleimt, B., Köhle, S., Kühn, R., Zisser, S. Application of models for Electrical Energy consumption to improve EAF operation and dynamic control. Proceedings of 8th European Electric Steelmaking conference, Birmingham, UK, 9-11 May 2005, p. 183 – 197

"P. Nyssen, C. Mathy, J. Borlee, J.L. Junque, N. Petre, M. Brimmeyer, J.C. Baumert: ""Automatic setting of the EAF burners"", Journees Siderurgiques Internationales, ATS, Paris, 14.-15. December 2006, and La Revue de Métallurgie-CIT, Octobre 2007, p. 501-506"

P. Nyssen, C. Mathy, M. Brimmeyer, D. Gualtieri, D. Rigoni J.C. Baumert: “Innovative technique for reliable operations and blow-back prevention of EAF combined burners, burners and injectors”. 9th European Electric Steelmaking Conference, Krakow, Poland, 19.-21. May 2008

S. Landa , T. Rodríguez, J.L. Muñoz and J.J. Laraudogoitia: Dynamic control of slag foaming at Sidenor Basauri meltshop. Proceedings 9th European Electric Steelmaking conference. Krakow, Poland, 19.-21. May 2008

RFSR-CT-2003-00042 BOFDYN

Dynamic end point in BOF through a fast and simultaneous determination of the steel/slag composition

Info

Type of Project	Research	Duration (months)	40
Total Budget	1102151 €	Start Date	1/09/2003
EU Contribution	661290 €	End Date	31/12/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24032:EN

Final Abstract

In order to achieve shorter tap-to-tap time and hence higher productivity at the BOF, process events related to the control of the melt analysis, such as stop of the oxygen blow, lance withdrawal or vessel tilting, have to be avoided. A new method for controlling the BOF process is proposed here. It involves the use of an original in-blow heterogeneous sampler simultaneously collecting slag and steel and a dedicated laser analytical method (LIBS). With this method, the aim is to deliver as quickly as possible a complete analysis of the steel and slag collected by the heterogeneous sampler (Fe, C, P, S ...). Besides the setting-up of the heterogeneous in-line sampling, a specific procedure has been developed in order to recognise the laser shots coming out from slag and from steel when moving the heterogeneous sample during its analysis. Combined with a metallurgical model, the processing of the data generated with the heterogeneous sampler leads to dynamically assess the state of the refining progress and to define the corrective actions in order to allow a safe direct tapping practice. The expected benefits are a reduced reblow rate, a tap-to-tap saving (a gain of 2-3 minutes per heat can be expected), a reduced trunion wear, as well as an increased refractory lining life and process yield. Developed for a converter without sub-lance, the method was adapted for converters equipped with a sub-lance. Results of orientation tests are presented here.

Partners

	Country	*Scientific person in charge*
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Michel WAUTERS (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Michel HEMMERLIN
HERAEUS ELECTRO-NITE INTERNATIONAL NV	BELGIQUE	Johan KNEVELS
SWEREA KIMAB AB	SVERIGE	Arne BENGTSON

RFSP-CT-2004-00006 DOT Application

Application of direct optical temperature measurement in steelmaking process

Info				
	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	789975 €	Start Date	1/07/2004
	EU Contribution	315990 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23736:EN

Final Abstract Evaluation of the bath temperature distribution at the end of the main blowing phase of an LD-steelmaking converter revealed that about 20 % of the heats have a temperature deficit and must be re-blown. Another 30 % of the heats are overblown with too high a bath temperature. To overcome these disadvantages, a new online temperature measuring system was developed to enable direct determination of bath temperature during the oxygen blowing process. The measuring system uses an optical fibre which is continuously fed into the steel melt through a bottom gas stirring nozzle. The measurement device was installed at a 185 t converter and several test campaigns were performed. With regard to the number of measured heats, the availability of the measuring system itself was better than 98 %, but the availability of a free bottom nozzle was only about 40 % due to the formation of accretions at the nozzle tip. Since the accuracy of the measuring system is influenced by working conditions, it was addressed in laboratory trials and plant trials. A standard deviation of 13.4 K was determined in the plant trials, whereas it was identified as 9.5 K in the laboratory trials. The measuring system was also used for end-point control of the oxygen blowing process. This was performed by continuous temperature measurement in the final refining stage. Re-blowing due to temperature deficit or over-blowing with too high bath temperatures could be minimised. However, further research is needed to establish how the passage through the bottom nozzle can be kept clear.

Partners		*Country*	*Scientific person in charge*
	AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Helmut LACHMUND (Pr. Coord.)
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Herbert KÖCHNER

Patents DE102005061675

Selected Publications

T. Lamp, H. Köchner, H. Lachmund, Y. Xie: Direct optical temperature measurement in the converter. Proceedings of the 27th ATS Conference 2006, Paris, 14-15.12.06, 224-225

H. Köchner, T. Lamp: Neue Techniken der kontinuierlichen optischen Temperaturmessung im Stahlwerk. Stahl und eisen 129 (2009) Nr. 3, 39-45

T. Lamp, H. Köchner, H. Lachmund, Y. Xie: Direct blowing end point determination by on-line temperature measurement in a LD-converter. Proceedings of the 6th European Oxygen Steelmaking Conference (EOSC), 2011, Stockholm

RFSR-CT-2004-00008 EAFCAMERA

Control by camera of the EAF operations in airtight conditions

Info

Type of Project	Research	Duration (months)	42
Total Budget	969780 €	Start Date	1/07/2004
EU Contribution	581868 €	End Date	31/12/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24986:EN

Final Abstract

growing number of EAFs are equipped with wall-mounted injectors and operate with the slag-door closed. In order to observe the scrap-melting process under these conditions, CRM has developed a camera-based technology to monitor the inside of the furnace during meltdown. The camera system is able to see through combustion gases by selecting its wavelength to be in the mid-infrared spectral band. The first industrial application of this camera technology was carried out at the ArcelorMittal Esch-Belval plant, which is equipped with a DC furnace. The endoscopic system was mounted inside a dedicated burner in the furnace sidewall. The burner flame provided a clearance area and helped to protect the optical window from slag/metalsplash. Many heats were monitored with this system, showing scrap-drop events and the scrap-melting phase in real time. The camera system was also installed in the roof of Corus Engineering Steel's AC 'N' furnace. A holder was especially designed to prevent slag and metal splash from adhering to the tip of the endoscope by blowing high volumes of air through a De-Laval nozzle. The image quality at the beginning and end of a melt was generally very good.However, after several minutes of arcing, generation of high dust density had a significantly deleterious effect on the resolution of the images. Towards the end of the melting period, the view cleared again and excellent quality images were seen of foaming slag behaviour. The tapping process could be plainly seen as well as the hot heel before next scrap charging.

Partners

	Country	*Scientific person in charge*
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Pierre NYSSEN (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Jacques HOFFMANN
MORE S.r.l.	ITALIA	Giancarlo ANTONELLI
TATA STEEL UK LIMITED	UNITED KINGDOM	M. Stuart MILLMAN

Patents NYSSEN Pierre, MATHY Cécile, SCHYNS Marc, "Device for observing the charge in an electric steel production furnace" Patent Number: EP1457575 A1 20040915

Selected Publications

P. Nyssen, C. Mathy, J.L. Junqué, N. Pétré, J.C. Baumert, J. Hoffmann, "Innovative Visualisation Technique at the Electric Arc Furnace",8th European Electric Steelmaking Conference, 9-11 May 2005, ICC, Birmingham, UK, ISBN 1-86125-161-1, Published by IOM, May 2005, pp. 165-172.

M.S. Millman, P. Nyssen, C. Mathy, D. Tolazzi, L. Londero, J.C. Baumert, M. Brimmeyer, D. Gualtieri, D. Rigoni, "Direct Observation of the Melting Process in an EAF with a Closed Slag Door", European Electric Steelmaking Conference, 19-21 MAY 2008, Jagiellonian University, Krakow, Poland, Archives of Metallurgy and Material, May 2008, Issue 2, pp. 464-468

RFSR-CT-2005-00003 CONOPT SCRAP

Control and optimisation of scrap charging strategies and melting operations to increase steel recycling ratio

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1854704 €	Start Date	1/07/2005
	EU Contribution	1112822 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25095:EN			

Final Abstract

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Michel WAUTERS (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Marco PICCO
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Piero FRITTELLA
	SWEREA MEFOS AB	SVERIGE	Jonas ALEXIS
	NLMK LA LOUVIERE S.A.	BELGIQUE	Bernard POIZOT
	TATA STEEL UK LIMITED	UNITED KINGDOM	Alan SCHOLES

RFSR-CT-2005-00004 HINIST

Mastering of P-ESR technology for high nitrogen steel grades for high value applications

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1076922 €	Start Date	1/07/2005
	EU Contribution	646153 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24347:EN			

Final Abstract

"To respond to the need to increase and guarantee the reliability of the P-ESR process for the production of high nitrogen steels in terms of nitrogen content of ingots, a better understanding about nitrogen pick-up from the gas phase at high pressure of nitrogen and its transfer through the molten slag to the metal was sought. Extended experiments at both pilot and industrial plant allowed the role of both slag composition and process parameters (mainly N partial pressure and melting rate) to be investigated: the result was the establishment of an optimised slag composition able to allow the highest N transfer from the gas phase to the molten metal and the confirmation of the positive role of a high nitrogen partial pressure as 40 bar. The activities concerned mainly a martensitic steel called Cronidur 30 with a minimum requested N content of about 0.35 % wt; a parallel activity was also carried out for two austenitic steels (P900N and P2000). Whereas standard production uses the continuous addition of N-rich compounds to the slag continuously during the process to reach the requested N content in the steel, experimentation at pilot plant and trials at industrial plant showed that a transfer of N just from the gas phase up to about 0.30 % wt is possible by the use of an optimised slag and high N pressure. Moreover, to guarantee the reliability of the P-ESR process in terms of nitrogen content in the produced ingots, a dynamic mathematic model, able to represent all the important nitrogen transfer mechanisms for the metal, has been set up to support a dynamic control tool of the process. Laboratory formability studies, thermomechanical processing in production conditions and mechanical testing on both steels confirmed the validity of the new P-ESR operation procedures set up in the project regarding quality aspects of the final product."

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Andrea CAROSI (Pr. Coord.)
	ENERGIETECHNIK ESSEN GmbH	DEUTSCHLAND	Volkher DIEHL
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT
	MATERIÁLOVÝ A METALURGICKÝ VÝZKUM s.r.o.	CZECH REPUBLIC	Vlastimil VODAREK

RFSR-CT-2005-00005 ImPurgingAr

Improvement of purging plugs performances by investigations on the materials, process analysis and continuous monitoring

Info

Type of Project	Research	Duration (months)	48
Total Budget	906380 €	Start Date	1/07/2005
EU Contribution	543828 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24987:EN

Final Abstract

The research programme was aimed at improving the purging plugs performance (desired gas injection flow rate through the plug for an adequate working time) in argon stirring operations. From the fundamental point of view, the thermochemical effect of the interaction between the plug refractory and the process has been investigated, in particular, concerning slag formation under the process temperature conditions, and the interaction between such a slag and steel. In parallel, the plugs thermo mechanical behaviour was studied, since thermal shock during stirring results in very strong mechanical stresses,harmful for the refractory. The technology of measuring refractory wear during working has been suitably applied to purging plugs. A thermal sensor has been improved and tested at laboratory scale. The proven technology, that foresaw thermocouples positioned along plug thickness, has been used for industrial trials to measure purging plug wear. Plug wear has been evaluated on the basis of the measured temperature and thermal distribution along the plug thickness. The solution adopted on plant in order to improve the purging plugs performance has foreseen the use of gas controller system, to detect the plug occlusion, and the implementation of gas maintenance procedure, aimed to remove the plug occlusions by blowing gas at high pressure. The technology capability was verified in detecting and solving the conditions of plug fully or partly 'blocked'.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Mario TONELLI (Pr. Coord.)
ACCIAI SPECIALI TERNI SpA	ITALIA	Massimo PROIETTI CERQUONI
CALDERYS ITALIA SRL	ITALIA	Renzo PARODI
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Christian DANNERT

RFSR-CT-2005-00006 PREDINC

Prediction of inclusions in the slabs from the process characteristics

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1570504 €	Start Date	1/07/2005
	EU Contribution	942302 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24992:EN			

Final Abstract This project is a collaboration between ArcelorMittal España, SA, SSSA, ILVA, Helsinki University of Technology, Politecnico di Milano, RWTH IEKH Aachen University and University of Oviedo and is coordinated by ArcelorMittal España. The aim of this project is to develop a system capable to determine the quality in the field of inclusions of steel before and during its production, in order to change the setups to improve it. Data from four Steel shops, two partners expert in metallurgical modelling and three partners with proven expertise in data-based models worked together, including crossed evaluation in order to produce, validate and conclude the cleanliness model. Two ways of model development were carried out: classical thermodynamic calculation and data-based analysis. Thermodynamical models provide good results for being the first approach to cleanliness models for selected cases. Data Mining models are capable to imitate classical models, improving their performance for more cases although it was demonstrated that it is not possible to manage all kinds of steel with a single model. Moreover, the need of improving reliability of inspection system output to be used as model input was identified. In order to validate the models and get deeper knowledge on inclusions formation inselected steel grades, several sampling campaigns and inclusions analysis have been done. As expected, for similar steel grades the results obtained were similar, as expected. Finally a user interface and requirements for integration of the developed models within the steel plant were also developed in the promising cases although it was not completely extended as the range of steels where models are applicable is limited. Potential areas of exploitation for the results from this project have been highlighted.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL ESPAÑA SA**	ESPAÑA	Luis Fernando SANCHO MENDEZ (Pr. Coord.)
	ILVA S.P.A.	ITALIA	Nicola DELRE
	POLITECNICO DI MILANO	ITALIA	Walter NICODEMI
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Jukka LAINE
	UNIVERSIDAD DE OVIEDO	ESPAÑA	Francisco ORTEGA FERNANDEZ

RFSR-CT-2005-00007 ANALCO

On-line determination of the CO/CO2 concentration in the OG system in BOF converter

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1228207 €	Start Date	1/07/2005
	EU Contribution	736924 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24460:EN			

Final Abstract

"The main results of the development are innovative systems for an online and accurate measurement of the concentration of COx and 02 at OG system of BOF converter. Based on this measurement, it is possible to develop models of the gas extraction system to optimise control over the OG system, improving the recovering and reuse of energetic gas. Two different technologies based on FTIR and microwave were developed and tested at the plant site: - an FTIR based system proved to fulfil requirements for online measuring proving its use in industrial application, in accordance with the results obtained, both at pilot plants in laboratory as well as in a measurement campaign at the LDA Steel-shop of ArcelorMittal — Avilés Plant; - a microwave based system tested at a pilot furnace in gas atmospheres with temperatures of 1 200 to 1 600 °C and 4 to 20 % vol. CO. The measured data showed peak frequencies, which were close to peak frequencies known in the literature, and a dependency of the frequency positions and line-widths from the gas temperature were observed. Integration with the plant automation of the new measuring technique was developed: communication protocol and databases. A model for dynamic BOF control by using regression analysis and neural networks was constructed. Coupling of the developed model based on artificial intelligence techniques with the already existing thermo-chemical automation system and the fast in situ off-gas analysis allows closed-loop control of the BOF process, with an average relative error of 0.028 and an average mean square error of 0.023."

Partners	*Country*	*Scientific person in charge*
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Fernando SANCHO MENDEZ (Pr. Coord.)
SWEREA MEFOS AB	SVERIGE	Johan ERIKSSON
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

RFS1-CT-2006-00002 EOSC 2006

5th European oxygen steelmaking conference 2006

Info				
	Type of Project	Accompanying measure (conferen	Duration (months)	0
	Total Budget	375400 €	Start Date	26/06/2006
	EU Contribution	20000 €	End Date	28/06/2006

State Project suspended, no final report published

Provisional Abstract

The objective of the present proposal is the organisation and hosting of an European conference in the field of oxygen steelmaking and secondary metallurgy.
The European Oxygen Steelmaking Conference (EOSC) series is organised in turn by one of the European Metallurgical Societies and Associations. As such it represents the most comprehensive expert knowledge in steelmaking.
Past of the EOSC venues were:
• 1993: Neuss, D
• 1997: Taranto, I
• 2000: Birmingham, UK
• 2003: Graz, A
The Steel Institute VDEh is pleased to announce that it will organize the 5th European Oxygen Steelmaking Conference to be held in Aachen, 26 – 28 June 2006.
The scope of the conference is to provide a forum for researchers, specialists and engineers from the European Union and abroad to discuss and to inform themselves about latest process and plant technology developmens, research projects and results, operation related questions of metallurgy, automation and process control and process integrated environmental protection aspects in all
areas of basic oxygen steelmaking. Within this frame the diffusion of results gained on research projects by the European Commission Steel RTD Programme is assured.

	Country	*Scientific person in charge*
STAHLINSTITUT VDEh	DEUTSCHLAND	Hans Bodo LÜNGEN

Selected Publications

Proceedings of the 5th European Oxygen Steelmaking Conference, 26 - 28 June 2006, Aachen (Germany). Verlag Stahleisen GmbH, Düsseldorf.

RFSR-CT-2006-00003 SSIA

Strengthened scrap impact area in BOF converters

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1539162 €	Start Date	1/07/2006
	EU Contribution	923498 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25349:EN			

Final Abstract The SSIA project was undertaken to develop and identify ways and means to improve the lining wear in exposed areas of BOF refractory, more specifically the scrap impact area. Different maintenance operations were evaluated on the impact on wear rates at different working conditions. A new improved refractory was developed and tested in field test in comparison with conventional refractory for the scrap impact area. Techniques for air-mist cooling of the converter shell and cooling by gas purging into the vessel were tested. Quantitative evaluation of different maintenance operations and new techniques was performed. The conclusions from the project are that preventive maintenance operations performed during lining campaigns, e.g. slag splashing and slag washing, are the most beneficial actions to achieve lower refractory wear rate in the scrap impact area. Type of refractory is also an important factor, but plant conditions needs to be considered in the choice of refractory type. Slag with bricks patching and patching with MgO-based masses are shown to be the most beneficial acute measures for repairing excessive wear in the scrap impact area.

		Country	*Scientific person in charge*
Partners	**SWEREA MEFOS AB**	SVERIGE	Johan ERIKSSON (Pr. Coord.)
	RHI AG	OESTERREICH	Gerald BUCHEBNER
	RAUTARUUKKI OYJ	FINLAND	Simo ISOKÄÄNTÄ
	SSAB EMEA AB	SVERIGE	Hakan WAHLBERG
	VOESTALPINE STAHL GMBH	OESTERREICH	Herbert MIZELLI

RFSR-CT-2006-00004 OFFGAS

Improved EAF process control using on-line offgas analysis

Info				
Type of Project	Research	Duration (months)	36
Total Budget	2716188 €	Start Date	1/07/2006
EU Contribution	1629711 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25048:EN

Final Abstract The objective of the project was to increase the efficiency of EAF oxygen injection and energy transfer to the scrap and melt. In expansion to short-term investigations using off-gas analysis to monitor energy flow rate of the off-gas, permanent on-line monitoring and control of the EAF process on the basis of off-gas analysis has been implemented. The continuous availability of an on-line monitoring system of the EAF melting process has shown its effectiveness to provide an important tool for the steel plant workers in order to optimize the EAF process with respect to optimal efficiency of oxygen lancing, carbon injection and addition, energy transfer either from the arc and from the gas phase to the melted pool (post-combustion, scrap preheating). The technical objective, to significantly increase the availability and applicability of the off-gas signals for on-line assessment and control of postcombustion and for comprehensive EAF energy monitoring, has been achieved. Additionally, EAF process models that were up to now mainly used for off-line process assessment of various aspects of EAF steel making, have been tested, developed and applied for on-line EAF process and energy control. The work programme of the OFFGAS project partners was organised by division into 8 work packages that were subdivided into various tasks. After installation and commissioning of the off-gas analysis systems at the industrial partners (WP 1), off-gas data were assessed together with additional process data in order to define the current state of EAF operation and to develop process models: optimal decarburization (WP 2), energy monitoring system and optimal energy efficiency (WP 3), optimal postcombustion (WP 4), optimal Consteel process (WP 5), advanced CRM process model at ArcelorMittal Differdange (WP 6). Results from plant trials and process modelling have been used to compare and adapt the different process models and rules from each industrial partner (WP 7). Final plant trials with the process models developed and/or adapted have been conducted as last work package (WP 8).

Partners		*Country*	*Scientific person in charge*
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Herbert PFEIFER (Pr. Coord.)
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Pierre NYSSEN
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Filippo CIRILLI
	DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Hans-Peter JUNG
	STAHL- UND WALZWERK MARIENHÜTTE GMBH	OESTERREICH	Axel GRABMEIER
	O.R.I. MARTIN - ACCIAIERIA E FERRIERA DI BRESCIA SpA	ITALIA	Uggero DE MIRANDA
	TENOVA SpA	ITALIA	Mauro BIANCHI FERRI
	THYSSENKRUPP NIROSTA GMBH	DEUTSCHLAND	Helge MEES
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT

Selected Publications

H.-J. Krassnig, B. Kleimt, L. Voj, H. Antrekowitsch. EAF post-combustion control by on-line laser-based off-gas measurements. 9th European Electric Steelmaking Conference EEC Krakau, 19. - 21.05.2008

V. Risonarta, L. Voj, H. Pfeifer, H.-P. Jung, S. Lenz. Optimization of electric arc furnace process at Deutsche Edelstahlwerke. 9th European Electric Steelmaking Conference EEC Krakau, 19. - 21.05.2008

H.-J. Krassnig, B. Kleimt, L. Voj, H. Antrekowitsch. EAF post-combustion control using laser off-gas analysis. stahl und eisen 128 (2008) 41-52

V. Risonarta, T. Echterhof, L. Voj, H. Pfeifer, H.-P. Jung, S. Lenz. Optimization of the electric arc furnance process at Deutsche Stahlwerke. stahl und eisen 129 (2009) 55-64

V. Y: Risonarta, T. Echterhof, H.-P. Jung, C. Beiler, S. Lenz, M. Kirschen, H. Pfeifer. Application of an Off-Gas Analysing System to Control Oxidation during Stainless Steelmaking in an EAF. steel research international 81 (2010) 778–783. DOI 10.1002/srin.201000134 URL http://onlinelibrary.wiley.com/doi/10.1002/srin.201000134/abstract

RFSR-CT-2006-00006 IMPHOS

Improving phosphorus refining

Info

Type of Project	Research	Duration (months)	42
Total Budget	1498546 €	Start Date	1/07/2006
EU Contribution	899127 €	End Date	31/12/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25005:EN

Final Abstract

Development of the slag/metal/gas emulsion plays a very important role in the dephosphorisation of steel and extensive in-blow sampling of the emulsion through the blow together with a thorough examination of these samples using the most capable techniques available is required in order to define and model phosphorus refining better than at present. To this end, a dedicated sampling system was designed and built in order to directly monitor, at several specific positions in the MEFOS 6t BOS converter, the formation and development of the slag/metal emulsion and its capability for refining throughout the blow. More than five hundred samples, taken systematically from twenty-three heats at the MEFOS 6 t BOS converter, have been thoroughly analysed using manydifferent sample preparation and analytical techniques to indicate relative refining capability in the slag/metal emulsion and the steel bath. The considerable number of sample results has been compiled into useful data sets where patterns of behaviour may be observed and understood. The main objective of this project is to utilise these results to improve our understanding of the mechanisms that take place during phosphorus refining and, in so doing, to offer a way to control phosphorus levels in a more systematic and effective manner.

Partners

	Country	*Scientific person in charge*
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SWEREA MEFOS AB	SVERIGE	Donald MALMBERG
SSAB TUNNPLÅT AB	SVERIGE	Mats BRÄMMING
TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Abha KAPILASHRAMI

Selected Publications

M.S. Millman, A. Overbosch, A. Kapilashrami, D. Malmberg, M. Brämming 'Sampling the Slag/ Metal Emulsion in a BOS Converter – Phosphorus Control', PROC. SCANMET 3, 3rd Int. Conf. on Process Development in Iron and Steelmaking, June, 2008, Lulea, Sweden, [1]

M.S. Millman, A. Overbosch, A. Kapilashrami, D. Malmberg, M. Brämming 'Study of Refining Performance in BOS Converter', Ironmaking and Steelmaking, 2011, Vol. 38, No.7, pp 499-509

M.S. Millman, A. Overbosch, A. Kapilashrami, D. Malmberg, M. Brämming 'Some Observations and Insights on BOS Refining', to be published in Ironmaking and Steelmaking, 2013, Vol. 40, No.6, (in July, 2013)

M.S. Millman, A. Overbosch, A. Kapilashrami, D. Malmberg, M. Brämming ' Observations on BOS Refining', to be published in Transactions of the Indian Institute of Metals, 2013, (either in the single October 63(5) issue or in the combined October –December 63(5-6) issue)

RFSR-CT-2006-00005 EAF-PROMS

Cost efficient metallurgy for the production of novel ultra high strength deep drawable steel grades with high Mn contents from 10 to 25 wt.-% by using EAF steel making route

Info

Type of Project	Research	Duration (months)	28
Total Budget	652769 €	Start Date	1/09/2006
EU Contribution	391661 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24225:EN

Final Abstract

The project presented comprises a selection of theoretical investigations, laboratory development and pilot-scale trials conducted to address the current need for ultra high-strength deep-drawable steels with high manganese contents. The aim of the work was the selection and development of suitable technologies of primary and secondary metallurgy for the production of these steels with emphasis on the EAF route. An assessment of the theoretical aspects of the process kinetics of the different EAF processes routes — such as the direct melt preparation, modelling of the slag properties, decarburisation and desilicification — has been made. Further experimental measurements were conducted on the basis of the theoretical modelling of direct reduction and slag foaming, and the effects of high manganese melt on the typical EAF components (bottom electrode, tapping technologies). The advantages and/or disadvantages of an AC/DC EAF furnace are discussed. Based on these investigations pilot-scale trials were carried out. Since the use of scrap as raw material results in the inclusion of certain tramp elements, these were investigated through tensile, castability and weldability tests. For the use of direct reduction processes, suitable manganese ore availability was looked at. Economic and ecological/recycling aspects were taken into consideration and the results are presented for different EAF routes. Furthermore the implications of manganese dust for health and safety are also reviewed. The EAF route, as a result of this work, is probably the most economically feasible route for the processing of high manganese steels.

Partners

	Country	*Scientific person in charge*
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Joachim KROOS (Pr. Coord.)
SWEREA MEFOS AB	SVERIGE	Pär HAHLIN
TECHNISCHE UNIVERSITAET CLAUSTHAL	DEUTSCHLAND	Karl-Heinz SPITZER

RFSR-CT-2007-00004 ONDECO

On-line control of desulphurisation and degassing through ladle bubbling under vacuum

Info				
Type of Project	Research	Duration (months)	36
Total Budget	948193 €	Start Date	1/07/2007
EU Contribution	568916 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25091:EN

Final Abstract The project objectives are to characterise gas stirring during ladle metallurgy using vibration and camera sensors, and to develop innovative signal processing for obtaining representative indices, used as input into online metallurgical models for adjusting and improving the process. DH and ArcelorMittal selected accelerometers as vibration sensors for the vacuum tank degasser. The effect of pressure and gas flow rate on the vibration signal was quantified by trials on ladle water models and steel plant. The measuring system efficiency is confirmed by long-term trials. A correlation provides the real gas flow rate from measured vibration index and vessel pressure. Available offline desulphurisation and degassing models were transformed into online models fed by process parameters and the vibration index. The model's connection to level 2 is successfully terminated. The vacuum treatment progress will be online controlled and optimised with simultaneous model calculations. VASL developed signal processing of optical camera images with fuzzy logic, providing the gas purging intensity during ladle furnace treatment and introduced a purging index combining stirring time. A linear model relating the desulphurisation degree with the purging index was proposed for grade families with different sulphur aims. The steel microcleanliness is linked to the purging index and higher purging indices correspond to bad castability, however with scatter. The online purging index is permanently integrated to the ladle furnace 1 automation and control level.

Partners	*Country*	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Michèle NADIF (Pr. Coord.)
AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Helmut LACHMUND
VOESTALPINE STAHL GMBH	OESTERREICH	Roman RÖSSLER

Selected Publications Michele Nadif, C. Pussé (ArcelorMittal Global R&D Maizieres Process), H. Lachmund, H. Abdullah, Y. Xie (Aktien-Gesellschaft der Dillinger Hüttenwerke) and Roman Roessler (voestalpine Stahl GmbH). On-line control of efficiency of ladle stirring treatment during secondary metallurgy. SCANMET IV, 10-13 June 2012.

H. Lachmund, Y. Xie, H. Abdullah: Online Monitoring and Prediction of the Effectiveness of the Vacuum Tank Degassing Process. Proceedings 1st ISIJ-VDEh-Jernkontoret Joint Symposium on Metallurgy (14th ISIJ-VDEh Seminar on Metallurgical Fundamentals, 8th Japan-Nordic Countries Joint Symposium on Science and Technology of Process Metallurgy), ISIJ, Osaka, Japan, 15.-16.04.2013, p. 121/129

RFSR-CT-2007-00005 SOPLIQS

Optimisation of sampling at liquid steel state and correlative inclusions assessment of liquid steel for the improvement of high performance steel grades production process

Info

Type of Project	Research	Duration (months)	36
Total Budget	1026340 €	Start Date	1/07/2007
EU Contribution	615804 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25039:EN

Final Abstract

The development of high performance steel grades leads to more and more severe requirements in terms of inclusion cleanness. Steelmakers need to control very early the inclusions present in the liquid state in order to improve the process and achieve the final product quality. Previous studies have shown that the inclusions observed in the samples taken in the liquid state are not always the inclusions really present in the liquid steel. Taking intoaccount that an incorrect cleanness evaluation can lead to quality troubles and to customer claims, the main objective of this project is to determine the most reliable liquid steel sampling method and the most appropriate inclusion assessment strategy. The second objective is the prediction of the final product cleanness on the basis of liquid steel analysis. By coupling modelling, laboratory-scale experiments, industrial sampling campaigns, statistical approaches and the improvement of certain techniques, the following conclusions are obtained. • The most reliable sampling procedure is to use an argon blowing device, which avoids slag entrapments, steel reoxidation and uncontrolled shrinkage location. The lollipop sample shapes are recommended.• The most reliable characterisation strategy is to implement PDA, which gives an oxide cleanness index, then automated SEM (oxides 2 ?m to 10 ?m) and, if necessary, automated LOM (oxides > 10 ?m) and EE (inclusions < 2 ?m).• Prediction of the oxide composition in the final product on the basis of the tundish samples is possible. Prediction of density and size is more difficult because they depend on inclusion deformation during rolling.

Partners

	Country	*Scientific person in charge*
ASCOMETAL S.A.S.	FRANCE	Fabienne RUBY-MEYER (Pr. Coord.)
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Rafael PIZARRO SANZ
KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Anders TILLIANDER
RIVA ACCIAIO SPA	ITALIA	Paolo ROSSI

Selected Publications

F. Ruby-Meyer, A. Karasev, P. Jönsson, M. Pérez-Alonso, S. Baragiola, Optimisation of sampling for inclusion assessmenet at liquid steel stage, Proccedings of Clean Steel 8 Conference, Budapest, May 2012

RFSR-CT-2007-00006 EPOSS

Energy and productivity optimised EAF stainless steel making by adjusted slag foaming and chemical energy supply

Info

Type of Project	Research	Duration (months)	42
Total Budget	1476421 €	Start Date	1/07/2007
EU Contribution	885853 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25082:EN

Final Abstract

The main aim of the project is to increase the energy efficiency and productivity during EAF high alloyed stainless steelmaking by development of innovative slag conditioning techniques for slag foaming and adjusted use of all available energy sources. For this reason, different process variants of slag conditioning have been investigated at the electric arc furnaces of three stainless- and special steel producers. For slag foaming and improved chromium control in the slag, a slag conditioning technique based on CaC2 mix injection has been developed by ACRONI in collaboration with BFI. This aim is also addressed by an optimised slag conditioning technique based on the adjusted addition of FeSi and injection of carbon/oxygen, which was developed by Gerdau Sidenor. Further, for adjusted supply of chemical energy to the EAF, an innovative slag conditioning technique based on the injection of aluminium granules has been developed by BGH in collaboration with BFI. All new slag conditioning techniques have been developed based on operational trials and measurements at the EAF. Optimum process parameters in terms of maximum chromium recovery, minimum electric energy consumption and minimum process cost have been selected by comparison with standard operational procedure. Finally, a concept for each optimised slag conditioning process variant is proposed.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Gerald STUBBE (Pr. Coord.)
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BGH EDELSTAHL SIEGEN GmbH	DEUTSCHLAND	Michael SEDLMEIER
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SWEREA MEFOS AB	SVERIGE	Johan BJÖRKVALL
OUTOKUMPU STAINLESS AB	SVERIGE	Lasse LILJEDAHL

RFSR-CT-2007-00007 OPCONSTAINLESS

Resource-saving operation and control of stainless steel refining in VOD and AOD process

Info

Type of Project	Research	Duration (months)	36
Total Budget	1386292 €	Start Date	1/07/2007
EU Contribution	831775 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25087:EN

Final Abstract

The argon oxygen decarburisation (AOD) and the vacuum oxygen decarburisation (VOD) processes are the dominant methods for refining stainless steels with low carbon contents. The objective of this project was to improve the operation and control of stainless steel refining within the VOD and the AOD processes by various methods. Detailed investigations with CFD-based process models coupled to thermodynamic equilibrium calculations have revealed fundamental insights to reaction kinetics and mixing times. Statistical evaluations of extensive slag analyses regarding chemical composition as well as phase structures during the oxidation phase have provided indications on how to accelerate the decarburisation process. Plant trials with different schemes for the vessel pressure and injection of oxygen via oxides in scale powder were carried out in order to examine alternative VOD operation modes with respect to a more effective decarburisation. Possible influences of scale injection on the steel cleanness were also investigated. The results of these extensive numerical, experimental and statistical studies were used for the development of dynamic process models which were then validated by offline simulations based on process data from AOD and VOD plants. In a next step, dynamic control functions were developed which evaluate the heat states observed and predicted by the dynamic process models. Finally, these models with their monitoring and control functions were implemented and tested within the automation environment of AOD and VOD plants. The online application of the models contributes to a more reliable and resource-efficient operation of the respective processes.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT (Pr. Coord.)
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KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Anders TILLIANDER
OUTOKUMPU STAINLESS AB	SVERIGE	Gunnar LINDSTRAND
SMS MEVAC GmbH	DEUTSCHLAND	Dieter TEMBERGEN
ACRONI, PODJETJE ZA PROIZVODNJO JEKLA IN JEKLENIH IZDELKOV, d.o.o.	SLOVENIJA	Anton JAKLIC

Selected Publications

"Z. Song, M. Ersson and P. Jönsson: ""Mathematical Modeling of VOD Oxygen Nozzle Jets"", Steel Research Int., 81 (2010), No. 12"

P. Ternstedt, R. Gyllenram, J. Bengtsson and P. Jönsson: ”Using AOD simulator workbench to support process control development”, SteelSim 2011, 27 June – 1 July 2011, Düsseldorf (Germany)

Schlautmann, M., Kleimt, B., Kubbe, A., Teworte, R., Rzehak, D., Senk, D., Jaklic, A., Klinar, M.: Dynamic process models for on-line control of steelmaking processes, exemplified for the VOD process. Stahl u. Eisen 131 (2011), Nr. 10, S. 57-65

P. Ternstedt, R. Gyllenram, J.Bengtsson, P.Jönsson and A. Tilliander: ”Simulating continuous decarburisation control with an AOD simulation workbench”, EOSC 2011, 7 – 9 September 2011, Stockholm (Sweden)

N. Andersson, A. Tilliander, L. Jonsson and Pär Jönsson: “ Modeling of decarburisation in an industrial AOD converter”, EOSC 2011, 7 – 9 September 2011, Stockholm (Sweden)

RFSR-CT-2007-00008 FLEXCHARGE

Cost and energy effective management of EAF with flexible charge material mix

Info

Type of Project	Research	Duration (months)	42
Total Budget	2223918 €	Start Date	1/07/2007
EU Contribution	1334351 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25094:EN

Final Abstract

The project aims to set up a methodology to manage the electric arc furnace(EAF) charged with the variable materials mix guaranteeing the required steel quality, minimising the cost to produce crude steel and the environmental impact, having in mind the volatility of scrap quality/price ratio and the pressures arising from CO2 trading legislation. Comprehensive data sets obtained, by historical data and dedicated tests, at four different EAFs (one DC and three AC), together with results of laboratory test campaigns (35 kg induction furnace and 1 tonne EAF pilot plant) have been evaluated by statistical methods to derive information on scrap properties like yield, chemical composition and specific meltdown energy requirements. The elaboration of optimisation tools has allowed robust charge mix tools to be set up to determine the scrap mix for a given steel quality and quantity while minimising cost and energy consumption. In parallel, dynamic mass and energy balances have been adapted to electrical arc furnaces, taking into account the measurement of the off-gas composition and the mass flow rate and temperature at fourth hole evaluated by virtual (SW) sensors developed in the project. The developed methodologies have been implemented on-site and online at the industrial partners' EAFs.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Enrico MALFA (Pr. Coord.)
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Marcel DORMANN
FERALPI SIDERURGICA S.p.A.	ITALIA	Francesco MAGNI
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Santiago LANDA LAZCANO
GEORGSMARIENHÜTTE GmbH	DEUTSCHLAND	Ingo KOLM
SWEREA MEFOS AB	SVERIGE	Erik SANDBERG
OVAKO BAR AB	SVERIGE	Risto PONKALA
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT

Selected Publications

E. Malfa, P.Nyssen,, E.Filippini, B.Dettmer, I.Unamuno, A.Gustafsson, E.Sandberg, B.Kleimt, COST AND ENERGY EFFECTIVE MANAGEMENT OF EAF WITH FLEXIBLE CHARGE MATERIAL MIX, EEC Electric Steelmaking Conference, June 2012, Graz, Austria

P.Frittella, A.Lucarelli , B.Poizot, M.Legrand, L. Angelini, E. Filippini , iCSMelt® applications to EAF operating practice optimization, Aistech2011, Indianapolis, USA

E. Malfa, P.Nyssen,, E.Filippini, B.Dettmer, I.Unamuno, A.Gustafsson, E.Sandberg, B.Kleimt, Cost and Energy Effective Management of EAF with Flexible Charge Material Mix, Berg- und Hüttenmännische Monatshefte (BHM) (2013), Vol. 158 (1), p. 3-12. DOI 10.1007/s00501-012-0103-y

R. Pierre, B. Kleimt, B. Dettmer, H. Schliephake. Quality and cost opimal charge material selection for the EAF, EEC Electric Steelmaking Conference, June 2012, Graz, Austria

RFSR-CT-2007-00009 StImprove

Improvement of ladle stirring to minimise slag emulsification and reoxidation during alloying and rinsing

Info

Type of Project	Research	Duration (months)	36
Total Budget	1011155 €	Start Date	1/07/2007
EU Contribution	606693 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25068:EN

Final Abstract

The objective of this research project was to improve steel metallurgy and quality by optimisation of the ladle stirring process. Throughout the project, the interactions between solid, liquid and gaseous phases involved in ladle stirring were examined.• Melting of alloying materials was investigated using mathematical models and camera-based monitoring. It was found that typical alloying materials are molten and homogeneously distributed after 360 s, even with soft stirring. • Emulsification of liquid slag into the steel around the open eye was investigated using theoretical considerations, physical modelling and camera-based monitoring of the open eye. The coarse contour of the open eye was found to be two times larger than expected. A threshold value of 15–25 STP m3/h stirring gas flow rate was suggested to minimise emulsification. • Reoxidation was investigated using camera-based monitoring of the open eye and sampling during industrial trials. It became clear that the camera-based technique is suitable to monitor stirring efficiency, whereas no clear correlation between the stirring gas flow rate and the size of the open eye could be observed. • Rinsing and the removal of inclusions were investigated using camera-based monitoring, theoretical considerations and sampling during industrial trials. Control of rinsing without the open eye was found to be difficult. Good removal of inclusions relies on low stirring gas flow rates and long stirring times. Optimised stirring procedures with stirring intensity reduced by 25–50 % were applied in a steelworks. Such stirring did not deteriorate the quality of the steel, while consumption of stirring gas was reduced. Further investigations, e.g. of the yield of alloying additions, produced promising prospects. As part of this project, the transfer of optimised stirring procedures into the steelworks was only just started. The implementation and adaptation of optimised stirring procedures in the steelworks and careful verification of the benefits should be the focus of further investigations.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Herbert KÖCHNER (Pr. Coord.)
KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Du SICHEN
SAARSTAHL AG	DEUTSCHLAND	Peter VALENTIN
AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Seppo LOUHENKILPI

RFSR-CT-2007-00010 URIOM

Upgrading and utilisation of residual iron oxide materials for hot metal production

Info				
Type of Project	Research	Duration (months)	42
Total Budget	1563498 €	Start Date	1/07/2007
EU Contribution	938099 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25081:EN

Final Abstract For reuse of residual iron oxides from stainless steelmaking within the steelworks itself, two new technologies have been developed. One technology is the inductively heated coke bed reactor (ICBR), which is coupled either with a cupola furnace or a flash reactor as pre-melting unit. Furthermore, a new briquetting technology using vegetable binders for briquette utilisation in the EAF has been developed. The first step of the investigations is the characterisation and selection of suitable residual iron oxide materials to be processed by the new technologies. For both technologies comprehensive process concepts have been developed based on laboratory- and technical-scale trials. Furthermore, a software process model has been developed for the coke bed reactor in order to support the development of the process concept. Finally, as a base for assessing economic aspects and metal yield, energy and material balances have been set up and the composition of products has been measured or calculated for both technologies.

Partners		*Country*	*Scientific person in charge*
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Gerald STUBBE (Pr. Coord.)
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RFSR-CT-2007-00011 STEELCLEANCONTROL

Development of steel grade related slag systems with low reoxidation potential in ladle and optimised ladle glaze technique for improving steel cleanliness

Info

Type of Project	Research	Duration (months)	36
Total Budget	1377999 €	Start Date	1/07/2007
EU Contribution	826800 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25076:EN

Final Abstract

The technical objective of this project was to investigate the interaction between deoxidised steel melts and metallurgical slags, ladle lining and ladle glaze during ladle treatment. Low carbon micro-alloyed steels and tool and stainless steels were chosen for investigation. These aspects were investigated on selected steel grades both under process and laboratory conditions. Sampling of steel and slag at defined steps in process routes was performed by industrial partners. At both universities, the thermodynamic calculation of inclusion composition change and the quantity change during ladle treatment were performed, as well as laboratory investigations. The formation and modification of inclusion by ladle slags, ladle lining and ladle glaze were studied by calculation and experimentally. As a result the steel grade-specific slag compositions and the ladle glaze procedure were optimised in view of low reoxidation potentials and a low tendency for uncontrolled inclusion formation. Finally the new slag compositions were tested in industrial trials and some changes in the ladle treatment procedure were implemented. In this way steel cleanliness was improved and lower amounts of non-metallic inclusions detected, which has a beneficial impact on productivity and quality of steel products. As an additional result the use of fluorspar was completely avoided or significantly reduced, which contributes to environment protection and health and safety in the workplace. Through the close cooperation between industrial partners and universities, optimised slag compositions and treatment strategies were developed and verified in industrial processes.

Partners

	Country	*Scientific person in charge*
TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Piotr R. SCHELLER (Pr. Coord.)
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THYSSENKRUPP NIROSTA GMBH	DEUTSCHLAND	Jörg-Friedrich HOLZHAUSER
UDDEHOLM TOOLING AB	SVERIGE	Mselly NZOTTA

RFSR-CT-2008-00002 INCLUSION

Innovative methodology for through process inclusion level forecasting of engineering steel

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1128550 €	Start Date	1/07/2008
	EU Contribution	677130 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26175:EN			

Final Abstract

"The project objective is to develop a method able to forecast the occurrence and geometry of large and harmful defects on rolled samples from a relatively rapid analysis of a limited number of inclusions in samples taken on cast products. The expected benefit of this information is to readdress the production scheduling in order to avoid, or reduce, downgrading of products. This new method is based on two tools: statistical inclusion analysis method called 'Extreme Values Analysis (EVA) Statistics'; inclusion deformation models. EVA is used to determine the expected maximum size of inclusions from a limited number of analysis of steel samples at the end of casting. This statistic approach is necessary to provide the right input to the elongation models. In fact the improved steel production of modern steelmaking plants led to a drastic reduction of the amount of inclusions dispersed in metals. Therefore conventional approaches of detecting average dimensions and number of particles are not useful for particle rating. From the information on inclusions present on as cast products, deformation models, purposely developed, calculate occurrence and geometrical characteristics of defects as a function of rolling programme. The method has been applied on two selected steel grades produced from the two industrial partners of the project. In one case the evaluation of the quality of the product is based on the microscopic analysis of the defect size. Inspection of the defect size in the final products confirmed the prediction based on statistical analysis of samples from as products and deformation models. In the second case the product quality is evaluated from fatigue tests. For this reason a known model, which correlates defect size with fatigue limit has been applied using as input the predicted defect size. The obtained values resulted in agreement with the measured values. The developed method can be used to: support the management of steel rolling operations; evaluate the advantages arising from a reduction of inclusion size in the billet on the quality of the final product"

		Country	*Scientific person in charge*
Partners	**COGNE ACCIAI SPECIALI SpA**	ITALIA	Elena BALDUCCI (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Filippo CIRILLI
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Jacinto ALBARRAN SANZ
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert LINK

RFSR-CT-2008-00003 LOWCNEAF

Optimised production of low C and N steel grades via the electric steelmaking route

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1698420 €	Start Date	1/07/2008
	EU Contribution	1019052 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25869:EN			

Final Abstract The project objective was to develop a through-process control strategy for a reliable, simultaneous achievement of low steel carbon and nitrogen levels within the electric steelmaking route under minimum energy and material costs with optimal productivity. Detailed investigations on the effect of material additions and operational parameters within all aggregates of the process route (EAF, LF, VD) on pick-up and removal of carbon and nitrogen have been performed, and regression as well as other data-based models have been developed to describe the relevant interdependencies. For the EAF the use of alternative iron materials like pig iron and HBI to lower C and N contents at tapping has been investigated. Also dynamic process models to describe and control the behaviour of carbon and nitrogen content have been developed and validated with process data from four different EAF plants. Regarding vacuum degassing a dynamic denitrogenation model has been developed and validated with the data of two vacuum tank degassing plants. The dynamic process models for EAF treatment and vacuum degassing, as well as the regression and data based models for all aggregates of the electric steelmaking process route were combined to a through process control strategy. The combination with suitable optimisation tools led to optimal solutions for the production of low carbon and nitrogen steel grades with regard to material and production costs as well as productivity. The through-process control systems were applied at five electrical steelmaking plants with different process routes and aggregates for various steel products.

Partners		*Country*	*Scientific person in charge*
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT (Pr. Coord.)
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	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Pierre NYSSEN
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Asier ARTEAGA
	PEINER TRÄGER GmbH	DEUTSCHLAND	Matthias SCHÖRING
	RIVA ACCIAIO SPA	ITALIA	Nicola VENERI

Selected Publications Kleimt B., Pierre R., Zagrebin V., Nyssen P., Ojeda C., Arteaga, A. Through process control strategies for reliable achievement of low carbon and nitrogen contents within the electric steelmaking route. Workshop Integrated Intelligent Manufacturing (I2M) in Steel Industry, 23-24 April 2012, Metz, France

"Improving steelmaking productivity by using advanced modelling techniques". Computers in Industry, April 2012

RFSR-CT-2008-00004 BATHFOAM

Control of slag and refining conditions in the BOF

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1838043 €	Start Date	1/07/2008
	EU Contribution	1102826 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25906:EN			

Final Abstract

		Country	*Scientific person in charge*
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	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Jean-Christophe HUBER
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Fernando SANCHO MENDEZ
	KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Du SICHEN
	POLITECNICO DI MILANO	ITALIA	Walter NICODEMI
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT

RFSR-CT-2008-00044 LAREFMON

Enhanced reliability in ladle refining processes (VD, VOD and LF) by improved on-line process monitoring and control

Info

Type of Project	Research	Duration (months)	36
Total Budget	1283954 €	Start Date	1/12/2008
EU Contribution	770372 €	End Date	30/11/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25947:EN

Final Abstract The objective of this project was to improve the reliability of vacuum degassing and ladle furnace treatment by joint application of new thermal imaging-based evaluation of stirring efficiency and improved dynamic process models. Enhanced online monitoring and control systems were developed and applied for reliable control and improved performance of the main metallurgical ladle refining processes: VD: A closed-loop control system for stirring gas rates based on thermal imaging and dynamic process modelling was developed and applied at the VD plant of ArcelorMittalRuhrort GmbH. Monitoring of the melt bath surface during VD treatment improved process control and reliability. VOD: Detection of slag slopping for SBQ steel grades and analysis of stirring power during the VCD part based on CCD images were realised at SIYD. Combination of the online tools and a different oxygen introduction pattern in the oxidising process phase led to a slight improvement in decarburisation rates. LF: An objective online stirring observation system based on CCD images as well as a temperature regulation module using a dynamic model and gas flow rate suggestion for operators based on the total oxygen content of the melt were implemented at VASD. The system is beneficial because of its objectivity (achieve sustainable steel quality) and furthermore for safety reasons. Continuous monitoring of the melt bath surface became an essential tool for the operators at ArcelorMittalRuhrort GmbH, Sidenor I+D SA and VASD to improve the stability and quality of the treatment processes and thereby the overall steel production.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Herbert KÖCHNER (Pr. Coord.)
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Asier ARTEAGA
ARCELORMITTAL RUHRORT GMBH	DEUTSCHLAND	Jürgen KRUCK
VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Gerald KLÖSCH

RFSR-CT-2009-00003 LADLIFE

Enhanced steel ladle life by improving the resistance of lining to thermal, thermomechanical and thermochemical alteration

Info

Type of Project	Research	Duration (months)	36
Total Budget	1241458 €	Start Date	1/07/2009
EU Contribution	744875 €	End Date	30/06/2012

State Project completed

Provisional Abstract

Ladle refractory wear is an important concern for steelmakers, not only for the material cost but also for its influence on plant productivity and safety. This project aims at enhancing ladle lining life, helping steelmakers in decisions about materials to use and in scheduling of maintenance operations. This will be
achieved by model based soft sensors and laboratory work. The wear of ladle lining is mainly due to its cyclic interaction with steel and slag during its normal operation. The understanding of the chemical, thermo-chemical and thermo-mechanical reactions in the metal-slag-refractory system is the key to reach
the planned goal.

Partners

	Country	*Scientific person in charge*
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Asier ARTEAGA (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Mario TONELLI
LUCCHINI S.p.A.	ITALIA	Luca TRILLINI
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Guido MITTLER

RFSR-CT-2009-00004 GREENEAF

Sustainable EAF steel production

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2031872 €	Start Date	1/07/2009
	EU Contribution	1219124 €	End Date	30/06/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26208:EN			

Final Abstract In the modern electric arc furnace (EAF) more than 40 % of energy comes from chemical sources by fossil fuels: natural gas is used in dedicated burner during the melting of the scrap while coal (mainly anthracite), lump in the basket and pulverised by wall injector, is used as foaming agent. In the frame of the European Research Fund for Coal and Steel (RFCS), project GREENEAF was carried out with the objective to replace coal and natural gas in EAF with char and syngas produced by biomass pyrolysis

		Country	*Scientific person in charge*
Partners	**FERRIERE NORD S.P.A.**	ITALIA	Loris BIANCO (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Filippo CIRILLI
	DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Hans-Peter JUNG
	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Marcos MILLAN
	STAHL- UND WALZWERK MARIENHÜTTE GMBH	OESTERREICH	Hans-Jörg KRASSNIG
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Lukas VOJ
	TECNOCENTRO ENG SRL	ITALIA	Giacomo Matteo RICCI

Selected Publications

T. Echterhof, H. Pfeifer: Potential of biomass usage in electric steelmaking, EECR steel 2011, 1st International Conference on Energy Efficiency and CO2 Reduction in the Steel Industry, 27. June – 1. July 2011, Düsseldorf, Germany

L. Bianco et al, Sustainable Electric Arc Furnace Steel Production: GreenEAF, Electric Steelmaking Conference – GRAZ , 25- 28 September 2012

F. Cirilli et al, Pirolisi di biomassa, uno studio su char e syngas, published on ICP, Rivista dell'industria chimica, N. 3 (2012), pp90-94

T. Demus, T. Echterhof, H. Pfeifer: Replacement of fossil carbon with biogenic residues in the electric steelmaking process, International EAF workshop, Milan 29-30 March 2012

T. Demus, T. Echterhof, H. Pfeifer, M. Schulten, P. Quicker: Investigations on the use of biogenic residues as a substitute for fossil coal in the EAF steelmaking process, 10th European Electric Steelmaking Conference, Graz, Austria, 25.- 28 September 2012

RFSR-CT-2010-00003 TOTOPTLIS

Multi-criteria through-process optimisation of liquid steelmaking

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1632592 €	Start Date	1/07/2010
	EU Contribution	979555 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract

Main project objective is the development of a through-process integrated approach for process chain optimisation in liquid steelmaking. Real-time monitoring and predictive models, elaborating process and sensor data from different aggregates, shall be integrated for a through-process multi-criteria optimisation of material and energy input regarding quality, productivity and costs. A dynamic and optimised modification of the planned process route for a heat will be suggested in case of detected deviations in quality relevant parameters.
The system shall be applied at two BOF and one EAF steelmaking plant with different routes and secondary metallurgy equipment, to ensure the concept transferability to further plants.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Maria MURRI (Pr. Coord.)
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	LUCCHINI S.p.A.	ITALIA	Marco BIANCHI
	PEINER TRÄGER GmbH	DEUTSCHLAND	Matthias SCHÖRING
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT

Selected Publications

"Project presentation at the workshop ""Integrated Intelligent Manufacturing in Steel Industry"" held on 23rd and 24th of April 2012 in Maizières-lès-Metz, France"

RFSR-CT-2010-00004 PROTECT

Processes and technologies for environmentally friendly recovery and treatment of scrap

Info	Type of Project	Research	Duration (months)	42
	Total Budget	3277463 €	Start Date	1/07/2010
	EU Contribution	1966477 €	End Date	31/12/2013
State	Running project			

Provisional Abstract

Recycling of coated scrap is currently limited by formation of problematic by-products, such as zinc containing dust and hazardous air emissions. A proposed innovative stand alone process for preheating and surface cleaning of scrap is expected to significantly improve the recyclability of such scrap sources, thus widening the scrap base, simplifying recycling of in-house by-products and reducing hazardous emissions. The process utilizes chlorine containig waste, such as automotive shredder residues, in separate oxygen combustion enabling minimisation of flue gases. The coatings are removed in gas phase and collected in dedicated recovery system rendering the possibility for recovery of valuable metals.

		Country	*Scientific person in charge*
Partners	**SWEREA MEFOS AB**	SVERIGE	Mikael LARSSON (Pr. Coord.)
	ENGITEC TECHNOLOGIES SPA	ITALIA	Massimo MACCAGNI
	IVL SVENSKA MILJÖINSTITUTET AB	SVERIGE	Anders BJÖRK
	SICON GMBH	DEUTSCHLAND	Gabriel LESINSKY
	SSAB TUNNPLÅT AB	SVERIGE	Leif NILSSON
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	STENA METALL A/S	DANMARK	Erik RASMUSSEN
	STENA RECYCLING INTERNATIONAL AB	SVERIGE	Christer FORSGREN
	UNIVERSITÄT SIEGEN	DEUTSCHLAND	Wolfgang KRUMM

RFSR-CT-2010-00005 OPTDESLAG

Increased yield and enhanced steel quality by improved deslagging and slag conditioning

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1030338 €	Start Date	1/07/2010
	EU Contribution	618203 €	End Date	30/06/2013
State	Running project			

Provisional Abstract The project objective is to improve the deslagging process during two process steps of liquid steelmaking, i.e. after hot metal desulphurisation and before secondary steelmaking, by applying image sensors to control deslagging operations. Aim is to increase the yield by minimising the metallic losses, and to minimise the amount of remaining slag after deslagging. Furthermore, based on new information from image analysis about the efficiency of deslagging, a dynamic control of the following slag conditioning process shall be developed, to ensure optimal conditions for subsequent metallurgical processes. Thus the quality of the liquid steel shall be improved.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Herbert KÖCHNER (Pr. Coord.)
	SWEREA MEFOS AB	SVERIGE	Lars-Erik FROM
	SAARSCHMIEDE GMBH FREIFORMSCHMIEDE	DEUTSCHLAND	Bernhard DONTH
	SSAB EMEA AB	SVERIGE	Magnus ANDERSSON

RFSR-CT-2011-00004 INTCLEANCON

Intelligent cleanness controls in secondary steelmaking by advanced off- and online process models

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1407643 €	Start Date	1/07/2011
	EU Contribution	844586 €	End Date	31/12/2014
State	Running project			

Provisional Abstract This project will develop new off-line and on-line models and will apply them for advanced industrial control strategies and practices in secondary metallurgy, in order to guarantee highest steel cleanness levels for high quality steels, with focus on case hardening and microalloyed grades. The application of on-line control strategies, based on a combination of through-process models and new monitoring and control techniques for stirring during ladle metallurgy processes, should enable the reliable achievement of improved quality and castability. This will lead to an increased yield due to a lower number of heats to be downgraded
due to quality problems.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	Borja PENA QUINTERO (Pr. Coord.)
	DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Hans-Peter JUNG
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	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Roger KOITZSCH

RFSR-CT-2012-00005 PLUGWATCH

Stirring plug monitoring system for improvement of plug availability and stirring performance

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1919343 €	Start Date	1/07/2012
	EU Contribution	1151605 €	End Date	30/06/2015
State	Running project			

Provisional Abstract The aim of this research proposal is the development and installation of online monitoring systems for stirring plugs in steel ladles in order to determine and predict their availability and performance for stirring processes.
This is realised by interaction of suitable measurement techniques for refractory temperatures, numerical simulations of process induced changes in stirring plugs during operation, plant trials with stirring plugs differing in composition and geometry and software engineering. Actual information of wear status, stirring plug availability and their performance avoids non-stirring events, provides accurate stirring procedures and therewith supports a trouble-free steel production.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Birgit PALM (Pr. Coord.)
	ACCIAI SPECIALI TERNI SpA	ITALIA	Massimo PROIETTI CERQUONI
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Mario TONELLI
	DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Leandro SCHÖTTLER
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Asier ARTEAGA

RFSR-CT-2012-00006 SLACON

Control of slag quality for utilisation in the construction industry

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1833659 €	Start Date	1/07/2012
	EU Contribution	1100196 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

During steelmaking, slag is generated in different kinds of processes. Processed slag can be used as building material if certain quality criteria are met. Slag quality is defined by mechanical properties and by environmental behaviour of slag. Maximum concentrations of leachable substances in the slag eluate, for example fluoride, molybdenum, chromium and vanadium, have been fixed to define slag quality. Slag quality and the possibilities of slag utilisation can be improved by: a) immobilisation of these leachable substances and b) recycling of washing/cooling water from slag treatment with elimination of leachable components. The project aims at ensuring and increasing the utilisation of steelmaking slags in the construction industry by improving the quality of slag. For this purpose, new techniques have to be developed to immobilise the critical elements and separate remaining leachable substances (e.g. fluoride, molybdenum, chromium and vanadium) from the washing/cooling water and to condition these separated substances for disposal or reuse. The elimination of leachable substances in a closed-loop process helps to avoid the entry of leachable substances into the environment and supports the resource-efficient utilisation of steelmaking slags.

		Country	*Scientific person in charge*
Partners	**FEhS - INSTITUT FÜR BAUSTOFF-FORSCHUNG e.V.**	DEUTSCHLAND	Dirk MUDERSBACH (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Filippo CIRILLI
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Iñigo UNAMUNO
	RIVA ACCIAIO SPA	ITALIA	Stefano BARAGIOLA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Barbara WENDLER

RFSR-CT-2013-00002 MeltCon

Determining process conditions for online monitoring of temperature and carbon content in the electric arc furnace to optimise end point control

Info

Type of Project	Research	Duration (months)	36
Total Budget	1536912 €	Start Date	1/07/2013
EU Contribution	922147 €	End Date	30/06/2016

State Running project

Provisional Abstract

The objective of this research project is to optimise the end point control of the refining process in the electric arc furnace and to determine process conditions for the use of online and continuous measuring systems in dynamic inhomogeneous melts. Online measurement systems for continuous monitoring of the process status during EAF treatment will be developed and applied. At one furnace an accretion free melt access will be created for fibre-optical temperature measurement. At another furnace a measurement system for combined optical determination of carbon content and temperature will be developed using an lance access. Based on online measurements and CFD modelling, a general procedure for continuous online measurements in dynamic, inhomogeneous melts will be derived. In combination with dynamic process models, EAF end point control will be improved. The main targets of the project are: - to monitor continuously the evolution of the liquid steel temperature and carbon content during the refining phase of the EAF treatment - to determine process conditions to perform representative continuous online measurements in dynamic inhomogeneous melts - to develop an enhanced dynamic process control using these novel online measurement data - to develop strategies and set point calculations for exact determination of control parameters for accurate EAF end point control - to evaluate the availability, the performance and limitations of continuous measuring during the EAF refining process. With those targets reached, the performance of the electric arc furnace process will be improved and deviations from optimum treatment will be avoided. Energy savings of 5 to 10 kWh/t and about 1% improved metallic yield are expected. These saving can be achieved with low quality scrap since the less precise scrap analysis will be compensated by the dynamic end point control. Working space safety will be enhanced by avoiding manual labour in the hazardous area in front of the furnace.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Tobias KORDEL (Pr. Coord.)
FERRIERE NORD S.P.A.	ITALIA	Loris BIANCO
POLITECNICO DI MILANO	ITALIA	Silvia BARELLA
SAARSCHMIEDE GMBH FREIFORMSCHMIEDE	DEUTSCHLAND	Bernhard DONTH

RFSR-CT-2013-00003 ILORA

Improvement of Ladle Opening Rates

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1024441 €	Start Date	1/07/2013
	EU Contribution	614665 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

The objective of the proposed project is to increase the ladle opening rate (LOR). In European steel works that produce low-alloyed carbon steel, the ladle opening rate (LOR) varies approximately between 82 and 99.7 % and is thus often far from the goal of 100 %. There is a big potential for improvement of the LOR and, consequently, of steelmaking process logistics, of safety at the workplace and of steel quality. We believe that the main reason for low LOR is that the nozzle filler sand blocks the flow of the liquid steel due to consolidation or rather solidification of the sand. There are two main concurrent processes that contribute to solidification: a) sintering of the nozzle filler sand and b) infiltration of the sand by liquid steel, which then freezes. Both processes result in regions of high strength in the sand. When the ladle slide gate is opened, these regions of high strength withstand the ferrostatic pressure of the liquid steel in the steelmaking ladle and the nozzle filler sand blocks the nozzle. Improved opening rates shall be reached: - by increasing the knowledge about the behaviour of nozzle filler sand during steelmaking (determine the real conditions in the nozzle filler sand during steelmaking, measure the thermal and mechanical properties of nozzle filler sand at high temperature in the laboratory), - by developing a model that simulates the behaviour of the nozzle filler sand and predicts the ladle opening behaviour in the steel works even for future heats - and by optimising steelmaking process routes and nozzle filler sands for high ladle opening rates for different steel grades. The industrial interest is comprehensive as improved LOR increases earnings and safety at the workplace. The results are of strategic importance to the sector.

Partners	*Country*	*Scientific person in charge*
FORSCHUNGSGEMEINSCHAFT FEUERFEST e.V.	DEUTSCHLAND	Christian DANNERT (Pr. Coord.)
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Asier ARTEAGA
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PURMETALL GESELLSCHAFT FUR STAHLVEREDLUNG GMBH u. Co. BETRIEBSKG.	DEUTSCHLAND	Kirsten WILM

RFS2-CT-2014-00002 VALEAF

Valorisation and dissemination of EAF technology

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	534151 €	Start Date	1/07/2014
	EU Contribution	320489 €	End Date	31/12/2015
State	Running project			

Provisional Abstract This valorisation project will disseminate results obtained in RFCS projects on Electric Arc Furnace (EAF) technology. In the frame of RFCS programme many projects have been carried out on EAF aiming at improving the process performance in terms of resource optimisation, flexibility, environmental impact. This effort contributed to the development of a number of models, technological solutions, hardware and software tools. The objectives are to promote the knowledge and various outputs derived form the European projects in this sector, and, on the basis of a clear picture of the real status of European EAF technology, to identify future industrial target and research needs.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Antonello DI DONATO (Pr. Coord.)
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	SWEREA MEFOS AB	SVERIGE	Johan ERIKSSON
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RFSP-CT-2014-00003 GREENEAF2

Biochar for a sustainable EAF steel production

Info	Type of Project	Pilot&Demonstration	Duration (months)	24
	Total Budget	2002370 €	Start Date	1/07/2014
	EU Contribution	1001182 €	End Date	30/06/2016
State	Running project			

Provisional Abstract The objective of this proposal is to apply as a standard practice the utilization of char from biomass as a substitute for fossil coal in the electric arc furnace. Previous carried out project GreenEAF demonstrated the feasibility of utilization of char in the EAF, but following aspects need to be investigated further: - charging in the bucket: preliminary industrial trials were promising, but char reactivity must be controlled and EAF operating practice optimised; - injection: in order to promote slag foaming, injection systems have to be improved. Modification of injection systems have already been studied but field validation is required. The effects on: plant productivity, costs, environmental issues, materials handling and storage are also evaluated.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Filippo CIRILLI (Pr. Coord.)
	FERRIERE NORD S.P.A.	ITALIA	Loris BIANCO
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	STAHL- UND WALZWERK MARIENHÜTTE GMBH	OESTERREICH	Thomas GRIESSACHER
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Thomas ECHTERHOF

RFSP-CT-2014-00004 AdaptEAF

Adaptive on-line control of the EAF based on innovative sensors and comprehensive models for improved yield and energy efficiency

Info

Type of Project	Pilot&Demonstration	Duration (months)	36
Total Budget	1006074 €	Start Date	1/07/2014
EU Contribution	503036 €	End Date	30/06/2017

State Running project

Provisional Abstract

The main objective of this Pilot & Demonstration project is to set up a new adaptive on-line control for the EAF depending on the properties of the actually charged materials, to optimise the efficiency of the chemical energy input and thus to reduce the total energy consumption and to improve the metallic yield. Novel sensors and measurement methods for online acquisition of bath level, steel and slag amount, and scrap melting behaviour will be applied. This additional process information will be used to enhance the performance and prediction accuracy of previously developed dynamic and statistical models for online monitoring of the process status. Furthermore relevant information on the efficiency of the different energy inputs and the metallic yield of the charged scrap will be derived. The on-line information on bath level, steel and slag amount, scrap melting progress and energetic behaviour will be used for model-based on-line control of scrap charging as well as chemical energy input via burners and oxygen injectors, aiming at: • Balanced electrical and chemical energy inputs for optimised energetic performance • Maximised metallic yield of the charged materials (avoiding yield losses by excessive oxidation) • Optimised furnace practise regarding scrap charging, steel bath level and slag amount Within the online control functions, also quality-dependant constraints regarding EAF tapping temperature and melt composition will be considered. The tools for monitoring, control and technical management of the EAF process will be implemented, tested and validated at a well-equipped and instrumented 140 t DC electric arc furnace, to demonstrate the energetic, metallurgical and economic benefits.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT (Pr. Coord.)
GEORGSMARIENHÜTTE GmbH	DEUTSCHLAND	Bernd DETTMER
HELMUT SCHMIDT UNIVERSITÄT UNIVERSITÄT DER BUNDESWEHR HAMBURG	DEUTSCHLAND	Vico HAVERKAMP

RFSR-CT-2014-00005 BOFdePhos

Dynamic on-line monitoring and end-point control of dephosphorisation in the BOF

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1831821 €	Start Date	1/07/2014
	EU Contribution	1099091 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

The control of the BOF converter process is generally based on the results of a static charge calculation, the observation of the decarburisation behaviour based on a continuous off-gas analysis and an in-blow measurement for steel temperature and oxygen content. As these measurements do not provide direct information on the steel phosphorus content, a steel sample is taken to be analysed at the lab. Afterwards re-blow actions have to be taken in case the target values of the process have not yet been reached. The objective of the project is the development of a comprehensive dynamic process model for the BOF which can be used for on-line monitoring and control of the process behaviour with focus on the dephosphorisation. This model shall also consider actual slag conditions and melt temperature, as both have a significant influence on the equilibrium conditions of the dephosphorisation reaction. The process model will be developed on the basis of detailed studies of the thermodynamic and reaction kinetic fundamentals, as well as an application of new sensors measuring the oxygen activity and height of the converter slag. The model-based on-line monitoring and control system shall be used to determine the end-point of the process with respect to phosphorus content and melt temperature with higher accuracy, and shall thus help to reduce the reblow rate and to shorten the process times, as waiting for the lab analysis can be avoided. Furthermore the model shall be used to calculate dynamic set-points in the final phase of blowing, in order to achieve the target values at minimal cost and time. The complete model based control system will be implemented, tested and validated at an industrial BOF plant. The transferability of the results to other converters of different size and equipment as well as to the production of various steel qualities shall be proved within the framework of offline simulations based on appropriate process data from further BOF plants.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Bernd KLEIMT (Pr. Coord.)
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	KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Du SICHEN
	MINKON GMBH	DEUTSCHLAND	Harald FISCHER
	SMS SIEMAG AG	DEUTSCHLAND	Norbert UEBBER
	TATA STEEL UK LIMITED	UNITED KINGDOM	B. Mariana. ADDERLEY

RFSR-CT-2014-00006 LADTHERM

Improving steelmaking processes by enhancing thermal state ladle management

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1373771 €	Start Date	1/07/2014
	EU Contribution	824262 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

This proposal aims to monitor the thermal state of steelmaking ladles during secondary steelmaking operations and to improve said operations. Improvements are derived from optimised utilisation of the heat stored in the ladle lining. Innovative temperature measurements provide online information to accompanying thermal models, calculating the actual total ladle heat content Q that is stored in the lining. This is a new input parameter for ladle thermal state monitoring systems, steel temperature prediction models and advisory systems for best ladle practices, so that optimum utilisation of the thermal energy stored in ladle lining will be achieved.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Herbert KÖCHNER (Pr. Coord.)
	ARCELORMITTAL BREMEN GMBH	DEUTSCHLAND	Nils RICHTER
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Asier ARTEAGA
	KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Du SICHEN

RFSR-CT-2014-00007 OptiScrapManage

Optimization of scrap charge management and related process adaptation for EAF performances improvement and cost reduction

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2052951 €	Start Date	1/07/2014
	EU Contribution	1231768 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

Process improvement and cost reduction need the improvement on charge practices, process management and definition of proper technological targets to be followed and in particular the optimization of scrap mix definition has to be coupled with optimization of operating practice adopted. Furthermore the balance between different process targets, also in opposition, has to be taken into account with a multi-criteria approach to give to the steelmaker an applicable system of improvement for the wide range of necessities of plant and process management. To combine these necessities with the application of the calculation tools available for these scopes it need a correct interpretation of the links between technological phenomena occurring in the process in the specific plant with the management actions realized and a multi-criteria approach has to be developed both for models tuning and for balancing different process targets with operating practice implemented. The project aim is the improvement of EAF process performances, steel quality and cost reduction in terms of metallic yield, energy efficiency, and steel quality following a continuous route of improvement including charge mix and operating practice optimization in a single step. A coupled aim is the production of higher quality steels via the electric steelmaking route instead of oxygen steelmaking and increase flexibility in use of lower value materials, through the adapted multi-criteria monitoring and control, to reach a cost reduction of charged material using scrap/materials available in the EU. The optimization activity will be coupled with modern techniques of process monitoring and control through multi-criteria approach of performances indicators involving a detailed modelling of interaction between steel/slag.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Piero FRITTELLA (Pr. Coord.)
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	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Claudio OJEDA
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Asier ARTEAGA
	TATA STEEL UK LIMITED	UNITED KINGDOM	William LAW
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	José Angel GUTIERREZ OLABARRIA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Ralf PIERRE

RFSR-CT-2014-00008 RIMFOAM

Recycling of industrial and municipal waste as slag foaming agent in EAF

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2297764 €	Start Date	1/07/2014
	EU Contribution	1378657 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

High electric energy and coal prices in combination with carbon dioxide taxes have driven European steelmakers to look for alternative chemical energy resources other than primary coal to remain competitive on the global steel market. This requires higher flexibility in the steel production route regarding raw material preparation and melting operation. This project seeks to partly substitute carbon and oxygen with industrial and/or municipal waste (ASR, rubber tyres, plastics, biomass waste and by-products, EAF dust and mill scale) for slag foaming purposes in the EAF. The goal is to explore cost- and energy-effective alternative slag foaming agents while maintaining or improving the slag foaming intensity, preserving the liquid steel quality and keeping emissions at a low level. An experimental approach will be adopted to meet the goal of the project involving material characterization, pre-treatment, lab- and pilot testing and industrial trials. Activities are carried out for industrial development, with support of research centres focused on materials characterization, definition of waste material pre-treatment, laboratory and pilot tests. Evaluation of the results will be based on technical feasibility, an economical perspective, emission levels and energy consumption. The development of methods to charge or inject industrial and municipal waste into the EAF will benefit the flexibility of the industry. The extensive material tests and pilot/industrial trials in the project will ensure that partial substitution of coal with waste materials can be done without increased environmental footprint or compromised steel quality. This will lead to a competitive and more environmental sustainable European steelmaking industry. The involvement of a variety of steelmakers with different EAF sizes and types (AC/DC) allows producing general guidelines for other European Electric Steelmakers, who can benefit from the increased knowledge.

		Country	*Scientific person in charge*
Partners	**SWEREA MEFOS AB**	SVERIGE	Erik SANDBERG (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Philippe RUSSO
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Thomas FREGONESE
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Eros Luciano FARACI
	FERALPI SIDERURGICA S.p.A.	ITALIA	Eric FILIPPINI
	HÖGANÄS SWEDEN AB	SVERIGE	Fredrik CEDERHOLM

Technical Group Steel 3

Casting

The scope of TGS3 includes:

- Continuous casting and near net shape casting techniques with or without direct rolling for flat and long products
- Chemistry and physics of solidification
- Ingot casting
- Maintenance and reliability of production lines
- Reduction of emissions, energy consumption and improvement of the environmental impact
- Standardisation of testing and evaluation methods
- Instrumentation, modelling and control of processes

RFSP-CT-2003-00033 THINSTRIP

Industrial realisation of the production of thin strip in a casting rolling line

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	696664 €	Start Date	1/09/2003
	EU Contribution	278666 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23351:EN			

Final Abstract The aim of the project was the substitution of cold rolled and annealed strip for deep drawing applications by hot strip thinner than 2 mm. The hot strips were produced on a casting rolling line by low-temperature ferritic rolling. Based on ELC steel grades, two production routes were used: 1. high finishing and coiling temperatures to get a soft and ductile thin gauge hot strip for direct application, 2. low finishing and coiling temperatures to get a strained thin hot strip for direct annealing, particularly well-suited to a hot dip galvanising treatment just after pickling. The first mill trial was carried out in 2003 with a Ti-concept. Strips with low coiling temperatures were produced. Selected strained thin hot strips were hot dip galvanised. The requirements for drawing quality could not be achieved in the first test. For comparison, the mill trial was repeated at the pilot line at TU BA Freiberg. The results of the mill trial were confirmed. In a next step the chemical composition was optimised in Freiberg. Alloying concepts with Ti, Nb and B were tested. Meanwhile, the lubrication system of the casting rolling line was modified and optimised. The tested boron concept showed promising results and new production trials were performed. The results of the mill trials showed a clear improvement, but in most cases the desired properties were not achieved. New pilot trials were performed in Freiberg. The target was the understanding of the differences between pilot and mill trials. Additionally the influence of a higher B level was studied. The results of all additional tests in Freiberg demonstrated no clear solution for further mill trials. The expected mechanical properties, low yield strength in combination with high r-values, could not be reached with an ELC steel. These results confirmed the conclusion that a safe and successful industrial production on the casting rolling line could not be guaranteed.

		Country	*Scientific person in charge*
Partners	**THYSSENKRUPP STEEL EUROPE AG**	DEUTSCHLAND	Hans-Peter SCHMITZ (Pr. Coord.)
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA

RFSR-CT-2003-00003 CASTDESMON

Improvement, control & prediction of cast & rolled products through development & application of novel engineering monitoring techniques

Info

Type of Project	Research	Duration (months)	50
Total Budget	1994997 €	Start Date	1/09/2003
EU Contribution	1196998 €	End Date	31/10/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23853:EN

Final Abstract

"The aim of the project has been to develop improved means of defining, monitoring and assessing the effects of caster design, condition and operation on slab, bloom and rolled product quality in order to enable better control of the process and to provide the required data for quality prediction. The project has determined the effect of mould taper, wear, metal level, heat transfer and friction under steady state and dynamic conditions; relationships with product quality data have been established together with means of predicting and controlling caster condition. New and existing engineering and operational monitoring techniques (both on- and off-line technologies) for the mould and strand support areas have been delivered. Relationships between engineering and operational parameters, monitored under both steady state and dynamic conditions, and cast product quality have been defined. An understanding has been developed using mathematical modelling and plant trials of mould taper and how its incorrect choice and loss affects the quality and shape of the continuously cast semi; this has included the development of improved off- and on-line taper measurement. The effect and extent of mould wear on surface and subsurface quality has been defined. Improved methods for wear measurement have been developed. Improved means of predicting and controlling caster condition and cast product quality have been delivered. These have included the development and application of data-based methods for quality prediction of cast and rolled product. Potential areas of exploitation for the results from this project have been highlighted."

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Gerard STEPHENS (Pr. Coord.)
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Fernando SANCHO MENDEZ
ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Bertram SEHER
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Arianna GOTTI
FORSCHUNGS- UND QUALITÄTSZENTRUM BRANDENBURG GmbH	DEUTSCHLAND	Ramona KLÖPPEL
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VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Markus FORSTHUBER
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert LINK

RFSR-CT-2003-00005 Nox-RF

Minimizing Nox emissions from reheating furnaces

Info				
Type of Project	Research	Duration (months)	42
Total Budget	2554141 €	Start Date	1/09/2003
EU Contribution	1532485 €	End Date	28/02/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23202:EN

Final Abstract Primary NOx reduction with low NOx burners can be considered the best available technology (BAT) for steel reheating furnaces. In fact, the results of testing and modelling flameless low NOx burners for both high temperature air combustion (e.g. Techint TSX and VTS-NFK HRS burners) and oxy-fuel combustion (Air Liquide ALROLL-S burner) indicated that much lower NOx emissions are possible than with traditional flame burners. This gives the steel industry new opportunities to reduce the environmental impact of traditional furnaces, and the great potential for energy savings and reduced emissions with this technology are worth further investigation in the new RFCS CO2RED project. NOx emissions are strongly dependent on not only the type of furnace and equipment but also the operational conditions (for example, the excess air, and furnace and combustion air temperatures). Therefore the low NOx burner trials were made varying these major operational parameters. Reducing the excess air reduced the NOx in general for all the types of burners tested, which is useful up to the process limitations (CO emissions, etc.) and process control accuracy (as flow measurements). Oscillating combustion gave modest NOx reductions. Secondary NOx removal with high-temperature reduction (HTR) competes with SNCR as an alternative for the NOx removal method with ammonia after the combustion chamber, with both methods having their special advantages and disadvantages. The NOx predictions using Fluent were lower than experimental data for dilute and flameless combustion, but reasonably good predictions were possible for conventional flame burners (e.g. for the furnace at voestalpine). More complex reaction models using Chemkin were not successful in accurately predicting NOx. NOx could be predicted using an empirical neural network-based program called NANOx for NOx in reheating furnaces.

Partners		*Country*	*Scientific person in charge*
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	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Enrico MALFA
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jesus DE LA QUINTANA
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Joao Fernando GOMES
	TENOVA SpA	ITALIA	Marco DANERI
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Heinz-Peter GITZINGER
	VOESTALPINE STAHL GMBH	OESTERREICH	Bernhard KAUFMANN

RFSR-CT-2003-00022 PRESEG

Prediction of rolled product properties by correlation with as-cast structure & rolled product, plant process variables, plant process variables including modelling of segregation

Info

Type of Project	Research	Duration (months)	42
Total Budget	1962853 €	Start Date	1/09/2003
EU Contribution	1177712 €	End Date	28/02/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23309:EN

Final Abstract

This project is a collaboration between Teesside Technology Centre — Corus UK Ltd, Centro Sviluppo Materiali (CSM), voestalpine Stahl Donawitz (VASD), Arcelor España, Corrosion and Metals Research Institute (KIMAB) — formerly (SIMR) Swedish Institute of Metals Research, Scuola Superiore Sant'Anna (SSSA) and Helsinki University of Technology (HUT). The project is coordinated by Corus. The aim of the project is to relate centreline segregation severity and distribution to the rolled product quality. This has been achieved by combining plant measurements, modelling and metallurgical assessment and taking an integrated view of the casting and subsequent rolling processes via slab, bloom and billet routes for both long and flat products. Industrial partners and partners with industrial contacts have collected plant process data and segregation data, including sulphur print images, for both as-cast semi products and for final rolled products. Image analysis programs have been used to characterise segregation in as-cast products and quantitative methods employed to determine segregation indices. Regression analyses and neural network studies have been carried out to determine links between as-cast process parameters/product qualities and rolled product qualities. Out of this study of as-cast product and rolled product datasets, correlation coefficients between key parameters have been evaluated and these coefficients have been used in mathematical models developed to predict both segregation profiles during casting and rolled product properties. Macrosegregation models have also been developed to enable slab, bloom and billet segregation profiles to be calculated, depending on process parameters and machine set-up conditions.

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Brian BARBER (Pr. Coord.)
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CENTRO SVILUPPO MATERIALI SPA	ITALIA	Irene LUZZO
HELSINKI UNIVERSITY OF TECHNOLOGY - TEKNILLINEN KORKEAKOULU	FINLAND	Jukka LAINE
SWEREA KIMAB AB	SVERIGE	Jacek KOMENDA
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Markus FORSTHUBER

RFSR-CT-2003-00027 FLUXFLOW

Enhanced steel product quality & productivity by improved flux performance in the mould through optimising the multiphase flow conditions & special regard to melting & entrapment

Info

Type of Project	Research	Duration (months)	42
Total Budget	1770935 €	Start Date	1/09/2003
EU Contribution	1062560 €	End Date	28/02/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23182:EN

Final Abstract

This project aimed at providing constructive and process engineering measures to guarantee sufficient melting of the flux and to avoid flux entrapment. Extensive operational investigations were carried out to identify parameters important for this flux-flow behaviour as well as to elaborate optimum set-points and SEN designs. Various methods for measuring flux layer thickness and horizontal flow velocity in the mould — important parameters influencing flux behaviour — were partly developed and applied. Investigations covered flat and long products as well as carbon and stainless steels. Substantial physical and mathematical modelling work was carried out to provide additional information on the correlation between operational parameters and flux behaviour. Here, advanced techniques with regard to simulation of flux layer evolution and formation — also under the influence of flow conditions in the mould — were applied. Modelling results were verified by operational trials. The research made it possible to identify certain parameters that are important for controlling flux behaviour according to goals: casting velocity, immersion depth, oscillation stroke, nozzle design and the free carbon content and viscosity of the flux. Also possible was the elaboration of statements concerning the proper adjustment of these parameters. On the other hand, parameters such as melt superheat or intensity of electromagnetic stirring have minor influence. A very important fact is that unsteady conditions increase the risk of entrapment. Here, there is a high risk when casting begins, and until the process achieves a certain degree of stability. Moreover, a loss in mould level stability or changes in near-surface flow velocities of the melt must be avoided. The results of this research are clearly useful for many European steel producers. To guarantee optimum flux behaviour, the parameters must be finely tuned to match the specific situation of an individual plant. The research demonstrates possible approaches to do this.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Sigurd RÖDL (Pr. Coord.)
ACERALIA CORPORACION SIDERURGICA S.A.	ESPAÑA	Luis Fernando SANCHO MENDEZ
COGNE ACCIAI SPECIALI SpA	ITALIA	Armando POLI
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THYSSENKRUPP NIROSTA GMBH	DEUTSCHLAND	Jörg-Friedrich HOLZHAUSER

Selected Publications

Holzhauser, J.-F., Ballewski, H.-H., Rödl, S., Striedinger, R. Improvement of product quality by optimized process control in a slab casting mould. Proceedings of the 3rd International Steel Conference on New Developments in Metallurgical Process Technologies. 11.-15. June 2007, Düsseldorf, Germany, pp. 759/767

RFSR-CT-2003-00036 REGTGF

Improvement of top gas fired reheating and direct reduction furnaces for high temperature using innovative regenerative burners

Info

Type of Project	Research	Duration (months)	40
Total Budget	1219192 €	Start Date	1/09/2003
EU Contribution	731515 €	End Date	31/12/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24029:EN

Final Abstract

The project was concerned with two main objectives: reduction of energy consumption and improvement of product quality in reheating and direct reduction furnaces. Components such as regenerators and burners have been tested at test facilities, with on-site measurements at conventional reheating furnaces with central recuperators. On-site measurements at conventional reheating furnaces in rolling mills have been done. Exhaust gas enthalpy is used to preheat combustion air by central recuperators. Operating data conform with data from literature and previous measurements of project partners. Several ceramic honeycombs as heat storage modules for regenerators and a regenerative burner system have been investigated at the test facilities of CSM and BFI. Characteristics of the possible regenerator configurations are described. Two burners using fuel gases with a wide spread in calorific value have been examined at test furnaces. Heat recovery from flue by thermal regenerators and recuperators for air and fuel preheating pushed furnace efficiency, temperature and power. In combination with CFD, burner design has been optimised regarding ignition, CO and NOx emissions. The influence of new heating technology on heat transfer inside an industrial furnace, on the reheating of products and on scale formation was analysed. The differences in the heating process and material quality using conventional furnace equipment or optimised technology have been worked out. Results have shown that an extensive heat recovery from flue gas in combination with optimised burner technology enables the substitution of valuable fuels in high temperature processes by weak by-products, to decrease fuel consumption and scale formation and to increase quality of product heating.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Wolfgang ADLER (Pr. Coord.)
AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Klaus EBERWEIN
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Umberto ZANUSSO

RFSR-CT-2004-00009 EDDYCAST

Multiplexed eddy-current arrays for the detection of corner cracks on as cast products in the inspection yard & at the exit of continuous casting

Info	Type of Project	Research	Duration (months)	54
	Total Budget	1039110 €	Start Date	1/07/2004
	EU Contribution	623466 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24181:EN			

Final Abstract Eddy-current arrays, which appeared on the market in 2000, may help us to solve an old problem: the qualification of corner-crack sensitive grade as-cast products at the exit of the continuous casting. The consortium led by ArcelorMittal, with Dillinger HW, Sidenor and TKS as partners, designed eddy-current array probes for detecting corner cracks and the mechanics for testing them at the exit of casting facilities, on slabs or billets. Detection results are contrasted, as follows. - For billets, the crack geometry allows easy detection, in handheld conditions. However, in order to operate the probe correctly, a 3 mm standoff is required, which could not be attained in the conditions of a billet conveyor. - For slabs, crack geometry requires that the slab temperature should not be excessively below Curie point, typically 710 °C. If these conditions are met at the exit of a continuous caster, then detection should be sufficient to allow slabs to be assessed and assigned.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Philip MEILLAND (Pr. Coord.)
	AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Helmut LACHMUND
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Juan José LARAUDOGOITIA
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Wolfram WEBER

RFSR-CT-2004-00010 CASTINCREM

Cast product improvement by "through process" inclusion assessment and removal

Info	Type of Project	Research	Duration (months)	45
	Total Budget	1256036 €	Start Date	1/07/2004
	EU Contribution	753621 €	End Date	31/03/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23898:EN			

Final Abstract Castincrem is a collaborative project involving Corus RD & T, BFI, Ascometal, Sidenor I & D and voestalpine Stahl Donawitz. The focus is to correlate inclusion-related events during casting with process parameters and develop techniques to alleviate problems of agglomeration, nozzle clogging and flow disruption in the mould. Work involved data collection for aluminium and non-aluminium killed steels by the industrial partners, followed by assessment of cleanness and correlation with production parameters. At Corus the focus was strip grade steels, at Ascometal automotive long products, and at Sidenor and VASD long products for engineering. Relationships have been shown for the influence of steelmaking and casting parameters such as inclusion modification, steel chemistry (influence of Al, Ca and possible role of Ti and V) and control of casting conditions (mould level, argon pressure and others) on castability and nozzle clogging. Use of advanced statistical methods including the statistics of extremes was also explored (Corus) to predict the largest particle likely to be present. CFD and physical modelling by BFI, beyond the previous state of the art, involved modelling of inclusion agglomeration and capture in the tundish in both stable and unstable operating conditions. This also involved consideration of multi-phase flows. Practical trials investigated improved steel feeding such as the stopper/nozzle combination and control systems, particularly with regard to the role of argon. A prototype idea for the promotion of inclusion removal by recirculating flows was also studied on the pilot scale and in initial production scale casts. Results are discussed and recommendations given.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Alan SCHOLES (Pr. Coord.)
	ASCOMETAL S.A.S.	FRANCE	Joël MANCINI
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Santiago LANDA LAZCANO
	VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Axel SORMANN
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Sigurd RÖDL

Selected Publications K. Marx, R. Koitzsch, S.Rodl. Investigations on inclusion agglomeration and separation in continuous slab casting tundish applying new numerical simulation approaches, 6th European Continuous Casting Conference, Riccione, 2008

RFSR-CT-2004-00011 FLOWVIS

Measurement, prediction and control of steel flows in the casting nozzle and mould

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1357913 €	Start Date	1/07/2004
	EU Contribution	814748 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24205:EN			

Final Abstract

Control of steel flow through the casting nozzle and within the mould is an important determinant of steel cleanness and surface quality. Techniques including visualisation of steel flow in the nozzle using electromagnetic, ultrasonic and thermal sensors in combination with the measurement of steel flow velocities and distribution in the mould allow project partners Corus RD & T, Sidenor I + D, BFI, Saarstahl and MEFOS to develop a physical picture of the steel flow behaviour during the casting process, including effects such as nozzle clogging and flow asymmetry/biased flow. In addition, a full-scale physical model of a slab caster has been designed and manufactured using a low-temperature liquid metal to simulate the casting process. Work has been carried out using these techniques to correlate with existing data, product grading schemes and both product cleanness and surface quality. An assessment has been made of the influence of flow pattern in the SEN and mould on solidification. A study was made of reasons for changes observed in flow patterns, including determination of why flow patterns change during stable casting. An investigation into the influence of casting parameters on clogging and wear has been carried out, including criteria for monitoring the condition of the nozzle during casting. From these assessments recommendations have been made for process optimisation. These include the control of flow pattern in the SEN, optimisation of SEN immersion depth and online monitoring of clogging. A comparison was made between the various techniques, indicating their capability and limitations.

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Stuart R. HIGSON (Pr. Coord.)
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Javier CIRIZA
SWEREA MEFOS AB	SVERIGE	Ulf SJÖSTRÖM
SAARSTAHL AG	DEUTSCHLAND	Peter VALENTIN
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Torsten LAMP

Selected Publications

S R Higson, P Drake (Corus R, D & T, UK), A Lyons (MPC AB, Sweden), A Peyton (University of Manchester, UK): 2nd International Workshop on Measuring Techniques for Liquid Metal Flows, Dresden, Germany. April 2007: An electromagnetic technique to measure steel flow patterns within the continuous casting nozzle.

U Sjöström (MEFOS, Sweden): 2nd International Workshop on Measuring Techniques for Liquid Metal Flows, Dresden, Germany. April 2007: Sensors for non-contact velocity measurements for continuous casting of steel.

Ultrasonic sensor:
http://www.bfi.de/en/fields_of_activity/Measurement_and_automation/_doc/Brochure_BFI_Measuring_Techniques_Metallurgical_Processes.pdf#page=15

RFSP-CT-2005-00008 Beam-blank MFC

Direct casting of small sections beam-blanks thanks to meniscus free casting technology

Info	Type of Project	Pilot&Demonstration	Duration (months)	48
	Total Budget	1467150 €	Start Date	1/07/2005
	EU Contribution	586860 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25057:EN			

Final Abstract This demonstration project aimed at showing through pilot trials that beam blanks for the production of small sections could be cast continuously close to the final shape using meniscus free casting (MFC) technology. Past experiences with bars and billets had shown that productivity and product quality obtained with MFC could be a serious advantage for near-net shape beam-blanks casting.A successful completion of this project could then lead to substantial savings in the casting operations. Additional cost reductions could be expected for the rolling operations, mainly due to the reduction in the number of rolling passes.Calculations and design work demonstrated the a priori possibility of such a casting with a particular mould and its dedicated feed head. Manufacturing the mould was ambitious, and answered the question of coating a smallbeam-blank shape, digging in appropriate copper blocks and machining properly the desired form.Eleven heats were cast on pilot caster during the trial campaign. The main technical results were as follows :• Adequate start-up procedure was defined. The compromise between anchoring and overcoming fast solidification in the web was reproduced twice.• Heat extraction in the designed MFC mould is possible but should be confirmed on further tests. Improvements of mould design are still possible and should provide better results.• Product quality is good and homogeneous. The presence of some cracks and overthicknesses could be reduced with taper adaptations.This demonstration project was technologically bold, and addressed only the validation of technical options. The bases for near-net shape casting have been settled, and the potential of such a technology is increased after the results obtained.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Martin BEAUVAIS (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Pierre HUBSCH

Patents WO2012175822 (A1) - METHOD AND DEVICE FOR CONTINUOUSLY CASTING A PROFILE MEMBER BLANK. JOLIVET JEAN-MARC [FR], BEAUVAIS MARTIN [FR], HEMMER CHRISTOPHE [FR], GAUGUE MICHEL [FR]

RFSR-CT-2005-00009 SMARTFIRE

Real-time intelligent diagnostics and optimisation of reheating furnace performance

Info

Type of Project	Research	Duration (months)	42
Total Budget	2056119 €	Start Date	1/07/2005
EU Contribution	1233672 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24174:EN

Final Abstract The Smartfire project was undertaken to identify ways of optimising the operation of reheating furnaces, maintenance and product quality by providing furnace diagnostic tools for monitoring and controlling process parameters. In one work stream, a technique was successfully developed to produce diagnostic signals from flame imaging. It also demonstrated for the first time that even nominally identical burners produce different characteristic signals. Without recalibration, this limits the transfer between burners, making furnace-wide application difficult. In another work stream, statistical and physical models of furnace features were developed and linked with furnace databases to form on-line real-time diagnostic systems, although the developed flame analysis system was not included in these diagnostic systems, as had originally been planned. Through development and implementation of these systems their benefits were demonstrated. The project was successful in developing a range of diagnostic techniques to help improve the operation of reheating furnaces as well as product quality. By exploring the techniques and by implementing models developed across a range of different furnaces, the project partners demonstrated broad applicability of the diagnostics they provide. The work will be beneficial for all furnace operators supervising their own furnaces.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Graham ANDREWS (Pr. Coord.)
	ACERALIA CORPORACION SIDERURGICA S.A.	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
	SWEREA MEFOS AB	SVERIGE	Bo LEDEN
	UNIVERSITY OF GLAMORGAN	UNITED KINGDOM	Steven WILCOX
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Guido MITTLER

Selected Publications

H.S. Chong, C.K. Tan, S.J. Wilcox, S.M. Thai, J. Ward, G. Andrews, “Development of an intelligent flame monitoring system for gas-fired steel reheating furnaces”. Proceedings of the 5th European Thermal-Sciences Conference, 18-22 May, Eindhoven, the Netherlands, 2008.

Thai, S.M., Wilcox, S.J., Ward, J., Tan, C.K., Chong, H.C., Andrews, G. “Monitoring and Diagnosis of Steel Reheating Burners”. IMECE2008-67205 ASME Congress, Boston, MA. October 30th to November 6th, 2008.

S.M. Thai, S.J. Wilcox, C.K. Tan, J. Ward, G. Andrews, “Development of an Intelligent Flame Monitoring System for Steel Reheating Burners”, Proceedings of the Institution of Mechanical Engineers, Part A, Journal of Power and Energy, 226(8): 1014-1031, 2012. doi: 10.1177/0957650912458859

RFSR-CT-2005-00010 CLOGGING

New strategies for clogging prevention for improved productivity and steel quality

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1858335 €	Start Date	1/07/2005
	EU Contribution	1115001 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24177:EN			

Final Abstract This was a cooperative project involving Betriebsforschungsinstitut, ComdicastAB, Voestalpine Stahl, RIVA Acciaio, Scuola Superiore di Studi Universitari e diPerfezionamento Sant'Anna, RWTH Aachen, Arcelor España and Kungliga Tekniska Högskolan. The focus was to develop innovative improvement measures for clogging prevention or minimisation. The developments are based on results of the analysis of operational praxis and on new basic knowledge concerning the clogging mechanism. Various databases were generated and proper statistical analyses on the influence of operational and metallurgical parameters on clogging were performed. Investigations on clogging mechanisms were carried out by theoretical studies and the use of a confocal scanning laser microscopy. Clogging rate deposition measurements were carried out by a clogging simulator. XBasic information on possible influences of physical processes on clogging was studied by means of physical modelling and numerical simulation. Investigations concerning new feeding systems designs and gas injection strategies were performed. Methods to predict clogging by suitably defined clogging indices based on operational parameters as well as a neural network-based predictor for steel castability and a clogging prediction model were developed. Operational trials were performed to validate optimisation measures. Important findings were developed which can be directly used by other European steel producers or at least can be used as an offset for activities adjusting methods and measures to their individual operational situation.

Partners	*Country*	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Sigurd RÖDL (Pr. Coord.)
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Fernando SANCHO MENDEZ
COMDICAST AB	SVERIGE	Sven EKEROT
KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Margareta ANDERSSON
RIVA ACCIAIO SPA	ITALIA	Nicola VENERI
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
VOESTALPINE STAHL GMBH	OESTERREICH	Guangmin XIA

Selected Publications

S. Stratemeier, D. Senk, A. Grosse und B. Kurth: Eigenschaften von mechanisch hergestelltem Desoxidationsaluminium, Stahl und Eisen 126, Nr. 11/2006

D. Senk and A. Grosse: De-oxidation practice in twin-roll-casting of aluminium-killed carbon steels. Proceedings of the 7th International Conference on Clean Steel, Balatonfüred/Hungary, 4-6 June 2007. pp. 254-263

Senk, D., Grosse, A., Gräf, G.: Dynamic de-oxidation and inline alloying of Al in continuous casting of billets and strips. La Metallurgie Italiana 101 (2009), Nr, 11-12, Page 65-70

Grosse, A.: „Entwicklung eines dynamischen Desoxidations- und Legierungsverfahrens für die Herstellung aluminiumberuhigter Kohlenstoffstähle beim Bandgießen" („Development of a dynamic deoxidation and alloying process for the production of aluminium-killed carbon steels during strip casting"), Ph.D. Theses, ISBN: 978-3-8322-8499-2

Senk D., Grosse A.: Dynamic de-oxidation and alloying for Al-killed carbon steel in billet and strip casting. Proceedings of the 8th International Conference on Clean Steel, Budapest/Hungary, 14-16. May 2012. Hungarian mining and metallurgical society, F_07/01.PDF (CD-ROM)

RFSR-CT-2005-00011 SOLIMOULD

Enhanced as-cast product quality by optimised mould taper design

Info

Type of Project	Research	Duration (months)	42
Total Budget	1286510 €	Start Date	1/07/2005
EU Contribution	771905 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24176:EN

Final Abstract

The goal of this project was to investigate how the taper in combination with shrinkage, operational parameters and other mould conditions (wear and distortion) affects as-cast product quality for different semis formats, namely billets and slabs. As a result, it was possible to gain crucial information for optimising mould design and operational parameters, with the aim of improving as-cast product quality. Plant trials were supported by mathematical modelling for early solidification and the interaction between solidified shell and mould. Work involved data collection for flat and long products by the industrial partners, followed by assessment of cross section profiles and correlation with production parameters. Corus focused on slabs and billets, while Sidenor concentrated on billets, and CSM and VDEh-BFI on the development of numerical methods for the simulation between mould and as-cast product. Analysis and the elaboration of theories concerning the interaction between as-cast product and mould for the standard casting practice were defined. It allowed the characterisation of the as-cast material results in terms of shrinkage, cross-section shape and quality results for the standard casting practice. Special attention was paid to the formation of oscillation marks, the phenomenon of binding between billet and mould, and the deformation of mould tubes due to thermal conditions and physical constraints, and its effect on the as-cast material transversal shape. On the other hand, the 2D in-mould solidification numerical model developed during the project was applied to simulate the solidification of the steel inside the billet moulds. From the calculated steel shell displacements, an ideal taper profile was derived, describing the way the length of the billet cross section perimeter changes from the meniscus level to mould exit.

Partners

	Country	*Scientific person in charge*
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Iñigo UNAMUNO (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Maria Rita RIDOLFI
TATA STEEL UK LIMITED	UNITED KINGDOM	Andrew CHOWN
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Oliver BREITFELD

Selected Publications

G. Alvarez de Toledo, I. Unamuno, J. J. Laraudogoitia, J. Ciriza, I. Alvarez. “Study of billet mould interaction during casting through billet contour measurements”, Proceedings ECCC2008, Riccione, Italy

RFSR-CT-2005-00012 SLAGFILMOWL

Optimising slag film properties and determination of operational windows for lubrication, mould heat transfer and shell formation

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2046240 €	Start Date	1/07/2005
	EU Contribution	1227745 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24988:EN			

Final Abstract To improve the surface quality of continuously cast semis, this collaborative project has developed further understanding of the events and conditions at the meniscus that affect slag infiltration and conditions in the mould-strand gap resulting from the properties of the slag film. This has been achieved in two ways. The first was by characterisation of the mould top slags and mould strand slag films from industrial casters of the partners and the correlation of these samples with plant operational and surface quality data. The second was by numerical modelling of early solidification and the effect of deformationand stresses on the shell and slag infiltration in the mould-strand gap. From the developed understanding, operational windows for lubrication, mould heat transfer and shell growth have been developed, resulting in surface quality improvements. At Sidenor the work focused on the development of a new high speed billet casting practice, Outokumpu aimed to reduce a specific type of deep longitudinal cracking found on wide slabs of a duplex stainless grade, GMH aimed to optimise surface quality of three special steel grades through plant trials and numerical simulation of its bloom mould by VDEh-BFI and Corus aimed to optimise heat transfer and surface quality on the Scunthorpe Slab Caster with particular focus on peritectic steel grades and the impact of a caster enhancement for faster casting. CSM has developed a coupled thermodynamic and heat transfer model to predict how heat transfer and lubrication change as a result of chemical interaction between mould slag and steel.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Bridget STEWART (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Antonello DI DONATO
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Iñigo UNAMUNO
	GEORGSMARIENHÜTTE GmbH	DEUTSCHLAND	Ingo KOLM
	SWEREA KIMAB AB	SVERIGE	Carl-Ake DÄCKER
	OUTOKUMPU STAINLESS AB	SVERIGE	Appell ANDERS
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Oliver BREITFELD

RFSR-CT-2005-00013 TUNDJUST

Innovative tundish management for final steel thermal and chemical adjustment

Info

Type of Project	Research	Duration (months)	36
Total Budget	1235681 €	Start Date	1/07/2005
EU Contribution	741409 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24348:EN

Final Abstract

"During research carried out in synergy by Centro Sviluppo Materiali (CSM), VDEh-Betriebsforschungsinstitut (VDEh-BFI), Cogne Acciai Speciali (CAS) and Deutsche Edelstahlwerke (DEW), operations were designed and carried out in real tundish to control steel composition and temperature, and to perform inclusion engineering. The research work was supported by fluid dynamics management, aimed at favouring dissolution of materials for alloying and inclusion modification, and at allowing the identification of injection techniques. Inclusion engineering was aimed at having matrix particles in metal that are beneficial to mechanical properties (improved machinability steels). As a result: - alloying techniques were defined and applied via CaSi/FeS wire injection; - inclusion engineering was performed via material (bags) poured into a pad that was suitably designed, modelled and tested. For temperature control: - local reheating was successfully achieved with exothermic powders at the surface above the exits; - a model for online control of steel temperature was set up and validated with plant data for operational purposes. The innovative character of the work consisted of the application in a 'continuous' reactor (tundish) of metallurgy operations typically exploited in a ladle ('batch' reactor). The application leads to cost savings allowing further steel composition/temperature control after ladle treatment, reducing downgrading occurrence, or avoiding critical involvement of treatment sites in routes. The results encouraged the workgroup to favour: - consolidation of their application for plant (e.g. CAS 'thermal heating' use and future use of wire feeders for ad hoc inclusion engineering); - dissemination via papers and further research activities proposals to enable operations to be systematic in steelmaking plants."

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Michele DE SANTIS (Pr. Coord.)
COGNE ACCIAI SPECIALI SpA	ITALIA	Armando POLI
DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Hans-Peter JUNG
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Carsten TSCHEUSCHNER

Selected Publications

M. De Santis , A. Poli, Inclusion engineering in tundish to produce improved workability , 2nd VDEh-AIM Joint Meeting on Metallurgical Fundamentals, 'New Developments in Electrical Steelmaking and Casting', September 30th, 2009, Duisburg

M. De Santis, A. Poli, Metallurgia in paniera: inclusion engineering per produzione di acciai ad alta lavorabilità, 34° Conv. Naz. AIM – Trento, Italy, nov. 2012

R. Koitzsch, C. Tscheuschner, S. Rödl, D. Leuverink, H.-P. Jung: New approaches for prediction of thermal conditions in a continuous casting tundish. Proceedings of the 7th European Continuous Casting Conference, 28.-30. July 2011, Düsseldorf (CD-ROM).

RFSR-CT-2005-00014 PRECIPITATION

Precipitation behaviour of microalloyed steels during solidification and cooling

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1911068 €	Start Date	1/07/2005
	EU Contribution	1146641 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24204:EN			

Final Abstract This was a collaborative project involving Corus R D & T, Teesside Technology Centre, Sidenor I + D, voestalpine Stahl Donawitz GmbH (VASD), Swerea KIMAB AB (KIMAB), ArcelorMittal Research and RWTH Aachen Technical University. It was coordinated by Corus. Building upon the knowledge gained from a previous project reported in EUR 22060, the goal of this one was to further understand the effects of the precipitation behaviour of microalloying additions during solidification and cooling, and their consequence on the quality of as-cast continuously cast semis. Using data and samples obtained from the industrial casters of Corus, Sidenor, VASD and ArcelorMittal, pilot plant and laboratory investigations by all the partners and supported by thermodynamic, numerical and kinetic modelling undertaken by KIMAB, ArcelorMittal, VASD and RWTH, further significant knowledge has been gained of the behaviour of microalloyed steels during solidification and cooling. The effects of mould cooling using different mould powders, the effect of secondary cooling using soft and hard cooling practices and the effect of strand cooling using different cooling bed conditions were explored. Equipment was developed and installed to explore billet deformation on-line as a function of steel chemistry. One alternative micro-alloying strategy was demonstrated at both Corus and Sidenor. Process route optimisation with one microalloyed steel grade was illustrated at Sidenor. The data gained during the project has illustrated how the precipitation during casting, solidification and cooling may possibly be altered to the benefit of surface quality and will enable optimisation of steel chemistry for final applications by using alternative microalloying strategies.

Partners		*Country*	*Scientific person in charge*
	TATA STEEL UK LIMITED	UNITED KINGDOM	Shahid RIAZ (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Yann LE PAPILLON
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Gonzalo ALVAREZ DE TOLEDO
	SWEREA KIMAB AB	SVERIGE	Stanislaw ZAJAC
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK
	VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Axel SORMANN

RFSR-CT-2006-00007 OPTHEAT

Quality improvement by metallurgical optimised stock temperature evolution in the reheating furnace including microstructure feedback from the rolling mill

Info

Type of Project	Research	Duration (months)	42
Total Budget	2549660 €	Start Date	1/07/2006
EU Contribution	1529796 €	End Date	31/12/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25001:EN

Final Abstract

The OPTHEAT project was undertaken to improve the quality and productivity of hot rolled products by using new heating strategies and optimisation of rolling schedules. To achieve these objectives the dependence of the material properties on the heating in the furnace and the microstructure evolution inside the stock during rolling has to been considered. The operational data with respect to reheating and rolling practice and common operation methods for different industrial furnaces and rolling mills across Europe were analysed. Based on these results, different steel grades and relevant material properties are selected for the experimental investigations. Sets of heuristic rules for control of the transient furnace operation and mill set up were estimated and operational strategies were developed. Mathematical modelling of the heating and rolling process with respect to microstructure, product quality, temperature and energy consumption was done andimplemented. After definition of relevant objective functions regarding the product quality, a user-friendly tool for prediction and optimisation of the microstructure was developed. Operational system tests were done at different furnaces and rolling mills to verify the new strategies. The productivity of the rolling mill and material quality can be increased by using improved furnace strategies for handling stoppages in the rolling mill and changes from one lot of certain steel grade to another.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Rolf KLIMA (Pr. Coord.)
ARCELORMITTAL SESTAO S.A.	ESPAÑA	Juan I. LANGARA
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jon BARCO
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
INSTITUT ZA KOVINSKE MATERIALE IN TEHNOLOGIJE	SLOVENIJA	Anton JAKLIC
SWEREA MEFOS AB	SVERIGE	Bo LEDEN
AB SANDVIK MATERIALS TECHNOLOGY	SVERIGE	Ebrahim MOOSAVI
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Felix PENALBA DIAZ

RFSR-CT-2006-00008 CO2RED

CO2 reduction in reheating furnaces

Info

Type of Project	Research	Duration (months)	48
Total Budget	2481055 €	Start Date	1/07/2006
EU Contribution	1488633 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25004:EN

Final Abstract

The project aims to demonstrate the capability of new combustion technology to allow a step change in environmental impact of reheating furnaces reducing, at the same time, the CO2 and the NOx emissions. A special effort has made for defining a clear reference for the specific consumption, and the consequent CO2 emission, of the present reheating furnaces equipped with central recuperator and for evaluating the potential impact of regenerative and oxyfuel combustion system based on flameless oxidation. Tests of honeycomb regenerator, flameless regenerative and oxy-fuel burners have been carried out at semi-industrial scale in the network of R & D combustion laboratories (BFI, CSM and MEFOS) with different fuels (NG, LPG, COG, BFG). The effect on product quality (scale formation) has been also evaluated. Regarding oxy-BFG burner tests have been carried out with pure BFG gas as well as BFG enriched with LPG. Long run tests of regenerative burner installed at Feralpi and Arcelormittal furnaces have been carried out for different gaseous fuels (NG, COG) confirming the reliability of the proposed technological solutions.In parallel, a common CFD approach for modelling the combustion process of gaseous fuels has been defined by partners having the goal to reproduce, with engineering accuracy, the velocity and temperature fields in a complex geometry. The tool has been used for design and verification of burners before the testing and to model the reheating process in the complete furnace.Guidelines for installation and operation of new combustion systems have been proposed and the expected benefits and drawbacks estimated.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Enrico MALFA (Pr. Coord.)
AGA AB	SVERIGE	Tomas EKMAN
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
FERALPI SIDERURGICA S.p.A.	ITALIA	Francesco MAGNI
SWEREA MEFOS AB	SVERIGE	Anders RENSGARD
TENOVA SpA	ITALIA	Maurizio SENAREGA
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Wolfgang ADLER

Selected Publications

E. Malfa, W.Adler, T.Ekman, M. Fantuzzi, E.Filippini , A. Rensgard, Juan Jose Arribas Ramirez, CO2 reduction in reheating furnaces, International Conference on Energy Efficiency in Steel Industry Ispat Bhawan, Ranchi – India, December 14-16, 2011

E V.Battaglia, E.Malfa , M. Fantuzzi, , CFD complete reheating furnaces modeling including stock advancement, Metal and Metallurgy China 2012, May 7-11, .2012

E. Malfa , W.Adler , T.Ekman , M. Fantuzzi , E.Filippini , A. Rensgard , Juan Jose Arribas Ramirez, CO2 reduction in reheating furnaces, International Symposium on High Temperature Air Combustion and Gasification (HiTACG), 5-7 July 2010, Potzan, Poland

V.Battaglia, E. Malfa, M.Fantuzzi, CFD SIMULATION OF COMBUSTION SYSTEMS FOR STEEL REHEATING FURNACES, 16° IFRF Members' Conference, Boston, USA June 08-10, 2009

J.Niska, A. Rensgard, T.Ekman, PILOT TRIALS WITH OXYFUEL COMBUSTION OF BLAST FURNACE GAS FOR STEEL REHEATING, 2nd International Conference: Clean Technologies in the Steel Industry 26-28 Sept. 2011, Budapest, Hungary

Software

Common approach for NG burner modelling based on CFD software - AnsysFluent The CFD simulations have been performed by commercial fluid dynamic code AnsysFLUENT . The selection of the physical models has been based on a extensive validation work dedicated to evaluate the performance of the different turbulence representations for simulating high velocity round jets and combustion scheme for natural gas. The Wilcox model with shear flow correction resulted the most appropriate to simulate the turbulent generation produced by strong velocity gradient in near jet zone. Different combustion models have been evaluate with the goal: the Finite Rate/Eddy Dissipation (EDM) model with two steps reaction mechanism (Westbrook&Dryer kinetic) , the Eddy Dissipation Concept (EDC) model with advanced reduced mechanism s(i.e ARMs, Kee58, GRI2.11).Simulation results confirms that EDM model represents the temperature field with accuracy comparable to the more complex and time consuming Eddy Dissipation Concept [13] approaches. Therefore being the main goal, to have a tool able to reproduce the combustion process of gaseous fuels with engineering accuracy, the Finite Rate/Eddy Dissipation (EDM) model with two steps reaction mechanism (Westbrook&Dryer kinetic) seems to be the best compromise between accuracy and CPU time. EDC with advanced reduced mechanism, that are more CPU time consuming, are necessary: to directly calculate the NOx concentration in the flue gases, to have a "generalised" reaction mechanics suitable for NG, COG, BFG and LPG.

Complete furnace model based on commercial available CFD software - AnsysFluent The physical and numerical model based for single burner simulation have been extended to complete furnace (multiple burners). The main problems to overcome have been: the large number of computational cells necessary to discretize the different geometry scale (burners .vs. furnace .vs. stocks), · the modeling of moving steel stock (in present applications the billets). The multi physics 3D Computational Fluid Dynamics (CFD) simulation of complete furnace coupling the reacting flow combustion models, conjugated heat transfer in the stock and scale formation has been validate comparing experimental data obtained with dedicated measurement activities.

RFSR-CT-2006-00018 GRAINCONT

Grain size control in steel by means of dispersed non-metallic inclusions

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1676679 €	Start Date	1/07/2006
	EU Contribution	1006007 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24993:EN			

Final Abstract This was a collaborative project involving Kungliga Tekniska Högskolan, Helsinki University of Technology, Centre de Recherches Métallurgiques, ArcelorMittal and ComdiCast AB. Stiftelsen for Industriell og Teknisk Forskning was also participating as subcontractor. The project objectives were to create and improve fundamental knowledge of grain size control by means of dispersoidic inoculants in the steel microstructure and to develop and establish a new addition technique applicable for steel continuous casting.Thermodynamic studies and modelling of potential inoculants yielded results which could be utilised during the progress of the project. Laboratory testing of inoculants systems and evaluation of the as-cast samples gave information regarding the potential grain refining effects. Ingots for further processing were produced. Research regarding production of inoculants alloys, both with exogenous particles and ferroalloys for in situ formation of inclusions (e.g. particles) in steel, was carried out. Grain refining effect of produced inoculants alloys was tested. An injection technique for addition of inoculants alloys powder directly in the continuous casting mould through a special submergedentry nozzle was developed and tested in pilot plant scale. Grain refining effect on ascast material was evaluated and samples for further processing was also here produced. A selection of the various steel samples produced in the project underwent hot and cold rolling simulation tests and the effects of grain refining on microstructure and mechanical properties of final products were evaluated. Finally, the results were summarised and an overall project evaluation was made.

		Country	*Scientific person in charge*
Partners	**KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY**	SVERIGE	Margareta ANDERSSON (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Thierry IUNG
	COMDICAST AB	SVERIGE	Sven EKEROT
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Paul NAVEAU
	AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Lauri HOLAPPA

RFSR-CT-2007-00012 MAGNETOHYDRO

Improvement to steel cleanness, castability and surface quality through the application of magneto-hydrodynamics during pouring and solidification

Info

Type of Project	Research	Duration (months)	42
Total Budget	1904900 €	Start Date	1/07/2007
EU Contribution	1142940 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25123:EN

Final Abstract

This collaborative project was coordinated by Tata Steel UK. It involved Gerdau-Sidenor I+D, voestalpine Stahl Donawitz GmbH (VASD), BFI, ArcelorMittal Research and Aalto University (TKK). The objective of this research was to improve steel cleanness, including improvement of the size and distribution of inclusions in the cast product, and to improve its final properties. The processing conditions and segregation were aimed at improving the use of conventional single mode and modern multimode mould electromagnetic stirring for long and flat products. The characterisation of the data and cast industrial samples at Tata Steel, Sidenor, VASD and ArcelorMittal using modified stirring, laboratory ductility investigations, offline and in-mould measurements of meniscus velocity, temperature, flow and surface waves height have helped to optimise the casting conditions for different casting formats. The improved steel cleanness, minimised powder entrapment and energy savings were achieved using practical information on flow and inclusions, supported by numerical and physical modelling by BFI, ArcelorMittal, TKK and Sidenor. The numerical models were validated with the practical information on inclusions and meniscus flow. The novel application of EM forces to control the meniscus flow and flow in the SEN was also investigated. Laboratory-based feasibility studies using the trial facilities at Forschungszentrum Dresden-Rossendorf (FZD), Germany, and the numerical and physical modelling by BFI, TKK and ArcelorMittal Research have shown that the rotational frequency of the external stirrer changed the flow within the SEN and in the mould. This has opened the way to assess the practical application of this technology on a larger scale casting.

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Shahid RIAZ (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Jean-François DOMGIN
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Gonzalo ALVAREZ DE TOLEDO
AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Seppo LOUHENKILPI
VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Karin ROCKENSCHAUB
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Ralph STRIEDINGER

RFSR-CT-2007-00013 NDTCASTING

Innovative non-contact, non-destructive sensors for automatic detection of surface and internal defects in hot continuously cast products

Info

Type of Project	Research	Duration (months)	42
Total Budget	1780199 €	Start Date	1/07/2007
EU Contribution	1068120 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25092:EN

Final Abstract

This was a cooperative project involving VDEh-Betriebsforschungsinstitut GmbH (BFI), Tata Steel RD & T Teesside Technology Centre (formerly Corus), ArcelorMittal R & D Technological Centre — Centro Desarollo Tecnológico and Scuola Superiore Sant'Anna (SSSA). The focus was to develop innovative non-contact, non-destructive sensors for automatic detection of surface and internal defects in hot continuously cast products. BFI has developed a technique, based on the ultrasound pulse-echo method. BFI's technique uses non-contact EMATs to both generate and receive ultrasonic signals. BFI has investigated the use of the developed phased-array system for surface and sub-surface defects. The inspection system can find defects on steel products, even if the surface is rough and contains oscillation marks and scale oxide. Tata Steel has carried out work to develop a prototype Laser-EMAT system. This has been installed on the pilot caster at Tata Steel. Extensive trials have been carried out on cold steel samples below the Curie temperature with good results but hot steel trials have been of limited success. The Laser-EMAT device has been equipped by SSSA with complete software for data visualisation and analysis and BFI has also developed the necessary tools for ultrasound data interpretation. ArcelorMittal worked in the extension of the application field of its CH system. As a result, defects such as very thin and zigzag cracks can now be reliably detected. A system to check the quality during and after scarfing was developed and integrated in the plant. A software tool for tracing slabs through the mill was developed, allowing downstream evaluation of the defects.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Dietmar OBERHOFF (Pr. Coord.)
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Fernando SANCHO MENDEZ
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
TATA STEEL UK LIMITED	UNITED KINGDOM	Stuart R. HIGSON

Selected Publications

BFI Activity Report 2009/2010. Page 33. Innovative non-contact, non-destructive sensors for automatic detection of surface and internal defects in hot continuously cast products

BFI Activity Report 2011/2012, Page 113-114. Innovative non-contact, non-destructive sensors for automatic detection of surface and internal defects in hot continuously cast products

RFSR-CT-2008-00005 MASTERBILLET

Mastering billet casting through integration of innovative mould sensoring and on line billet surface quality monitoring

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1565787 €	Start Date	1/07/2008
	EU Contribution	939472 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25862:EN			

Final Abstract Within the research, two sets of equipment were developed with innovative sensors to improve billet casting monitoring, one based on mould steel level and powder layer thickness measurements and one on thermal field at mould top. For the first, CSM together with CNR-IEIIT cared the molten steel level sensor based on electromagnetic resonance phenomena. Mould walls, steel surface and a properly designed metallic structure, form a closed electromagnetic cavity (electromagnetic waves sent by a launcher). A receiver measures resonance, and the frequency response is compared with launchers. Lubricating powder and nozzle permittivity/resistivity were measured. A mathematical model was developed to foresee sensor performance for a well-defined configuration. A mock-up was made and tested under different operating conditions. Each component was made, assembled and installed for testing on Ori Martin caster. Three campaigns were carried out and data logged. An easy-to-use data format was developed to define operating practice rules. For the second, Fibre-Optical-Sensors (=FOS) technique was applied. BFI developed hardware/software prototypes for monitoring steel level and mould thermal mapping. Installation positions at two continuous casters were determined with Gerdau-Sidenor and Ori Martin. Plant tests were successfully performed highlighting the effect on mould wall temperature of manual powder feeding and meniscus level oscillation. FOS handling was much easier than multi-thermocouple installations. Continuous online information on gap lubrication and rim formation was reachable for the first time in long product casting. The results achieved were encouraging. The work done is a sound basis for further improvement of the presented technique and technology on wider as-cast formats.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Franco MACCI (Pr. Coord.)
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Iñigo UNAMUNO
	O.R.I. MARTIN - ACCIAIERIA E FERRIERA DI BRESCIA SpA	ITALIA	Uggero DE MIRANDA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Torsten LAMP

RFSR-CT-2008-00006 AcTuM

Active tundish metallurgy

Info				
Type of Project	Research	Duration (months)	42
Total Budget	2108929 €	Start Date	1/07/2008
EU Contribution	1265358 €	End Date	31/12/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25875:EN

Final Abstract The Active Tundish Metallurgy project aimed at improved, better guaranteed steel cleanness by applying tailored tundish slag with high capacity to efficiently absorb macro- and micro-inclusions from different steels. Thermodynamic calculations showed that industrial partners' slags used in their standard practice were either solid or have only limited capability to dissolve inclusions from steel at tundich temperatures. Fundamental studies on factors influencing inclusion removal and inclusion cleanliness in tundish as well as thermodynamic calculations showed that more basic slag would lead to a more effective tundish slag having higher capacity to absorb inclusions compared to standard practice. Based on these results better slags and practices were proposed for industrial trials. Experimental tests with the new proposed tundish powders showed improvement in steel cleanness compared to standard practice. At OvakoImatra due to good results with the usability of the new powder the old tundish powder practice was abandoned, and a new basic powder was adopted into regular use. At Sidenor new tundish cover is used for heats with special cleanness requirements, however length would be limited to 3 heats due to the excessive erosion of isostatic refractory pieces and slag cover hardening. At DEW good results with the new suggested cover powders will be verified in large scale production trail and based on these results their implementation to standard tundish practice will be evaluated. At Tata Steel two new powders have been tested with good results, but no long-term proof of cleanness improvements has been found and hence economic benefits cannot be shown.

Partners	*Country*	*Scientific person in charge*
AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Marko KEKKONEN (Pr. Coord.)
DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Hans-Peter JUNG
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Mónica SERNA
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Tamara RODRÍGUEZ DURAN
OVAKO BAR OY AB	FINLAND	Kari VÄLIMAA
TATA STEEL UK LIMITED	UNITED KINGDOM	William LAW
TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Piotr R. SCHELLER

Selected Publications

L. Holappa, M. Kekkonen, S. Louhenkilpi, P. Scheller, R. Hagemann, C. Schröder. Active Tundish Slag. Steel Research International. Article first published online: 18 FEB 2013. DOI 10.1002/srin.201200209

R. Hagemann, L. Petzold, P.R. Scheller. Dissolution behaviour of oxides in synthetic and industrial slags. Challanges and Solutions in Mineral Industry. Beiträge zum 4. Freiberger - St. Petersburger Kolloquium junger Wissenschaftler (60.BHT), 2009, pp.251-257.

L. Holappa, M. Kekkonen, S. Louhenkilpi, P. Scheller, R. Hagemann and C. Schröder. Active Tundish Slag. Keynote-presentation at the MOLTEN12, Ninth International Conference on Molten Slags, Fluxes and Salts. Beijing, China May 27-30, 2012.

M. Kekkonen, D. Leuverink, L. Holappa. Active tundish metallurgy. SCANMET IV, 4th International Conference on Process Development in Iron and Steelmaking, June 10-13, 2012, Luleå, Sweden. Vol. 1, pp. 407-416.

RFSR-CT-2008-00007 DEFFREE

Integrated models for defect free casting

Info				
Type of Project	Research	Duration (months)	42
Total Budget	1874435 €	Start Date	1/07/2008
EU Contribution	1124661 €	End Date	31/12/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25874:EN

Final Abstract The objective of the project was to develop a new modelling-based optimisation and quality control system for continuous casting. The concept was based on studying critical parameters affecting steel quality and finding safety ranges for them to ensure good quality in continuous casting. Several fundamental and semi-empirical models were developed in the project. The critical features affecting steel quality were defined through mathematical modelling and industrial casting trials. Both good quality casts and casts with some defects were simulated to find features which have an effect on steel quality. Cracking indices, fluid flow parameters in the mould and segregation severity parameters are examples of critical parameters defined in the project. Safety ranges inside which the critical parameters had to stay during casting were determined in steady-state casting conditions. If a critical feature could not be adjusted on-line during casting, for example, surface velocity of liquid in the mould, this feature was expressed as a function of casting parameter, e.g. casting speed, which can be controlled and modified during casting. For optimising and controlling steel quality during casting the following online models were developed in the project: transient 2D centreline segregation model, dynamic 3D heat transfer model and inverse mould heat flux difference model. These models can be applied also to other casters for online simulation, once the caster has been set up and casting process data is available.

Partners		*Country*	*Scientific person in charge*
	AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Heli KYTÖNEN (Pr. Coord.)
	COGNE ACCIAI SPECIALI SpA	ITALIA	Elena BALDUCCI
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Michele DE SANTIS
	ISD DUNAFERR DUNAI VASMU Zrt.	HUNGARY	Robert JOZSA
	NLMK LA LOUVIERE S.A.	BELGIQUE	Guy MARTIN
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Sigurd RÖDL

RFSR-CT-2008-00008 LSSEMIQUAL

Reduction in surface cracking in as-cast low sulphur and calcium treated steels

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1417420 €	Start Date	1/07/2008
	EU Contribution	850452 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25885:EN			

Final Abstract This collaborative project was co-ordinated by Tata Steel UK involving RIVA AcciaioSpA, ArcelorProfil Luxembourg S.A., BFI and RWTH Aachen University. The objective of this proposal is to investigate why certain low and very low sulphur content and calcium treated steels are more prone to longitudinal face, transverse face and corner and network type cracking in the as-cast surface. Tata Steel, RIVA, ArcelorMittal and RWTH are involved in industrial and laboratory tests to investigate the effects of sulphur on hot ductility, surface metallography and defect investigations. The statistical analysis of different casting conditions and steel chemistries is also being considered to obtain a deeper understanding to the cracking phenomenon. BFI is involved in the mathematical modelling and physical simulations to investigate dynamic behaviour at the meniscus. Thermodynamic and Numerical modelling of inclusion formation and chemistry as well as thermomechanical and oscillation conditions of strand down the caster were evaluated by different partners. The statistical analysis of the defect data for as-cast and rolled product and the hot ductility testing near liquidus temperature down to below ?-ferrite temperature did not show an obvious relationship between sulphur level in steel and surface defects. It is, however, noted that casting parameters such as long delay in ladle furnace operation, high casting speed, high superheat etc. as well as level of C in the peritectic range and precipitation of AlN in steel have some influence on crack formation with low level of S in steel.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Shahid RIAZ (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicolas CAILLET
	RIVA ACCIAIO SPA	ITALIA	Mauro NEGRO
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Sigurd RÖDL

RFSR-CT-2009-00005 TRANSIENT

Effect of transients on quality of continuously cast product

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2277097 €	Start Date	1/07/2009
	EU Contribution	1366258 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26399:EN			

Final Abstract "This is a collaborative project between Tata Steel (formerly Corus), Gerdau- Sidenor (formerly Sidenor), VDEh-BFI, Tecnalia (formerly Labein), Riva, SSSA and ArcelorMittal Rurhort. The principal aim of this project has been to improve the understanding of the causes and effects of transient conditions on surface and internal quality during the continuous casting of a range of grades as slabs, blooms and billets. The transient conditions have included casting speed variations, flow rate changes, ladle changes, flying tundish changes, start and end of casts, and grade changes. This has allowed new practices to be developed to eliminate or reduce the quality problems associated with transient events and new rules for downgrading as-cast material following transient events. Four innovative caster monitoring systems were developed in this project and used to gather process and quality data. Several advanced models were developed using CFD, FEM and finite difference methods, as well as artificial neural networks; these were used to understand more deeply the transient phenomena investigated and to develop countermeasures where possible. Plant trials on five industrial casters covering a variety of formats and grades, led to the identification of nineteen transient phenomena. These were investigated using data analysis, metallurgy and modelling. Where possible, countermeasures were developed, trialled and refined, leading to improvements in operability and substantial improvements in product quality. A guide sheet has been created to assist plants in tackling similar phenomena, and to identify areas for more in-depth research. The exploitation and impact of the results have been discussed"

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Gerard STEPHENS (Pr. Coord.)
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Izaskun ALONSO
	ARCELORMITTAL RUHRORT GMBH	DEUTSCHLAND	Dieter KIRSCH
	RIVA ACCIAIO SPA	ITALIA	Marco PIANEZZOLA
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Juan PALACIOS
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Torsten LAMP

RFSR-CT-2009-00006 LUBRIMOULD

Identification of optimal mould lubrication conditions through an innovative hot and cold simulation method

Info

Type of Project	Research	Duration (months)	42
Total Budget	1905569 €	Start Date	1/07/2009
EU Contribution	1143341 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26173:EN

Final Abstract

The complex system consisting of a flux in a mould during steel continuous casting has been represented by a set of concepts and modelling tools. The concepts concern some aspect that are not usually considered for the choice of a mould flux such as the NBO/T index, whereas the modelling tools reproduce the occurring phenomena depending on process conditions and mould powder characteristics. This allows for identifying the proper casting parameters and flux properties to be used for optimising different steel casting. This set of tools has been verified on industrial fields. The results led to a decrease of the defects on casting products without affecting productivity. The proposed method has a general applicability as demonstrated by the wide range of steels and mould powders involved in the project

Partners

	Country	*Scientific person in charge*
COGNE ACCIAI SPECIALI SpA	ITALIA	Marco MASSAZZA (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Umberto MARTINI
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Iñigo UNAMUNO
SWEREA KIMAB AB	SVERIGE	Carl-Ake DÄCKER
TATA STEEL UK LIMITED	UNITED KINGDOM	Bridget STEWART
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Roger KOITZSCH

RFSR-CT-2010-00006 ICCRACK

Intercolumnar cracking and its relationship to chemistry and applied strain

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2257364 €	Start Date	1/07/2010
	EU Contribution	1354418 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract The objective aims at the reduction of intercolumnar (IC) cracking in continuously cast semis through a programme of work to establish the levels of strain (and strain rates) associated with intercolumnar cracks and to correlate these with the chemistry of the steel being cast and the casting process parameters. Both routine and novel plant engineering monitoring will be used to determine the levels of strain through the caster. A critical supportive aspect of the programme is a numerical simulation of strain at the solid-liquid interface. The work is planned for slab, bloom and billet in carbon and stainless steel grades.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Gerard STEPHENS (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Nicolas TRIOLET
	COGNE ACCIAI SPECIALI SpA	ITALIA	Marco MASSAZZA
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Andrea DE VITO
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Gonzalo ALVAREZ DE TOLEDO
	LUCCHINI S.p.A.	ITALIA	Marco BIANCHI
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Carsten TSCHEUSCHNER

RFSR-CT-2011-00005 DIRECT DEFECT TOOLBOX-DDT

Development of a toolbox for direct defect prediction and reduction through the characterisation of the meniscus-slag bed behaviour and initial shell solidification in CC

Info

Type of Project	Research	Duration (months)	42
Total Budget	2481352 €	Start Date	1/07/2011
EU Contribution	1488811 €	End Date	31/12/2014

State Running project

Provisional Abstract

This project seeks to directly determine the transient occurrence of defects and process problems during slab casting. Direct-defect prediction is possible through numerous plant-trials and liquid-metal experiments to characterise the heat-transfer and dynamic behaviour of the slag-bed and meniscus (particularly, at the meniscus corner where initial solidification occurs). Microstructural evolution including the formation of defects (cracks) will be observed through novel “in-situ experiments” and steel properties are addressed through high-temperature measurements. Expertise acquired will be used to develop numerical models that predict metalslag-argon flows, heat-transfer, mould-oscillation, solidification, stress-strain, shell microstructural evolution and the explicit formation of defects. This will provide the steelmakers with a new set of tools to improve the casting practice.

Partners

	Country	*Scientific person in charge*
SWEREA MEFOS AB	SVERIGE	Thomas JONSSON (Pr. Coord.)
SWEREA KIMAB AB	SVERIGE	Carl-Ake DÄCKER
SSAB TUNNPLÅT AB	SVERIGE	Patrik WIKSTRÖM
TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	D. VAN DER PLAS
THE UNIVERSITY OF MANCHESTER	UNITED KINGDOM	Peter LEE

RFSR-CT-2011-00006 IPTINGOT

Innovative process technology for ingot casting by application of simulation and measuring techniques

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2049802 €	Start Date	1/07/2011
	EU Contribution	1229880 €	End Date	31/12/2014
State	Running project			

Provisional Abstract Systematic research for ingot casting has been strongly neglected in Europe during the last decade irrespective the fact that about 8 % of the world steel tonnage are still produced the ingot casting route. Moreover special steel products and their necessary steel grades, as for example tool steel, can only be produced by ingot casting in larger volumes. New technologies for CO2 reduction and resource savings demands the development of new special steel products where especially customer demands on clean steel quality of the ingot production is very high and further increasing. The proposal is addressing this by a through process optimisation with new simulation techniques, measuring and process technology concerning mould filling, solidification and application of mould powders.

		Country	*Scientific person in charge*
Partners	**SWEREA KIMAB AB**	SVERIGE	Carl-Ake DÄCKER (Pr. Coord.)
	BUDERUS EDELSTAHL GMBH	DEUTSCHLAND	Martin SEEMANN
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
	PROSIMET SPA	ITALIA	Marco ALLONI
	UDDEHOLM TOOLING AB	SVERIGE	Ewa SJÖQVIST PERSSON
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Roger KOITZSCH

RFSR-CT-2011-00008 KINPCC

Kinetics of precipitation during continuous casting of plate steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	928289 €	Start Date	1/07/2011
	EU Contribution	556973 €	End Date	30/06/2014
State	Running project			

Provisional Abstract The objective of the proposal is to establish methods for the prediction of precipitation during continuous casting of microalloyed plate steels. As surface cracks are induced by precipitate particles, this is a precondition for understanding the causes of cracking and thus for the minimization of such defects. A quantitative description of the effect of strains and stresses on precipitation is needed and will be developed. Laboratory investigations will be performed and thier results translated into mathematical approaches using the MatCalc tool. This will be complementedby industrial studies on continuously cast slab material of representative microalloyed plate steels.

		Country	*Scientific person in charge*
Partners	**AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG**	DEUTSCHLAND	Helmut LACHMUND (Pr. Coord.)
	POLITECNICO DI MILANO	ITALIA	Carlo MAPELLI
	TECHNISCHE UNIVERSITAET WIEN	OESTERREICH	Ernst KOZESCHNIK
	VOESTALPINE STAHL GMBH	OESTERREICH	Guangmin XIA

Selected Publications T. Wojcik et al., Shell-wise growth of (Nb,Ti)(C,N) precipitates during cyclic cooling of micro-alloyed steel, EUROMAT2013

Software MatCalc A thermodynamic simulation for precipitation kinetics in steel. Development started in 1993 and the software was enhanced to adress the specific problems in the project. http://matcalc.tuwien.ac.at/

RFSP-CT-2012-00007 FOMTM

Application of fibre optical thermal monitoring at CC-billet mould for improved product quality

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	855824 €	Start Date	1/07/2012
	EU Contribution	427912 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

Aim is to develop and operate a better control of initial solidification at meniscus level to enhance surface quality of as-cast products. An innovative sensor system based on fibre optical mould temperature sensors will be used which was initially developed in the previous RFCS research project MasterBillet. This system will be further developed to identify irregular casting conditions with particular reference to mould powder feeding, slag rim formation and irregularities in initial solidification. The developed system will be put into practice at a billet mould and corrective actions to assurance a better quality of as cast product will be validated.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Torsten LAMP (Pr. Coord.)
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Iñigo UNAMUNO

Patents DE 102009060548.7

RFSR-CT-2012-00008 PMAP

Influence of composition and continuous casting parameters on the precipitation of microalloyed particles of B microalloyed steel grades and Mn alloyed steel grades

Info

Type of Project	Research	Duration (months)	42
Total Budget	1220551 €	Start Date	1/07/2012
EU Contribution	732331 €	End Date	31/12/2015

State Running project

Provisional Abstract

The overall objective of the PMAP project is to reduce the rejection and the requirements for surface repair due to cracking defects of the continuously cast semis by optimization of microalloying steel composition and related casting parameters. This objective will be accomplished by the extension of the knowledge on precipitation of B, Nb, V (C,N) in the CC process and its effects on as-cast surface and internal crack sensitivity. It will focus on interaction among those precipitates with MnS inclusions during solidification and cooling and on their influence on austenite decomposition temperature and kinetics for high Mn steels grades, including microalloyed TRIP steel chemistries. Combined influence of those parameters with thermo-mechanical billet history will be considered studying the strain induced precipitation during bending and straightening CC operations. The Boron segregation during solidification and the B effects on austenite/ferrite transformation low ductility zone will be studied in combination with precipitation of MnS and other microalloying elements, where Mn content varies from 0.6 to 30 wt.-%. The approach to the project is threefold: industrial tests, laboratory and pilot plant experimental work, and numerical modelling. Mathematical/thermodynamic modelling is to be extended and applied on prediction and improvement of experimental and industrial routes. The dissolution technique together with electron microscopy will be used to evaluate precipitation on industrial samples and to simulate the industrial process in the lab.

Partners

	Country	*Scientific person in charge*
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Gonzalo ALVAREZ DE TOLEDO (Pr. Coord.)
SWEREA KIMAB AB	SVERIGE	Jacek KOMENDA
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter G. SENK
TATA STEEL UK LIMITED	UNITED KINGDOM	Shahid RIAZ

RFSR-CT-2012-00011 INNOSOLID

Investigation of innovative methods for solidification control of liquid steel in the mould

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1293873 €	Start Date	1/07/2012
	EU Contribution	776324 €	End Date	31/12/2015
State	Running project			

Provisional Abstract The objective aims at controlling the heat transfer in the mould in order to improve product quality and process stability with special regard to the meniscus and the mould corners. The work will include the modification of the primary cooling as well as the modification of the cooper surface geometry. Based on pilot plant trials, physical and numerical modelling operational measures will be derived and tested in operational trials. An additional outcome of the numerical modelling will be an online-model for the primary cooling control.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Carsten TSCHEUSCHNER (Pr. Coord.)
	SALZGITTER FLACHSTAHL GmbH	DEUTSCHLAND	Peter MÜLLER
	TATA STEEL UK LIMITED	UNITED KINGDOM	Shahid RIAZ
	VOESTALPINE STAHL GMBH	OESTERREICH	Guangmin XIA

RFSP-CT-2013-00004 NDTSLAB

Innovative non-contact, non-destructive prototype system for automatic detection of surface and subsurface defects in slabs

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	1318580 €	Start Date	1/07/2013
	EU Contribution	659289 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

The quality of slabs is the basis of good quality for all other steel products in the downstream production process. The automatic on-line detection and logging of surface and subsurface defects e.g. for the controlling and optimization of the scarfing process and for use during continuous casting is an important improvement for steel production. A prototype test system based on EMAT (Electro Magnetic Acoustic Transducer) and Phased-Array-technology will be developed to detect these defects. Nevertheless there is no commercial systems available. It is highly desirable that sensors and instruments used in this environment are non-contact, capable to work at high temperatures and to function reliably for an extended period of time in a harsh industrial environment. To date, the EMAT technique is designed for steel with a surface temperature below 760°C - the Curie point. This inspection system uses surface waves (Rayleigh waves). The RFCS project NDTCASTING of BFI, TATA and ArcelorMittal have shown the possibility of the EMAT system on hot surfaces with oscillation marks and scale. The carried project showed that sensitive flaw detection under these difficult conditions is possible - defects with a length less than 10% of the chosen wavelength (λ = 14 mm) can be repeatedly detected. The project deliverables will lead to the following industrial benefits: improved productivity, improved product quality, saving of energy, material, work time and reduced production costs. The final goal of the project is a conceptual design and specification of an automatic inspection system useable under industrial conditions. The on-line inspection of cast products is of very high interest to the steel industry and also for the project industrial partners Salzgitter AG and VOEST Alpine. The developed systems could also be made commercially available. If the project will be successful the integration of this technology in many European steel-plants will be probable.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Dietmar OBERHOFF (Pr. Coord.)
	SALZGITTER FLACHSTAHL GmbH	DEUTSCHLAND	Peter MÜLLER
	TATA STEEL RESEARCH & TECHNOLOGY - TEESSIDE TECHNOLOGY CENTRE	UNITED KINGDOM	Oliver MILLING
	VOESTALPINE STAHL GMBH	OESTERREICH	Rudolf CIHAL

RFSR-CT-2013-00005 GRAMAT

Research on innovative corrosion resistant gradient tubes for biomass power generation installations

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2341852 €	Start Date	1/07/2013
	EU Contribution	1405111 €	End Date	30/06/2017
State	Running project			

Provisional Abstract SSharp increase of energy production based on renewable resources (co)firing is forcing boiler makers to apply expensive high-alloyed materials/claddings/barriers resistant to aggressive corrosion atmospheres into places where applied pressure and temperature would enable use of low-alloyed materials. The projects main aim is to acquire knowledge necessary to develop new cost-effective manufacturing technology of boiler tubes made from semiproducts with through thickness gradient chemical composition, tailored to carry both creep loading (low alloyed body) and fireside corrosion (high alloyed shell). Gradient tubes will be rolled in existing facilities from semiproduct manufactured by unique casting technique To accomplish this, basic knowledge about gradient material behaviour during casting (metallurgy), rolling (forming) and final properties (operation) has to be investigated and collected. Project is inderdisciplinar, combining activities which fall under technical group TG3 (focused on casting) and TG4 (focused on rolling). As stated in particular annexes, we consider the research on manufacturing of gradient semiproduct (casting) the key issue of present project. For this reason we allocated it under TG3.

		Country	*Scientific person in charge*
Partners	**VYSKUMNY USTAV ZVARACSKY - PRIEMYSELNY INSITUT SR**	SLOVAKIA	Anna HAMBALKOVA (Pr. Coord.)
	BENTELER TUBE MANAGEMENT GMBH	DEUTSCHLAND	Thomas VIETORIS
	COMTES FHT a.s.	CZECH REPUBLIC	Filip TIKAL
	FOSTER WHEELER ENERGIA OY	FINLAND	Arto HOTTA
	ZELEZIARNE PODBREZOVA AS	SLOVAKIA	Martin DOMOVEC
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Eva HÄKKÄ-RÖNNHOLM
	ZDAS a.s.	CZECH REPUBLIC	Ludvík MARTINEK

RFSR-CT-2014-00009 TICLOGG

Investigation of the effect of Ti on clogging of feeding systems and its prevention for continuous slab casting

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1675591 €	Start Date	1/07/2014
	EU Contribution	1005353 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

Ti-stabilised steels ULC steels are important due to their positive properties, but they are also problematic with regard to clogging occurrence. The mechanisms of inclusion formation, behaviour and deposition are not yet understood in detail although investigations were performed on European and International level. Against this background the main objectives of this proposal are achieving a better understanding of the mechanisms contributing to clogging as well as the exploitation of this enhanced knowledge focused on process and constructive measures leading to reduction/ prevention of clogging. Different methods will be applied: laboratory and plant trials, numerical computations and clogging simulator trials. The derived interaction between the different work packages is a promising concept for exchange of knowledge and results, e.g. the laboratory trials will provide information concerning clogging occurrence and clogging rate under realistic and reproducible conditions as well as wetting behaviour. This information will be an outstanding basis for the adjustment and verification of the mathematical/numerical models which will be applied on microscopic (focusing on the SEN) as well as macroscopic (including tundish outlet, feeding system, SEN and mould) scale. The numerical work is aiming at an improved and more realistic approach for investigation of the clogging phenomenon. As outcome of the proposed work an improved understanding of the mechanisms contributing to clogging phenomenon is expected. Adjusted concepts for operational praxis as well as constructive measures aiming at a further improvement of product quality and yield will be elaborated leading to concrete recommendations/guidelines for operational practices. Therefore the outcome of this research should provide a step beyond the state-of-the-art. It is expected to lead to production of steel with improved quality and an increased yield resulting from a lower risk of SEN clogging.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Carsten TSCHEUSCHNER (Pr. Coord.)
	COMDICAST AB	SVERIGE	Sven EKEROT
	MONTANUNIVERSITÄT LEOBEN	OESTERREICH	Menghuai WU
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Technical Group Steel 4

Hot and cold rolling processes

The scope of TGS4 includes:

- Reheating furnaces
- Hot and cold rolling
- Thermal treatments
- Standardisation of testing and evaluation methods
- Maintenance and reliability of production lines
- Reduction of emissions, energy consumption and improvement of the environmental impact
- Instrumentation, modelling and control of processes

RFSR-CT-2003-00002 PACROLP

The prediction and avoidance of cracking in long product hot rolling

Info	Type of Project	Research	Duration (months)	46
	Total Budget	1835773 €	Start Date	1/09/2003
	EU Contribution	1101464 €	End Date	30/06/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23890:EN			

Final Abstract There is a need for EU steel producers to gain a scientific understanding across the board of the damage mechanisms inducing ductility break-ups at both the surface and sub-surface of deforming stock during hot rolling, for a range of free machining (FCS) and heat treatable (HT) steels. These steels, especially as-cast FCS steels, have inherent low ductility, which is conducive to corner cracking. The main objective of this multi-partner project was to develop a physical understanding of the causes and mechanisms of crack initiation and growth at high temperature and the relatively high strain rate during rolling of low ductility steel long products. This objective was achieved using a combination of innovative laboratory mechanical and pilot rolling tests, material constitutive modelling, microstructural characterisation, and online defect assessment and detection methods. Key beneficial or detrimental microstructural and geometrical parameters have been identified covering 'hook type' oscillation marks, cortical zone, mean local area fraction of MnS, Mn/S ratio, cohesive strength of inclusion/matrix, matrix hardening rate, initial solidification structure and surface state (oxidation/embrittlement). The project outcome concluded on the relevance of large and/or closely spaced MnS inclusions at early stages of void nucleation while small particles (including clustering) will mainly control the fracture event. Likewise, the influence of process parameters, such as reheating time, temperature-strain rate and tensile triaxiality-strain relationships, amongst other a-dimensional parameters, have been identified and accounted for in a range of material models. The project concludes with practical rolling recommendations and innovative concepts for future work.

Partners	*Country*	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Didier FARRUGIA (Pr. Coord.)
ASCOMETAL S.A.S.	FRANCE	Joëlle DEMURGER
ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	José Maria RODRIGUEZ IBABE
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Juan Hector BIANCHI
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
SWEREA MEFOS AB	SVERIGE	Jan-Olov PERÄ
OVAKO BAR OY AB	FINLAND	Martti VEISTARO

Selected Publications

Farrugia D.C.J, “Investigation into Mechanisms of High Temperature Damage in Free cutting Steels, SMEA Conference, June 2008

Foster A. D., Lin J.*, Farrugia D.C.J, Dean T.A. , “An Investigation into Damage Nucleation and Growth for a Free-Cutting Steel at Hot Rolling Conditions”, J. of Strain Analysis. Vol 42, 2007, pp. 227-235. ISSN 009-3247. DOI: 10.1243/03093247JSA230.

Liu Y., Foster A. D., Lin J., Farrugia D., T. A. Dean. “On micro-damage in hot metal working Part 1: Experimental investigation”, J. of Engineering Transactions. 54(4), 2006, pp. 271-287, ISSN 0867-888X.

J. Lin, A. D. Foster, Y. Liu, D.C.J. Farrugia and T. A. Dean, “On micro-damage in hot metal working Part 2: Constitutive modelling”, J. of Engineering Transactions. 55(1), 2007, pp. 1-18. ISSN: 0867-888X

Foster A. D., Lin J., Farrugia D.C.J, Dean T.A, “Modelling material flow characteristics over multiple recrystallisation cycles, Proceedings of the 10th ESAFORM conference on Material Forming, Zaragoza (Spain), 2007, pp. 59-63, ISBN: 978-0-7354-0414-4

RFSR-CT-2003-00011

Improvement of strip guiding and related effects in cold rolling of high strength steel grades

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1088545 €	Start Date	1/09/2003
	EU Contribution	653127 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23606:EN			

Final Abstract The work of BFI and EKO has focused on the investigation of flatness degrading effects, i.e. irregular wear and unwanted roll movement during rolling at the first stand of EKO's tandem cold mill. Different models have been developed by BFI to describe the behaviour of rolling stand 1. A universal tool has been created that can be used not only for static contact analysis but also for dynamic modal analysis for all possible rolling parameters. A first measurement campaign has been carried out by EKO and has concluded that the measured roll-position changes lie in an acceptable range, and no unwanted roll movements exist at the neck area. Subsequently two vibration measurement campaigns with a sum-rate of about 100 kHz revealed an 'unusual' behaviour in form of a measured splitting of the acceleration signals, which may be an indication of self-excited vibrations and 'slipping effects' between the work roll and the backup roll. Different root causes of this phenomenon have been pointed out, and measures recommended to reduce the examined wear effect. Arcelor Research and EKO focused on strip guiding in stand 1. The first step was a benchmark within the Arcelor cold rolling mill to see how strip off-centre (SOC) can be characterised. The next step was modelling. Three approaches were developed: turning moment-based, pseudo static-based and physical equations resolution-based. Pilot mill and industrial trials were performed to evaluate sensitivities and validate models. Finally, some recommendations to decrease strip off-centre were suggested. — Increasing strip tension reduces SOC generation. — Slowing down the strip reduces SOC generation. — Limiting the first stand reduction does not have any effect on SOC (when the EMG controller is on). — Use of the tension differential measurement can also be interesting as it is a good image of SOC. After calibration, this SOC estimation could be used by the operator to detect SOC variation. Furthermore, this rough estimation has the advantage of being almost zero cost. It could also be used for a stand tilting controller, for example in a slow feedback PI as shown by simulations.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Patrick SZCZEPANSKI (Pr. Coord.)
	ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Hagen KOTHE
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Mohieddine JELALI

RFSR-CT-2003-00012 TESTRA

Temperature and straigthness at straigthening of sections and rails

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1111618 €	Start Date	1/09/2003
	EU Contribution	666970 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25088:EN			

Final Abstract Straightening at higher temperatures is of great industrial interest due to the bottle neck function of the cooling bed. By solving the problems encountered during hot straightening, the production performance can be increased significantly. The curvature change during cooling after straightening is the main issue that has to be faced.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Frank GORGELS (Pr. Coord.)
	PEINER TRÄGER GmbH	DEUTSCHLAND	Arved HAASLER
	UNIVERSIDAD DE LA RIOJA	ESPAÑA	Joaquín ORDIERES MERE
	VOESTALPINE SCHIENEN GmbH	OESTERREICH	Birgit EISENKOLB

RFSR-CT-2003-00039 SHAPEHPM

Reduction of shape defects & yield losses by advanced online-adaptation of control systems & new operating strategies in heavy plate rolling mills

Info

Type of Project	Research	Duration (months)	48
Total Budget	1428517 €	Start Date	1/09/2003
EU Contribution	857110 €	End Date	31/08/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25089:EN

Final Abstract

The aim of the project was the reduction of shape defects and yield losses in heavy plate rolling by providing new operating strategies, ski-end control and optimised set-up adaptation for ski and control for camber/thickness profile. This approach encompasses the application of the new topometrical measurement system TopPlan® to collect data on plan view shape and ski, advanced FE modelling and rules to predict shape defects and the development and use of advanced online models for ski control. To compensate for the deficits of conventional models and control methods, iterative learning control was developed for a pass-to-pass set-up adaptation of ski control and of camber control that takes into account the cross-thickness profile. The concept has been optimised by runs of a real time HPM simulator built up by online models to predict shape and ski. The developments have been based on the following. • Comprehensive data acquisition campaigns under typical operational conditions on a plate mill inclusive of online flatness measurements. • Pilot mill trials to investigate the influence of the shape factor on the ski-end formation applying a transportable ski-measurement system based on image processing. • Advanced finite element (FE) models of plate rolling roughing stand. • A simplified empirical model describing incremental plan view shape (PVS) evolution on a pass-by-pass basis and application at plate mills. • A ski-form model based on gram decomposition and its application for ski control.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Ulrich MÜLLER (Pr. Coord.)
SWEREA MEFOS AB	SVERIGE	Annika NILSSON
RAUTARUUKKI OYJ	FINLAND	Agne BOGDANOFF
TATA STEEL UK LIMITED	UNITED KINGDOM	Andrew RICHARDSON

Selected Publications Activity Report 2007 / 2008, VDEh-Betriebsforschungsinstitut GmbH

RFSR-CT-2004-00012 IMPROSOUND

Improvement of central soundness in long products from a through process control of solidification and reheating and rolling parameters

Info

Type of Project	Research	Duration (months)	36
Total Budget	1279958 €	Start Date	1/07/2004
EU Contribution	767975 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23588:EN

Final Abstract

This project aims at improving central soundness in rolled long products and thus at increasing significantly the current range of rolled sizes in one heat. Solidification and rolling have been treated as an integrated process. A large number of process parameters have been considered in order to assess their impact on pore closure. The work carried out using coupled experimental and industrial tests as well as numerical simulation has permitted the ranking of those effects and consideration of all of them from a through process point of view, establishing which one (or group) is the most efficient and why. Concerning the solidification process, lower filling velocity and steeper mould taper favour central porosity reduction during ingot casting. For continuous casting, S-EMS results in an even distribution of small pores in the centre but larger total pore volume. The combination of S-EMS and F-EMS gives small pores concentrated in the centre. Additional application of mechanical soft reduction has been proved to reduce central porosity in terms of size and number of pores. The results of thermal soft reduction are conditioned to the hard cooling segment position. The required elongation for pore closure during rolling depends on pore distribution of the stock. An even distribution of small pores in the centre region is preferable to large pores in the metallurgical centre with smaller total fraction of pores. Rolling with larger roll diameter and smaller roll gap, minimising turns between passes, applying a larger reduction in the first passes and reheating and transport strategies to provoke a specific transversal thermal gradient have been shown to promote central soundness.

Partners

	Country	*Scientific person in charge*
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ (Pr. Coord.)
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CENTRO SVILUPPO MATERIALI SPA	ITALIA	Michele DE SANTIS
SWEREA MEFOS AB	SVERIGE	Jan-Olov PERÄ
AB SANDVIK MATERIALS TECHNOLOGY	SVERIGE	Bo ROGBERG

Selected Publications

Deliverable 1. Strategies to integrate the solidification and reheating-rolling processes under a methodology of through process control

Deliverable 2. Methodologies for pore assessment

"Deliverable 3. A numerical model involving thermo-fluid-dynamics, magneto-hydro-dynamics and solute distribution in order to give the proper contribution in the casting section to an improvement of the central soundness in the rolled material

RFSR-CT-2004-00013 HSM LUBRICATION

New lubrication technology for the hot strip mill

Info

Type of Project	Research	Duration (months)	42
Total Budget	1339873 €	Start Date	1/07/2004
EU Contribution	803924 €	End Date	31/12/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24192:EN

Final Abstract The use of lubrication during hot rolling presents a lot of advantages. One of the main advantages is the considerably high reduction of rolling force, which leads besides the energy saving (up to 15%) to a reduction of roll wear (longer rolling campaigns and roll lifetime). Product surface quality is greatly improved by a decrease of shearing forces in the roll gap and it can also be used for the reduction of the final thickness of hot strips of different steel grades. In recent years, most hot mills have been equipped with lubrication systems, all based on water-lubricant unstable emulsion application. The drawbacks of actual emulsion systems, mainly uncontrollable oil-water mixing, pipe stops due to water in oil emulsion, influence of the specific flow rate, and distortion by skin cooling, instigated the search for a new method of lubrication. A new lubrication technology adapted by CRM based on the atomising of pure (natural) oil in very low quantities (0.4 g/m2) and good homogeneity has been tested in stand F2 of the hot strip mill in ArcelorMittal Dunkerque. Its implementation is the result of close cooperation between CRM, TKS, ArcelorMittal R&D (ARSA) and ArcelorMittal Dunkerque. The main benefit of pure (natural) oil atomising is increased efficiency: 40 to 50 % higher efficiency compared to emulsions (with additives). With this technology it is possible to use low polluting (natural) oils and to regulate directly the oil flow rate on top and/or bottom roll, without negative effect when skin cooling is switched on.

Partners

	Country	*Scientific person in charge*
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Bart VERVAET (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Guy HAURET
SOLLAC ATLANTIQUE SA	FRANCE	Denis AVEDIAN
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Roland WUNDERLICH

Patents Spray Lubrication Unit And Method For Rolling Cylinders (date of deposit: 07/10/2008)

Selected Publications B. Vervaet, D. Avedian and C. Pesci “New lubrication technology for the hot strip mill” Revue de Métallurie 107, 237-244 (2010) DOI: 10.1051/metal/2010025, www.revue-metallurgie.org

RFSR-CT-2004-00014 SSSSS

Optimised through process shape of stainless steel wide strip

Info	Type of Project	Research	Duration (months)	54
	Total Budget	1744196 €	Start Date	1/07/2004
	EU Contribution	1046517 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24249:EN			

Final Abstract The project aim is to reduce the principal sources of poor shape within the stainless steel strip production route (Sendzimir Mill, vertical bright annealer (VBA), tension leveller), taking into account interactions between various hot/cold mill processes. Strip condition is monitored through the production route Sendzimir Mill, coiling+decoiling, vertical bright annealer, to quantify shape changes occurring, influences of process variables/engineering condition of plant and interactions between successive processes. Therefore the further development of the flatness measurement system TopPlanReflect for high reflective strip was necessary. TopPlanReflect was tested at a vertical bright annealing line. Unfortunately the vertical bright annealer had long down times and created hence only a small data basis. Within the limited data basis a strong change in flatness in the regarded process route was observed. Further investigations with a bigger amount of data are necessary to validate the determined models or to deliver statistical more reliably flatness prediction models for the whole process route. The shape modelling during rolling and tension levelling establishes sensitivities/key engineering priorities. To improve flatness a new shape control system is developed and implemented online at a Sendzimir mill of TKS-NR. The integrated thickness and flatness control system considers the cross coupling between thickness and flatness. As a result all actuators can be used with maximal speed without disturbing thickness of flatness and an improved flatness is the benefit.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Jan POLZER (Pr. Coord.)
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	LUCOIL STEEL AB	SVERIGE	Carl Erik GRIP
	SWEREA MEFOS AB	SVERIGE	Olof WIKLUND
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	TATA STEEL UK LIMITED	UNITED KINGDOM	Andrew RICHARDSON
	THYSSENKRUPP NIROSTA GMBH	DEUTSCHLAND	Helge VOLLMANN

RFSR-CT-2004-00015 EWRCOOL

Effective roll cooling

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1906889 €	Start Date	1/07/2004
	EU Contribution	1144134 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23866:EN			

Final Abstract The EWRCOOL project has improved knowledge of roll cooling systems used on long product roiling mills and transferred knowledge from flat product rolling mills. The design of roll cooling for long product mills has been progressed by improved understanding of the performance of spray nozzles and the application of new technologies. Finite element models have been developed that represent the geometry of profiled rolls better than simplified models. FE models have enabled comparisons between different cooling configurations to be undertaken and modifications to be tested on production mills with confidence that the cooling provided will increase work roll life. The capability of modelling stress distributions induced into work rolls by the heating and cooling cycle imposed by production, leading to the modelling of crack initiation and propagation has been demonstrated. This capability has been used to provide comparisons between different roll cooling designs, thereby designing better systems for long product mills. Investigations of the effects of using mill water containing typical pollutants, have demonstrated that oil-based lubricants will reduce the heat transfer coefficient arising from spray cooling systems in relation to the concentration of the pollutant. Chemical salts were found to have little direct influence upon the HTC achieved but would be expected to affect the performance over longer durations, owing to deposition of the mineral content onto the nozzles. Roll wear patterns have been measured but were not necessarily consistent with the wear expected. Guiding of the product into the roll bite was noted to cause asymmetric roll wear.

		Country	*Scientific person in charge*
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RFSR-CT-2004-00016 GLOBALSHAPECONTROL

Flatness set-up in hot strip mills tailored to the demands of next step processes and final customers

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1578443 €	Start Date	1/07/2004
	EU Contribution	947065 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25119:EN			

Final Abstract

The claim to produce flat products in hot strip rolling lines strictly tailored to the demands of next step processes and final customers has been tackled for a long time only in terms of enhanced local flatness of the strip in the line. Thus the core aim of the project is the development of a coordinated flatness set-up system, based on an 'Adaptive Flatness Predictor', which optimises all actuator set points relevant for the evolution of flatness downstream from the exit of the finishing train to the cold coil and takes into account all process and actuator constraints inclusive of the special conditions of edge masking. The basis for the development of the coordinated flatness set-up system was the performance of rolling trials at a pilot line, field investigations at HSMs and structured data analysis to identify the parameters of a hybrid model of flatness evolution downstream the complete line.

Partners		*Country*	*Scientific person in charge*
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Ulrich MÜLLER (Pr. Coord.)
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	SWEREA MEFOS AB	SVERIGE	Olof WIKLUND
	SSAB EMEA AB	SVERIGE	Bengt BROLUND
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA
	UNIVERSIDAD DE OVIEDO	ESPAÑA	Daniel F. GARCIA

Selected Publications

Activity Report 2003 / 2004, VDEh-Betriebsforschungsinstitut GmbH

RFSR-CT-2004-00017 SOFTDETECT

Intelligent soft-sensor technology and automatic model-based diagnosis for improved quality, control and maintenance of mill production lines

Info

Type of Project	Research	Duration (months)	36
Total Budget	1862138 €	Start Date	1/07/2004
EU Contribution	1117283 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23893:EN

Final Abstract

The main goal of this project is the development and application of software sensors for the estimation of hard-to-measure quality and process parameters (e.g. thermal state, mill state and process state) during processing. This builds up the basis for automatic fault-detection and diagnosis of causes. The considered processing stages are hot rolling, tandem cold rolling and temper rolling. Hot strip mill: A virtual thermal sensor system was developed, based on the intelligent elaboration of data coming from the various thermal measurement devices along the line. The system is able to predict instabilities in rolling operation and to detect quality inconsistencies. The virtual global thermal indicator has been implemented to give support to operators by providing intelligent information about the whole thermal characteristics of the slab/bar/strip and the concerned rolling stability. Tandem mill: The developed system extracts new knowledge from the facility, taking advantage of the great automation that is implemented nowadays. Two main topics were treated during the project, both referring to mill quality: rolls evolution and coil quality online assess. The system is able to perform online visual data mining. Temper mill: Several modules for automatic and systematic quality defect detection have been developed and tested: an automatic diagnosis system supervising 39 defect frequencies, automatic identification/differentiation of incoming and locally produced periodic thickness faults, a chatter mark compensation system, a soft-sensor for coil tumble detection, extended methods for control performance monitoring and the 'dynamic fingerprint' method.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Jan POLZER (Pr. Coord.)
ACERALIA CORPORACION SIDERURGICA S.A.	ESPAÑA	José Luis RENDUELES VIGIL
ACCIAI SPECIALI TERNI SpA	ITALIA	Luca ONOFRI
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Fabio SANFILIPPO
IMS Messsysteme GmbH	DEUTSCHLAND	Jörg BUSCH
THYSSENKRUPP RASSELSTEIN GMBH	DEUTSCHLAND	Paul MICHELS
UNIVERSIDAD DE OVIEDO	ESPAÑA	Alberto DIEZ GONZALEZ

RFSR-CT-2004-00018 INCOSTEEL

In-line quality control of hot wire steel. Towards innovative contactless solutions and data fusion

Info

Type of Project	Research	Duration (months)	54
Total Budget	2453177 €	Start Date	1/07/2004
EU Contribution	1471906 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24184:EN

Project web page http://projects.tecnatom.es/incosteel/index.htm

Final Abstract

The main goal of the Incosteel project has been to carry out research on new in-line hot steel wire inspection techniques. Surface defects must be detected in extreme operating conditions: up to 120 m/s rolling speed and temperatures from 850 °C to 1 200 °C (non-ferromagnetic behaviour above Curie temperature). Non-contact electromagnetic techniques have therefore been proposed and developed in the project. Conventional eddy current (EC) techniques show significant weaknesses to detect and characterise longitudinal and large surface defects in general. This is why EC arrays and electromagnetic acoustic transducers (EMATs), as well as a combination of techniques (data fusion) have been proposed. The EMAT technique was finally rejected because it was considered unfeasible for longitudinal defect detection, after performing several feasibility tests with experienced research centres, such as the SouthWest Research Institute (SwRI), CESI and Partykel Analytic (from RITEC). As a result, the project focussed on EC techniques in the end. The current encircling coil (currently in use in most rolling mills) was improved, and the concept of an EC array sensor was developed. The University of Kassel and Tecnatom proposed several unitary elements (surface coils) and related array sensors. The University of Kassel modelled most of them to check feasibility and to help improve sensors and techniques. The technology developed (EC sensors, EC electronics and excitation modes) was validated first at laboratory level by Tecnatom and the University of Kassel (cold tests). After that, hot tests started in the continuous pilot rolling mill at TU-BA-Freiberg and finally at Sidenor (industrial conditions). Successful results were achieved with the inspection prototypes developed.

Partners

	Country	*Scientific person in charge*
TECNATOM S.A.	ESPAÑA	Carmen PEREZ (Pr. Coord.)
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA
UNIVERSITÄT KASSEL	DEUTSCHLAND	Rene MARKLEIN

Selected Publications

Ricken, W., Hartmann, K., Becker, W-J., Pérez, C., Gonzalo, L. (University of Kassel, Germany, Tecnatom, Spain). “Improved eddy current sensor for hot wire inspection“. 9th ECNDT, Berlin,2006.

Rahman, M.-U., and Marklein, R. Advanced Techniques for Modelling and Detection of Cracks in Hot Wire Steel, presented at the International Magnetics Conference (INTERMAG), 2008, Madrid.

Ribes, B., Rego, J.M., Hernández, J., Gonzalo, L, Guerra, F.J. (Tecnatom, Spain). ET Array Probe Applications with TEDDY+ System. 6th International Conference on NDE in Relation to Structural Integrity for Nuclear and Pressurized Components, Budapest, Hungary, October 2007.

Mehbub-Ur Rahman. Optimization of In-line Defect Detection by Eddy Current Techniques. Kassel University Press

Ricken, W., Hartmann, K., Becker, W-J., Pérez, C., Gonzalo, L. (University of Kassel, Germany, Tecnatom, Spain). Optimised Eddy Current Sensor. Improved Defect Detection on Hot Wire Steel. Published in Technisches Messen, Vol. 75, Issue 9, September-2009, Pags. 501-507, Oldenbourg Wissenschaftsverlag publication.

RFSR-CT-2004-00019 OPTILUB

Optimisation of rolling lubricants for improved operation of cold rolling mills

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1918154 €	Start Date	1/07/2004
	EU Contribution	1150893 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24031:EN			

Final Abstract The aim of the project is to propose methods for improving the operation of cold rolling mills by optimising the use of cold rolling lubricants. This will be achieved by: - developing fast analytical methods for monitoring emulsion properties, - developing function tests to evaluate the technological performance of rolling oils, - elucidating the mechanisms of formation and transformation of surface residues after different processing steps, and - developing methods for the recovery of oils from used rolling emulsions. A literature survey has been carried out to find promising methods for the fast chemical analysis of rolling oil emulsions. A variety of sensors has been successfully tested in the laboratory for determining emulsion characteristics and composition. Pilot mill trials have been carried out with different oil formulations, and preliminary investigations were undertaken to correlate the results with laboratory tests. Furthermore, the influence of water quality on the functional properties of emulsion has been evaluated. An overview of the literature on the different aspects of the formation of surface residues has been compiled. After different processing steps, the surfaces have been examined in order to characterise surface residues and to elucidate the mechanisms of formation. Oils separated from used emulsions have been utilised in different cleaning techniques, such as extraction, flocculation and evaporation and the resulting samples have been analysed. The technical performance and costs of these techniques could hence be compared. Furthermore, full-scale trials with a combined centrifugation/evaporation system for used emulsions have been carried out.

Partners		*Country*	*Scientific person in charge*
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Martin RAULF (Pr. Coord.)
	HYDRO ALUMINIUM DEUTSCHLAND GmbH	DEUTSCHLAND	Gerhard KUDERMANN
	IVL SVENSKA MILJÖINSTITUTET AB	SVERIGE	Östen EKENGREN
	LUXCONTROL SA	LUXEMBOURG	Mohammed CHTAIB
	SWEREA MEFOS AB	SVERIGE	Nils-Göran JONSSON
	SAPA AB	SVERIGE	Arne BERG
	SSAB TUNNPLÅT AB	SVERIGE	Lars-Henrik ÖSTERHOLM
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Burkhard SCHMIDT
	VOESTALPINE STAHL GMBH	OESTERREICH	Hubert DUCHACZEK
	YKI, YTKEMISKA INSTITUTET AB	SVERIGE	Karin PERSSON

Selected Publications M. Raulf, K. Persson"Steel rolling" in Encyclopedia of Lubricants and Lubrication. Springer, Heidelberg New York, submitted and revised

RFSR-CT-2005-00016 Scale Control

Control of scale during steel processing

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1817016 €	Start Date	1/07/2005
	EU Contribution	1090210 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24261:EN			

Final Abstract "This project involved collaborative and complementary contributions from Corus UK Limited, Swinden Technology Centre (UK), CSM (Italy), VDEh-BFI (Germany), Swerea MEFOS (Sweden), and The University of Oulu (Finland), and was co-ordinated by Corus. Complementary controlled atmosphere thermobalance tests were conducted in the laboratories of Corus, CSM, BFI and MEFOS under isothermal or continuous heating conditions. Factors affecting the formation of an irregular primary scale were identified, and oxidation parameters were derived. CSM concentrated on austenitic and ferritic stainless steels, Corus on diverse plate-grade steels, BFI on sections and MEFOS a range of carbon, low alloy and stainless steels. Related series of pilot plant descaling or descaling and rolling trials were conducted by Corus, CSM and MEFOS to extend laboratory tests to a larger scale. These tests have helped to identify the effects of steel type, slab surface condition, furnace atmosphere and primary and secondary hydraulic descaling parameters on surface condition with respect to scale defects. In addition, MEFOS used image analysis after descaling in a HSM to identify factors causing poor descaling. BFI developed an empirical model to predict scale formation, incorporating non-isothermal thermobalance data, and to make recommendations, based on pusher furnace records, that would minimise billet sticking. The University of Oulu developed a coupled FE model of oxidation and descaling processes during hot rolling and hydraulic descaling, a ""through-process"" model of surface oxide scale, incorporating data generated in the descaling tests at MEFOS."

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Bridget STEWART (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Nicoletta ZACCHETTI
	SWEREA MEFOS AB	SVERIGE	John NISKA
	OULUN YLIOPISTO*UNIVERSITY OF OULU	FINLAND	Pekka MÄNTYLÄ
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Christian BÜHNER

RFSR-CT-2005-00017 WACOOL

Width-adaptable optimized controlled-cooling systems (WACOOLs) for the production of innovative advanced HSS grades and the study of strip shape changes while cooling

Info

Type of Project	Research	Duration (months)	48
Total Budget	1969698 €	Start Date	1/07/2005
EU Contribution	1181819 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25062:EN

Final Abstract

The overall aim of this project is to develop cooling technology applicable to the production in an HSM of advanced high-strength steel (AHSS) grades for the most effective controlling of their microstructure and mechanical properties. Different types of laminar flow cooling headers (Wacools 1–3), which also permit considerable reduction of water consumption by limiting the cooling width to the width of the strips, as well as facilitating the edge-masking feature, were developed and integrated. New cooling strategies were investigated, especially for the finishing mill and run-out tables, to improve the mechanicaland metallurgical properties of AHSS. A theoretical investigation of the strip shape changes during cooling, before and after coiling the strips, was undertaken with the aim of optimising the strip flatness after being cooled down to room temperature. The cooling header Wacool1 constructed at ThyssenKrupp Steel, Bochum satisfied the specifications well, whereas Wacool3 was integrated to the HSM of ArcelorMittal, Aviles after successful tests. At the average strip width of about 1.2 metres they give water savings of about 30 % and 10 % respectively. Cooling rates of 100 to 120 K/s are attainable. Due to technical and cost problems Wacool2 was not constructed. The thermomechanical model was developed by SSSA and a piece of software, CCT_Calc, for the calculation of the cooling curves, was developed, implemented and validated using the experimental data produced at ILVA. Both the statistical flatness model developed by ArcelorMittal and the physical/mathematical model of strip shape changes developed by Corus provided new knowledge that can be used for selecting optimal cooling strategies to retain the flatness until after the final cooling.

Partners

	Country	*Scientific person in charge*
CETTO AG	DEUTSCHLAND	Scaria MANNANAL (Pr. Coord.)
ACERALIA CORPORACION SIDERURGICA S.A.	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
ASTURFEITO S.A.	ESPAÑA	José Luis GONZALEZ GARCIA
ILVA S.P.A.	ITALIA	Massimiliano PAGLIARO
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Jaap VAN DER LUGT
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Jürgen DREVERMANN

RFSR-CT-2005-00018 TOPROLLS

Damage resistant and roughness retaining work rolls for cold rolling and temper rolling

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2943354 €	Start Date	1/07/2005
	EU Contribution	1766012 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25330:EN			

Final Abstract At cold and temper rolling mills, loss of roughness and/or surface texture ('wear') is a major reason for work roll changes. Another limitation to roll performance is damage inflicted to work rolls by mill incidents, requiring redressing in the roll shop. If a defect or damage is present in a forged roll, catastrophic roll failure may occur in an explosive manner. Improvement of the value-in-use of a work roll, whilst taking mill-specific factors into account, implies pursuing a superior wear resistance and damage resistance, and elimination of the safety risks associated with explosive roll failures. A concerted R & D approach was followed by a consortium of roll users in the steel industry, a roll manufacturer, a supplier of roll damage detection equipment, and research institutes. Roll damage and roll failure cases in industrial cold rolling mills were examined comprehensively. Cold rolling trials have been performed, using pilot mills as well as industrial mills, with novel forged HSS work rolls versus conventional forged 3 to 5 % Cr steel rolls. Separate trials were designed to focus on either the aspect of roughness evolution or damage resistance. Complementary data from various laboratory tests and industrial mill and roll shop data have been collected. Models have been developed for damage evolution in a roll, and for roughness evolution of the roll surface. Novel non-destructive detection systems and sensors have been designed and tested successfully in industrial cold mill roll shops. Enhanced testing and release procedures implemented in roll shops have led to a diminishing of catastrophic roll failures.

Partners		*Country*	*Scientific person in charge*
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Petrus Henk BOLT (Pr. Coord.)
	AKERS BELGIUM S.A.	BELGIQUE	Claude GASPARD
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Maxime LAUGIER
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Olivier LEMAIRE
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Roberta VALLE
	LISMAR ENGINEERING B.V.	NEDERLAND	Frans STORK

Patents EP 2 495 340 A1. C. Gaspard, C. Vergne and D. Batazzi. Forged roll meeting the requirements of the cold rolling industry and a method for production of such a roll. Date of publication: 05.09.2012

Selected Publications

P.H. Bolt, D. Batazzi, N.P. Belfiore, C. Gaspard, L. Goiset, M. Laugier, O. Lemaire, D. Matthews, S.Mul, T. Nylén, K.M. Reuver, D. Stocchi, F. Stork, J. Tensen, M. Tornicelli, R. Valle, E. van den Elzen, C. Vergne and I.M. Williams. Damage resistance and roughness retention of work rolls in cold rolling mills. Revue de Métallurgie 107 (2010), 245–255. DOI: 10.1051/metal/2010026.

C. Gaspard, C. Vergne, D. Batazzi, T. Nylen, P.H. Bolt, S. Mul and K.M. Reuver. Implementation of In-service Key Parameters of HSS Work Roll Grade Dedicated to Advanced Cold Rolling. AISTech2010 Conference Proceedings, Pittsburgh (USA) 2010, Vol. II, p. 347-358. URL: http://digital.library.aist.org/pages/PR-358-166.htm

C. Gaspard, C. Vergne, D. Batazzi, T. Nylen, P.H. Bolt, S. Mul and K.M. Reuver. Implementation of In-service Key Parameters of HSS Work Roll Grade Dedicated to Advanced Cold Rolling. Iron & Steel Technology August 2011, p. 97-106. URL: http://www.aist.org/magazine/11_aug_tblcon.htm

C. Gaspard, C. Vergne and D. Batazzi, Åkers forged High Speed Steel work roll for cold mills launched under brand name "INVICTA" after successful industrial cold mill trial, as project deliverable. URL: http://www.akersrolls.com/upload/Product%20data%20sheets/INVICTA/INVICTA%20data%20sheet_Rev.%202011-09-09.pdf

Lismar Engineering B.V., Roll Shop NDT Combi system including Surface Acoustic Wave (SAW) prototype was tested in cold mill roll shop as project deliverable and subsequently industrialised. URL: http://www.lismar.com/Products%20SW.html

RFSR-CT-2005-00019 FINALPLATEFLATNESS

Optimisation of final plate flatness by set-up coordination for subsequent manufacturing processes

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1894199 €	Start Date	1/07/2005
	EU Contribution	1136519 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25852:EN			

Final Abstract Nowadays the flatness performance of plate manufacturing lines is still tackled in terms of enhanced local flatness of the plates in the line. The aims of this project had been to optimise local flatness approaches and to progress from this basis by taking the flatness requirements of the subsequent production quantitatively into account in form of a co-ordinated flatness set-up system. This system should integrate all sub models including models of transfer conditions from process stage to process stage and perform a line through process flatness prediction. Based on this a line set-up optimiser connecting local stage rules by a line optimisation strategy should generate the best fitting actions relevant to the evolution of flatness. The plate processing comprises rolling, cooling, hot and cold levelling quenching and stacking, whereas the process stages in each individual process route may differ, being product related. The development, enhancement and extension of process models to predict the flatness produced at each processing stage in dependence of plate data, entry flatness, main process characteristics and setup values have been investigated comprehensively. Analyses of the gained plate flatness in the various process routes showed that the reduction / evolution of flatness defects is nearly independent from the considered process route. Furthermore it has to be confirmed that flatness defects are not passed through the processing chain. This is the main reason which makes it impossible to create global flatness predictions and coordinated optimisations. As a fundamental prerequisite for global flatness control is that various inputs (e.g. changes of rolling process) would have a strongly correlated impact on final flatness. However, this correlations could not been identified on the basis of the comprehensive process data analysis. Therefore the development and implementation of the 'Global through-process flatness predictor and coordinated optimiser' is obsolete by physical reasons.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Ulrich MÜLLER (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
	SWEREA MEFOS AB	SVERIGE	Olof WIKLUND
	RAUTARUUKKI OYJ	FINLAND	Pasi LUOTO
	TATA STEEL UK LIMITED	UNITED KINGDOM	Steve HENDERSON
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Wolfram WEBER

Selected Publications Activity Report 2009 / 2010, VDEh-Betriebsforschungsinstitut GmbH

RFSR-CT-2005-00020 AWiCCo

Advanced width and camber control

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1867705 €	Start Date	1/07/2005
	EU Contribution	1120623 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25042:EN			

Final Abstract The aim of the Awicco project was the optimisation of the hot rolled strip geometry concerning width and camber. For this purpose, in a first stage two innovative camber measuring systems were installed in the roughing mill providing very accurate camber values. Another measuring system was developed and installed in order to measure the width position between stands at the finishing mill. A common database was defined and created and the data of the existing and new measuring systems were integrated. For the avoidance of camber formation at the rougher two different means were tested. A new type of side guiding system based on a BFI invention was installed at a pilotmill and used to control the roll gap tilting. The guiding system consists of pairs of rolls which guide the slab at the entry side of the mill during rolling. The load and the position of each guiding roll were measured, and based on the difference in load between operator side and drive side the tilting of the work rolls in the horizontal stand could be controlled. The test results demonstrate clearly that the system is able to avoid the camber formation. One major advantage of the system is the fact that the roll gap tilting can be controlled immediately after start rolling. Although the test results are very good there is one difference compared to practice. The common layout of a rougher is mostly a combination of vertical and horizontal stand located close together. Since the pilot mill has no vertical stand this situation could not be tested. It may be reasonable to build a scaled down pilot mill with the typical layout of a rougher and continue the development of the new guiding system.In a second stage a camber model was developed that allows prediction of the camber tendency at an industrial roughing mill. Using this model it was possible to provide a new set-up system to avoid camber formation. Measurement of camber is complex as it must be done at both sides of the roughing mill due to its semi-continuous way of work. Anyway, it is possible to determine a value estimating the risk of causing camber in different ways, according to its shape. Modelling shows that the variables with most influence are related to temperature (roll thermal crown, mill production, bar temperature profile, heating strategies at furnaces), slab dimensions and difference of forces between operator and drive side. Concerning the width prediction, a clear improvement of an existing set-up model could be achieved considering new investigated main influence values. Interesting relationshipswere detected in some of the compositions, specifically S, Ti and mainly B, theinfluence of which was not clearly defined previously. On the other hand, the development of a hybrid analytical/data-based width model did not lead to the expected results. It was not possible to find a solution by means of modelling and database analysis to reduce the width deviation after the finishing train. The database analyses did not indicate clear influencing factors regarding the width deviation. It might be possible that there is even no solution possible by means of software-based control. A better solution to reduce the width deviation is expected by the use of an additional (light) edger located between one of the last finishing stands. Furthermore, such an edger would provideadditional means, for example, to influence and control the edge drop of the slab.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Roger LATHE (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
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	RAUTARUUKKI OYJ	FINLAND	Juha JOKISAARI
	UNIVERSIDAD DE OVIEDO	ESPAÑA	Francisco ORTEGA FERNANDEZ
	VOESTALPINE STAHL GMBH	OESTERREICH	Wolfgang SEYRUCK

RFS3-CT-2005-00015 | RFS-CR-03012

Stay for applied steel thermal and straightening processes research

Info	Type of Project	Accompanying measure (training)	Duration (months)	3
	Total Budget	6750 €	Start Date	1/09/2005
	EU Contribution	6750 €	End Date	30/11/2005
State	Research completed without final report			

Provisional Abstract

1. As a researcher, it would be profitable to learn from the experience of working in one of Europe's leading private-sector institutes for applied research and development in the field of steel technology. This involves gain knowledge with training activities on the data-warehouse, control, data analysis, etc. of the processes' pilot plants related to my research line during my thesis production, in fields closed to the profile straightening.
2. Take part of the strategies' design to intend to improve the processes concerning the Project, changing the present configuration based (along with other parameters) on the result obtained in the numerical simulations required, in a continue feedback (testwork-numerical simulation).
3. Knowledge generation to be consolidated in papers. Our intend is the publication of article between the Universidad de La Rioja and BFI from the results obtained during the stay period. The Universidad de La Rioja and its candidate are committed to that publications or other information disclosure wont infringe possible intellectual property rights and wont compromise the protection (such as patentability) of any results, inventions or know-how from third parties.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Axel MAAG (Pr. Coord.)
	UNIVERSIDAD DE LA RIOJA	ESPAÑA	Alpha PERNIA ESPINOZA

RFSP-CT-2006-00009 Anti-chatter CHD

Controlled hydraulic damper to prevent chatter in cold rolling

Info	Type of Project	Pilot&Demonstration	Duration (months)	24
	Total Budget	632679 €	Start Date	1/07/2006
	EU Contribution	253072 €	End Date	30/06/2008
State	Project suspended, no final report published			

Provisional Abstract

The project aims at installing and testing an innovative mechanical device, called Controlled Hydraulic Damper, to prevent 3rd octave chatter in cold rolling of thin steel strip. It would provide adequate passive damping to the stands, so that the roll-ability limits due to chatter (rolling speed, achievable strip thickness or maximal reduction) are widened. The proposal includes vibration analysis, numerical simulation, design and construction of the device, installation and validation of the anti-chatter device in industrial conditions.
Savings of 8.5 M€/year can be expected for the European production of cold rolled packaging steel.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Rémi BONIDAL (Pr. Coord.)
	ARCELORMITTAL ATLANTIQUE ET LORRAINE	FRANCE	Laurent VERMOT DES ROCHES
	SIEMENS VAI METALS TECHNOLOGIES SAS	FRANCE	Stéphane GOUTTEBROZE

RFSP-CT-2006-00013 ROLLMARK

Roll mark detection on the tandem mill

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	1515830 €	Start Date	1/07/2006
	EU Contribution	606332 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24999:EN			

Final Abstract "The project aim was to develop an innovative industrial system based on the multireflectivity measurements technology and able to detect on-line roll marks on the strip at the tandem mill exit, then to assess this new system on inspection line. In parallel to these developments, roll marks classification was defined. Four versions of the new sensor were designed, modelled, manufactured and assessed in the laboratory and on the inspection line to determine the best measurement configurations for the roll marks detection. Three other sensor versions were required to optimise the sensor performance and increase its industrial reliability. In parallel a dedicated electronics was developed to manage this new system. Finally, a specific data processingalgorithm based on the main property of roll marks: their periodicity, was imagined to allow the automatic roll marks detection at the tandem mill exit.All these developments were integrated in a first industrial device to monitor 200 mm strip width. This device was assessed on coils on industrial inspection line. The results demonstrated a high sensitivity of this new device, as expected, validating the achieved developments. Furthermore, the environmental constraints for an implementation at the tandem mill exit were evaluated. The optic cleanliness and the strip vibrations were identifiedas the two main constraints. A new industrial system capable of detection on-line roll marks was developed. It should be able to reach an on-line detection rate of 90 % with an over-detection rate between 5% and 10 % ; performances totally compatible with an industrial application."

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Thierry JACQUOT (Pr. Coord.)
	ARCELORMITTAL BELGIUM NV	BELGIQUE	Jean SCHELINGS
	SR-INSTRUMENTS OY	FINLAND	Seppo PYÖRRET
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Jouni TORNBERG

RFSR-CT-2006-00010 LOWWEAR

Controlling wear and surface cleanliness during cold rolling

Info				
Type of Project	Research	Duration (months)	42
Total Budget	2000054 €	Start Date	1/07/2006
EU Contribution	1200033 €	End Date	31/12/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25074:EN

Final Abstract This report describes the work done in the LOWWEAR project. The project objectives were to increase the fundamental understanding of wear in cold rolling processes, to experimentally determine the rolling parameters that have an influence and to develop (online) methods to measure wear. The analytical techniques revealed the different wear mechanisms (abrasive, chemicaland adhesive) that play a role in cold rolling. Iron fines were found to originate mostly from the strip. An overview was made of the usefulness of different analytical techniques. A plate-out tester was developed. As for the lubricant application parameters it appeared that spray pressure, sample and emulsion temperature have a significant influence on the plate-out. With the tester it was not possible to wash off the wear debris from the strip surface by impact of the applied coolant/lubricant. In the experimental rolling programme it was established that the rolling parameters that have most influence on strip cleanliness after cold rolling are :• work roll roughness• work roll coating• strip thickness reduction• rolling speed• material grade of rolled stripRolling parameters that have surprisingly only a small influence on strip cleanliness are :• oil composition• oil concentration in the emulsion• forward slipTwo online measurement methods were developed, one to measure the amount of iron fines in the emulsion, the other to measure the strip cleanliness on the strip. Both have shown to be accurate but robustness is still a problem. One method has been implemented in an industrial mill.

Partners		*Country*	*Scientific person in charge*
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	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Cécile PESCI
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	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Jochen KURZYNSKI

Selected Publications

L. Jacobs, B. Vervaet, H. Hermann, M. Agostini, J. Kurzynski, N-G Jonsson, J. Perez, K. Reuver, H. van Steden, “Improving Strip Cleanliness after Cold Rolling”, Journal of Engineering Tribology, vol 225, issue 9, 2011, DOI: 10.1177/1350650111413639

L. Jacobs, “Improving Strip Cleanliness after Cold Rolling”, 4th int. conf. tribolgy in manufacturing processes, Nice 2010.

RFSR-CT-2006-00011 ASYMMROLL

Using asymmetrical rolling for increased production and improved material properties

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1592905 €	Start Date	1/07/2006
	EU Contribution	955744 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25061:EN			

Final Abstract

In this project, hot asymmetric rolling with different asymmetries has been studied. The results show that asymmetric rolling is efficient for thinner dimensions, particularly when using high-speed differences between the work rolls. A decrease in roll force and torque can be obtained. Curvature in asymmetrical passes can be avoided by rolling at the turning point betweenthe 'ski-up/ski-down' conditions or by letting the plate bend into the roller table. An interesting result is that lubrication could be used to change the bending direction. Single drive often gives gripping problems. Tests of rolling with different work roll diameters using single drive or twin drives showedthat the effect of the speed on the torque has a larger impact than the effect of the diameter. Interesting texture analysis was performed that demonstrated that the texture from a dual-drive asymmetrical rolling trials showed shearing up to the centre of the sample : this shearing was superior to the shearing introduced by any single-drive configuration. Asymmetrical rolling gives a small increase in abrasive wear and has a slightly negative effect on the protective oxide formation. Contact force measurements show that a contact pressure peak is less pronounced for a non-driven roll. Small variations in roll size and roll speeds will not give the benefits of asymmetric rolling.

Partners		*Country*	*Scientific person in charge*
	SWEREA MEFOS AB	SVERIGE	Annika NILSSON (Pr. Coord.)
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jurgen MALBRANCKE
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Ilaria SALVATORI
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Roger LATHE

Selected Publications

ANNIKA NILSSON AND NILS-GÖRAN JONSSON, Swerea MEFOS AB Box 81 SE-971 25 Luleå – Sweden, CONTACT PRESSURES AND FRICTIONAL FORCES IN THEROLL GAP DURING SYMMETRIC AND ASYMMETRIC HOT ROLLING Proceedings of the 4th international conference on Tribology in Manufacturing Processes,Nice, France June 13th-15th, 2010, p 859-868

G. Lannoo, I. Tolleneer, J. Malbrancke (CRM), ASYMMETRIC ROLLING IN A HOT STRIP MILL/ OPPORTUNITIES AND METALLURGICAL EFFECTS, ATS International Steelmaking conference, Paris, December 13-14, 2007

G. Lannoo, G. Malbrancke, I. Tolleneer, (CRM), EFFECT OF ASYMMETRIC ROLLING ON PROCESS AND PRODUCTS PROPERTIES, Proceedings of the annual conference, SF2M, JA 2011

RFSR-CT-2006-00012 LASERHARD

Laser treatment of profiled rolls

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1306438 €	Start Date	1/07/2006
	EU Contribution	783863 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25064:EN			

Final Abstract The aim of Laserhard was to develop and implement a laser based strategy for the surface treatment of roll surfaces, to improve their wear resistance and maintain surface integrity. To that end, six roll grades were selected, which were considered to be representative of the wide range of materials currently employed for profiled rolls. Laser hardening process trials were carried out for optimisation in terms of microstructure, cracking, hardness, wear and thermal fatigue. Additionally, two roll grades were laser hardened and subjected to industrial trials. Laser hardening produced surface layers 1-2 mm thick with hardnesses in excess of 800 Hv. However, in highly alloyed grades this was accompanied by regions of softer retained austenite and in some instances cracking of the surface layer. Industrial trials on forged steel and pearlitic cast iron roll grades revealed that laser hardening significantly increased the wear resistance. Even though cracks were present the forged steel material retained its structural integrity. However, large carbide networks in the pearlitic cast iron material led to further crack propagation and spalling. It has been shown that the laser hardened materials do not provide any resistance to crack propagation, but do offer resistance to crack initiation. Hence, it is crucial to optimise laser hardening of a roll such that cracking does not occur during processing. Once this is achieved there can expected to be improvements in terms of cracking in service due to the higher resistance to crack initiation.

Partners		*Country*	*Scientific person in charge*
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RFSR-CT-2006-00014 OPTCOOLUB

New cooling techniques for enhanced roll bite lubrication during cold rolling of high strength steels and thin packaging steels

Info

Type of Project	Research	Duration (months)	42
Total Budget	1609006 €	Start Date	1/07/2006
EU Contribution	965405 €	End Date	31/12/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25322:EN

Final Abstract This project aimed at improving cooling performances in cold rolling to make better lubricant properties in order to limit interaction between cooling and mill vibrations and to optimise selective cooling for flatness control. Tests of new cooling techniques (combination of different types or arrangements of nozzles, high turbulence cooling techniques) have been derived in design procedures and practical recommendations to improve cold mills productivity, product quality and water usage. When a lower exit strip temperature and/or a decrease of sensitivity to mill vibrations are required without designing completely new headers on an existing mill, a solution consists in optimising interstand strip cooling through the use of two coolant temperature circuits (one hot and one cold) in combination with drying ramps in last mill interstands to limit perturbation of lubrication by cooling. When a decrease of water usage is required while maintaining a good cooling capacity, it is recommended to design new headers to use full cone nozzles for interstands strip cooling and new headers for the use of small roll cooling nozzles: the benefit in terms of flow rates (so water usage) may be more than 30 % water usage decrease in comparison to mills with normal to high flow rates. The High Turbulence Roll Cooling solution, alternative to nozzles-based cooling techniques, is a promising technique that should avoid perturbation of the lubrication system by cooling while working at a very low pressure (saving of energy). A new algorithm of selective cooling for exit strip flatness has been developed that determines automatically the required number of nozzles opened to maintain a good flatness. This new control strategy contributes to having an optimum efficiency of selective cooling whatever rolling conditions. Different types of models have been developed and further used to design the above new cooling configurations and to deeply understand what makes a cooling configuration or technique efficient. The expected benefits for the European steel industry are the possibility to achieve higher rolling speeds and reductions, to decrease oil consumption and oil cost, and to reduce water consumption and recycled coolant quantities (positive environmental aspect).

Partners	*Country*	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Nicolas LEGRAND (Pr. Coord.)
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LECHLER GMBH	DEUTSCHLAND	Jochen MUNZ
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RFSR-CT-2007-00014 OPTIFIN

Optimisation of finishing processes for eliminating rectification of plate and section products

Info

Type of Project	Research	Duration (months)	42
Total Budget	1194543 €	Start Date	1/07/2007
EU Contribution	716726 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25080:EN

Project web page http://www.optifin.agh.edu.pl/

Final Abstract

This research fund for coal and steel project was aimed at developing a scientific understanding through the length scale of the influence of cooling, levelling (hot and cold levelling) and straightening on the as-rolled properties (achieved after cooling) and the final mechanical properties/shape following rectification (straightening, levelling), thereby allowing minimisation (i.e. reduced severity of machine penetration) and even potential elimination of cold rectification. This objective has been achieved by a combination of innovative laboratory mechanical tests, material constitutive modelling accounting for length scale effect, microstructural characterisation and finally optimisation methods and selective trials on mills.

Partners

	Country	*Scientific person in charge*
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ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Isabel GUTIERREZ SANZ
RIVA ACCIAIO SPA	ITALIA	Marco PIANEZZOLA

Selected Publications

Multiscale numerical simulation of the phase transformation during industrial cooling ECCM conference, 2010 L. Madej, P. Spytkowski, K. Perzyski, D. Farrugia, M. Pietrzyk

Mathematical Models and Artificial Intelligence Techniques Jointly Applied to the Prediction of Hot-Deformation Resistance during Processing of Microalloyed Steels in Plate Rolling Process, Dimatteo, M. Vannucci, V. Colla PERCRO-CEIICP, Scuola Superiore Sant'Anna, Pisa, Italy, ISIJ International

Modelling of shape and property during spray cooling of long product sections, D Farrugia, A. Richardson, 10th International Rolling Conference, Beijing, Sept 2010

A combined model to describe both the mechanical and microstructural transient under a reversal of strain, D. Jorge-Badiola, J.L. Lanzagorta, I. Gutiérrez, accepted for publication in METALLURGICAL AND MATERIALS TRANSACTIONS A

Computer Aided development of the levelling technology for flat products, Madej et al. www.elsevier.com/locate/cirp

RFSR-CT-2007-00015 EDGECONTROL

Minimised yield losses by innovative integrated edge-drop, width and shape control based on soft-sensor technology and new actuators in cold rolling mills

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1808963 €	Start Date	1/07/2007
	EU Contribution	1085378 €	End Date	31/12/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25334:EN			

Final Abstract The project Edge control aims at systematically studying width variation and edge-drop in cold rolling mills. Mechanisms producing these phenomena were investigated and classified for different materials and mill types. Advanced strategies for controlling edge-drop and width were proposed. The development and implementation of portable edge-drop and width measurement systems to be used at different locations and mills, where no such facilities are available, builds the basis for advanced knowledge in the strip edge area during the rolling process. The combination of three-dimensional models, numerical simulations and data gathered in rolling trials are used to describe the width and profile variations. On the other hand, comprehensive measurement campaigns with the developed measurement systems have been carried out at different industrial mills to calibrate and validate models and improve the understanding of edge-drop and width variations. Soft sensors and simplified formulae have also been developed to estimate the edge-drop and width variation in tandem cold mills. Different actuators for controlling strip width variation and edge-drop were investigated and classified by order of importance and contribute to the strategy to be used in each target rolling mill, and to propose potential new width and edge-drop actuators. Development of intelligent soft sensors for the prediction and estimation of the edge-drop evolution in tandem cold rolling mills is a key instrument to develop future strip edge profiles. The implementation and first trials with advanced edge-drop and width control systems at the industrial facilities at Arcelor España, Arcelor Eisenhüttenstadt (Germany) and Sandvik (Sweden) demonstrate that control strategies and systems for different materials and cold rolling mills can help minimise side trimming.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Mohieddine JELALI (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Nicolas LEGRAND
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Guillermo VECINO
	ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Jürgen BATHELT
	SWEREA MEFOS AB	SVERIGE	Patrik SIDESTAM

RFSR-CT-2007-00016 Hyprocom

Development of an innovative hybrid procedure for combining tension-levelling and skin pass rolling

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1287748 €	Start Date	1/07/2007
	EU Contribution	772649 €	End Date	31/12/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25093:EN			

Final Abstract The elimination of the yield elongation with its appearance of the so called Lüder´s lines and transfer of surface texture up to now is realised by the skin pass rolling process. In case of highest flatness requirements a subsequent tension levelling process is put into operation. Due to the extended use of high strength materials and the high surface texture requirements two main problems arise. Regarding high strength steel grades requiring high roll force for yield elongation elimination extreme roll wear and strongly reduced service life is the consequence. Otherwise soft steel grades, requiring only small amount of skin pass deformations and thus rolled with only light roll forces, demand for higher roll forces to ensure sufficient roughness transfer. It gets obvious that the roll force has to fulfil two main but conflicting functionalities: Skin pass reduction for yield elongation elimination and surface roughness transfer. Thus the main objective of the project is the development of an innovative strip finishing procedure by combining tension levelling and skin pass rolling into one production step and thus to overcome restrictions given with the common skin pass process and to shorten the process chain. It could be demonstrated that the new hybrid process is able to adjust material mechanical and surface roughness properties independently. The required roll force could be reduced by 25 %.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Volker DIEGELMANN (Pr. Coord.)
	BILSTEIN GmbH & Co KG	DEUTSCHLAND	Gerald Otto ZWICKEL
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Helena GOUVEIA
	SUNDWIG GmbH	DEUTSCHLAND	Udo WEIRAUCH
	UNIVERSIDAD DE LA RIOJA	ESPAÑA	Eliseo VERGARA

Patents DE 10 2006 006 530 A1 2007.08.16

Selected Publications

Tim Schubert. Scale-Up und Optimierung einer Versuchsanlage zum Streckbiegedressieren (Scale-Up and Optimization of a Test Plant for combined Tension Levelling – Skinpassing). FH Südwestfalen, University of applied Sciences, Batchelor Thesis 2012

V. Diegelmann, G. Zwickel, M. Ullrich, H. Gouveia, U. Weirauch, A.V. Pernia. Entwicklung eines neuartigen Verfahrens zur Einstellung der mechanischen und topographischen Eigenschaften von Bandmaterial innerhalb eines Prozessschrittes. Tagungsband, ISBN 978-3-902078-17-9, XXXI. Verformungskundliches Kolloquium 25.02.2012, Planneralm, Steiermark

V. Diegelmann, G. Zwickel, M. Ullrich, H. Gouveia, U. Weirauch, A.V. Pernia. Novel Method for Setting the Mechanical and Topographic Properties of Strips within one Process Step. 30th “JOURNEES SIDERURGIQUES INTERNATIONALES”, 18-19 December 2012

V. Diegelmann, G. Zwickel, M. Ullrich, H. Gouveia, U. Weirauch, A.V. Pernia. Novel Method for Setting the Mechanical and Topographic Properties of Strips within one Process Step. 9th International Rolling Conference and the 6th European Rolling Conference 2013

Activity Report 2011/2012. VDEh-Betriebsforschungsinstitut GmbH

RFSP-CT-2008-00009 SELECTIVEROLLCOOLING

Industrial implementation of a selective roll cooling system for big rolls with multiple groves in long product rolling based on advanced cooling technology

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	1049431 €	Start Date	1/07/2008
	EU Contribution	419772 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25889:EN			

Final Abstract "This is the final report of the selective roll cooling project. The general aim of this pilot and demonstration programme is to demonstrate that the cooling of big grooved work rolls can strongly be improved by the use of advanced cooling technology and a selective cooling strategy. Long product mills observe frequently severe work roll thermal fatigue at certain positions. This increases the roll costs and decreases the product quality. To improve the work roll life time, several new roll cooling systems have been developed and tested. Three industrial stands have been selected to work on; the sheet piling finishing stand of Arcelor Mittal Belval and the intermediate and finishing stand of the Tata steel Scunthorpe Rail and Section Mill. Each system is designed to have the optimal cooling of the work roll where needed. Characterisation- and industrial trials demonstrated the superiority of the new developed cooling systems in comparison with the current cooling systems. Not only is the work roll surface temperature lower, also the surface quality improves. This project also demonstrated the aptitude for further improvements by implementing high turbulence roll cooling. The industrial implementation is however not considered by the mill management as their targets have been reached and HTRC work roll cooling requires more attention related to the different profiles."

		Country	*Scientific person in charge*
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	TATA STEEL UK LIMITED	UNITED KINGDOM	Christian ONISA

RFSR-CT-2008-00011 LUBWORK

Increase of cold rolling performance by new lubricant and innovative work roll concepts

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1464064 €	Start Date	1/07/2008
	EU Contribution	878439 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25861:EN			

Final Abstract The objective of Lubwork was the improvement of cold rolling performance by the use new lubricant concepts and the improved work roll capability. Oil-free and recycled lubricants, nanoscaled solids as additives in conventional lubricants and wear reducing coatings have been investigated. Lubricants based on poly alkylene glycols showed comparable or even better lubrication than conventional lubricants. The expected simplified handling properties were given and enable savings through less loss of base oil during continuous care steps. The application of recycled oils by conditioning of a second raffinate is possible, the performance is acceptable but due to high additivation currently out of economic scope. The implementation of nanoscaled solids as additive compound showed positive impact from MoS2 particles. Nevertheless the handling has to be improved as well as environmental impact is not finally clarified. PVD-coatings of TiHfCrN have shown good resistance against wear on different substrates. Massively increased wear on products side was not finally clarified, therefore further examination is necessary. Technical scale trials with PAG-based lubricants have shown good results for steel either hot aluminium. An economic application is possible, long-term effects of lubricants behaviour and impact on subsequent processes has to be examined in detail.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Tilo REICHARDT (Pr. Coord.)
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	VOESTALPINE STAHL GMBH	OESTERREICH	Hubert DUCHACZEK
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Selected Publications

Siegmann A., Sartor M. Master Thesis: Erfassung und Bewertung der Exposition von nanoskaligen Partikeln beim Einsatz in Schmier- und Beschichtungssystemen bei der Metallumformung, Beuth Hochschule für Technik Berlin University of Applied Sciences, 2010

K. Persson, S. Ali, J. Andersson, I. Blute, F. Alonso, A. Losch, R. Luther, A. Mascaró, J. Rausch: The tribological properties of rolling oil emulsions with and without nanoparticles. CETAS-conference Luxembourg, 2011

S. Ali: Investigation of the use of nanoparticles as additives in steel rolling emulsions. Diploma work, YKI, at Stockholm university – department of materials and environmental chemistry, 2010

T. Reichardt, M. Raulf, M. Herrmann, P. Dahms, G. Kudermann: Oilfree lubrication in steel cold rolling, 15th International Conference on Experimental Mechanics, Porto – Portugal, July 2012

T. Reichardt, H. Deli, M. Raulf, M. Herrmann, P. Dahms, C. Mömming, C. Müller, S. Myslowicki: Oil free lubrication in steel hot and cold strip rolling, 30th JSI, 18-19 December, 2012 Paris

RFSR-CT-2008-00012 CHILLUB

Advanced method to improve work roll life time and surface quality of hot rolled strip by new coupled oil free lubrication and chilling

Info

Type of Project	Research	Duration (months)	47
Total Budget	1423894 €	Start Date	1/07/2008
EU Contribution	854336 €	End Date	31/05/2012

State Project completed

Provisional Abstract

CHILLUB will gain detailed knowledge of heat transfer mechanism of strip surface before and the mechanism of friction and roll fatigue in the roll bite when applying new coupled oil free lubricant (water soluble) with strip cooling (chilling) during hot rolling. Research work is primarily related to work roll deterioration and strip surface quality.
Secondary the suppressing of scale formation is examined.
Objectives of the investigations are:
- Increase work roll life time
- Improving strip surface quality
- Enlarged process window when rolling high strength steels.
Results are integrated into set-up and control models revealing into an industrial prototype.

Partners

	Country	*Scientific person in charge*
TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Harry VAN STEDEN (Pr. Coord.)
BRNO UNIVERSITY OF TECHNOLOGY - VYSOKE UCENI TECHNICKE V BRNE	CZECH REPUBLIC	Miroslav RAUDENSKY
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Bart VERVAET
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Christian MUELLER
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Tilo REICHARDT

RFSR-CT-2008-00013 WINROLLS

Work rolls in the roughing mills: roll grade and process optimisation to save energy and roll cost of use

Info

Type of Project	Research	Duration (months)	48
Total Budget	2273616 €	Start Date	1/07/2008
EU Contribution	1364169 €	End Date	30/06/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26421:EN

Final Abstract

On-line and off-line tools have been developed to characterise the roll surface evolution (WP1). We focused on oxide thickness measurement, surface characterisation (degradation), sub surface characterisation and slab speed measurement. It allowed us to build a complete database (WP2). We analysed it in order to understand the degradation mechanisms, and specifically the oxidation phenomenon all along the roll life, and also to compare work roll grades (HSS, 1/2HSS and HiCr). A system measuring the heat transfer coefficient in the roll stand has been designed (WP3). Unfortunately, trials couldn't be performed, but procedure and numerical simulations are done in order to perform the trial under the best conditions. Comparison of classic cooling and HTRC cooling led to the conclusion HTRC was more efficient (WP4) in terms of heat removed. Also the optimal position and pressure have been defined on roll cooling simulator. The optimisation of starting conditions (WP5) revealed that the higher the initial roughness, the quicker the oxidation. Pre-heating of roll also leads to a better oxidation. Trials on the twin disk showed that the pre-oxidation layer on roll was not able to give additional protection (not adhesive enough). A new work roll grade has been developed by Åkers (WP6) based on the analysis and correlation of data gathered in on-line trials, and on laboratory trials performed on existing grades. The new work roll grade (WP7) showed improved oxidation kinetics at the beginning of the campaign. Moreover the depth of thermal cracks is uniform, which limits the risk of pitting

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Minouche MOHAMMADI TEHRANI (Pr. Coord.)
AKERS BELGIUM S.A.	BELGIQUE	Claude GASPARD
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jurgen MALBRANCKE

RFSR-CT-2008-00014 OPTITUBE

Improvement of the internal wall surface of seamlesss tubes by optimisation and anticipating management of the mandrel bar operation and supervision of the internal tool process

Info	Type of Project	Research	Duration (months)	63
	Total Budget	1313723 €	Start Date	1/07/2008
	EU Contribution	788234 €	End Date	30/09/2013
State	Running project			

Provisional Abstract This project aims to optimise the internal wall surface of seamless tubes. Systems to measure internal tool condition and process forces will provide a database for correlation analysis and on-line prediction-based processing and anticipating maintenance. Hybrid correlation & Finite Element Models will predict the internal wall surface quality based on internal tool condition evolution and tool process parameters. New wear resistant tool materials/coatings and enhanced process lubrication will be introduced to optimise internal tool surface and process parameters. A supervision system will integrate the on-line information and an anticipating strategy to handle internal tool processes and maintenance
proposals e. g. of the time to replace the tool. The system will be demonstrated at a push bench tube line of Benteler.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Hagen KRAMBEER (Pr. Coord.)
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	COMTES FHT a.s.	CZECH REPUBLIC	Michal ZEMKO
	ROVALMA SA	ESPAÑA	Isaac VALLS ANGLES

RFSR-CT-2008-00015 CHATTER

Global adaptive model for prediction, characterization and damping of vibrations in hot strip mills

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1879635 €	Start Date	1/07/2008
	EU Contribution	1127781 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25924:EN			

Final Abstract The overall aim of this research project is to develop the technology for a global approach to the effective prediction, detection, characterisation and damping of vibrations and spurious oscillations experienced by the hot strip mill machinery during rolling in order to minimise their adverse effects on the volume of production and on the strip quality. Investigations were centred on the hot strip mills of ThyssenKrupp Steel at Bochum and ArcelorMittal at Aviles. Mainly three types of new sensors — torque sensor, distance sensor and sound sensor — were developed and installed in the participating mills for chatter on-line monitoring. Elementary analysis of the data from these sensors empirically showed the dependence of chatter on the material type and dimensions, the speed, the rolling force, etc. The data were also used to develop and test three models. A software tool based on the SOM neural network model permits earlier identification of chatter cases. A physical roll gap model of the stand and an FE model were able to identify the natural frequencies of rolling stand oscillations. The FE model also visualised the effect of chatter on various components. It has been established that chatter is the resultant of both torsion and translational oscillations. A very effective mechanical chatter damping system was developed based on the stand model and tested on a test bench. Due to an ongoing modernisation work at the Bochum hot strip mill the models could not be implemented on-line as scheduled. This also hampered the ultimate merging of all the models into a global model.

Partners		*Country*	*Scientific person in charge*
	CETTO AG	DEUTSCHLAND	Scaria MANNANAL (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Jürgen DREVERMANN
	TECHNISCHE UNIVERSITAET CLAUSTHAL	DEUTSCHLAND	Hans-Peter BECK
	UNIVERSIDAD DE OVIEDO	ESPAÑA	Ignacio ALVAREZ GARCIA

RFSR-CT-2008-00016 OxMaPro

Oxidation Management in hot rolling processes

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2619191 €	Start Date	1/07/2008
	EU Contribution	1571515 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25898:EN			

Final Abstract A project on through process management of oxidation during hot rolling based on a combined approach of innovative coating development and application and study of their behaviour during reheating, descaling, rolling and finishing processes through advanced characterisation methods has been established, involving collaborative contributions from Tata Europe (UK), Arcelor Research, VDEh-Betriebsforschungsinstitut, Centre de RecherchesMetallurgiques, Sidenor I + D and HoeschHohenlimburg. The work has led to the development and application of a series of coatings for reheating and post-secondary descaling, i.e. finishing rolling for both long and flat products and range of steel grades from ULC to high C bearing steels. Assessment looked also at downstream application, H&S and mill management/ changes in rolling practices. Coatings tested and developed were both active and passive coatings ranging from sol-gel to inorganic oxide coating with specific inhibitors for either scale modification or protection. Up to 50 % reduction in oxidation and x4 reduction in decarburisation can be achieved as a function of steel grade and processing conditions. The project has been innovative with the following items/concepts developed: — Detailed methodology for coating pre-screening and application for reheating, descaling, rolling and finishing processes (picking, wire drawing) — Application of advanced pilot descaling and coating rig such as DESCOAT — Application and testing in both hot strip and long product mills — Establishment of relationships with current processing conditions inc. roll force and roll degradation — Innovative scale and residual characterisation for both off-line and on-line application based on IR, CCD camera and X-ray diffraction.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Shahid RIAZ (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Cécile PESCI
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Isabelle TOLLENEER
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
	HOESCH HOHENLIMBURG GmbH	DEUTSCHLAND	Holger ADLUNG
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Rolf KLIMA

RFSR-CT-2009-00007 PACROLP-II

The prediction and avoidance of cracking in long product hot rolling. Phase II.

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1514966 €	Start Date	1/07/2009
	EU Contribution	908980 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26321:EN			

Final Abstract Pacrolp-II project is aimed at minimising ductility break-ups on 'apparently sound' as-cast semis (blooms/billets), which are prone to surface cracking during reheating/rolling. The main singularity of this project has been a multiscale analysis combined with a through process evaluation (casting/ reheating/rolling) of damage by experiments and simulation. The study of as-cast structures has led to identify the microstructural features that are relevant in subsequent process steps (grain distributions, nature, distribution size and location of MnS inclusions, incipient solidification damage ...). The reheating is an important step that can eliminate, enhance or provoke surface defects, depending on the steel grade and furnace conditions. A wide range of mechanical tests, combined with fine microstructural evaluation and FEM models for analysis of damage levels, have allowed: the definition of thresholds of triaxiality and strain for nucleation and cracking, the evolution of plasticity of inclusions with applied strain, a better understanding on the interaction between austenite grain boundaries and MnS inclusions in the early stages of damage nucleation and the relevance of inclusions spatial distribution in all the steps of damage evolution. Multiscale modelling has been developed to study the effect of macro processing and as-cast conditions on the MnS inclusions at the scale of interest. These models, in combination with laboratory tests and analysis, have allow the identification and quantification of a high number of factors (micro-macro) intervening in the damage process. The relevant role of stress triaxiality/strain path suggests the convenience of proper design of entry bite geometry and grove radius in roughing passes

Partners		*Country*	*Scientific person in charge*
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	José Maria RODRIGUEZ IBABE (Pr. Coord.)
	ASS. POUR LA RECHERCHE ET LE DEV. DES METHODES ET PROC. IND., ARMINES	FRANCE	Marc BERNACKI
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Juan Hector BIANCHI
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
	TATA STEEL UK LIMITED	UNITED KINGDOM	Didier FARRUGIA

Selected Publications

C Puncreobutr, P D Lee, M Kaye, D Balint, D Farrugia, T Connolley, and J Lin, Quantifying damage accumulation during the hot deformation of free-cutting steels using ultrafast synchrotron tomography, 2012 IOP Conf. Ser.: Mater. Sci. Eng., 33 (2012) 012038, doi:10.1088/1757-899X/33/1/012038 012038

D. Farrugia, High temperature ductile damage during rolling of free cutting steels", Ironmaking and SteelMaking , 37, 2010 , pp. 298-305, DOI: http://dx.doi.org/10.1179/030192310X12646889255906.

E. Roux, M. Bernacki, P.O. Bouchard, A level-set and anisotropic adapted remeshing strategy for the modeling of void growth under large plastic strain, Comp. Mater. Sci. 68 (2013) 32-46, http://dx.doi.org/10.1016/j.commatsci.2012.10.004.

RFSR-CT-2009-00008 ROLLGAP SENSORS

Advanced roll gap sensors for enhanced hot and cold rolling processes

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2050913 €	Start Date	1/07/2009
	EU Contribution	1230548 €	End Date	31/12/2012
State	Project completed, final report not published yet			

Provisional Abstract

To achieve higher product quality and productivity on rolling mills, it becomes necessary to get a profound knowledge of friction, heat transfers and lubrication in the roll gap.
An approach is proposed to develop innovative roll gap sensors to measure simultaneously at the roll-strip interface thermal and mechanical conditions and oil film thickness: different sensor designs are evaluated and compared in hot and cold rolling using laboratory, pilot and industrial mill tests. Finally the sensors, combined with modelling and mill measurements, are used to increase mills productivity (lower roll surface degradation) and to improve product quality (better strip thickness).

Partners		*Country*	*Scientific person in charge*
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Nicolas LEGRAND (Pr. Coord.)
	BRNO UNIVERSITY OF TECHNOLOGY - VYSOKE UCENI TECHNICKE V BRNE	CZECH REPUBLIC	Jaroslav HORSKY
	COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	FRANCE	Pierre FERDINAND
	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	FRANCE	Pierre MONTMITONNET
	SWEREA MEFOS AB	SVERIGE	Nils-Göran JONSSON
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Ditmar PIESACK
	THE UNIVERSITY OF SHEFFIELD	UNITED KINGDOM	Robert DWYER-JOYCE

RFSR-CT-2009-00009 HIDES

Innovative high temperature descaling techniques

Info				
Type of Project	Research	Duration (months)	42
Total Budget	1142360 €	Start Date	1/07/2009
EU Contribution	685416 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26177:EN

Final Abstract This project aims to address the surface quality problems associated with descaling efficiency through the development of new integrated routes involving the use of new water-free descaling techniques and optimisation of current water-based descaling processes. The focus of the project was primary scale of high alloyed steels from ULC electrical to high C rail steels with a range of Si-Al-Cr additions. Primary scale high pressure water descaling technique was reassessed in detail and further optimised with introduction of improved set-ups. HPW descaling parameters were studied in detail in view of optimising descalability and surface-sub-surface chilling. Methodologies were developed to test influence of nozzle geometry and latest nozzle on descaling efficiency. Hot shot blasting as an alternative to high pressure descaling has been assessed by static shot blasting trials. Complementary trials have then been performed to define shot blasting parameters, flow rate, shot size, shot velocity, etc. An industrial wheel blasting machine was modified for pilot trials at hot temperature under conditions as close as possible to industrial parameters. The cross comparison with HPW descaling shows that shot blasting can be as efficient as HPW in removing primary scale. Important attention has been paid to the cross comparison between HPW and HSB descaling related to cost and upscaling. The cost estimation based on the pilot trials performed with an industrial wheel blasting machine, shows a lower cost for HSB descaling, but both cost calculations (HPW and HSB) are based on the test done during this project

Partners		*Country*	*Scientific person in charge*
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Diana ESPINOSA (Pr. Coord.)
	KARLSRUHER INSTITUT FÜR TECHNOLOGIE (KIT)	DEUTSCHLAND	Volker SCHULZE
	TATA STEEL UK LIMITED	UNITED KINGDOM	Didier FARRUGIA
	WINOA S.A.	FRANCE	Tony PREZEAU

RFSR-CT-2009-00035 FOSUCOR

Future-oriented supervision of the cold rolling process in reversing mills

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1406453 €	Start Date	1/07/2009
	EU Contribution	843872 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26171:EN			

Final Abstract "Pass schedule design and roll geometry are decisive criteria for the productivity of a mill stand and the quality of the final product. Within the framework of this project, the intelligent use of existing process data should replace the use of empirical values at the pass schedule calculation and replace the trial and error approach to achieve optimal roll geometries. The main objectives of the project were to develop an auto-adaptive pass schedule calculation taking into consideration pre-calculated strip flatness and a software programme to help plant operators optimise the roll geometry. To take into consideration the strip flatness, a programme was developed which determines roll force limitations within it is ensured that the flatness actuators will be able to achieve the target strip flatness. Calculations show that this calculation approach reacts much more flexibly to different rolling conditions (like different strip width, work roll diameter, material) and that a clear increased production rate could be achieved. The programme was successfully validated at two mills, providing improved pass schedules, especially in cases outside the usual product range. Analyses of the as-is state of roll geometries showed the clear potential to improve the geometry and the clear benefit of a programme which is able to predict the effect of changed geometries. With the help of the developed programme, it is possible to quickly find the optimal roll geometry (roll crown of work roll, idle and driven rolls; taper length and taper inclination) for the particular product range"

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Roger LATHE (Pr. Coord.)
	SWEREA MEFOS AB	SVERIGE	Jan LEVEN
	OUTOKUMPU NIROSTA GmbH	DEUTSCHLAND	Jörg KAZMIERSKI

RFSR-CT-2010-00007 ROLLWITECH

Application of novel wireless technologies to improve rolling performances

Info

Type of Project	Research	Duration (months)	42
Total Budget	1665860 €	Start Date	1/07/2010
EU Contribution	999517 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract This project aims at developing integrated wireless micro sensors which can be placed in almost any part of a rolling mill, allowing for new measurement locations in the mill. As a result monitoring and control can be extended and improved. To facilitate continuous measurements without the need for maintenance, suitable energy harvesting systems will be designed. The versatility of the technology will be demonstrated by the development of a roll chock and work rolls with embedded auto-monitoring systems. To prove the advantages of the technology, wireless sensors will be incorporated in a new monitoring system for mill vibration.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Jesus Maria PEREZ (Pr. Coord.)
ASTURFEITO S.A.	ESPAÑA	Daniel DIAZ
STICHTING IMEC NEDERLAND	NEDERLAND	Dennis HOHLFELD
FUNDICION NODULAR	ESPAÑA	Leonel ELIZONDO
TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Jan PONSIOEN
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Werner WOESTE

RFSR-CT-2010-00008 HRENERGYCONTROL

Minimising energy loss in hot rolling by intelligent manufacturing

Info				
Type of Project	Research	Duration (months)	42
Total Budget	1886437 €	Start Date	1/07/2010
EU Contribution	1131862 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract The electrical consumption in the hot rolling operation is more than 70 KW/ton. The main consumers are the rolling stands and the coilers. Auxiliary equipment can however not be neglected as it represents 25% of the electrical energy. The total energy loss is however much higher related to latent heat of the hot rolled product emitted to the coolants and the environment (0.56 GJ/ton).
The aim of this research program is to get a better understanding of all energy flows in the hot rolling operation and to define and validate major opportunities for energy loss reduction.

Partners		*Country*	*Scientific person in charge*
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Hugo UIJTDEBROEKS (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	José Ramón GONZÁLEZ SUÁREZ
	UNIVERSIDAD DE OVIEDO	ESPAÑA	Fernando BRIZ
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Tilo REICHARDT

RFSR-CT-2010-00009 LPROLLCOAT

Increased abrasive wear and thermal fatigue resistance of long product work rolls by application of novel coating technologies

Info

Type of Project	Research	Duration (months)	42
Total Budget	2375700 €	Start Date	1/07/2010
EU Contribution	1425419 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract The project is aimed at improving life of work rolls during hot rolling of long products by novel applications of available wear resistant coatings as well as development of new generation of wear and thermal barrier coatings. An improved resistance to thermal fatigue, spalling and wear under both existing and reduced conditions of cooling will be targeted. These objectives will be achieved by advanced modelling techniques, innovative pilot and laboratory simulations and industrial production rolling. Knowledge developed will be used to identify, rank and cost coatings and coating application methods to meet current and future demands on work rolls.

Partners

	Country	*Scientific person in charge*
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jurgen MALBRANCKE (Pr. Coord.)
ASOCIACION DE INVESTIGACION METALURGICA DEL NOROESTE - AIMEN	ESPAÑA	Alberto FERNÁNDEZ VICENTE
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicolas RICH
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Ramon GONZALEZ GARCIA
TATA STEEL UK LIMITED	UNITED KINGDOM	Christian FEDORCUIC-ONISA
TEER COATINGS LIMITED	UNITED KINGDOM	Shicai YANG
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Tilo REICHARDT

Patents European Patent Application No. EP12153200: Method for laser cladding a steel substrate (pending)

Selected Publications

Shicai Yang, Kevin Cooke, Hailin Sun, Xiaoying Li, Kaijie Lin and Hanshan Dong. Development of advanced duplex surface systems by combining CrAlN multilayer coatings with plasma nitrided steel substrates, 20th Congress of International Federation for Heat Treatment and Surface Engineering, October, 2012 Beijing, China, Proceedings (2012)593-596

Rademacher, M. Investigations on the ability of electroless nickel dispersion, Master Thesis Hochschule Niederrhein, 11/2012 Krefeld

J. Malbrancke, H. Uijtdebroeks, G. Moreas, C. Fedorciuc-Onica On-line evaluation of work roll degradation in hot rolling mills, Rolling 2013 / Associazione italiana di metallurgia (AIM) (Milan, Italie). Congrès: 9th International/6th European Rolling Conference (10-12 June, 2013. Venise, Italie

RFSR-CT-2010-00010 MICROCONTROL

Combined Online Microstructure sensor and model for a better control of hot rolling conditions and final products properties

Info

Type of Project	Research	Duration (months)	42
Total Budget	1747589 €	Start Date	1/07/2010
EU Contribution	1048554 €	End Date	31/12/2013

State Running project

Provisional Abstract

To achieve higher product quality and productivity on rolling mills, it becomes necessary to measure, and possibly feed back control, microstructure on line.
A laser ultrasonic sensor based on innovative optical concepts is developed for microstructure evaluation all along a hot strip mill: in inter-stands for recrystallization and grain growth kinetics, on the run out table for phase transformation and final strip microstructure. This sensor is validated with laboratory and pilot rolling tests. It is finally tested in industrial hot rolling conditions for a complete calibration of an on line microstructure evolution model with the aim to improve rolling process and final strip microstructure.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Nicolas LEGRAND (Pr. Coord.)
NATIONAL RESEARCH COUNCIL OF CANADA CNRC	CANADA	Jean-Pierre MONCHALIN
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Griet LANNOO
IMAGINE OPTIC SA	FRANCE	Nicolas LEFAUDEUX
SWEREA KIMAB AB	SVERIGE	Lena RYDE
SWEREA MEFOS AB	SVERIGE	Nils-Göran JONSSON

RFSR-CT-2010-00011 INTERCOOL

Improved temperature control with integrated roll and strip cooling

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1008366 €	Start Date	1/07/2010
	EU Contribution	605019 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract

The proposal aims to study and validate a very innovative idea: the possibility to integrate the application of interstand cooling and strip surface chilling into the design of the work roll cooling system with a minimum water cooling pressure. Besides a simplified design, it opens the possibility to increase strip temperature homogeneity and to increase work roll cooling efficiency by cooling the work roll directly at the roll bite exit.
Decreased energy consumption, improved strip quality (less scale, flatness, ..), strip temperature homogeneity and increased work roll life are the main stakes of this proposal.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Bart VERVAET (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Jean-Luc BOREAN
	TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Pieter Drent

RFSP-CT-2011-00009 INCOOL

Intensive cooling in cold rolling

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	1249595 €	Start Date	1/07/2011
	EU Contribution	624797 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

The objective of this pilot and demonstration project is the industrialisation of the intensive, high turbulent, Water Pillow Cushion (WPC) cooling technology in cold rolling mills for work roll cooling and strip cooling. The implementation is based on preliminary trials, performed in the RFCS research project “OPTCOOLUB” [1].
This innovative project aims to improve cooling performance in order to suppress temperature related defects, to enhance lubrication efficiency and to increase rolling speed. The intensive WPC cooling technology will also create the opportunity to minimise energy costs, the amount of recycled flow rate and oil contamination in the coolant.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Bart VERVAET (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Makhlouf HAMIDE
	TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Leon JACOBS

RFSR-CT-2011-00007 CONSTOX

Control of steel oxidation in reheating operations carried out with alternative fuels and new combustion technologies

Info

Type of Project	Research	Duration (months)	36
Total Budget	1195272 €	Start Date	1/07/2011
EU Contribution	717163 €	End Date	30/06/2014

State Running project

Provisional Abstract

A lot of research work has been devoted to guarantee steel quality by controlling oxidation process in re-heating furnaces and hot rolling operations.
Nowadays there is trend to improve energy efficiency and to reduce the environmental impact by using innovative combustion technologies (like flameless) and alternative fuels (waste gas).
The aim of the project is to favour the exploitation of these technologies by defining optimum processing parameters to ensure that primary scale and associated scale defects do not persist through to the final product also when new combustion systems and fuels different from natural gas are used in re-heating operations.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Irene LUZZO (Pr. Coord.)
FERALPI SIDERURGICA S.p.A.	ITALIA	Lorenzo ANGELINI
TATA STEEL UK LIMITED	UNITED KINGDOM	Didier FARRUGIA
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Robert OROSZ

RFSR-CT-2011-00010 WORODEFS

Tailoring and testing of novel work roll developments for the early finishing stands of hot strip mills

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2441125 €	Start Date	1/07/2011
	EU Contribution	1464675 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

During finishing hot rolling, tight interrelations occur between rolling process conditions, work roll behaviour and performance, and strip surface quality. Nevertheless, innovative work roll grade developments, mill process optimisation, and roll shop technology improvements are usually carried out separately, resulting in sub-optimisation and slow developments.
This proposal aims to improve the performance of work rolls in the early finishing stands, by integrating the process conditions and roll shop measurement techniques into the roll grade development. The main objectives of the proposal are improved roll performance, improved understanding of roll degradation for different hot strip mills, and improved NDT inspection techniques.

		Country	*Scientific person in charge*
Partners	**TATA STEEL NEDERLAND TECHNOLOGY B.V.**	NEDERLAND	Petrus Henk BOLT (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Eliette MATHEY
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Gisèle WALMAG
	LISMAR ENGINEERING B.V.	NEDERLAND	Frans STORK
	UNION ELECTRIC STEEL UK LTD	UNITED KINGDOM	Jason SYCHTERZ

RFSR-CT-2011-00012 CRFREEROLLS

Substitution of chrome plating for the rolls of skin-pass mill

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2249683 €	Start Date	1/07/2011
	EU Contribution	1349810 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

Hard chrome plating is applied for long to rolls of rolling mills, especially skin-pass mills. It gives the benefits of keeping consistent roughness all along a rolling campaign and in turn reducing the roll consumption.
However chrome plating involves carcinogenic CrVI. Therefore it will be banned at mid-term in the EU, like other applications of CrVI. have been..
The objective of this proposal is to evaluate the performances of substitutes to chrome plating so that efficient alternatives can be implemented.
Alternatives will be evaluated in two directions:
- Harder rolls (HSS) that resist wear without plating
- Cr-free alternative coatings
Evaluation will include laboratory, pilot and first industrial tests

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Hugo UIJTDEBROEKS (Pr. Coord.)
	AKERS BELGIUM S.A.	BELGIQUE	Claude GASPARD
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Akli ELIAS
	SARCLAD LIMITED	UNITED KINGDOM	Gareth EVANS
	SULZER METCO COATINGS GMBH	DEUTSCHLAND	Franz JANSEN
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Petrus Henk BOLT

RFSR-CT-2011-00011 OPTISHAMP

Optimal control of shape and materials properties

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2029061 €	Start Date	1/12/2011
	EU Contribution	1217437 €	End Date	30/11/2015
State	Running project			

Provisional Abstract Customers demand for steel grades with increased strength and balanced formability as well as optimal shape. Shape & mechanical properties are strongly affected by the deformation and thermal treatment during the hot and cold rolling. In this project, a through-process control systemwill be developed for the simultaneous optimisation of shape & mechanical properties along the production chain of hot and cold rolling. The optimisation system will be realised and tested at two mills. Furthermore, possibilities to optimise shape & mechanical properties by controlled coil-cooling and improvements in the shapemeter roll for n-line shape measurement during hotrolling will be investigated.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Andreas WOLFF (Pr. Coord.)
	ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Sascha HÜMANN
	SWEREA MEFOS AB	SVERIGE	Mats KARLBERG
	TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Rob VERHOEF

RFSR-CT-2012-00009 DYNAMO

Advanced measurements and dynamic modelling for improved furnace operation and control

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2271460 €	Start Date	1/07/2012
	EU Contribution	1362876 €	End Date	31/12/2015
State	Running project			

Provisional Abstract Advanced measuring technology will be used initially to improve reheating furnace operation and temperature control which will yield improved furnace efficiency and lower CO2 emission. Comprehensive furnace measurements will also provide validation data for the development of three-dimensional dynamic 'virtual furnace' models for investigating enhanced furnace control strategies, especially during transient conditions, where existing supervisory control has severe limitations. These combined approaches of advanced process measurements and simulation techniques will result in better understanding of novel heating strategies to improve stock temperature homogeneity and the link between furnace and rolling mill, whilst initiating the evolution of the next generation of supervisory furnace controllers

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Andreas QUECK (Pr. Coord.)
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
	SWEREA MEFOS AB	SVERIGE	John NISKA
	SAARSTAHL AG	DEUTSCHLAND	Jörg CLEMENS
	TATA STEEL UK LIMITED	UNITED KINGDOM	Graham ANDREWS
	UNIVERSITY OF GLAMORGAN	UNITED KINGDOM	Chee-Keong TAN

RFSR-CT-2012-00010 HELNOX-BFG

High efficiency low NOx BFG based combustion systems in steel reheating furnaces

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2169711 €	Start Date	1/07/2012
	EU Contribution	1301827 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

This project aims to develop a combustion system for an efficient utilization of blast furnace gas (BFG) in steel reheating furnaces, by means of fuel preheating (gas-gas heat exchangers or regenerators), so as to maintain the same production level of a high heating value fuel, reducing natural gas dependence and CO2 emissions.
This system will be tested at laboratory and industrial scale both in case of air and oxy-fuel combustion technology, in order to:
- define the guidelines for a safe application in the industrial environment;
- address technical and economical issues;
- put forward guidelines for retrofitting existing furnaces.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL ESPAÑA SA**	ESPAÑA	Victor CUERVO PINERA (Pr. Coord.)
	AGA AB	SVERIGE	Bo SUNDELIN
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Umberto ZANUSSO
	SWEREA MEFOS AB	SVERIGE	Anders RENSGARD
	TENOVA SpA	ITALIA	Massimiliano FANTUZZI
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Wolfgang ADLER

Selected Publications

Víctor Cuervo, Carsten Rein, Chuan Wang. High Efficiency Low NOx Blast Furnace Gas Based Combustion Systems in Steel Reheating Furnaces – State of Art.

RFSR-CT-2012-00012 CERROD

New generation of highly resistant wear and thermal fatigue ceramic - CERMET work rolls for rod mill application

Info

Type of Project	Research	Duration (months)	42
Total Budget	1907357 €	Start Date	1/07/2012
EU Contribution	1144415 €	End Date	31/12/2015

State Running project

Provisional Abstract

Rod mills in the finishing no twist mill block, use currently cemented carbide (CC) sleeve disks with different binding content and although developments in this hardmetal material has taken place throughout the years, a step change in roll wear, thermal fatigue, product surface quality and dimensional tolerance could be gained by use of more advanced and environmentally friendly ceramic and cermet materials. The project aim is to make this step to meet the requirements of modern rod mills by developing a detailed understanding of cost-applicability of ceramic and cermet work rolls function of industrial conditions taking into account cooling and lubrication. The project will also contribute to reduce EU dependency on strategic material such as Tungsten from China as recently highlighted in EU review [32].
The main objectives of this project are:
- to develop a detailed understanding of applicability and tailoring of ceramic and cermet materials for work roll sleeve as likely replacement candidate materials to cemented carbide in rod rolling applications
- to develop an approach combining the rolling process and roll shop practices (sleeve mounting, dressing), with key intrinsic properties such as toughness, thermal fatigue and wear to improve applicability of these materials
- to critically assess the thermal, mechanical and tribological properties of ceramic and cermet candidates, against current benchmark CC material, with the final objective of issuing a cost performance benefit analysis which should be transferrable to other EU rod mills
The main deliverables are:
1. Functional specification for roll sleeve material in no twist rod mill with applicability to roller guide
2. A methodology for pre-screening ceramic/cermet material
3. Regime maps for ceramic and cermet material applicability
4. Cost performance benefit analysis (versus current CC material)
5. Strategy/roadmap for utilisation, upscaling and further development of these materials

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Didier FARRUGIA (Pr. Coord.)
ARCELORMITTAL GANDRANGE SA	FRANCE	Jean-Paul RICHARD
ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	José Manuel SANCHEZ
CERATIZIT LUXEMBOURG SARL	LUXEMBOURG	Ralph USELDINGER
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jurgen MALBRANCKE

RFSR-CT-2012-00045 ROLLSTREM

Work roll stress management during hot rolling of long & flat products

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1840041 €	Start Date	1/07/2012
	EU Contribution	1104024 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

The main objective of the project consist in developing a detailed understanding of roll stress evolution through the service life of typical work rolls during hot rolling of long products which can be extended also for flat products with the aim to design a range of stress corrective solutions to minimise their effect on the added thermal and mechanical stress cycles experienced by the material. The envisaged improvement will be to extend the roll campaign increasing the mill productivity avoiding time and production looses in fixing problems due to roll repairing processes.
Work rolls experienced very high mechanical and thermal stresses in service. These stresses are the reason of appearance of surface cracks on the rolls; these cracks cause problems on the materials being rolled. To remove these cracks the rolls are subjected to dressing processes that consist generally in removing material by machining to obtain a roll with a diameter more reduced so it can be used on different mills. This process means to stop the production, a loss of material and reduce the mill productivity.
Nowadays, the control of the stresses generated during the process is more related with the thermal stresses due to the contact of the rolls with the hot product being rolled. The main parameters are cooling and lubrication of the rolls in service.
As this thermal stress together with mechanical stress due to the loads applied to perform the reductions are added to the internal or residual stresses of the rolls, a deeper knowledge of the stress state of the rolls during its service life can be useful to assess their influence on the behaviour of the rolls.
Some possible solutions are envisaged in the project: the influence of surface treatments as those imparted by peening processes, the influence of dressing parameters will be also evaluated.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	José Carlos GARCIA (Pr. Coord.)
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Hugo UIJTDEBROEKS
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
	SONATS - SOCIETE DES NOUVELLES APPLICATIONS DES TECHNIQUES DE SURFACE	FRANCE	Frédéric CHÂTEAU
	TATA STEEL UK LIMITED	UNITED KINGDOM	Didier FARRUGIA

RFSP-CT-2013-00006 HIRODS

On-Line High sensitive Roll Mark Detection System: industrialization and assessment

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	940951 €	Start Date	1/07/2013
	EU Contribution	470476 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

Roll marks represent on average the half of defects observed on the cold rolling mill. They are tiny defects barely visible on the strip at this process stage, in the majority of cases. Their automatic detection would be the most efficient at this stage in terms of product quality and costs savings, but no adapted industrial device on the market exists. Nevertheless, a previous RFCS project, ROLLMARK, demonstrated that a modular system based on the multi-reflectivity measurement should be able to detect on-line roll marks, even the tiniest. EU savings of such industrial system have been evaluated at about 9M€/year in Europe. This system will also enable steel producers to offer high-quality products especially for automotive industry and enhance their brand image. HIRODS is a demonstration project aiming at providing an industrial high sensitive detection system able to efficiently detect on-line roll marks at the cold rolling mill exit and thus avoid their reproduction on long series of steel coils. This industrial system is based on the ROLLMARK project, in which measurements and detection potentials have been validated. Some detector modules were installed at the ArcelorMittal Sagunto's tandem mill exit to validate the possibility of on-line measurements in real industrial environment. The objectives of this project are thus: - to complete the system implementation at the tandem mill in order to monitor the full steel strip width, - to optimize the data processing algorithms specifically developed to reach a high level of roll marks detection, - to integrate them in the system processors to obtain an automatic inspection system, - to provide the most suitable and ergonomic system for an easy use by operators, - to assess the completed system in real industrial conditions and determine its performance level. The expected performance is an on-line roll mark detection rate of at least 92% with an over-detection rate lower than 10%.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Thierry JACQUOT (Pr. Coord.)
	ARCELORMITTAL SAGUNTO SL	ESPAÑA	Jose Luis GARCIA FERNANDEZ
	SR-INSTRUMENTS OY	FINLAND	Seppo PYÖRRET

RFSR-CT-2013-00007 VirtROLL

Virtual strip rolling mill

Info	Type of Project	Research	Duration (months)	40
	Total Budget	1949219 €	Start Date	1/07/2013
	EU Contribution	1169531 €	End Date	31/10/2016
State	Running project			

Provisional Abstract The proposal is aimed at creation of a computer system dedicated to modelling of hot rolling mill and supporting flexible design of new rolling technologies (i.e. SSMR and JFE processes). The functionality of the system will include the following modules: - numerical simulation of rolling processes based on flexible rolling technology design, - numerical simulation of material behaviour implemented using AHSS and UHSS metallurgical investigation, - optimization of the rolling technology regarding homogeneity and final product properties, - inverse analysis for identification of process and material parameters, - metamodelling increasing computational efficiency, - knowledge base for support of new technology design.

		Country	*Scientific person in charge*
Partners	**AKADEMIA GORNICZO-HUTNICZA IM. STANISLAWA STASZICA W KRAKOWIE AGH**	POLAND	Jacek KITOWSKI (Pr. Coord.)
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	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Volker DIEGELMANN

RFSR-CT-2013-00008 IntelLub

Increased mill capability and performances by the application of intelligent lubrication

Info

Type of Project	Research	Duration (months)	42
Total Budget	2231645 €	Start Date	1/07/2013
EU Contribution	1338987 €	End Date	31/12/2016

State Running project

Provisional Abstract This proposal aims to increase mill capability and optimize mill performances by the application of intelligent lubrication. The main objectives are: to improve the consistency of lubrication by the introduction of new technologies for optimum plate out efficiency, to control the torque distribution over the top and bottom spindle by the implementation of a variable lubricant control unit based on model presetting and the measured torque, and to define operator guidelines to maximise performance taking into account overall costs (e.g. investment, lubricant, maintenance, energy saving, roll performance), product quality and environmental impact.

Partners	*Country*	*Scientific person in charge*
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jurgen MALBRANCKE (Pr. Coord.)
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VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Tilo REICHARDT

RFSR-CT-2014-00010 HiPerScale

High performance hot rolling process through steel grade-dependent influencing of the scale formation and flexible descaling control

Info

Type of Project	Research	Duration (months)	42
Total Budget	4199422 €	Start Date	1/07/2014
EU Contribution	2519650 €	End Date	31/12/2017

State Running project

Provisional Abstract

For steel grades which are difficult to descale or prone to scale-related defects (e.g. Ni-plate, Al-Si, Si-Cr, spring steels, electrical steel, High C steel, etc.) processed from both conventional (long, flat) and compact strip hot rolling lines, poor primary descalability, remnant residual scale affected by secondary/tertiary scale lead to surface defects and poor as-rolled surface quality. Especially for strip grades, these defects may not be removed totally during the subsequent pickling/annealing operation and lead finally to surface impairments resulting in customer complaints or rejections of the final product. HiPerScale will develop an integrated, energy efficient and flexible approach for hot rolling (long, flat) to minimise oxidation/decarburisation and overall descalability and surface quality for difficult to descale steel grades (alloyed with Si, Cr, Ni) by combining application of scale conditioning coatings with development in reheating and descaling methodologies. Focus is on scale-metal interface and morphology and the understanding of its behaviour and conditioning through innovative application of coating, reheating, descaling and rolling with the view to optimise influence and interaction of each input process and product factor affecting scale. Regime maps, resource efficiency and overall cost-performance of the various approaches developed will be issued. The main innovative contributions of this project to the European industry is an innovative strategy to increase the productivity by higher efficiency of the descaling and to influence processing conditions and scale conditioning to avoid surface defects caused by residual scale by combining direct actions (coatings, improved descaling) with indirect actions (improved process strategies, scale residuals detection systems). Beside the increased product quality also positive effects on the resource consumption (water and energy consumption in descaling, less rejects of products) are expected.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Miriam SARTOR (Pr. Coord.)
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ARCELORMITTAL RUHRORT GMBH	DEUTSCHLAND	Ingo FRICKE
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RFSR-CT-2014-00012 HEROLL

Hydrogen Embrittlement of Cold Rolls

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2435994 €	Start Date	1/07/2014
	EU Contribution	1461594 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

During the last years an increasing number of cold rolling work rolls failing due to hydrogen embrittlement were observed. These damages and/or failures can also cause dangerous explosions of the work roll bodies, which is an important factor for the safety aspect. One reason are the increased mechanical loads during processing. The difficulties will even increase as the production rates of materials are rising and as the protective plating materials, which are currently produced by Cr-VI compositions, are supposed to be banned by EU restrictions. In a first step the occurrences of hydrogen embrittlement in cold rolling work rolls shall be characterised. Therefore the critical cases in the process data of the participating cold rolling mills will be identified and fracture analyses of damaged rolls with evaluation will be done. In a second step control measures for influencing factors will be determined for industrial cold rolling mills and a new hydrogen sensor will be developed to measure the hydrogen content on rolls. Possibilities of lubricant improvement will be examined by the participating lubricant supplier and improvements of the work roll materials will be carried out by the participating cold roll supplier. Based on the results of laboratory works the further step will be the implementation of 3-4 best configurations at a pilot line plant simulating the conditions of industrial production. Finally the best configuration from the pilot line tests will be implemented in industrial service tests. Thus, this proposal aims to strengthen the European steel industry by developing new concepts for the diminishment or even prevention of hydrogen embrittlement in cold rolling work rolls. This includes improved work roll materials and lubricants, which would be alternatives to plating produced by Cr-VI compositions. On the other hand the general knowledge considering the stress corrosion cracking of massive steel parts shall be widened and strengthened.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Tilo REICHARDT (Pr. Coord.)
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	HOUGHTON DEUTSCHLAND GmbH CHEMIE FÜR METALLBEARBEITUNGS-TECHNIK	DEUTSCHLAND	Stephan CONRADT
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	RISSE + WILKE KALTBAND GmbH & CO. KG	DEUTSCHLAND	Rolf DÖPPER
	STEINHOFF GmbH & Cie. OHG	DEUTSCHLAND	Carl Justus HECKMANN
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Norbert RÖSSLER

Technical Group Steel 5

Finishing and coating

The scope of TGS5 includes:

- Heat treatment technology
- Chemical treatments, finishing and coating techniques including new technologies
- Coating development, including new coatings
- Surface characteristics
- Corrosion properties
- Standardisation of testing and evaluation methods
- Maintenance and reliability of production lines
- Reduction of emissions, energy consumption and improvement of the environmental impact
- Instrumentation, modelling and control of processes

RFSR-CT-2003-00021 FAMEGA

Failure mechanisms during galvanising

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1086681 €	Start Date	1/09/2003
	EU Contribution	652009 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23195:EN			

Final Abstract The overall objective of the Famega project was to identify the mechanisms controlling liquid metal assisted cracking (LMAC) of high-strength structural steels during hot-dip galvanising. Sixteen steel sections were obtained and classified in terms of chemical composition, microstructure and mechanical properties, including high-temperature properties as inputs for FE modelling. Measurements of web residual stress showed predominantly compressive values of up to 50 % of yield. In contrast, welding processes resulted in tensile residual stresses close to yield near the weld. Details of the galvanising process considered important to FE models were obtained from operators in Germany, Spain, Luxembourg and the United Kingdom. Eighty full-scale galvanising tests were carried out on 2 m long beams with welded half-cover plates. Beams without welded plates did not crack. Techniques to reduce LMAC showed that thermal stress relief with a hand-held torch was highly effective, while sand blasting, ultrasonic peening and additional weld beads proved ineffective with compressive stresses confined to surface layers. LMAC tests in three laboratories were carried out using newly developed and conventional test piece types and a variety of Zn alloys. Factors which contributed to LMAC included: Zn–Sn baths, lower strain rates and steel. High hydrogen levels were found at the steel/zinc alloy interface but did not contribute to cracking. Combining threshold stress and stress intensity using an FAD approach showed that fracture mechanics was only appropriate for cracks > 2 mm. Modelling of welding and galvanising showed the importance of stress concentration near the half cover plate, residual stress, dipping speed and angle, and the heat transfer coefficient associated with a Zn–Sn alloy bath.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Bill RUDD (Pr. Coord.)
	INGENIEURBÜRO FÜR WERKSTOFFTECHNIK	DEUTSCHLAND	Peter LANGENBERG
	ProfilARBED S.A.	LUXEMBOURG	Boris DONNAY
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
	UNIVERSIDAD DE CANTABRIA	ESPAÑA	Federico GUTIERREZ-SOLANA
	TECHNISCHE UNIVERSITÄT KAISERSLAUTERN	DEUTSCHLAND	Benedikt LÖSER

RFSR-CT-2003-00028 ZINC-ALLOY

Fundamental aspects of corrosion and delamination behaviour of novel zinc alloy coatings and Zn-intermetallic phases

Info

Type of Project	Research	Duration (months)	40
Total Budget	1766060 €	Start Date	1/09/2003
EU Contribution	1059636 €	End Date	31/12/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23178:EN

Final Abstract

The elimination of the yield elongation with its appearance of the so called Lüder´s lines and transfer of surface texture up to now is realised by the skin pass rolling process. In case of highest flatness requirements a subsequent tension levelling process is put into operation. Due to the extended use of high strength materials and the high surface texture requirements two main problems arise. Regarding high strength steel grades requiring high roll force for yield elongation elimination extreme roll wear and strongly reduced service life is the consequence. Otherwise soft steel grades, requiring only small amount of skin pass deformations and thus rolled with only light roll forces, demand for higher roll forces to ensure sufficient roughness transfer. It gets obvious that the roll force has to fulfil two main but conflicting functionalities: Skin pass reduction for yield elongation elimination and surface roughness transfer. Thus the main objective of the project is the development of an innovative strip finishing procedure by combining tension levelling and skin pass rolling into one production step and thus to overcome restrictions given with the common skin pass process and to shorten the process chain. It could be demonstrated that the new hybrid process is able to adjust material mechanical and surface roughness properties independently. The required roll force could be reduced by 25 %.

Partners

	Country	*Scientific person in charge*
MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Michael ROHWERDER (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Kevin OGLE
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Maiwenn LARNICOL
DOC DORTMUNDER OBERFLÄCHENCENTRUM GmbH	DEUTSCHLAND	Monika RIEMER
TATA STEEL UK LIMITED	UNITED KINGDOM	P.S. LEGOOD

Selected Publications

Michael Rohwerder, Andrey Lyapin, Florin Turcu. INHERENT DELAMINATION PROTECTION BY NOVEL ZINC ALLOYS. GALVATECH 2007

RFSR-CT-2003-00046 CARSTEEL

Characterizing the surface waviness of hot dip galvanized steel sheets for optical high-quality paintability

Info

Type of Project	Research	Duration (months)	48
Total Budget	1435539 €	Start Date	1/09/2003
EU Contribution	861324 €	End Date	31/08/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23854:EN

Final Abstract

"Waviness in the surface of steel sheets may cause waviness in the topcoat ('orange peel effect') of painted sheets. This is undesirable because it impairs the optical impression and customers interpret this as bad paint quality. Therefore, the production of high-quality sheets needs the control of waviness in the sheet surface. At present, this is difficult since car producers demand different parameters to quantify waviness with regard to paintability. The aim of this project is to characterise and optimise the paintability of hot dip galvanised sheets on the basis of uniform parameters accepted by both the steel and automotive industry. To achieve this aim the 'Carsteel' project was carried out by a consortium of 16 partners (five steel, eight automotive, two paint industries and one research institute). It was discovered that the hot dip galvanising process generates total new surface topographies; the waviness is influenced only by the skin pass process. The surface waviness of the work rolls and the skin pass process are thus the main influencing parameters for the strip surface waviness. Therefore a target of further investigations should be to minimise the work roll surface waviness for the different used work roll texturing methods without altering the work roll surface roughness. On the basis of laboratory and paint shop paintings, the interrelationship between steel sheet surface waviness and top coat appearance was investigated with regard to all European used waviness characterising parameters. Thereafter, a practical measuring procedure and waviness characterising parameter was developed to assess the paintability of automotive sheets in practice. Furthermore, a new waviness gauge was designed and produced, that allows the calibrating of the required measuring systems and verifying the parameter calculation."

Partners

	Country	*Scientific person in charge*
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SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Kerstin ULLRICH
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Hans-Gerd WEYEN
VOESTALPINE STAHL GMBH	OESTERREICH	Dieter PAESOLD

RFSR-CT-2004-00020 TOPOMETER

On-line topography measurement of uncoated/coated deterministic or random surfaces

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1412523 €	Start Date	1/07/2004
	EU Contribution	847513 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24212:EN			

Final Abstract More stringent customer requirements and the need to increase productivity are two of the numerous reasons that push steelmakers to deliver higher surface quality strips. Even with the recent process improvements, the strip surface is not yet fully under control. To support a better control of the process, an online topography sensor has been developed based on a completely new approach. The neural network installed in the process computer of the galvanising line at Aviles now predicts the level of force needed to comply with some given elongation, as well as the top and bottom roughness, with a precision of around 20 %. The use of SRM and of the neural network will be pursued to improve the process. Different process models have been tuned at AM Gent allowing, among other benefits, the online calculation giving the skinpass operator a real advantage compared to manual offline stylus roughness measurements on sheet samples. The models can be used to predict roughness values for the coils coming next, leading to a decrease in workroll changes with a substantial financial advantage. Concerning the 3D parameters, due technical deadlock, no efficient optical solution has been found for multiple line projections. To solve this, work has been done on one line profile and on background image leading, through the use of a model, to the calculation of new parameters. The new proposed statistical parameters allow a better classification of the surface structure of strip material regarding its formability and coating properties.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Geneviève MOREAS (Pr. Coord.)
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RFSR-CT-2004-00021 CUT-EDGE

Self-healing at cut-edge

Info				
Type of Project	Research	Duration (months)	42
Total Budget	1673309 €	Start Date	1/07/2004
EU Contribution	1003986 €	End Date	31/12/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24219:EN

Final Abstract The major aim of the project was to develop optimised zinc coatings with significantly improved self-healing properties against cut edge corrosion. Although this ambitious aim was not achieved, the project was quite successful in enhancing our understanding of what needs to be considered. We could show that under certain conditions Mg in Zn-Mg definitely has a positive effect on the cut edge, clearly improving the performance by a factor of 5 or more. However, the effect of Mg is not a robust one: for example if these conditions are not met, under immersion in a greater volume, no effect is discernible. This has to be considered when planning the proper use of Zn-Mg. For Al no effect on cut edge protection was found. However, from thermodynamic considerations a positive effect on the alloy corrosion itself can be assumed. The lack of robustness found underlines that the real potential lies in the concept of incorporating nanoparticles into the zinc coating that can release inhibitors where needed, i.e. they themselves are released from the zinc coating during its anodic dissolution and then can migrate/diffuse to the steel surface where they decompose and release their load of inhibitors. In this way localised dispension of inhibitors is possible, i.e. they are release where needed. The desirability of this was shown for the example of phosphate. For global release, such as from an organic coating, phosphate cannot reach its full potential. Only by the targeted release from a nanoparticle can the optimum protection be reached. This project can be regarded as a milestone in this direction. Particularly noteworthy are the progress made in the inhibitor mechanism at the cut edge, novel findings of synergy between zinc and magnesium, the successful synthesis, loading and encapsulation of mesoporous silica nano-particles, the formulation of a theory for the incorporation of nano-particles into zinc, and a first demonstration of the performance of incorporated particles.

Partners	*Country*	*Scientific person in charge*
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FUNDACION ITMA*INSTITUTO TECNOLOGICO DE MATERIALES	ESPAÑA	Olga CONEJERO
VOESTALPINE STAHL GMBH	OESTERREICH	Alexander TOMANDL

Selected Publications

F. Thébault, B. Vuillemin, R. Oltra, C. Allely, L. Dosdat,, K. Ogle. Cathodic reduction inhibition on galvanized steel cut-edges. ELECTROCHIMICA ACTA 53 (2008) 5226-5234. DOI: 10.1016/j.electacta.2008.02.066

A.M. Simões, R. Picciochi, J.P. Torres, J.C.S. Fernandes. Corrosion inhibition at cut edges by sodium phosphate. Electrochimica Acta 54 ((2009) 3857-3865. Doi:10.1016/j.electacta.2009.01.065

RFSR-CT-2004-00022 CLEAN

New approaches in electrolytic cleaning of cold rolled steel sheet

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1347799 €	Start Date	1/07/2004
	EU Contribution	808679 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24970:EN			

Final Abstract The major technical questions of electrolytic cleaning as a step of preparation for coatings of zinc, aluminium-zinc or tin were studied in the frame of this project. Anodic, cathodic and alternating current was tested. Important is a final anodic polarisation of the steel strip even if current reversal is technically used.

		Country	*Scientific person in charge*
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	VOESTALPINE STAHL GMBH	OESTERREICH	Johann GERDENITSCH

RFSR-CT-2004-00023 IMGALVA

Investigation, modelling and control of the influence of the process route on steel strip technological parameters and coating appearance after hot dip galvanising

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1328089 €	Start Date	1/07/2004
	EU Contribution	796853 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23919:EN			

Final Abstract In this project, methods were developed for the prediction of quality-relevant product properties for hot dip galvanised material. Information concerning product properties to expect was gained during the hot dip galvanising process and preceding production steps. These predictions were based on operational variables of the process and extensive measurements, for instance by the HACOM system or LUS (laser ultrasonic) and surface inspection systems (SIS or SIAS). The models found and the developed applications shall be used for open-loop quality control. That means that the deviation between predicted and required properties is used to inform production and quality staff about deviations of product properties and to adjust process parameters if possible. The examined aspects of relevant product properties concern the prediction of technological parameters and the coating appearance of galvanised strips. They are founded on data-based and physical models. Operators' knowledge has been utilised as much as possible. To obtain improvement of the product quality of galvanised steel strip, the following main tasks were executed: - investigations into measurement systems for technological properties of galvanised strip, like HACOM and LUS, for continuous operation, - improvements of physical modelling of material structure evolution, - concepts and applications for product tracking and tracing to connect information from different sources for analysis and modelling, - application of data-based techniques for analysis and modelling of technological parameters, both length related and coil-wise, - modelling of the zinc coating appearance, - integration of methods and models into a framework for monitoring and open-loop control.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Norbert LINK (Pr. Coord.)
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RFSR-CT-2005-00021 HIGH-PICK

Optimised productivity and quality of pickling by on-line control of pickled surface

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1652096 €	Start Date	1/07/2005
	EU Contribution	991258 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24998:EN			

Final Abstract

"The objective of the project is an enhanced mastering of the pickling process and more precisely gaining high productivity and quality standards. This objective is to be attained via intensive monitoring of the process and the treated strip and via deep knowledge and process modelling. It is foreseen in the same time to look for savings in acid and energy consumption and address the case of sensible grades. Most of the objectives have been fulfilled (even in some cases data that came out during the project forced to adapt the work strategy). So it can be reported that at the end of the project a wide knowledge and a wide-ranging control system have been developed.In more details :• The analysis of acid and iron content has been developed in laboratory and validated in side-of-line tests• A model of pickling line has been attempted; after many unsuccessful tests, it exhibited good results when based on balanced 'virtual dataset'• Those two developments can be linked to constitute a feed-forward control to preset the line• An under-pickling optical sensor has been developed and tested in an industrial line ; it proved to be robust and detect efficiently under-pickled areas• An over-pickling sensor based on hydrogen emission has been developed and tested on line ; it appear directly linked to all over-pickling occurrence• An electrochemical method was developed to evaluate inhibitor via emitted hydrogen• Those 3 last developments can be grouped to form a powerful feed-back control of the pickling line. Some of the developments are already about to go on the market, being ready for diffusion."

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Jean CRAHAY (Pr. Coord.)
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	ILVA S.P.A.	ITALIA	Daniele AGAZZANI
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Holger SCHMERMBECK

RFSR-CT-2005-00022 Advanced Wiping

New wiping techniques to produce efficiently the suitable coating layers at high speed in the hot dip galvanising process

Info

Type of Project	Research	Duration (months)	42
Total Budget	1952127 €	Start Date	1/07/2005
EU Contribution	1171277 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24208:EN

Final Abstract The objective of this project was to find an innovative way to efficiently wipe suitable coating layers at high speed in the hot dip galvanising process. Three technical fields were examined with the support of numerical modelling, with the aim of an industrial scale trial. Contrary to our first thoughts, no thinner gauges could be obtained if the drag-out is lower: laboratory trials have shown that pre-wiping is worthless because of the natural ability of the strip to drag liquid out of the bath. First, a pilot line trial at CRM presented the hydrodynamic foil wiping technique as an interesting solution for high speed galvanising. Second, a rotating permanent magnets' approach, adjacent to the bath level, was analysed and evaluated in a small laboratory scale trial. Third, an electromagnetic technique was tested on CRM's pilot line where both wiping efficiency and finish quality have to be improved. Also a strong disturbance force, normal to the strip's plane, demands stabilisation developments. In the numerical field, a wiping model was developed and adapted for each technique with some limitations. Finally, the realisation of an industrial trial was forecast on the condition of successful pilot line tests and modelling results, meeting all industrial criteria. That was not the case despite prolongation and additional efforts devoted to defining viable technical solutions. The positive outcome is a possible application of foil wiping. However, that technique requires additional efforts to improve the handling of drosses and surface oxides.

Partners

	Country	*Scientific person in charge*
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Patents BE1018202A3 – Dispositif pour l'essorage hydrodynamique d'une bande en défilement continu
http://worldwide.espacenet.com/publicationDetails/biblio?DB=worldwide.espacenet.com&II=0&ND=3&adjacent=true&locale=en_EP&FT=D&date=20100706&CC=BE&NR=1018202A3&KC=A3

RFSR-CT-2005-00023 SPACE

Space efficient curing methods and simulation-aided coating engineering for extending lifetime of aesthetic coil coatings

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1296030 €	Start Date	1/07/2005
	EU Contribution	777618 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24213:EN			

Final Abstract The project 'Space-efficient curing methods and simulation-aided coating engineering for extending lifetime of aesthetic coil coating — SPACE', has been a 3.5 year six-partner research project focusing on irradiative methods to cure coatings on steel sheets produced in coil-coating lines. The project has focused on the possibilities of space-efficient curing methods and structure — property relationships as tools for the development of complex coil-coatings for exterior architectural applications. Two radiation curing methods have been studied more closely, (i) UV-curing and (ii) IR/NIR-curing. The main focus has been to see how these technologies can be used in existing coil-coating lines, but the results of the detailed studies may of course also be applied to totally new lines where radiation curing would replace conventional convective curing. The project was divided into six work packages, out of which five were concentrated on active research. All in all some 2 300 separate single measurements were performed within the project on some 50 various types of novel two and three-layer coating systems. All tests were summarised into a qualitative ranking system, made for both the reference systems and novel systems developed in the project, summarising all the performance tests done on the coating systems. The best ranking value, eight, was found for one of the two-layer reference systems and one of the newly-developed systems, a three-layer system utilising an IR-cured midcoat. The economical assessments showed that a coil-coating line producing two-layer coatings and utilising UV-curing was clearly the cheapest compared to any other case. It was further assumable that a radcure three-layer line in cheaper than a conventional three-layer line.

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RFSR-CT-2005-00024 DECOBIOF

Development and evaluation of coatings and surface conditions on steel for antibacterial and easy to clean properties

Info

Type of Project	Research	Duration (months)	42
Total Budget	1693189 €	Start Date	1/07/2005
EU Contribution	1015914 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24189:EN

Final Abstract

This project aims to develop hygienic surfaces and coatings on steel, in order to reduce microbial proliferation and related contamination, and to provide easy-to-clean or self-cleaning surfaces. With this objective in mind, coatings/treatments with antimicrobial and easy-to-clean properties were produced by sol-gel, magnetron sputtering, organic coating application, ion implantation and plasma polymerisation techniques, on stainless steel and galvanised and polyester coated steels. The developed surfaces were characterised according to composition, morphology, surface roughness and water contact angle. The silver-containing coatings/treatments showed antibacterial activity. No evidence was detected of antimicrobial activity for TiO2 coatings, suggesting no photocatalytic activity of TIO2 under test conditions. No influence of biocide agents in corrosion performance was observed, except in the Kesternich test for silver-implanted stainless steel. Accelerated laboratory tests simulating exposure media and service conditions were successfully set up, namely the carbon black test and food staining test. The coatings/ treatments were exposed to simulated environments of outdoor industrial, food processing, and road tunnel and field tests in a sewage water plant, HVAC, food-processing environment and outdoor building exposure were carried out. Excellent cleanability and self-cleaning behaviour was observed for sol-gel coatings, mainly attributed to the highly hydrophilic surfaces achieved with these coatings. The sol-gel coating with TiO2 and Ag, the amorphous TiO2 coating with Ag by magnetron sputtering, Ag implantation and V3+B6 polyester coating modified with silver glass/zeolite were selected as the coatings/ processes with best functional performance. The functional long-term durability as well as the mechanical properties of the coatings should be further studied.

Partners

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Selected Publications

K. Yliniemi, P. Ebbinghaus, P. Keil, K. Kontturi, G. Grundmeier. Chemical composition and barrier properties of Ag nanoparticle-containing sol–gel films in oxidizing and reducing low-temperature plasmas. Surface & Coatings Technology 201 (2007) 7865–7872, DOI 10.1016/j.surfcoat.2007.03.023. URL http://www.sciencedirect.com/science/article/pii/S0257897207003428

P. Keil, V. Mollmann, J. Zuo, T. Titz, G. Grundmeier. Structural investigations of Ag containing TiO2 nanocomposite thin films prepared by means of RF-magnetron sputtering. 5th International Materials Symposium, MATERIAIS 2009, Lisbon, Portugal,5-8th April 2009. DOI: 499025. URL http://edoc.mpg.de/499025

O. Zubillaga, V. Madina, I. Braceras, L. Sánchez, N. Alvárez, J. Lorenzo. Surface modified stainless steel with antimicrobial activity by silver ion implantation. Twelfth International Conference on Plasma Surface Engineering September 13 - 17, 2010, in Garmisch-Partenkirchen, Germany. Poster presentation http://www.pse2010.net/tl_files/abstract-print/PSE2010-PO3044.pdf

S. Read, V. Madina, M. G. Serra, D. Jacobsson. Test methods for evaluation of hygienic surfaces. DECOBIOF project Deliverable 2.

V. Madina, S. Read, V. Matres, O.Van Den Berg, G. Grundmeier, D. Jacobsson, M. G. Serra. Guidelines for customers to specify products according to required properties in specific applications. DECOBIOF project Deliverable 5.

RFSR-CT-2005-00052

Improvement of line productivity and of immersed hot dip galvanizing roll lifetime by dross build-up-control

Info

Type of Project	Research	Duration (months)	36
Total Budget	1265704 €	Start Date	1/07/2005
EU Contribution	759422 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24260:EN

Final Abstract

In galvanizing baths, dross build-up is a chemical reaction involving the precipitation and growth of Fe2Al5Znx crystals on immersed rolls thanks to the iron and aluminium supplied from the bath. Hydrodynamics is one of the most influencing parameters. The crystals grow fast and big thanks to the high fluid velocity and the quick iron and aluminium supply by convection. Since the crystal content in iron is assured predominantly by the iron from the bath, the generation of Fe2Al5Znx crystals of 100 ?m requires a bath continuously saturated and supplied in dissolved iron. The mechanism of the phenomenon is more probably explained by a growth of the Fe2Al5Znx crystals (dross 'build-up'), than by an entrapment of bath drosses on the rolls (dross 'pick-up'). Immersion trials of small samples have showed that dross build-up microstructure and thickness are the same whatever the material nature and wetting ability. But the adhesion of the dross build-up layer is different and a use of a scraper can be made easier with well chosen materials. The actuator which was identified for dross build-up strong limitation is a local overheat of rolls. Two possible strategies are applicable. The first one involves the strip immersion at a temperature 10 to 15°C higher than the bath one. The second strategy is a direct local overheat of rolls.

Partners

	Country	*Scientific person in charge*
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Selected Publications

Y. Hardy , M. Dubois , J.-J. Bertrandie , H. Saint-Raymond. Mechanisms of Dross Build-up on Hot-Dipped Hardware. 7th International Conference on Zinc and Zinc Alloy Coated Steel Sheet, Galvatech '07. November 18-22, 2007, Osaka, Japan. Proceedings pp. 111-116. ISBN : 9784930980656

Y. Hardy, M. Dubois, J.-J. Bertrandie and H. Saint-Raymond (2007). Dross developing on immersed hardware. Revue de Métallurgie, 104, pp 354-358. DOI 10.1051/metal:2007112. URL http://dx.doi.org/10.1051/metal:2007112

RFSR-CT-2006-00015 NOVANNEAL

Novel annealing procedures for improving HDG of HSS

Info

Type of Project	Research	Duration (months)	36
Total Budget	1566642 €	Start Date	1/07/2006
EU Contribution	939984 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24990:EN

Final Abstract In the framework of this project, the effect of high oxygen partial pressure annealing conditions on zinc coating quality was investigated. It was shown that while lowering the hydrogen partial pressure at low dew points has already a positive effect on IF steels and also slightly on DP steels, for TRIP steels higher dew points are required. However, decarburisation is then a problem. While the wetting behaviour was observed to be well in agreement to the results obtained in the surface analytical investigation of the samples after the different annealing tests, adhesion did not show such a direct correlation. Even for perfectly grown inhibition layers, low adhesion was observed for TRIP annealed at very high oxygen partial pressures, due to decarburisation and grain cohesion problems caused by the massive internal oxidation. Clue-bend test and the advanced ball impact test were found to show higher sensitivity to the real adhesion situation than the standard ball impact test. Furthermore, important data was collected providing information about which oxygenleakages can be tolerated at different temperatures and hydrogen partial pressures. In the industrial trial, it was shown that lowering the hydrogen amount to 1 % shows good results for the DP and IF steels. This means that one direct outcome of this project is that saving of energy and costs in production lines can be immediately implemented. For improving the coating of TRIP steel the reaction window was found, however, to be too narrow.

Partners

	Country	*Scientific person in charge*
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DOC DORTMUNDER OBERFLÄCHENCENTRUM GmbH	DEUTSCHLAND	Ronny LEUSCHNER
VOESTALPINE STAHL GMBH	OESTERREICH	Gerhard ANGELI

Selected Publications

M. Rohwerder, S. Swaminathan. ON THE MECHANISM OF REACTIVE WETTING IN HOT-DIP GALVANIZING OF HIGH STRENGTH STEELS. GALVATECH 2011

S. Frenznick, S. Swaminathan, M.Stratmann, M. Rohwerder. A novel approach to determine high temperature wettability and interfacial reactions in liquid metal/solid interface. J Mater Sci. 45 (2010) 2106–2111. DOI 10.1007/s10853-009-4147-7

L. Bordignon, X. Vanden Eynde. Capabilities of Laboratory Equipments to Simulate and Improve the Industrial Hot Dip Galvanizing Process. GALVATECH 2011

RFSR-CT-2006-00016 WAVIMETER

Development of a waviness measurement for coated products

Info	Type of Project	Research	Duration (months)	43
	Total Budget	1556741 €	Start Date	1/07/2006
	EU Contribution	934046 €	End Date	31/01/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25877:EN			

Final Abstract If the waviness of the steel sheet is above defined limits, the steel user does not accept the product because it causes bad quality and downgrading in the further processing steps. As waviness, except for high glossy surfaces, is mostly not eye visible before painting, a measurement is required to online evaluate its level. As nothing exists today, a novel online system, measuring the waviness and recognising its type during the production process, is of great interest and was the main objective of this project.

		Country	*Scientific person in charge*
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	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Guillermo VECINO
	SOCIETE EUROPEENNE DE GALVANISATION SA - SEGAL	BELGIQUE	Ernesto MONTAGNA
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RFSP-CT-2007-00017 Stripvibrations reduction

Improvement of productivity on hot dip galvanizing line by decreasing strip vibrations in gas jets cooling system

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	1518256 €	Start Date	1/07/2007
	EU Contribution	607303 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25317:EN			

Final Abstract The high quality standard of coated steels requires good stability of the strip, particularly in the cooling tower after the zinc bath, where the gas jets of the cooling equipment excite the strip. The objective of the pilot project is to increase the line productivity and coating quality by decreasing the vibrations along the cooling path, not with external stabilising actuators but by the improvement of existing cooling technologies. We applied a methodology mixing industrial trials, experiments on a semi-industrial facility and a theoretical approach. Despite the unforeseen withdrawal of the initial line due to financial difficulties in the European steel industry, we choose a new industrial line. Thus the major achievements are as follows. — Actual state of vibration amplitudes under industrial conditions and the effect of the major process parameters. — A model coupling physical and numerical approaches, able to predict the vibration amplitudes and frequencies for specific process parameters and configurations. — A new cooling technology that significantly reduces strip vibration amplitudes was designed and tested before being implemented on the chosen industrial line (revamping of existing cooling equipment). — The principles of those findings extended by the partner Drever to a new efficient cooling equipment dedicated to fast cooling sections (protective atmosphere). Many new lines are equipped with this innovative equipment. Acceptance tests show significant benefits. The project ended with success: the innovation has been implemented worldwide on many HDG lines. There are great benefits: strip stability, cooling efficiency and product quality. The results are shared with the community: six publications 1–4, 25–26 and two patents 27–28.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Karen BEAUJARD (Pr. Coord.)
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	DREVER INTERNATIONAL SA	BELGIQUE	Michel RENARD

Patents

EP2100673 (B1) Jérôme Muller, Akli Elias, Thierry Petesch, Ivan Santi, Paul Durighello, Karen Beaujard, Method and device for blowing a gas onto a moving strip

WO 2004024959 (A1) Jean-Marc Raick, Jean-Pierre Crutzen, Edgard Dosogne, Michel Renard, Atmosphere control during continuous heat treatment of metal strips

Selected Publications

Makhlouf Hamide, Karen Beaujard, Predictive model of strip vibrations in gas jets cooling sections, Galvatech Conference 2011, Genoa, Italy, June 21-24

Michel Renard, Edgar Dosogne, Jean-Pierre Crutzen, Jean-Marc Raick, Ma jia ji , Lv jun and Ma bing zhi, High cooling performances of Ultra Fast Cooling Technology, Galvatech Conference 2011, Genoa, Italy, June 21-24

Michel Renard, Edgar Dosogne, Jean-Pierre Crutzen, Jean-Marc Raick, Ma jia ji , Lv jun and Ma bing zhi. Improvement of Cooling Technology through Atmosphere Gas Management. Asia-Pacific Galvanizing Conference 2009, Korea, November 8-12, 2009

M. Renard, K. Beaujard Control of strip vibrations in cooling equipments of galvanizing lines. 5th China International Steel Congress, Shanghai (China), June 1-4, 2008

M. Renard, J. Muller, D. Van de Vyver, F. Gurniki, K. Beaujard , Control of strip vibrations in gas jets cooling areas, Proceedings of Galvatech'07, 7th International Conference on Zinc and Zinc Alloy Coated Sheet Steels, Osaka (Japan), November 18-22, 2007, pp. 57-62

RFSR-CT-2007-00018 Hppm

Methodology of hydrogen measurement in coated steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	959871 €	Start Date	1/07/2007
	EU Contribution	575922 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25949:EN			

Final Abstract A valuable collection of more than 500 hydrogen articles was compiled into a searchable database including all articles as PDF files. Calibration of hydrogen analysers was studied for both procedures, gas and reference materials. Recommendations are given on how to proceed. A new electrochemical calibration method was developed and its performance is described in detail — including a novel feature, the effusion transient shaping. Details of the required cleaning steps and requirements for coating removal to avoid changes in the apparent hydrogen content are described in detail. In addition proper storage conditions were identified. The influence of each single parameter (weight, form, width, cleaning heating rate, heating programme, etc.) on the hydrogen content was studied to derive rules for high reproducibility, repeatability, accuracy, linearity, selectivity, specificity and robustness of melt and solid extraction. The limits of GDOES as an analytical tool were identified as well. Screening of local hydrogen analysis was performed by means of ToF-SIMS and nano-SIMS. Chemical charging in deuterated solutions has been identified as a powerful tool for the identification of the reaction mechanism and the diffusability of hydrogen in steel.

		Country	*Scientific person in charge*
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	VOESTALPINE STAHL GMBH	OESTERREICH	Alexander TOMANDL

RFSR-CT-2008-00017 IPSA

Innovative packaging steel with enhanced adhesion to organic coatings based on nanostructured interphases

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1384623 €	Start Date	1/07/2008
	EU Contribution	830774 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25888:EN			

Final Abstract This project aimed to develop an 'innovative-packaging-steel with enhanced adhesion' (IPSA) as replacement for ECCS. Therefore different surface treatments were used to generate thin oxide-films on low-tin-steel (LTS). Different LTS was produced. Scale-up was done on a pilot line and two variants (reflown/non-reflown) were produced industrially. LTS with 0.5 g/m2 non-reflown was best substrate. Plasma polymer-films based on silica were deposited onto LTS. Barrier properties of these films were good, but complete loss of adhesion was found after curing. SnOx-thermal-CVD-films revealed better adhesion, but wet adhesion was bad. This was due to cohesive failure. Titanium oxide-films exhibit good adhesion, with films deposited at 150 °C. None of the gas-phase deposited oxide-films have same performance as ECCS. Also water-based surface treatments were selected from different suppliers. Nine different systems were prepared onto LTS. Samples were investigated without and with organic coatings following a well-defined test-program. Selection was further narrowed down to five systems, three for spray application and two for electrochemical application. In many aspects of product performance non-reflown LTS is comparable to ECCS. For polymer-coated applications, LTS does not provide a suitable substrate since it shows poor adhesion of the polymer-film after DRD deformation. LCA and food safety evaluation was done. Pack test material and DRD cans were produced semi-industrial. After DRD-can forming adhesion loss and high porosity was observed for all alternatives, ECCS is still the best for 3-step-DRD application. Applications like crown corks, closures or ends might be replaceable by LTS or LTS with spray-application surface treatment H5.

		Country	*Scientific person in charge*
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RFSR-CT-2008-00018 MICSIPE

Microbiologically induced corrosion of steel structures in port environment: improving prediction and diagnosis of ALWC

Info

Type of Project	Research	Duration (months)	36
Total Budget	1490294 €	Start Date	1/07/2008
EU Contribution	894176 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25904:EN

Final Abstract

This project deals with accelerated low water corrosion (ALWC) on steel structures in the port environment. It aims at improving knowledge of this microbiologically influenced corrosion by studying metabolically active bacterial diversity and at proposing a model for ALWC diagnosis. The first part of this work consists in the multidisciplinary analysis (physics, chemistry, microbiology, corrosion, modelling …) of corrosion deposits sampled in three European ports. Distinctions could be made between ALWC and NLWC (normal low water corrosion) in terms of physicochemical and microbiological compositions. Diversity of total and active bacterial communities was evaluated by molecular methods applied on corrosion deposits for the first time. Specific species of SRB and SOB were found to create an active sulphur cycle in ALWC corrosion deposits. In a particular case, the presence of photosynthetic micro-organisms in NLWC deposits could have influenced corrosion processes. These results lead to a statistical model for ALWC diagnosis. Accuracy of the proposed positive and negative markers could be improved by the implementation of more data. Laboratory system devices were also developed to assess biotic and abiotic parameters influences. ALWC was simulated on steel specimens and a specific active bacterial species (type SRB) has been highlighted to have a role in ALWC, even at low concentration. This project enables to reinforce that ALWC is microbiologically influenced and is a complex phenomenon. Molecular methods developed during the project as well as laboratory devices and statistical model are promising tools to have a more comprehensive insight of ALWC mechanism and to help for its diagnosis.

Partners

	Country	*Scientific person in charge*
CENTRE REGIONAL D'INNOVATION ET DE TRANSFERT DE TECHNOLOGIE B-N COT.	FRANCE	Emilie MALARD (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Anne FAGOT
SWEREA KIMAB AB	SVERIGE	Rolf GUBNER
TECHNISCHE UNIVERSITEIT DELFT	NEDERLAND	Gerard MUIJZER
UNIVERSIDAD DE CADIZ	ESPAÑA	Francisco Javier BOTANA PEDEMONTE
UNIVERSITE DE ROUEN HAUTE-NORMANDIE	FRANCE	Laurent QUILLET

Selected Publications

F. Marty et al., Evaluation and optimization of nucleic acid extraction methods for the molecular analysis of bacterial communities associated with corroded carbon steel, Biofouling 28, (2012) 363-380. DOI:10.1080/08927014.2012.672644. http://www.tandfonline.com/doi/abs/10.1080/08927014.2012.672644?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub=pubmed#.UcLU79g1Bbw

Païssé S, Ghiglione JF, Marty F, Abbas B, Gueuné H, Amaya JMS, Muyzer G, Quillet L. 2012. Sulfate-reducing bacteria inhabiting natural corrosion deposits from marine steel structures. Applied Microbiology and Biotechnology:1-12. DOI 10.1007/s00253-012-4464-7. http://link.springer.com/article/10.1007/s00253-012-4464-7

Lemière A. Towards a better diagnosis for suspected ALWC affected port structures. World Port Development. April 2012. 37-39.

RFSR-CT-2008-00019 FERRIGAL

Steady reactivity in hot-dip coating by direct deposit of iron oxides

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1147262 €	Start Date	1/07/2008
	EU Contribution	688358 €	End Date	30/06/2011
State	Project completed			

Provisional Abstract The inert oxides of resistance steel grades are a major problem for hot dip galvanizing. Especially interesting from the industrial point of view are concepts to avoid surface oxide formation of alloying elements. One approach is to modify the annealing procedure prior to hot dip galvanising. This proposal suggests a much simpler and easy to apply procedure: to deposit a thin iron oxide layer, e.g. by a simple dipping deposition, as barrier against segregation. The iron oxide is reduced during the annealing and serves then as a reactive surface excellently wettable by the liquid zinc.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Maiwenn LARNICOL (Pr. Coord.)
	MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Michael ROHWERDER
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Victoria MASAGUER TORRES
	TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Florian MENGUELTI

RFSR-CT-2008-00046 NEXTEP

Novel externally enhanced pickling improvement for short / mid term

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1908963 €	Start Date	1/07/2008
	EU Contribution	1145378 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25887:EN			

Final Abstract The purpose of this project was to develop and then to evaluate boosting techniques to accelerate pickling in existing pickling lines. The three techniques under study were AC processing, dynamic control and remote cavitation. The final objective was the processing of difficult-to-pickle grades without decreasing while keeping the same speed and thus high productivity. A collateral intended benefit was the reduction of the environmental impact of pickling. The three boosting techniques were investigated at various levels. At first, each of them was developed and tested in the laboratory. Then, all the techniques were tested in one common pilot rig, using the same samples. This common testing enabled very objective comparisons as well as the analysis of possible combinations. Several partners took part in the common tests. The main results of the investigations have been summarised by means of pickling time improvement. Moreover the application of each boosting technique has been considered in a very practical way: space needed, cost evaluation, energy consumption. This gives the tools to select one possible boosting technique depending on the amount of difficult-to-pickle steel grades, the space constraints and the availability of energy. The specific costs and savings have been quantified, in order to give as precise as possible industrial guidelines.

		Country	*Scientific person in charge*
Partners	**ILVA S.P.A.**	ITALIA	Floriano FERRO (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	José Luis RENDUELES VIGIL
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jean CRAHAY
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Armando GIANNETTI
	TENOVA SpA	ITALIA	Gerolamo FASCE
	SIEMENS VAI METALS TECHNOLOGIES SAS	FRANCE	Philippe BARBIERI
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Frank RÖGENER

RFSR-CT-2009-00010 REPAIR

Evaluation of new coating concepts based on active network reconstruction and their applicability to the production of coil-coated steel sheet

Info

Type of Project	Research	Duration (months)	36
Total Budget	1181533 €	Start Date	1/07/2009
EU Contribution	708920 €	End Date	30/06/2012

State Project completed

Provisional Abstract The aim is to evaluate existing concepts of self-repair functionalities found for polymeric materials for their suitability to the production of coil-coated steel products. The goal is to develop a coating, maintaining its integrity, correcting its in-use damages and thereby increasing its life-time. The project is not focusing on corrosion inhibition although an increased corrosion protection is a consequence of the self-repair functionality. The project will choose 4 - 5 “selfrepair” concepts and develop out of them 1 - 2 fully formulated coil-coating systems. These will be evaluated on their potential to become successful coil-coated products with good business potential.

Partners

	Country	*Scientific person in charge*
TOP ANALYTICA OY AB	FINLAND	Bengt-Johan SKRIFVARS (Pr. Coord.)
AKZO NOBEL INDUSTRIAL FINISHES AB	SVERIGE	Irina TRAN
RUUKKI METALS OY	FINLAND	Pasi VÄISÄNEN
SSAB TUNNPLÅT AB	SVERIGE	Per-Erik SUNDELL
UNIVERSITÄT PADERBORN	DEUTSCHLAND	Wolfgang BREMSER
VOESTALPINE STAHL GMBH	OESTERREICH	Michaela SCHATZL

RFSR-CT-2009-00014 AUTOCOAT

Advanced zinc-based hot dip coatings for the automotive application

Info

Type of Project	Research	Duration (months)	42
Total Budget	1605356 €	Start Date	1/09/2009
EU Contribution	963214 €	End Date	28/02/2013

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26323:EN

Final Abstract

The aims of this project were to establish connections between the coating composition, microstructure, pre-treatment and corrosion performance of ZnAlMg 'ZMA' coatings both in accelerated tests and field exposures. Line hot dip materials including four conventional zinc coatings and three ZMA coatings (ZnMg1%Al1%, ZnMg2%Al2%, ZnMg1.5%Al1.5%) were selected. In addition, a galvanising simulator was used to prepare ZMA coatings with different compositions of Mg and Al (up to 4 %). ZMA coatings were suitable for standard phosphatising process and showed good robustness in respect to process variations. ZMA coatings also showed rather comparable application properties to HDG regarding formability, spot welding and adhesive bonding. Significant improvements of ZMA over standard coatings were observed to be more pronounced for the most aggressive tests and especially for early stages of corrosion. ZMA coatings exposed in stationary sites and on-vehicle showed an improvement of 2 compared to HDG when tested unpainted in open configurations, while no differences were observed on painted samples after 2 years. For hem-flange designs, the improvement of ZMA was not obvious whatever the tests. The corrosion performance of ZMA was not linked to the presence of a specific corrosion product (simonkolleite or hydrotalcite). Rather, it is suggested that the effect of the alloying element is in the change of the microstructure and resulting anode/cathode ratio that will profoundly affect the pH of the cathode and explain the improved corrosion behaviour. This also explains why the improvement after long-term field exposure tests is less pronounced, as this effect is mainly active in the initial stages

Partners

	Country	*Scientific person in charge*
INSTITUT DE LA CORROSION SASU	FRANCE	Nathalie LE BOZEC (Pr. Coord.)
CENTRO RICERCHE FIAT S.C.p.A.	ITALIA	Giancarlo MARCHIARO
FIAT GROUP AUTOMOBILES SpA	ITALIA	Gian Carlo LUNAZZI
LIMEDION GMBH	DEUTSCHLAND	Frank FRIESS
MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Michael ROHWERDER
RUUKKI METALS OY	FINLAND	Ari PELTOLA
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Linda LUXEM
VOESTALPINE STAHL GMBH	OESTERREICH	Gerald LUCKENEDER

Selected Publications

N. LeBozec, D. Thierry, M. Rohwerder, D. Persson, G. Luckeneder, L. Luxem . Effect of carbon dioxide on the atmospheric corrosion of Zn–Mg–Al coated steel, Corrosion Science, 2013, in press. URL : http://dx.doi.org/10.1016/j.corsci.2013.05.011

N. LeBozec, D. Thierry, A. Peltola, L. Luxem, G. Luckeneder , G. Marchiaro, M. Rohwerder. Corrosion performance of Zn–Mg–Al coated steel in accelerated corrosion tests used in the automotive industry and field exposures, Material and Corrosion, 2013, in press. DOI: 10.1002/maco.201206959

Guidelines for the industry, Autocoat project Deliverable D15

RFSR-CT-2010-00012 HEAT

High emissivity annealing technique

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1671966 €	Start Date	1/07/2010
	EU Contribution	1003179 €	End Date	31/12/2013
State	Running project			

Provisional Abstract The study suggests to reduce/suppress the selective oxidation made during the recrystallisation annealing by a layer of shielding iron oxide. This iron oxide has to be thin and continuously kept during the whole heating and soaking steps for avoiding the external selectve oxidation and for increasing thermal transfer from the radian tube furnace, which should significantly reduce the fuel consumption. To ensure that this strategy can be readily adopted by steel industry, the kinetics of oxidation and reduction need to be studied and an online monitoring for the layer iron oxide thickness to be developped.

		Country	*Scientific person in charge*
Partners	**THYSSENKRUPP STEEL EUROPE AG**	DEUTSCHLAND	Patrick KUHN (Pr. Coord.)
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Louis BORDIGNON
	MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Michael ROHWERDER
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Wanda MELFO
	VOESTALPINE STAHL GMBH	OESTERREICH	Alexander JAROSIK

RFSR-CT-2010-00013 ULTRA DRY COOLING

Development of an ultra fast cooling concept based on the dispersion of a liquid hydrocarbon in a continuous heat treatment line for steel strips

Info

Type of Project	Research	Duration (months)	48
Total Budget	979426 €	Start Date	1/07/2010
EU Contribution	587655 €	End Date	30/06/2014

State Running project

Provisional Abstract The project aims at developing a technological breakthrough in the area of steel strip cooling devices, in continuous processing lines. This new cooling device consists in projecting a spray of liquid hydrocarbon (such as pentane) on the strip surface. The hydrocarbon is vaporized by the hot steel, extracted from the cooling box, and re-condensated to operate in closed-loop. This original process brings tremendous advantages to steelmakers: much higher cooling rates without strip fluttering compared to classical jet cooling systems, no strip oxidation compared to water-based cooling systems, and ultra low energy consumption.

		Country	*Scientific person in charge*
Partners	**CMI GREENLINE SAS**	FRANCE	Ludovic FERRAND (Pr. Coord.)
	ASS. POUR LA RECHERCHE ET LE DEV. DES METHODES ET PROC. IND., ARMINES	FRANCE	Maroun NEMER
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Pascal GERKENS

Patents 1 patent EPO, Brasil, Russia, India, China, Canada, USA. EPO n° 10290086.7, 19/02/2010

Selected Publications

P. Dubois, L. Ferrand, D. Abdo, M. Brunet, D. Clodic, M. Nemer, M. Zoghaib. A breakthrough in intense cooling technologies non oxidant process based on Alkane phase change. Galvanizer 2009

D. Clodic, M. Nemer, M. Zoghaib. A laboratory test bench to characterize the cooling performance of the spray. Project Delivrable 1.1

L. Ferrand, P. Dubois, D. Abdo, M. Zoghaib. A pilot bench for cooling an endless strip with alkane sprays. Deliverable4.

RFSR-CT-2010-00014 HIJETROD

High pressure water descaling for wire rod

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1751940 €	Start Date	1/07/2010
	EU Contribution	1051164 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract During rolling and annealing of steel, metal oxides are formed on the steel surface. For downstream processing a scale-free surface is essential. The project aims to reduce the high effort required for pickling to remove scale and to replace resource-intensive pretreatment by employing environment-friendly high pressure water jets both within and downstream of the pickling process. This high pressure water treatment used as “cold” scale removal is new with respect to wire rod, and is being pursued for the first time. The development risk can be clearly assessed by the partners thanks to their complementary expertise regarding research and application.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Barbara WENDLER (Pr. Coord.)
	COGNE ACCIAI SPECIALI SpA	ITALIA	Alessio CAVALIERI
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Nicoletta ZACCHETTI
	DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Jürgen ALEX
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ

RFSR-CT-2010-00015 Flat strip control

Controlling flatness of strips in furnace of continuous annealing/galvanising lines

Info	Type of Project	Research	Duration (months)	46
	Total Budget	883732 €	Start Date	1/07/2010
	EU Contribution	530239 €	End Date	30/04/2014
State	Running project			

Provisional Abstract Buckling and strip tracking are common problems in continuous lines with annealing furnace and they are sources of product downgrading and/or loss of productivity. This phenomenon is more likely to occur on thin and wide material and consequences are more disastrous. Unfortunately, market trend is towards such material.
A way of gaining control over the strip flatness into the furnace would be of great help to produce this material cost-effectively. It is thus proposed to measure the strip shape and temperature across its width inside the furnace in one or several locations for gaining knowledge about buckling.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Yves HARDY (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Noelle MICQUE
	SWEREA MEFOS AB	SVERIGE	Annika NILSSON

RFSR-CT-2010-00016 ELOTOP

Influences of the electro galvanizing process on the surface topography alterations

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1369914 €	Start Date	1/07/2010
	EU Contribution	821949 €	End Date	31/12/2013
State	Running project			

Provisional Abstract Steel flat products are protected against corrosion by electrolytic zinc coatings. The roughness is very important regarding the deep drawability and the paintability. Presently it is difficult to produce the final roughness in such close tolerances as demanded by the automotive industry.
Main influencing variables are: topography and steel grade of the primary material, plant configuration, process parameters and composition of the electrolyte applied. Aim of this project is to investigate the electrolytic zinc coating process and to develop rules and models to achieve designated final roughness. The models will be applied and verified.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Jochen KURZYNSKI (Pr. Coord.)
	SALZGITTER FLACHSTAHL GmbH	DEUTSCHLAND	Andreas HOLDINGHAUSEN
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Alexander BUTTLER
	VOESTALPINE STAHL GMBH	OESTERREICH	Johann GERDENITSCH

Selected Publications Activity Report 2011/2012. VDEh-Betriebsforschungsinstitut GmbH (www.bfi.de)

RFSR-CT-2010-00017 FLEXPROMUS

Flexible production by multi sensor process control of pickling lines

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1387689 €	Start Date	1/07/2010
	EU Contribution	832613 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract The project aims at smart control of stainless steel pickling lines by developing a multi-sensor concentration detection system and advanced process control models. The concentration detection combines online-sensors and a model-based multi-physics model algorithm for acids and metal concentration detection in mixed-acid pickling liquors. For smart process control an intelligent and a standard process control model are developed and investigated in two different stainless steel pickling line types. Actually the stainless steel sector is under economic pressure. The smart control system will be a major contribution for improved product quality and flexible production in stainless steel pickling lines.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Matthias WERNER (Pr. Coord.)
	ACERINOX EUROPA SA	ESPAÑA	Maria José GUIO BONANY
	ANDRITZ AG	OESTERREICH	Albert LEBL
	SWEREA KIMAB AB	SVERIGE	Petter BERGSJÖ
	OUTOKUMPU NIROSTA GmbH	DEUTSCHLAND	Hans-Günther HARTMANN

RFSP-CT-2011-00013 WAVISURF

On-line industrial waviness measurement

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	1549090 €	Start Date	1/07/2011
	EU Contribution	774545 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

The mastering of the waviness is becoming a major issue for making high quality coated steel.
If the waviness of a steel sheet is above defined limits, the steel user does not generally accept the annealed and galvanised product for high added value application because it can cause poor quality and downgrading in the further processing steps, notably the finishing and painting operations.
Except the sensor developed in a now completed RFCS project “Development of a waviness measurement for coated products”, no waviness measurement exists today on line on moving products. When waviness is measured, it is in a static way and quasi always on samples taken from head or tail of coils, so not necessarily representative of all the length of coil.
As a consequence, an on-line measurement is mandatory to fully evaluate the surface quality all along the coil and to potentially control the production parameters.
In this pilot project, the on-line method proposed by CRM will be put at the industrial level with two main objectives:
- To assess the operating guidelines allowing to reach the waviness target defined by the customers.
- To collect all the data needed for the implementation and the commercialisation of a commercial industrial sensor.

		Country	*Scientific person in charge*
Partners	**CENTRE DE RECHERCHES METALLURGIQUES ASBL**	BELGIQUE	Geneviève MOREAS (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Adrian ESPINE VIELLA
	AMEPA ANGEWANDTE MESSTECHNIK UND PROZESSAUTOMATISIERUNG GMBH	DEUTSCHLAND	Wolfgang BILSTEIN
	SOCIETE EUROPEENNE DE GALVANISATION SA - SEGAL	BELGIQUE	Ernesto MONTAGNA

RFSR-CT-2011-00014 VADPSHEETS

Property oriented design of hard constituent hardness and morphology in continuously annealed/galvanised DP sheets

Info

Type of Project	Research	Duration (months)	42
Total Budget	1567758 €	Start Date	1/07/2011
EU Contribution	940655 €	End Date	31/12/2014

State Running project

Project web page http://www.vadpsheets.agh.edu.pl/

Provisional Abstract

The proposal is aimed at developing a metallurgicaly based model for continuous annealing/galvanizing process capable of identifying the quantitative effect of chemical composition and thermal profile on the properties of DP sheets, including:
• Strength and uniform elongation;
• Press formability (stretch-flengeability, bending formability, stretch-formability, drawing formability);
• Fatigue;
• Bake hardenability;
• Weldability;
• Resistance to crack formation during cold deformation;
• Crash worthiness.
The model will be implemented in the computer software for the representation of explicit picture of microstructure (Digital Material Representation) and properties prediction. The software will be used for the process parameters adjustment to meet specific customer requirements.

Partners

	Country	*Scientific person in charge*
INSTYTUT METALURGII ZELAZA IM. STANISLAWA STASZICA	POLAND	Roman KUZIAK (Pr. Coord.)
AKADEMIA GORNICZO-HUTNICZA IM. STANISLAWA STASZICA W KRAKOWIE AGH	POLAND	Maciej PIETRZYK
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Mohamed GOUNE
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Griet LANNOO
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Norbert KWIATON

RFSR-CT-2011-00015 ATCORAS

Modelling of atmospheric corrosion of steel protected by aluminium based alloys, applied by hot dip processing

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1327462 €	Start Date	1/07/2011
	EU Contribution	796477 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

In this project a modelling tool is developed and validated for the understanding of the atmospheric corrosion behaviour of steel protected by aluminium based alloys, applied by hot dip processing. In particular, the role of additives (Mg, Si, Zn …) is studied. The research aims to model the impact of the metallic coating compositions in various conditions of the liquid film (pH, Cl-, thickness, ...) and to explore and evaluate how the developed model can be integrated with life time prediction tools of real structures under varying atmospheric corrosion conditions.
The final objective is to design optimal coatings for given atmospheric conditions.

		Country	*Scientific person in charge*
Partners	**VRIJE UNIVERSITEIT BRUSSEL**	BELGIQUE	Johan DECONINCK (Pr. Coord.)
	ELSYCA NV	BELGIQUE	Leslie BORTELS
	INSTITUTO SUPERIOR TECNICO	PORTUGAL	Sviatlana LAMAKA
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Joost DE STRYCKER
	UNIVERSIDADE DE AVEIRO	PORTUGAL	Mikhail ZHELUDKEVICH

RFSR-CT-2011-00016 ICONTENS

Intelligent self-learning control of levelling processes by use of soft sensor techniques to predict residual stress and flatness

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2113670 €	Start Date	1/07/2011
	EU Contribution	1268203 €	End Date	31/12/2014
State	Running project			

Provisional Abstract Leveller settings are normally done by experience of the operator, using visual feedback of the geometrical shape of strip. The increasing use of (A)HSS requires levelling strategies preventing loss of deformation properties. This project aims at developing multi-physics process models for different leveller types for automated auto-adaptive set-up and advanced on-line control of residual stress and flatness using intelligent soft sensors predicting residual stresses and flatness. Bending processes around deflection rolls and coilers will be considered while developing strategies for minimum total elongation. With automated control for minimisation of residual stresses, quality and consistency of the strip levelling process are optimised

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Volker DIEGELMANN (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Tété DOSSAH
	ACCIAI SPECIALI TERNI SpA	ITALIA	Mirko NICOZIANI
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Maurizio LUBRANO
	SWEREA MEFOS AB	SVERIGE	Annika NILSSON
	OUTOKUMPU NIROSTA PRECISION GmbH	DEUTSCHLAND	Christoph MÜLLER

RFSR-CT-2012-00013 ZINCOBOR

Exploring of crack initiation mechanisms and process parameter interactions in press hardened boron steel components actively protected by Zn-based coatings

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1546342 €	Start Date	1/07/2012
	EU Contribution	927804 €	End Date	31/12/2015
State	Running project			

Project web page http://zincobor.ctm.com.es/

Provisional Abstract

The increasing demand for light weight car body structures with enhanced safety properties is the main driving factor for the introduction of press hardened components in automotive applications. The desire to use such components with superior mechanical properties in heavy-duty corrosion applications led to the development of zinc-based coatings on high-strength steels in order to provide an active corrosion protection. Up to the present these coatings exhibit the main drawback of cracks appearing after the direct press hardening regardless the applied coating process with the risk of intolerable crack propagation into the base material. Some presumptions concerning the underlying mechanisms already exist, e.g. a liquid melt assisted cracking in the presence of a Znmelt and a stress state or a grain boundary embrittlement caused by a corrosive composition of the coating and the possibility of diffusion processes, but the real mechanisms may be even more complex due to superposition of various effects. Up to now there is a major lack of knowledge about the responsible thermo-chemical, thermomechanical and/or high-temperature tribological effects and conditions which are responsible for the crack initiation and its growth. Therefore, the motivation of this project is to deal with such drawbacks and increase the existing knowledge allowing to understand them. The objective is to explore the mechanisms of crack initiation and propagation, to identify the process parameters responsible for such detrimental effects and develop solutions to prevent it. The information about these phenomena is essential for an optimisation of the coatings, its deposition methods and/or for the design of direct press hardening processes. For this the influence of each step in the process chain will be investigated separately but with consecutively increasing complexity of the responsible mechanisms and interactions by the use of modified test facilities and tests on industrial scale.

		Country	*Scientific person in charge*
Partners	**FUNDACIO CTM CENTRE TECNOLOGIC- CTM**	ESPAÑA	Daniel CASELLAS (Pr. Coord.)
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Guido HENSEN
	UNIVERSITÄT KASSEL	DEUTSCHLAND	Kurt STEINHOFF
	VOESTALPINE STAHL GMBH	OESTERREICH	Thomas KURZ

RFSR-CT-2012-00014 BOLT_ZnAlMg

Better offshore lighter batch HDG technology using Zn Al Mg alloys

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1209813 €	Start Date	1/07/2012
	EU Contribution	576693 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

Presently, flat products are galvanized with ZnAlMg alloys using continuous HDG processes while long products use batch double dip HDG technology which is only available in Asia. However, when targeting the development of spin batch HDG processes, additional challenges exist to galvanize with these complex alloys. In fact, batch single dip HDG technology using ZnAlMg alloys is not yet developed in Europe either with or without spinning.
Therefore, this proposal intends to use existing state-of-the-art to develop spinnable ZnAlMg alloys and respective batch HDG technology for offshore threated fasteners which are mechanically reliable, cheaper and more corrosion resistant at reduced thicknesses.

		Country	*Scientific person in charge*
Partners	**METALOGIC AI TECHNOLOGIES & ENGINEERING NV**	BELGIQUE	Erik THOMAS (Pr. Coord.)
	GFD SAS	FRANCE	Laurent GINEYS
	GALVA POWER GROUP NV	BELGIQUE	Caroline MASQUELIER
	HILTI AG	LIECHTENSTEIN	Frédéric POL
	PROGATEC AB	SVERIGE	Kaj STEEN
	STEINBEIS GMBH & CO KG FÜR TECHNOLOGIETRANSFER	DEUTSCHLAND	Peter HAEFELE

RFSR-CT-2013-00009 EfficientELO

Energy and resource efficient electro-galvanizing of steel strip

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1759212 €	Start Date	1/07/2013
	EU Contribution	1055528 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

Main advantages of steel strip electrolytic galvanizing are the visual appearance of the coated sheets, high flexibility of the plants and a low impact on material properties due to the low process temperature. Disadvantages are the high electrical energy consumption and the associated costs. Large amounts of Zink containing dross occur as residues in the hot-dip galvanizing lines which could cover a considerable part of the zinc requirement for the electro-galvanizing lines. To improve the application of electro-galvanizing, the proposed project aims at improving the energy and resource efficiency of the coating processes. To lower the energy consumption for electro-galvanizing processes of steel strips, the conductivity of the electrolyte solutions will be improved by both, increasing the temperature and developing new electrolyte formulations. Furthermore, the influence of the dross accompanying elements – such as Aluminium and Magnesium – on electrolyte conductivity and the quality of the resulting coatings will be examined. For the utilization of zinc containing top-drosses extensive examinations on dissolution and purification will be necessary to develop an appropriate process. The most important restriction for the further enhancement of the conductivity by increasing the temperature, acid concentration or by any other changes in formulation is the insufficient corrosion resistance of some plant components: Especially, the lifetime of the catalytic active coatings on the anodes is decreased and need therefore a further improvement in terms of long-term stability. The applicability of new formulations, the generation of electrolytes from top dross and the examination of component of component stability will take place in both, lab and technical scale. For selected electrolytes and components, tests on pilot and industrial scale will be performed.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Andreas BAN (Pr. Coord.)
	ANDRITZ AG	OESTERREICH	Tomaz LAVRIC
	INDUSTRIE DE NORA SPA	ITALIA	Alice CALDERARA
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Marc DEBEAUX
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Alexander BUTTLER
	VOESTALPINE STAHL GMBH	OESTERREICH	Johann GERDENITSCH

RFSP-CT-2014-00013 ACE-PICK

First Worldwide full-scale demonstration of Alternating Current (AC) Electrolytic PICKling on carbon and stainless steel coils

Info	Type of Project	Pilot&Demonstration	Duration (months)	39
	Total Budget	2974444 €	Start Date	1/04/2014
	EU Contribution	1487220 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

An innovative electrolytic pickling process, based on Alternating current (AC), have been developed at laboratory scale for carbon and Stainless steels. AC represents a real breakthrough in the field of pickling process. Laboratory tests showed for Stainless steel grades a very higher efficiency than conventional treatment, in terms of reduction of pickling time, saving of fresh chemicals e minimization of environmental impact. Also surface quality is enhanced by AC pickling due to the fact that shot blasting and or abrasive brushing can be eliminated or reduced. Regarding carbon steel, laboratory tests and also the RFCS project “NEXTEP” confirmed that AC electrolytic pickling can be used as a booster able to provide to pickling lines a higher productivity or an increased flexibility in terms of range of products that can be treated at the same line speeds. This in particular for C-steel grades that normally result harder to be pickled such as special C-steel grades. The main objectives of this project are to install a AC pickling section on a Annealing and Pickling Line (and to validate on full industrial scale the new AC process/technology both on stainless steel grades and on carbon ones. The main activities to be carried-out in the project may be arranged as following: 1.Design, installation and erection of the new electrolytic section for using with the AC process. 2. Laboratory definition of working conditions with the AC on Stainless Steel and Carbon grades. 3. Design of an innovative filtering system for the removal of unsolved scale and on line validation test; 4. Durability and reliability evaluation of employed technological solutions; 5. Long-term pickling tests on Hot and Cold Rolled steel grades. 6. Qualitative and comparative surface characterization. 7. Evaluation, of the effects of AC on consumption of fresh chemicals and sludge production. 8. Technical-economical balance of the benefit of AC process/technology compared to conventional ones.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Stefano LUPERI (Pr. Coord.)
	ARCELORMITTAL BREMEN GMBH	DEUTSCHLAND	Dietmar RINGEL
	MARCEGAGLIA - S.P.A.	ITALIA	Arnaldo BARINI
	SCANACON AB	SVERIGE	Thorsten SCHNEIKER
	TENOVA SpA	ITALIA	Stefano MARTINES

RFSR-CT-2014-00014 STEELPV

Sustainable steels for direct deposition of photovoltaic solar cells

Info	Type of Project	Research	Duration (months)	39
	Total Budget	2201974 €	Start Date	1/07/2014
	EU Contribution	1321183 €	End Date	30/09/2017
State	Running project			

Provisional Abstract

By 2020, several European Directives promoting renewable sources to produce 20% of the EU energy consumption and to reach a nearly Zero Energy Buildings have to be fulfilled. To date, only high cost solar grade stainless steel has been industrially used as direct flexible substrate for photovoltaic applications, offering a great possibility for steel value added products expansion. Indeed, STEELPV project proposes to functionalize 'rough' structural steel as direct substrates for photovoltaic devices. Three steel grades will be used (stainless steel different from solar grade stainless steel, galvanized/aluminized cold rolled low carbon steel and bare cold rolled low carbon steel) taking into account industrial implementation feasibility of the steel/PV systems. Steels compatibility with the thin film PV deposition processes selected, based on silicon, chalcopyrite and organic technologies, will be carried out through the development of intermediate layers using non-vacuum and vacuum strategies. The viability of steel/Intermediate layer solutions will be shown through different prototypes (including 30cm x 30cm flat panels, 18cm x 180cm flexible sheets and 30cm wide coils) using different deposition technologies that could be easily integrated into a steel coating line. At the end of STEELPV project, a portfolio of value added steel products will be ready, enabling steel partners direct access to the photovoltaic industry. The products developed in STEELPV will be suitable for different steel thicknesses what could drive to flexible (used to cover geometrical complex structures already existing) or semi-rigid (used as mechanical part of the structure) final applications. Sectors such as building envelopes (façades and roofs) of both new and existing buildings (residential, industrial), road infrastructures and transports will take benefit of the STEELPV developments.

		Country	*Scientific person in charge*
Partners	**FUNDACION ITMA*INSTITUTO TECNOLOGICO DE MATERIALES**	ESPAÑA	Pascal SANCHEZ (Pr. Coord.)
	ABENGOA SOLAR NEW TECHNOLOGIES S.A.	ESPAÑA	José Maria DELGADO SANCHEZ
	BANGOR UNIVERSITY	UNITED KINGDOM	Jeff KETTLE
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Domenico STOCCHI
	MK METALLFOLIEN GMBH	DEUTSCHLAND	Yun LAN
	UNIVERSITY OF WALES SWANSEA	UNITED KINGDOM	David GETHIN

Technical Group Steel 6

Physical metallurgy and design of new generic steel grades

The scope of TGS6 includes:

- Precipitation, re-crystallisation, microstructure & texture and ageing
- Predictive simulation models on microstructures & mechanical properties
- Development of steel with improved properties at low and high temperatures such as strength and toughness, fatigue, wear, creep and resistance against fracture
- Magnetic properties
- New steel grades for demanding applications
- Standardisation of testing and evaluation methods

RFSR-CT-2003-00009 MEPMO

Mechanical property models for high strength complex microstructures

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1634073 €	Start Date	1/09/2003
	EU Contribution	980444 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23181:EN			

Final Abstract

"This work investigated the relations between the complex microstructures in high-strength steels and their mechanical behaviour, aiming to develop/validate microstructure-property models. Several steel grades were laboratory cast or industrially sampled. The analysed microstructures that were produced on industrial plate and strip mills or in the laboratory and were characterised through different techniques include: precipitation strengthened, quenched and tempered, dual phase, multiphase and TRIP steels. Previous formulations based on physical principles have been refined in order to predict more accurately the stress-strain behaviour of single constituent microstructures. In particular, the equation for ferrite now includes the effect of the internal stresses in DP steels and/or the precipitation strengthening. Several approaches have been used to develop and validate property models for multiphase steels: — for quasistatic tensile properties: - empirical model for the properties in the as-quenched and Q & T conditions, - empirical model in terms of multiphase strains for DP, - analytical self-consistent model, including a correction term for ferrite strengthening, - self-consistent strain model corrected with a multiphase interaction term for ferrite strength that incorporates strain partition (ferrite-martensite), FEM local model, - FEM discrete model for combinations of ferrite-martensite, - iso-E model, - austenite transformation model for TRIP effect; — for toughness, rate dependent FEM models including damage: - continuous models based on the multiphase strain that incorporates nucleation and growth of distributed tensile damage, applied to non-quasistatic tensile and highly notched tensile testing, - discrete FEM model for combinations of ferrite-martensite with an experimental failure criterion, applied to Charpy testing."

Partners

	Country	*Scientific person in charge*
ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Isabel GUTIERREZ SANZ (Pr. Coord.)
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Caroline GALLEZ
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Juan Hector BIANCHI
TATA STEEL UK LIMITED	UNITED KINGDOM	Sally PARKER
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Georg PAUL
TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA

Selected Publications

R. Rodriguez, I. Gutierrez, Mechanical behaviour of steels with mixed microstructures, 2nd Internacional Conference on Thermomechanical Processing of Steels TMP´ 2004, 15-17 june-2004, Liège, Belgium, Proc. TMP´2004, Ed. M. Lamberigts, Verlag Stahleisen GMBH, Düsseldorf, 2004, pp. 356-363

M. A. Altuna, A. Iza-Mendia, I . Gutierrez, Precipitation strengthening produced by the formation in ferrite of Nb carbides, La Metallurgia Italiana, June, 2009, 41-47, http://www.gruppofrattura.it/pdf/ext/AIM/Anno%202009/6/005.pdf

J H Bianchi, P. Vescovo, 'Development and Validations of Mechanical Property Models for DP steels', New Development on Metallurgy and Applications of High Strength Steels, Buenos Aires 2008. http://www.tms.org/pubs/Books/PDFs/08-7292-CD/08-7292-CD-0.pdf

I. Gutierrez, A. Altuna: Work hardening of ferrite and microstructure-based modelling of its mechanical behaviour under tension, Acta Materialia, 56, 2008, 4682-4690. doi:10.1016/j.actamat.2008.05.023

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RFSR-CT-2003-00015 PREMPROP

Prediction of the mechanical properties at hot strip processing plants

Info	Type of Project	Research	Duration (months)	36
	Total Budget	932288 €	Start Date	1/09/2003
	EU Contribution	559373 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23852:EN			

Final Abstract The project aims to reach a better understanding of the influences of hot strip processing on its mechanical properties. ECSC projects have shown the potential of models used for online prediction at hot strip processing plants. The resulting simulation results give valuable information about the process and the produced strips' properties. Prior to their delivery as hot strip to customers and processors, further processing is carried out on a large number of strips. These operations include pickling, temper rolling and slitting, and influence the mechanical properties, making the calculated results, valid for the hot strip mill, obsolete. In the project a larger set of laboratory investigations were performed on commercial and laboratory steels with regard to levelling, temper rolling, pickling and ageing. These data were backed up by data collected from commercial production lines covering levelling and pickling. On the modelling side a new microstructure-based approach is presented for kinematical hardening of ferritic-pearlitic steels, including microalloying. The development of this model has also led to improved characterisation tests for the Bauschinger effect. This test could successfully be transferred to a Gleeble 3500 thermomechanical simulator. For levelling and temper rolling, models from the literature review have been suggested and implemented. While the leveller models presented in literature use mainly empirical equations for the strain hardening behaviour, the newly developed kinematical hardening model allows a more sophisticated approach.

		Country	*Scientific person in charge*
Partners	**THYSSENKRUPP STEEL EUROPE AG**	DEUTSCHLAND	Georg PAUL (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Astrid PERLADE
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Caroline GALLEZ

RFSR-CT-2003-00020 BIOWAS

Materials for increased performance in sustainable fuel combustion

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1884928 €	Start Date	1/09/2003
	EU Contribution	1130958 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23868:EN			

Final Abstract The aim of the project was to identify suitable material as well as weld overlays and thermal spray coatings for service in high temperature combustion plants, i.e. waste and biomass incineration and a cement kiln plant. The project combines investigation in the laboratory on fundamentals of oxide scale breakdown and the effect of preoxidation as well as laboratory exposures in simulated combustion environments and in-plant exposures in combustion plants.The fundamental investigations have shown that preoxidation of pure metals (Fe, Ni, Cr) and alloys is beneficial if the metal forms an oxide different from iron oxide. Iron oxide, formed on iron, is easily penetrated by chlorine, thereby initiating the mechanism of 'active oxidation'. Nickel, which is preoxidised in S02-containing gases, is also not protective, because NiS04 is formed, which is converted to NiCl2 upon exposure to HCl-containing gas. HCl-induced high temperature corrosion under thermal cycling conditions has been studied for iron/carbon steel, nickel and chromium together with two austenitic steels (304 and 310). Experiments were conducted with 14 cycles at 700 °C and with 49 cycles at 400 °C. The hot dwell time was 20 hours and cold dwell time approximately 4 hours. Both as-ground and materials preoxidised at either 400 °C or 700 °C were exposed. A large difference in growth rate kinetics was seen when experiments at 400 °C and 700 °C were compared. At 700 °C, iron and carbon steel had a gross mass change up to around 400 times higher than the austenitic 310 steel. However, at 400 °C the difference was only 5 to 10 times higher. With almost no exceptions, materials preoxidised at 400 °C exhibited the lowest corrosion rate and a better oxide adhesion. Preoxidation at 700 °C had a similar beneficial effect in testing at 400 °C, but no obvious positive impact at 700 °C.The plant exposures have shown that weld overlays of alloy 625 exhibit promising behaviour in a number of plants, i.e. under strong sufidising and chloridising conditions, and in the temperature ranges chosen. It is also immediately clear that all cast austenitic stainless steel grades exhibit intergranular attack by sulphur and/or chlorine. The behaviour of the thermal spray coating implies that the Ni-FeCrSiCe is the most promising solution. Preoxidation has some effect, as shown in the exposures of preoxidised tubes and rings in the Schweinfurt plant. It was shown by in-plant exposure that preoxidising of AC 66 reduces corrosion by a factor of about 20 %.

		Country	*Scientific person in charge*
Partners	**MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH**	DEUTSCHLAND	Michael SPIEGEL (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Franco MANCIA
	CLAUSTHALER UMWELTTECHNIKINSTITUT GmbH	DEUTSCHLAND	Stefan VODEGEL
	ECOSESTO SPA	ITALIA	Franco BELLEI
	Fundación INASMET	ESPAÑA	Iñaki AZKARATE
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Gervásio FERREIRA PIMENTA
	SWEREA KIMAB AB	SVERIGE	Rachel PETTERSSON
	UNIVERSITAET STUTTGART	DEUTSCHLAND	Klaus R.G. HEIN

RFSR-CT-2003-00040 MIHAR

Metallurgical impact of hot asymmetric rolling

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1033709 €	Start Date	1/09/2003
	EU Contribution	620226 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23335:EN			

Final Abstract The impact of hot asymmetric rolling was thoroughly investigated during this three-year project, by efficiently combining experimental and simulation work. Experimentally four different configurations of asymmetric hot rolling have been explored in the project, differing by the roll diameters or the fact that one or both rolls are driven. It turned out that asymmetric hot rolling reduces rolling force, torque and current. The effect of hot asymmetric rolling with respect to grain refinement appears lower than what was expected at the start of the project. Concerning austenitic rolling, asymmetric rolling can be used to gain through thickness homogeneity and in refinement by applying higher reductions thanks to the gain in rolling load. Results also suggest that asymmetric ferritic rolling could help achieving lower thickness reductions in the hot band (and so in the cold strip) by combining reduction of rolling forces, easier recrystallisation during coiling and no remaining shear texture component in the final cold rolled and annealed microstructure. Finally this project provides a good overview of the potentiality of hot asymmetric rolling with respect to metallurgical interest. It has defined for which applications asymmetric rolling could show interesting prospects. Further investigations are now required to confirm the interest of hot asymmetric rolling combining metallurgical and economical aspects, especially regarding hot ferritic rolling for soft drawable grades with the aim of reducing final thickness and grain refinement through achievement of higher thickness reductions due to gain rolling forces.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Gwenola HERMAN (Pr. Coord.)
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Griet LANNOO
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Ilaria SALVATORI

RFSR-CT-2004-00024 NUSIMAG

Cross numerical simulations & characterisations of magnetic steel properties for non destructive evaluation purposes

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1591878 €	Start Date	1/07/2004
	EU Contribution	955127 €	End Date	30/06/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23749:EN			

Final Abstract Online magnetic non-destructive assessment of mechanical properties is of growing interest. As there is a need for better understanding of the magnetic behaviour of steels in relation to their microstructural features, the consortium undertook the following theoretical and experimental work. - To write and execute finite element simulations to predict the magnetic behaviour of a selection of BCC steels. With respect to this target, the consortium managed to outline the limitations of 2D simulations, which feature realistic distributions of magnetic domains but fail to predict the interaction between microstructure and magnetisation processes. Therefore, 3D computations are required, but cannot be executed with reasonable computing power. - To check applicability with online measurements (AlK BH applications, other microstructural features for IF steels, bearing grades). Results allowed grading of the relevances of microstructural features on magnetic properties. First order effects come from the distribution of precipitates and secondary phase islets exceeding 150 nm in diameter, and the presence of uniformly distributed dislocation cells. Texture and slight non-recrystallised fractions are of less importance. Temper-rolling-induced elongation is sensed only through high-frequency magnetic techniques, which investigate depths comparable to the surface layers featuring the dislocation tangles. For long products, magnetic techniques are clearly able to assess microstructural changes induced by thermal treatments, such as pearlite spheroidisation.

Partners	*Country*	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Philip MEILLAND (Pr. Coord.)
ARCELORMITTAL ATLANTIQUE ET LORRAINE SAS	FRANCE	Jean-Jacques MAREZ
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Jacinto ALBARRAN SANZ
ISTITUTO NAZIONALE DI RICERCA METROLOGICA	ITALIA	Giorgio BERTOTTI
ASSOCIATION LEONARD DE VINCI	FRANCE	Michel BERNADOU
TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Henk T. PLOEGAERT

RFSR-CT-2004-00025 MANNESTRAMP

Influence of tramp elements (P, Cu, S, Sn) on the Mannesmann effect in the transversal hot rolling of engineering steels

Info

Type of Project	Research	Duration (months)	42
Total Budget	1078008 €	Start Date	1/07/2004
EU Contribution	646805 €	End Date	31/12/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23597:EN

Final Abstract

The main aim of the project was the analysis of the influence of some tramp elements on the susceptibility of engineering steels to axial crack generation during cross wedge rolling (CWR). Therefore, during the first half of the project, nine experimental heats with different levels of tramp elements were manufactured and all of them metallurgical and mechanically characterised. Hot torsion and tensile tests were also carried out, but no clear effect of tramp elements was determined in the experimental phase. CWR trials with some industrial heats and the development of the numerical model started to be carried out. During the second part of the project, the numerical model has been optimized following the law of “Norton-Hoff” for two different steel grades, C70S6 and 16MnCr5 at different temperatures. Subsequently, its validation in the CWR industrial trials has been carried out. Otherwise, to evaluate the influence of the chemical composition and the content and distribution of inclusions, all the manufactured industrial heats (C70S6, 16MnCr5, 30MnSiV6, 20MoCrS4, 20MnCr5 and 100Cr6) have been metallurgical and mechanically characterised and forgeability tests have been carried out. As it was expected, it has been confirmed the important influence of the MnS in the generation of internal cracks, which explains the high tendency of the C70S6 and the low tendency of 100Cr6 to the generation of internal cracks during the CWR trials. Finally, it has been possible to reproduce in a laboratory test a stress field similar to a hot cross rolling process, generating internal cracks by Mannesmann effect.

Partners

	Country	*Scientific person in charge*
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Zuriñe IDOYAGA (Pr. Coord.)
ASCOMETAL S.A.S.	FRANCE	Boris KIEBER
FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG e.V.	DEUTSCHLAND	Matthias KOLBE
INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Helena GOUVEIA
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

Selected Publications

Kolbe M., Neugebauer R., Lorenz B., Glaß R. Advanced Developments in Research Open up New Potentials, 18th International Forging Congress, Nagoya, 2005, pg. 41 - 48

Kolbe M., Neugebauer R., Lorenz B., Glaß R. Innovative Process Chains to Fabricate Hollow Shafts by Partial Forming, 5th International Conference on Industrial Tools, Velenje, 2005, pg. 79 – 85

O. Toscanelli, V. Colla: European Modelling Symposium SEM 2010, Pisa, 2010.

RFSR-CT-2004-00026 CONSTAINSSA

New design concept of stainless steels for structural applications

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1731619 €	Start Date	1/07/2004
	EU Contribution	1038972 €	End Date	30/06/2007
State	Project suspended, no final report published			

Provisional Abstract

The proposed project aims at determining the composition and the fabrication cycle of a family of new high-nitrogen austenitic stainless steels, less expensive than those presently on the market, that combine resistance to corrosion, high ductility and toughness with a high mechanical strength.
The expected balance performance/costs for products designed for the Strip Casting route will considerably improve the potential of Stainless Steels as structural materials, opening wide new market opportunities. In addition, this new technique allows alloying more nitrogen without producing defects, increasing austenite stability and mechanical strength.
Laboratory testing will suggest the composition for testing on full scale pilot production. Steel performance will be evaluate on prototypes of structural components.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Giuseppe ABBRUZZESE (Pr. Coord.)
	ACCIAI SPECIALI TERNI SpA	ITALIA	Antonio BUFALINI
	EMO-ORODJARNA d.o.o.	SLOVENIJA	Renato FIJAVZ
	THYSSENKRUPP NIROSTA GMBH	DEUTSCHLAND	Michael SACHTLEBER
	VOEST-ALPINE INDUSTRIEANLAGENBAU GmbH & Co	OESTERREICH	Gerald HOHENBICHLER

RFSR-CT-2004-00028 CARBAIN

New ecological and low cost answers to end-user demands on high performance steel components

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1563708 €	Start Date	1/07/2004
	EU Contribution	938225 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24173:EN			

Final Abstract The project is focused on the development of new ecological and economical production routes to obtain high-performance components that meet the demand from the automotive industries. The investigated routes are: high-temperature vacuum carburising (HTVC), which requires steel grades with effective grain growth control at high temperature, and the dry bainitising (DB), which requires the combination of a suitable heat treatment facility and adapted steel. Testing with experimental steel grades has allowed for: — designing modified steel grades for both routes, by mean of microalloying (Al/N/Nb and/or Ti) for grain growth control during HTVC, or modifications to the chemical composition of the standard grade to enhance hardenability and shorten the transformation for the DB process, — developing a prototype facility to perform DB treatments at the industrial scale, — developing a grain growth model to predict the different grain growth behaviours during carburising, by merging experimental data and the two other models developed for precipitation C diffusion during carburising treatment. Components' characterisation shows that HTVC is a suitable process for cost reduction by shortening the process. The grain growth model has shown that local fluctuation of the pinning particles distribution or local initial grain size may lead to uncontrolled grain growth. Distortion analysis of the HTVC components shows that the final hard machining cannot be avoided completely. The dry bainitising process has proven to be an alternative to the conventional austempering process. DB components have shown comparable characteristics to the serial parts. No hazardous substances and cleaning operations are needed for DB.

		Country	*Scientific person in charge*
Partners	**GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.**	ESPAÑA	Rafael PIZARRO SANZ (Pr. Coord.)
	ALD VACUUM TECHNOLOGIES GmbH	DEUTSCHLAND	Klaus LÖSER
	ASCOMETAL S.A.S.	FRANCE	Elvire CHARBONNELLE
	ROBERT BOSCH GmbH	DEUTSCHLAND	Jochen SCHWARZER
	PERKINS ENGINES Co Ltd	UNITED KINGDOM	Andrew McGILVRAY
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
	TATA STEEL UK LIMITED	UNITED KINGDOM	P.E. REYNOLDS
	ZF FRIEDRICHSHAFEN AG	DEUTSCHLAND	Jörg KLEFF

RFSR-CT-2004-00029 PREST

Intense precipitation strengthening of bainitic flat and long products - mechanisms, means and process routes

Info

Type of Project	Research	Duration (months)	36
Total Budget	1516104 €	Start Date	1/07/2004
EU Contribution	909663 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23722:EN

Final Abstract

Modern high and ultra-high strength bainitic steels derive their strength from fine and ultra-fine bainitic ferrite grains in which the contribution from precipitation strengthening is of paramount importance. In the present work the strengthening potential of V, Nb, Ti and Cu has been evaluated for ultra-low, low and medium carbon bainitic steels. It was found that titanium provides a very strong and reliable precipitation strengthening of about 200 MPa at 0.2% Ti, directly after coiling at temperatures from 550°C to 350°C. The strengthening effect of niobium is weaker, with 150 MPa at 0.1% Nb, and requires coiling at temperatures of around 550°C. In plate rolling Nb can be fully utilised after post-TMCP heat treatment at 550-600°C. Vanadium shows a weak effect both in as-hot rolled products (strip and plate) and in isothermally heat-treated engineering steels, even at high V+N contents. This result is in sharp contrast with the well-established V-strengthening effect of polygonal ferrite, and is explained in the present work by the sluggish precipitation of V(C,N) in bainitic ferrite and low modulus of the weak, shearable (V,X)(C,N) particles. The full effect of V+N can only be obtained after heat treatment of the direct quenched material. The strengthening effect of copper was found to be also weak, with 50 MPa at 1 % Cu. Models were developed for predicting both the precipitation behaviour and the contribution from precipitates to yield strength. The strength of particles is expressed as a function of particle size which reaches the maximum level when the critical size of non-shearable particles is obtained.

Partners

	Country	*Scientific person in charge*
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RFSR-CT-2004-00030 REHOMI

Refinement and development of homogeneous microstructures through the thickness of heavy products in V-steels

Info

Type of Project	Research	Duration (months)	36
Total Budget	1174656 €	Start Date	1/07/2004
EU Contribution	704794 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23876:EN

Final Abstract

This research aims at studying the combination of high vanadium, nitrogen and carbon on the formation of acicular ferrite. A new cooling concept — alternate water cooling — for the in-depth cooling of heavy products was investigated and consists of a succession of passes in an accelerated cooling line. The acicular ferrite microstructures were generally difficult to obtain in laboratory experiments with industrially achievable chemical compositions or cooling cycles. The combination of high vanadium and nitrogen allows for the production of acicular ferrite microstructures. This was not associated with the foreseen improvement of the tensile or toughness properties when compared with bainitic microstructures. EBSD and image analysis of LOM were applied to separate bainite from acicular ferrite. The increase of vanadium content from 0.06 to 0.11 % smoothes the hardness gradient through the thickness. This evolution is associated with a shift to a high cooling rate of the polygonal ferrite nose in the phase transformation diagram. In terms of properties, the gain on the yield strength is about of 50MPa but, in some cases, at the expense of the toughness. Rolling schedules and chemical analyses were determined to fulfill requirements of heavy beams in vanadium steel in the as-rolled and welded conditions.

Partners

	Country	*Scientific person in charge*
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SWEREA KIMAB AB	SVERIGE	Stanislaw ZAJAC
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Carl Justus HECKMANN

RFSR-CT-2004-00027 ISA-PESR

Integrative simulation of advanced protective gas electro-slag-remelting for the production of high-quality steels

Info

Type of Project	Research	Duration (months)	36
Total Budget	1598182 €	Start Date	1/09/2004
EU Contribution	958910 €	End Date	31/08/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23917:EN

Final Abstract

In the framework of the European RFCS project named ISA-PESR, an integrative software simulation tool focusing on numerical modelling of the protective gas electro-slag remelting (PESR) process has been built up. To achieve this goal several tasks were organised. First the collection of data concerning the physical properties of the materials involved during the process was performed. This concerns the selected slag, the steel and the copper mould. In the second task, several experimental remeltings were performed within both small- and industrial-scale devices. After remelting, the pool profiles and the electrode shapes were obtained. The third task consisted of investigating numerically some phenomena that are not well understood at the present time. In particular, the interaction between the falling steel droplets and the slag flow was carried out with a multiphase model of the Fluent CFD software. In addition to that, the prediction of the exact shape of the metal-slag interface was successfully undertaken. The last task was to develop and implement a module into Calcosoft-2D, a commercially available software package of the ESI Group, originally dedicated to continuous casting process simulation. The mathematical, numerical and validation development are presented in details. This software package is able to predict all important steps of the PESR operation such as the melting of the electrode, the influence of Lorentz forces on buoyancy, and the melt convection during solidification. By simulating the PESR process it is now possible to improve the process control during remelting and optimise the feed rate of additives and alloying elements during remelting.

Partners

	Country	*Scientific person in charge*
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ESI GROUP	FRANCE	Mark SAMONDS

Selected Publications

"Kharicha A., Schützenhöfer W., Ludwig A., Tanzer R., Wu M.: Steel Research Int., 79 (2008) 632-36. ""On the Importance of Electric Currents Flowing directly into the Mould during an ESR Process"""

"Kharicha A., Schützenhöfer W., Ludwig A., Tanzer R., Wu M.: 2nd Int. Conf. on Simulation & Modeling of Metall. Processes in Steelmaking (STEELSIM 2007), Graz, Austria, ed.: Ludwig A. (2007) 105-10., ""On the Importance of the Electric Currents Flowing directly into the Mould during an ESR Process"""

"Kharicha A., Mackenbrock A., Ludwig A., Schützenhöfer W., Maronnier V., Wu M., Köser O., Tanzer R.: Int. Symp. on Liquid Metal Processing and Casting (LMPC-07), Nancy, France, eds.: Peter D. Lee, Alec Mitchell, Jean-Pierre Bellot, Alain Jardy (2007) 113-9. ""Selected Numerical Investigations on ESR Process"""

"Kharicha A., Schützenhöfer W., Ludwig A., Tanzer R., Int. Symp. on Liquid Metal Processing and Casting (LMPC-07), Nancy, France, eds.: Peter D. Lee, Alec Mitchell, Jean-Pierre Bellot, Alain Jardy (2007) 107-11., ""Multiphase Modelling of the Slag Region in the ESR Process"""

"Kharicha A., Schützenhöfer W., Ludwig A., Tanzer R.: 6th Int. Conf. on Multiphase Flow (ICMF 2007), Leipzig, Germany (2007) 113-9. , ""Interaction between steel droplets and slag in the ESR process"""

RFS1-CT-2005-00025 MICROAS 05

Microalloying for new steel processes and applications

Info				
	Type of Project	Accompanying measure (conferen	Duration (months)	3
	Total Budget	85800 €	Start Date	1/07/2005
	EU Contribution	20000 €	End Date	30/09/2005

State Research completed without final report

Provisional Abstract

The objective of the present proposal is the organisation and hosting of an International Symposium on the use of microalloying in steels for new processes and applications.
The scope of the conference is to provide a forum for researchers and industrialist from the European Union and abroad to discuss developments and new perspectives on microalloying in novel applications and improved steel grades.
Within this frame, and given the participation of European researches in previous Conferences on similar topics, the diffusion of results gained on research projects founded by the European Commission Steel RTD programme is assured.

Partners		*Country*	*Scientific person in charge*
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	José Maria RODRIGUEZ IBABE (Pr. Coord.)

Selected Publications

Microalloying for New Steel Processes and Applications, J.M. Rodriguez-Ibabe, I. Gutierrez, B. López and A. Iza-Mendia eds., Materials Science Forum, vol. 500-501, 2005, pp. 1-818, DOI: 10.4028/www.scientific.net/MSF.500-501.

RFSR-CT-2005-00026 PISAC

Properties improvement by stress-assisted control of the metallurgical transformations for HSS and BH steels

Info

Type of Project	Research	Duration (months)	36
Total Budget	1215497 €	Start Date	1/07/2005
EU Contribution	729299 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25872:EN

Final Abstract The nature and morphology of microstructures obviously control the mechanical properties of steels, especially HSS and BH steels. The microstructures are usually obtained by changing the temperature and the chemical composition, and by plastic deformation before phase transformation and recrystallisation. A complementary fully innovative approach to microstructure control is proposed. Applied stress is considered as a new driving force for metallurgical evolution. Indeed, stress effects afford many promising opportunities: In this RFCS project the effects of applied line tension during annealing have been examined for a number of steel types (low carbon aluminium-killed deep drawing and bake hardening steels, cold rolled micro-alloyed steels, dual phase and TRIP steels). One of the major achievements is the development by each partner of adequate thermo mechanical simulators to adequately follow microstructure evolution under applied stresses. Gleeble or in-house simulators were used for that purpose and will be advantageously used in future for similar studies (including hot strength measurements). From the laboratory and the simulator experiments performed in the project, the effect of stress applied on the microstructure and the mechanical properties of steels are contrasted. It appears that the effect depends on the type of steel and the part of the process when the stress is applied. In some cases stresses in the 10–40 MPa range have no measurable effects, but in paint curing of BH steel, intercritical annealing of some dual phase and TRIP steels or microalloyed steels the effect is noticeable.

Partners

	Country	*Scientific person in charge*
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RFSR-CT-2005-00027 HIPERC

A novel, high-performance, economic steel concept for linepipe and general structural use

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1592775 €	Start Date	1/07/2005
	EU Contribution	955666 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24209:EN			

Final Abstract "The HIPERC project has examined the effects of alloying elements and processing conditions in low carbon, inferior 0.09 wt %., niobium containing, 0.05 - 0.12 wt.%, steels. Laboratory-scale heats and pilot rolling trials simulating air and water-cooled plate production as well as hot-rolled strip production have been made. The effects of C, Mn, Ni, Cu, Cr, Mo, Nb, Ti and B, on transformation characteristics and temperatures of recrystallisation have been determined along with regression equations for characterisation of microstructure, tensile and impact properties, and for the weldability of these steels. The properties of products processed commercially to plate and coil-plate and made into pipe and to plate for structural use were determined and these compared well with the values predicted from the regression equations. The project has shown that excellent combinations of strength, toughness and weldability can be obtained using this steel type. Additional experiences have been gained in the processing of these steels through three commercial rolling mills and benefits were seen with this steel type due to higher production rates and lower amounts of surface dressing compared with steels currently being used to satisfy equivalent property specifications. Recommendations on the limits for niobium in Euronorms have been proposed; concerns relating to weldability have been addressed by proposing varying limits based on the carbon and manganese contents of the steel. This report makes the output of this project available to CEN working groups to support the revision of Euronorms based on the gathered data."

Partners	*Country*	*Scientific person in charge*
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Selected Publications

Stephen Webster, Lyn Drewett. The HIPERC Project: the use of Nb for high performance and economy in steel for linepipe and general structural use. The 6th International Conference on High Strength Low Alloy Steels (HSLA Steels 2011). Journal of Iron and Steel Research International, Volume 18 Supplement 1-2 May 2011

Marcos Pérez-Bahillo, Nenad Gubeljak, David A. Porter, Beatriz López, Jožef Predan, Antonio Martín-Meizoso. Tensile test models for low-carbon microalloyed steels with high niobium contents. Technical Gazette 18, 4(2011) , 561-569. URL http://hrcak.srce.hr/index.php?show=clanak&id_clanak_jezik=111974

Stephen Webster and Lyn Drewett. The EU project HIPERC - high performance, economic steel concept for linepipe and general structural use. Published in Niobium Bearing Structural Steels, TMS (The Minerals, Metals & Materials Society) 2010, ISBN 978-0-87339-755-1

Ouaissa, B., Brózda, J., Pérez-Bahillo, M., Bremer, S., de Waele, W., Investigations on microstructure, mechanical properties and weldability of a low-carbon steel for high strength helical pipe. EPRG-PRCI-APIA 17 th Joint Technical Meeting on Pipeline Research. Milan, May 2009

Barbara Zeislmair, Influence of the chemical composition and the process route of the mechanical properties, low-C steel containing Nb of 0.1% for use as a pipeline steels, Reports from the Institute of Ferrous Metallurgy, 2010, 4, Published by Shaker, ISBN 978-3-8322-9579-0 (in German) URL http://www.buchhandel.de/detailansicht.aspx?isbn=9783832295790

RFSR-CT-2005-00028 ASTEX

Modification of textural distribution in hot rolled stainless steels using asymmetric hot rolling technique

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1131546 €	Start Date	1/07/2005
	EU Contribution	678928 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24207:EN			

Final Abstract The main aim of this project was to investigate the effect of asymmetric hot rolling on the microstructural and textural distribution in hot-rolled strip and on the final properties of stainless steels, as a possible solution to the ridging problem for ferritic grades, and for improving deep drawability of the material. The study focused on the EN 1.4016 (AISI 430) and on EN 1.4512 (AISI 409) ferritic stainless steels and on EN 1.4301 (AISI 304) austenitic stainless steel. Results show that after asymmetric hot rolling a greater recrystallised structure can be detected in all the materials. From the textural angle especially, samples show a better homogenised structure. After cold rolling and final annealing, bands of grains with similar orientations causing roping phenomenon, tend to disappear when the final product has been previously asymmetrically hot-rolled. Decreasing the grain size of the hot band in the asymmetric hot-rolling process drops the 'grain banding' on the final product. The mechanical properties of these materials show that asymmetric hot rolling can have a beneficial effect both on the strength and elongation for the EN1.4512 ferritic grade and the EN1.4301 austenitic grade. Analysis of the hot-rolling data shows that the asymmetric rolling leads to a clear reduction in rolling force, rolling torque and total motor current, showing that asymmetric rolling also has technological advantages.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Ilaria SALVATORI (Pr. Coord.)
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	TATA STEEL UK LIMITED	UNITED KINGDOM	John BUTLER
	ARCELORMITTAL STAINLESS FRANCE	FRANCE	Francis CHASSAGNE

Patents PCT/FR09/00134

Selected Publications “Effect of asymmetric rolling on roping in ferritic stainless steels” I. Salvatori: Proceedings of International Conference on Advanced Steels 2010, China.

RFSR-CT-2005-00029 MISTRETO

Toughness and ductility improvement in complex microstructure HSS by means of microstructural parameters optimization

Info

Type of Project	Research	Duration (months)	42
Total Budget	1796570 €	Start Date	1/07/2005
EU Contribution	1077942 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24185:EN

Final Abstract

This project aims to improve the toughness and ductility of high-strength steels by identifying the microstructure constituents which control these properties using new experimental techniques. The following steels — which are of high or ultra-high strength and for which improvement in toughness and ductility is of critical importance — have been selected by partners for this project: Medium-carbon martensitic/bainitic steels - High-strength Q&T steels for oil and gas applications - High-strength Q&T plates for constructions High-carbon bainitic/martensitic steels - High-strength bainitic steels for automotive applications Low-C multiphase steels (Ferrite, Bainite, Martensite) - Industrial high-strength steels for construction applications thermomechanically processed in the laboratory - Industrial high-strength strip steels for construction applications - High-strength bainitic steels for automotive applications HS strip steels for formable parts - High-strength strip steels for formable parts A modified law of mixtures has been applied to successfully model the shape of the Charpy curves. The 50 % FATT expression initially defined for F+P microstructures has been extended to complex microstructures taking into account steel composition, effective grain size, grain boundary carbide, pearlite (or degenerated pearlite) and extra yield stress (due to precipitation or transformation dislocations). Two equations for the ductile to brittle transformation temperature at 27 J were derived for fully martensitic and bainitic materials. In order to study the basic relationships between ductility and microstructural parameters in multiphase steels, a research approach was designed involving the analysis of the behaviour of model microstructures comprising one or, in some cases, two of the main constituents usually present in high-strength multiphase steels.

Partners

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AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Sebastian MEDINA
SWEREA KIMAB AB	SVERIGE	Stanislaw ZAJAC
VOESTALPINE STAHL GMBH	OESTERREICH	Martin KLEIN

RFSR-CT-2005-00030 Metaldesign

Metallurgical design of high strength austenitic Fe-C-Mn steels with excellent formability

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1436332 €	Start Date	1/07/2005
	EU Contribution	861800 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25063:EN			

Final Abstract Five TWIP steel grades (Fe-Mn-C-N and Fe-Mn-Al-Si-C) were selected, adopting stacking fault energy (SFE) and austenite phase stability as the main metallurgical characteristics for alloy design. The selected TWIP grades were characterised in terms of SFE, mechanical properties, microstructure, recrystallisation, welding and forming ability.The performance analysis revealed that only TWIP2 and TWIP3 clearly behave as expected from TWIP steels, with the typical hardening stage associated with profuse deformation twinning. The variants with lower Mn and C content (TWIP1, TWIP4, TWIP5) require a further set-up of steel chemistry to better balance the SFE and avoid the formation of second phases (ferrite or deformation-induced martensitic phases). The results achieved in the project allowed to define the suitable industrial manufacturing route to produce the TWIP steel. However two main issues resulted with an importance stronger than expected in the technical annex: hydrogen embrittlement susceptibility and strip surface decarburization. The first issue has suggested to delay the industrial heat scheduling to evaluate the risk of hydrogen embrittlement for TWIP steels and the need to include a vacuum degassing facility for industrial TWIP steel manufacturing. The decarburization issue revealed that during the annealing process a proper atmosphere control is necessary to avoid within the decarburised layer the formation of deformation induced martensitic phases (?'+?).The activity results revealed that the investigated TWIP steels have excellent tensile properties together with good welding and galvanizing ability that make them extremely attractive for automotive applications both for structural reinforcement (body in white) and for energy absorption.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Alessandro FERRAIUOLO (Pr. Coord.)
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Patents Process for manufacturing high manganese content steel with high mechanical resistance and formability, and steel so obtainable. Patent WO2012077150A3.

Selected Publications

F. de las Cuevas, M. Reis, A. Ferrraiuolo, G. Pratolongo, L.P. Karjalainen, J. Alkorta, J. Gil Sevillano: "HALL-PETCH RELATIONSHIP OF A TWIP STEEL", XI Congreso Nacional de Propiedades Mecánicas de Sólidos, 2008 El Bosque (Cádiz).

F. de las Cuevas, M. Reis, A. Ferrraiuolo, G. Pratolongo, L.P. Karjalainen, V. García Navas, J. Gil Sevillano: "KINETICS OF RECRYSTALLIZATION AND GRAIN GROWTH OF COLD ROLLED TWIP STEEL", International Conference Thermec'09. Berlín.

F. de las Cuevas, M. Reis, A. Ferrraiuolo, G. Pratolongo, L.P. Karjalainen, J. Alkorta, J. Gil Sevillano: "HALL-PETCH RELATIONSHIP OF A TWIP STEEL", Key Engineering Materials Vol. 423 (2010) pp 147-152 © (2010) Trans Tech Publications, Switzerland doi:10.4028/www.scientific.net/KEM.423.147.

F. de las Cuevas, M. Reis, A. Ferrraiuolo, G. Pratolongo, L.P. Karjalainen, V. García Navas, J. Gil Sevillano: "KINETICS OF RECRYSTALLIZATION AND GRAIN GROWTH OF COLD ROLLED TWIP STEEL", Advanced Materials Research Vols. 89-91 (2010) pp 153-158 © (2010) Trans Tech Publications, Switzerland doi:10.4028/www.scientific.net/AMR.89-91.153.

A.S. Hamada, L.P. Karjalainen, A. Ferrraiuolo, J. Gil Sevillano, F. de las Cuevas, G. Pratolongo, M. Reis: "FATIGUE BEHAVIOR OF HIGH-Mn TWIP STEELS", Metallurgical and Material Transactions A DOI: 10.1007/s11661-010-0193-7 The Minerals, Metals & Materials Society and ASM International 2010.

RFSR-CT-2005-00031 COHEADBAIN

Cold heading quality low-carbon ultra-high strength bainitic steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1212554 €	Start Date	1/07/2005
	EU Contribution	582992 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24191:EN			

Final Abstract The chemical composition and wire-rod production process of low-carbon, precipitation-strengthened bainitic steels were specially designed for the production of cold-headed products without heat-treating operations. The chemical composition of the bainitic steel was developed using high Ti content, in the range of 0.1-0.2 %. The experimental steel contained 0.06-0.08 % C, ~ 1.9 % Mn, ~ 0.3 % Ni + Cu, ~ 0.002 % B and ~ 0.1 % Ti. The low-carbon cementite-free granular bainite, in which the precipitation of brittle cementite is replaced by the finely dispersed MX-type carbides and a ductile second phase, is the most suitable microstructure, which fulfils the cold headability requirements. The investigation has shown that the exceptional workability of wire rod, as well as the high strength and ductility of the final products, can be achieved by developing in the wire rod during TMCP either non-recrystallised (pancaked) or, alternatively, dynamically recrystallised austenite grains with an average size of less than 15?m, followed by accelerated cooling at rates in the range 3-6 ° C/s to 500-400 °C. After accelerated cooling, the wire rod is slowly cooled in coil, which allows for intense precipitation of TiC. Industrial trials of wire rod rolling were successfully performed. Industrial trials of cold forging of the rod and wire rod produced from the Ti steel were also conducted. The cold-headed fasteners and machinery components were thoroughly investigated. The trials finished with the production of cold-headed fasteners fulfilling the 8.8 class property requirements without the Q & T treatment.

		Country	*Scientific person in charge*
Partners	**INSTYTUT METALURGII ZELAZA IM. STANISLAWA STASZICA**	POLAND	Roman KUZIAK (Pr. Coord.)
	SWEREA KIMAB AB	SVERIGE	Stanislaw ZAJAC
	ARCELORMITTAL STEEL POLAND SPOLSKA AKCCYJNA	POLAND	Jerzy STODOLNY
	MITTAL STEEL HAMBURGGmbH	DEUTSCHLAND	Karl STERCKEN
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA
	SWISS STEEL AG	SUISSE	Lotfi CHABBI

RFSR-CT-2006-00017 MICRO-QUANT

Microstructural quantification of multi phase steels

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2340492 €	Start Date	1/07/2006
	EU Contribution	1404296 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24980:EN			

Final Abstract Detailed understanding of process–microstructure–property relationships for highstrength steels is a prerequisite for their optimal design. This demands the ability to perform advanced microstructural quantification of their complex (multi-phase) microstructures, addressing the full range of microstructural properties that are relevant to an appreciation of their macroscopic mechanical behaviour. In turn, this requires that conventional light-optical microscopy (LOM) is complemented with high-resolution analytical techniques and image analysis to perform advanced morphological quantification of microstructures and to determine intrinsic mechanical, chemical and crystallographicproperties of phase constituents. This project has aimed to develop a range of advanced metallographic procedures to deal with morphological analysis based on scanning-electron microscopy (SEM) and electron backscatter diffraction (EBSD) together with pixel- and context-based image analysis routines. Developed procedures have been evaluated via process–microstructure–property studies on steels ranging from DP/TRIP to highly challenging complexphase (CP) and bainitic/martensitic steels. In addition, methods to determine intrinsic properties of constituents have been investigated by means of EBSD-guided nanoindentation, SEM/EDX, electron probe micro-analysis (EPMA) and high-resolution secondary ion mass spectrometry (NanoSIMS).Highlights of this project are : • a classification scheme with definitions of matrix and secondary phase constituents. • procedures for advanced morphological quantification via LOM/SEM and pixel- or context-based image analysis. • EBSD partitioning rules for phase constituents in DP/TRIP/CP steels. • EBSD-guided nano-indentation study with evidence of indentation-induced phase transformation of retained-austenite in TRIP. • visualisation of martensite tempering in DP steel by means of NanoSIMS. • process–microstructure–property relationships for DP/TRIP/CP and bainitic/martensitic steels.

		Country	*Scientific person in charge*
Partners	**TATA STEEL NEDERLAND TECHNOLOGY B.V.**	NEDERLAND	Maxim AARNTS (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Didier HUIN
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Liesbeth BARBÉ
	SWEREA KIMAB AB	SVERIGE	Stanislaw ZAJAC
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Volker MARX
	VOESTALPINE STAHL GMBH	OESTERREICH	Reinhard HACKL

RFSR-CT-2006-00019 MAGPRO

Magnetic field processing for customized microstructures and properties in steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1402388 €	Start Date	1/07/2006
	EU Contribution	841432 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25069:EN			

Final Abstract

The objectives of this project were: • to investigate in detail and to determine quantitatively the effect of magnetic fields on phase transformations, recrystallisation and grain growth of C steels in order to build up a comprehensive basic knowledge that is substantially improved, rationalised and specifically oriented towards a feasible industrial application for steel processing. • to evaluate thermo-magnetic processing as a new technology for modifying phase equilibria and phase transformation kinetics in C steels, with the goal of developing novel microstructures and properties unattainable through conventional thermomechanical processing.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Ilaria SALVATORI (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Jean-Louis URIARTE
	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	FRANCE	Eric BEAUGNON
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Philippe POUTEAU

Patents

Method and device for treating a material exposed to a magnetic field., T. Garcin, S. Rivoirard, E. Beaugnon, P.F. Sibeud, PCT/EP2010/061028 du 29 juillet 2010

Dispositif multi?usage de traitement sous champ magnétique, T. Garcin, S. Rivoirard, E. Beaugnon, P.F. Sibeud, 31 Juillet 2009, FR 0955380

Selected Publications

Experimental evidence and thermodynamics analysis of high magnetic field effects on the austenite to ferrite transformation temperature in Fe-C-Mn Alloys. T. Garcin, S. Rivoirard, C. Elgoyhen, E. Beaugnon, Acta Materialia, vol 56, issue 6 (2010) 2026-2032.

Kinetic effects of magnetic field on the ?/? interface controlled reaction in iron. T. Garcin, S. Rivoirard, F. Gaucherand, E. Beaugnon, Journal of Applied Physics 2010, 107(10):103903 - 103903-4

High Temperature Dilatation Measurements by in situ laser interferometry under high Magnetic Field. S.Rivoirard, T.Garcin, E.Beaugnon, F. Gaucherand, Rev. Sci. Instrum. vol 80 n10 (2009), 103901.

Effect of magnetic field processing on recrystallization and grain growth. I. Salvatori, Material Science Forum, Vols. 706-709, p. 2806, (2012)

RFSR-CT-2006-00020 ODS-STEEL

Novel oxide dispersion strengthened steels obtained by high productivity casting process with innovative injection of suitable special powders

Info

Type of Project	Research	Duration (months)	48
Total Budget	1224657 €	Start Date	1/07/2006
EU Contribution	734794 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25040:EN

Final Abstract

The objective of manufacturing steel by continuous casting with homogeneous dispersion of very fine oxides (oxide dispersion strengthening) encountered the difficulty of not being able to disperse the oxides during the casting process : this difficulty was due to different technological aspects concerning both the manufacturing of OD powder, to be added during the pouring process, and the injection technology itself. The innovative idea to add oxide particles to the liquid flow by using an oxide-dispersed metallic powder, to be injected by a special device called a 'hollow jet nozzle' immersed into the steel flow, encountered the following problems :• difficulty of manufacturing OD powder having on one hand a high oxide volumetric content (of about 60 %) needed to match at the same time HJN specifications (max 1.5 % flow rate of OD powder with respect to the steel flow) and final oxide content into the steel (about 0.5 % wt) and on the other hand the requested granulometric characteristics (< 50 microns instead of 100 to 200 microns) for an efficient use of the HJN. • difficulty of obtaining at least a good dispersion of the oxide particles into the final ingot composition obtained by the HJN technology (powders agglomerated close to the nozzle).A large amount of work was carried out to set up both the OD powder manufacturing process and the melting/pouring/injection procedures. Nevertheless, research activity didn't allow manufacturing of any ODS continuous-cast billet to be tested.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Claudio TESTANI (Pr. Coord.)
COGNE ACCIAI SPECIALI SpA	ITALIA	Andrea LANDINI
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Paul NAVEAU
ARCELORMITTAL STAINLESS FRANCE	FRANCE	Jean-Denis MITHIEUX

RFSR-CT-2006-00021 CP-steels

Cold-rolled complex-phase (CP) steel grades with optimised bendability, stretch-flangeability and anisotropy

Info

Type of Project	Research	Duration (months)	48
Total Budget	1385699 €	Start Date	1/07/2006
EU Contribution	831419 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25041:EN

Project web page nothing to declare

Final Abstract

This RFCS project started on 1 July 2006 and was coordinated by Swerea KIMAB. Other partners engaged in the project were Ruukki Metals Oyj (Ruukki), Rheinisch-Westfälische Technische Hochschule (RWTH), SSAB EMEA (SSAB) and voestalpine Stahl GmbH (voest). This final technical report includes contributions from all partners and describes the results of the research carried out over the entire project. The overall goal of this project was to identify microstructures with optimised balance between strength, bendability and stretch-flangeability and to develop guidelines on how to produce this cold rolled sheet steel through three processing routes, i.e. by continuousannealing with gas cooling, continuous annealing with quenching, and the thirdroute was hot dip galvanizing. The objectives were to produce material with the following properties : a tensile strength of more than 800 MPa, a hole expansion ratio (HE) of more than 35 % and a bending angle, Ri/t<1. This has been obtained through a sequential narrowing of the processing parameters and the chemical composition, using laboratory simulations in several steps in parallel with some on line trials. The final results were then achieved in full scale trials. The required property goals for the project were reached for all processing routes, although their different design has introduced differences in the microstructures that are reflected in the properties.

Partners

	Country	*Scientific person in charge*
SWEREA KIMAB AB	SVERIGE	Lena RYDE (Pr. Coord.)
RAUTARUUKKI OYJ	FINLAND	Pasi PEURA
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
SSAB EMEA AB	SVERIGE	Björn CARLSSON
VOESTALPINE STAHL GMBH	OESTERREICH	Thomas HEBESBERGER

RFSR-CT-2006-00022 CORINOX

Avoiding catastrophic corrosion failure of stainless steels

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1280666 €	Start Date	1/07/2006
	EU Contribution	768401 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25003:EN			

Final Abstract The focus of the project was the development of a comprehensive way of assessing the risk for localised corrosion of stainless steels. Pitting, crevice corrosion, stress corrosion cracking and crevice-crack interactions were evaluated in terms of the effects of temperature, chloride concentration, potential, pH and cold work. The main emphasis was on the testing of the austenitic 1.4404 and the superduplex 1.4410 in solutions of NaCl and MgCl2.An intercomparison of the electrochemical test methodologies between laboratories was carried out and refined until consistent results were obtained. Pre-exisiting data for the two grades of interest were compiled and the environmental conditions prevailing in different applications were characterised. Measurement of pitting potentials and critical pitting temperatures gave reasonable agreement, while spring-disc crevice formers yielded lower critical temperatures for crevice corrosion than use of a modified flushed-port cell.The presence of crevices was found to have only a marginal influence on the development of stress corrosion cracking, and results from U-bend and slow strain rate testing were largely compatible. Results from field testing gave generally good agreement with laboratory data, but could in cases result in higher limiting conditions for localised corrosion. The results have been compiled into design diagrams defining the regimes in which there is a danger for different types of localised corrosion as a function of the main variables,chloride concentration and temperature. This provides indicative information for materials selection and a framework into which future data from both laboratory testing and field testing can be included.

		Country	*Scientific person in charge*
Partners	**SWEREA KIMAB AB**	SVERIGE	Rachel PETTERSSON (Pr. Coord.)
	ACERINOX SA	ESPAÑA	Maria Victoria MATRES
	BÖHLER EDELSTAHL GmbH & Co. KG	OESTERREICH	Günter HOCHÖRTLER
	CENTRUM TECHNIKI OKRETOWEJ S.A. - SHIP DESIGN AND RESEARCH CENTRE S.A.	POLAND	Pawel DOMZALICKI
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Gervásio FERREIRA PIMENTA
	OUTOKUMPU STAINLESS OY	FINLAND	Thomas OHLIGSCHLÄGER
	OUTOKUMPU STAINLESS AB	SVERIGE	Anna IVERSEN
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	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Heikki LEINONEN

RFSR-CT-2006-00023 MARTIMPROP

Martensitic steels with improved properties

Info

Type of Project	Research	Duration (months)	42
Total Budget	1265112 €	Start Date	1/07/2006
EU Contribution	759067 €	End Date	31/12/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25006:EN

Final Abstract The maximal strength level for a given steel composition can be realised with the martensitic microstructure. However as-quenched martensitic microstructures have a low formability and toughness level. This project exploits the benefits of tempered martensite using a quenched and tempering process that can be integrated in some existing hotrolling lines or during low temperature galvanising. The benefits in term of mechanical and user properties are exposed. A selection of B and Mo alloyed 0.15C steels was made among cast steels based on hardenability. A tensile strength of 1200MPa was reached using a thermo mechanical treatment instead of a quench and tempering process. The user properties were tested and the laboratory and industrially produced tempered martensitic steels showed an improved toughness level and reduced H2 sensitivity but a lower fatigue limit.

Partners	*Country*	*Scientific person in charge*
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jean-Louis COLLET (Pr. Coord.)
SWEREA KIMAB AB	SVERIGE	Carl-Ake DÄCKER
ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Sophie LACROIX
VOESTALPINE STAHL GMBH	OESTERREICH	Helmut SPINDLER

RFSR-CT-2006-00024 ACTRESS

Austenite strengthening and accumulated stress for optimum microstructures in modern bainitic microalloyed steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	935659 €	Start Date	1/07/2006
	EU Contribution	561396 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24981:EN			

Final Abstract The effect of austenite strengthening by thermomechanical processing on the bainitic transformation, and therefore on the final microstructures and properties, constitutes a key issue In the development of modern bainitic steels, particularly considering that bainite transformation shows characteristics that are significantly different from those in ferrite–pearlite diffusion transformation and also from those in martensitic diffusionless transformation. Project Actress addresses this issue, focusing on the study of the effect of austenite strengthening in low carbon bainitic steels under conditions simulating those in industrial rolling of high-strength steel plates for linepipe applications. With a design of experiments aimed at isolating the effect of austenite strengthening, hot torsion simulation and laboratory rolling simulation has been applied in CMn and Nb microalloyed steels. The strengthening of austenite was fully characterised and quantified both in terms of accumulated strain — and accumulated stress — from the evolution of means flow stress (MFS) during the thermomechanical treatments. Austenite strengthening was related to the morphology, phase composition and effective grain size of bainitic microstrucures quantitatively characterised by the EBSD technique applied on FEG-SEM. A twofold effect of austenite strengthening was identified and quantified on the resulting ultrafine grain structures (deff5°< 2 ?m), a weak grain refinement of the given bainitic phase and a strong effect on the morphology and phase composition of the transformation products favouring the development of granular bainite over lath like bainitic ferrite. Transformation temperature and austenite strength in terms of MFS showed a strong impact on the bainitic microstructures. In this project the impact of austenite strengthening on the properties of strength and impact toughness has been analysed and directly linked to the twofold effect observed in the microstructures.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Sebastian COBO (Pr. Coord.)
	AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Georg KALLA
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Sebastian MEDINA
	OULUN YLIOPISTO*UNIVERSITY OF OULU	FINLAND	Pentti KARJALAINEN

RFSR-CT-2006-00025 CHARGE&LOAD

Hydrogen embrittlement and delayed fracture of advanced multiphase high-strength steels

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1677657 €	Start Date	1/07/2006
	EU Contribution	1006595 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25323:EN			

Final Abstract This project was initiated with the objective of obtaining a thorough understanding of the H-embrittlement mechanisms in multiphase carbon and stainless steels, in particular the influence of the steel's strength level, the influence of second phases and the influence of strain ageing. Seven carbon steels and seven stainless steels with varying microstructure and mechanical properties were investigated. All steels were ranked in terms of their H-management, i.e. their capacity to trap hydrogen in their microstructure. The major influencing parameter turned out to be the Ti + Nb precipitation. A dual phase ferrite-martensite microstructure seemed to induce rather 'enhanced' H-mobility. For C-steels, as well as for stainless steels, mechanical characterisation via various characterisation techniques allowed ranking of the grades in three groups depending on their sensitivity to H-embrittlement: steels with an excellent resistance to H-embrittlement in all tests, steels which seemed to be rather vulnerable to embrittlement in all tests, and steels with a dual behaviour, i.e. whose sensitivity seemed very dependent on the conditions of laboratory tests. Detailed characterisation of the tested materials revealed various microstructural features that might influence the hydrogen induced cracking. Ti,Nb-precipitates, centreline segregation, inclusions, etc. were found to influence crack initiation and propagation in carbon steels. In austenitic stainless steels the martensite content seemed to have a major influence. Guidelines were given how to control this martensite content in metastable austenitic grades. This project can be a strong reference to future research on H-embrittlement, in terms of material evaluation and in terms of the development of experimental procedures.

		Country	*Scientific person in charge*
Partners	**ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.**	BELGIQUE	Lode DUPREZ (Pr. Coord.)
	OUTOKUMPU STAINLESS AB	SVERIGE	Mats LILJAS
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
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	AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Hannu HÄNNINEN
	VOESTALPINE STAHL GMBH	OESTERREICH	Klemens MRACZEK

RFSR-CT-2007-00020 ELEXIR

Electrical steel with improved "core loss" due increasing of resistivity and low magnetostriction by Al and Si deposition on surface and subsequent solid state diffusion

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1905613 €	Start Date	1/07/2007
	EU Contribution	1143368 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25073:EN			

Final Abstract This project had the final target of setting up the process conditions for the production of Electrical Steel strips with improved magnetic characteristics, due to increased electric resistivity, by Al and/or Al/Si alloys deposition on the surface and subsequent diffusion annealing. To such purpose two different techniques were studied: hot dipping and cladding. In the original plan the industrial feasibility of the two set-up deposition processes and identifying which one is the most promising for industrial application was within the scope of the project. For what concern hot dipping, the trials were planned to be performed through the modification of a continuous line at CSM laboratories which had to be modified inside the project. For what concern cladding the feasibility trials had to be performed through an external partner equipped with proper rolling mill. As better explained below it was not possible to do any industrial feasibility trials. Thanks to the work performed in the framework of the project the correct preparation technique for substrate conditioning has been identified as a key step to obtain good coating quality. The substrate surface characteristics necessary to obtain a good quality coating have been also identified. The laboratory studies both concerning hot dipping and cladding have allowed the authors to identify the correct deposition techniques as well as the adequate diffusion annealing procedures. The effect on magnetic and mechanical properties of deposition and diffusion processes have been determined. Conclusions on the project have been deduced.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Stefano CICALE (Pr. Coord.)
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Christophe VAN DE SLYCKE
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Karl TELGER
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA
	UNIVERSITEIT GENT	BELGIQUE	Yvan HOUBAERT

RFSR-CT-2007-00021 DELOC

Development of methods for the characterization, fracture assessment and life prediction of new high strength steel under variable temperature operating conditions

Info

Type of Project	Research	Duration (months)	36
Total Budget	1320289 €	Start Date	1/07/2007
EU Contribution	792174 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25916:EN

Final Abstract Fatigue and creep are the most important aspects of structures failure to be considered in components designing for service under cyclic loads and high temperatures generating thermo-mechanical fatigue (TMF) stresses. Furthermore, understanding these failure mechanisms is in residual stress concentrations from welded joints, geometry or size factors. This report aims to present appropriate findings to the behaviour of the advanced 9%Cr steel and their weldments subjected to TMF, creep and creep/ fatigue loading for notched and pre-cracked geometries showing high multiaxial stresses. Furthermore through development of a model using fracture mechanics and local damage methodologies an attempt has made for tests failure prediction. The present work objective was, therefore, to derive appropriate material properties for case specific tests, to numerically model fatigue life under TMF loading and apply the concepts to high temperature components under both isothermal and non-isothermal conditions for 9%Cr steels and weldments. Specific tests on smooth, welded and notched specimens were designed and performed to improve the limited literature database, targeting TMF damage based model development. The possible residual stress effects, Stress Intensity Factor on TMF and creep/fatigue loading were also considered, modelled and validated. The validated results and models are considered when developing a new draft of Code of Practice life assessment methodology for creep/fatigue loading of cracked weld components, containing residual stress. The approach, similar to isothermal creep/fatigue loading conditions, considers the two components of creep and fatigue as independent failure mechanism which once computed can be linearly accumulated to obtain total life.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Augusto DI GIANFRANCESCO (Pr. Coord.)
ANSALDO ENERGIA S.p.A.	ITALIA	Vincenza D'AURIA
IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Kamran NIKBIN
INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Manuel GOMES
SOCIETA' DELLE FUCINE SRL	ITALIA	Stefano NERI

RFSR-CT-2007-00022 Bainite Design

Design of bainite in steels from homogeneous and inhomogeneous microstructures using physical approaches

Info

Type of Project	Research	Duration (months)	36
Total Budget	1337469 €	Start Date	1/07/2007
EU Contribution	802482 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25859:EN

Final Abstract

The project focused on the development of bainite transformation models. From literature a model proposed by Azuma et al. was regarded to be best suited as a basis for the project. It includes in principle in a complex way all important features of bainitic transformation. To get a data basis to fit the models experimental tests were conducted with cycles coming from austenite or from the intercritical region. The transformation kinetics was measured in dilatometer tests. The achieved microstructures were analysed by optical metallography, TEM, EBSD and microprobe. The results showed the influence of the starting structure, of the thermal cycle, of the most important alloying elements and of the homogeneity of the initial microstructure. The chosen approach was programmed under different program codes, tested, evaluated and connected to an extended thermodynamic basis. An approach has been introduced as how to consider the influence of Silicon and Aluminium to paraequilibrium cementite in the data retrieved from thermodynamic databases. Further the model has been extended in such a way that the interfacial energies are computed on a thermodynamic basis rather than adjusting them as a fitting parameter. Further a 2D respective 3D Cellular Automaton model has been developed, which uses probability distribution functions to describe the transformation into different phases. This model is able to consider distinct segregation states and realistic initial microstructures as starting conditions to the simulation. An assessment of important controlling mechanisms was made. The model has been extended in order to simulate transformation into bainitic structures both coming from homogeneous austenite as well as starting with an inhomogeneous austenite-ferrite structure. The different model implementations have been extensively validated and found to show a wide range of applicability in combination with a good reliability. Finally typical TTT- and CCT-diagrams could be derived from the transformation simulations.

Partners

	Country	*Scientific person in charge*
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Georg PAUL (Pr. Coord.)
ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Javier GIL SEVILLANO
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Gregory N. HAIDEMENOPOULOS
VOESTALPINE STAHL GMBH	OESTERREICH	Thomas HEBESBERGER

Selected Publications

G. Paul et al. The value of on-line prediction and the challenge of modern multiphase steels. Stahl und Eisen 06, 2012.

G. Paul, et al. The value of on-line prediction and the challenge of modern multiphase steels. In: 4th International Conference on Modelling and Simulation of Metallurgical Processes in Steelmaking SteelSim 2011, Vol. 2011 (Ed.: VDEh), VDEh. Düsseldorf 2011.

RFSR-CT-2007-00023 BAINHARD

Bainitic hardenability - Effective use of expensive and strategically sensitive alloying elements in high strength steels

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1906904 €	Start Date	1/07/2007
	EU Contribution	1144142 €	End Date	31/12/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25072:EN			

Final Abstract The main objective of this project was to determine the bainitic hardenability for alloying elements, both singly and in combination and develop a bainitic hardenability model for use in steel design to ensure optimum use of expensive or strategically sensitive additions in high and ultra-high strength bainitic strip, plate and long products. The work has been concentrated on a low carbon base alloy with the composition of 0.05wt-% C, 1.5wt-% Mn, 0.3wt-% Si and small amounts of Cu, Ni, Cr, V, Ti and Mo where the different alloying systems were divided among the partners where test materials were made based on reference material manufactured by SZMF. The work was progressing in steps first with a detailed mapping of alloy influence on structure development with TTT, CCT and DCCT diagrams. The information fromdilatometer tests, mechanical tests and micro structural analysis has been gathered in the Bainhard database which was exclusively developed for the project to facilitate the development of models for bainitic hardenability. This was done in two ways, based on thermodynamic inverse calculations for thermo mechanically treated materials as well as on experimental results based on Jominy tests and CCT-diagrams. The modelling work based on the large amount of data generated was also used for regression analysis which gave information of the hardenability effect from the alloy elements which was studied within the project both as single element as well as in combinationwith others. Finally a number of full-scale tests were made at three steel plants in order to validate the models and get more practical information regarding the hardenability of bainitic steels of real steel products.

		Country	*Scientific person in charge*
Partners	**SWEREA KIMAB AB**	SVERIGE	Carl-Ake DÄCKER (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Gwenola HERMAN
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Liesbeth BARBÉ
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Roberto ELVIRA EGUIZABAL
	INSTYTUT METALURGII ZELAZA IM. STANISLAWA STASZICA	POLAND	Roman KUZIAK
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Norbert KWIATON
	TATA STEEL UK LIMITED	UNITED KINGDOM	Peter F. MORRIS

RFSR-CT-2007-00024 ESTEP OPTIMET

Optimisation of themetallurgical structures and mechanical properties by improving the heat-treatment processes in flat and long production lines with new setup and control methods

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1815098 €	Start Date	1/07/2007
	EU Contribution	1089058 €	End Date	31/12/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26174:EN			

Final Abstract The project aims at optimising the heat treatment processes in the downstream area to improve the metallurgical quality of the final product and reduction of costs, based on models and online measurements of the mechanical properties. One focus was on evaluating different pyrometers and testing and evaluating different radiation shields addressing the problem with measurements with hot furnace background radiation. Work has concentrated on developing applicable physically and data-based material models for the annealing of austenitic stainless steels, with parameters fitted in based on existing material data. The second main aspect is the development of statistical models to predict the hardness (yield point and strength stress) at the exit of a continuous annealing line based on process data and using data mining techniques. Different processing technologies for long products have been investigated, and a methodology and tool have been developed to fine tune the heat treatment processes in order to obtain the desired mechanical characteristics eliminating unwanted scattered values of hardness, due to uneven heating along the furnace. An FE model based on the moving fluid approach, as well as simplified models have been developed for the description and simulation of the dynamic (temperature) behaviour of annealing lines, and validated/adapted using measured process data and optimisation techniques. The last focus was on the design of model predictive control (MPC) and iterative learning control (ILC) systems. A simulator for annealing furnaces has been developed, integrating the property models as well the designed controllers

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Andreas WOLFF (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	José Luis RENDUELES VIGIL
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
	SWEREA MEFOS AB	SVERIGE	John NISKA
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA

RFS1-CT-2008-00020

6th European stainless steel conference, science and markets

Info	Type of Project	Accompanying measure (conferen	Duration (months)	3
	Total Budget	189500 €	Start Date	1/06/2008
	EU Contribution	20000 €	End Date	31/08/2008
State	Research completed without final report			

Provisional Abstract

The 6th European Stainless Steel Conference, in June 10-13, 2008 in Helsinki, Finland, is devoted both to the scientific aspects of stainless steels and their market issues. The objectives for the conference is to be a meeting place for specialists, both industry and academic sectors, from the European Union and abroad, involved in new growing steel applications and in research and development. Meetings between these groups have proved to be a seed for the fruitful and successful development of manufacturing processes, new steel
grades and new applications for stainless steels. Within this frame the diffusion of results also gained on some research projects funded by the Research Fund for Coal and Steel is assured.
The conference will address the specific issues and role of stainless steels in meeting the challenge of the modern society, particularly in terms of sustainability. Issues addressed will include the consequences of restricted availability of specific alloying elements (leading to alloy substitution), newly developed grades,
improvement of current austenitic, ferritic, martensitic, duplex and new high-Mn and duplex steel grades, and the demand for modified and innovative production routes. User concerns, including improved performance in terms of welding, corrosion and forming, will also be important.
Europe has until now been the leader in the production of stainless steel. China is, however, now coming as a strong player into this field. They will soon have some of the biggest stainless steel works in the world. In order to support the competitiveness of the European stainless steel industry and to keep its leading position, we must even more strengthen our research and in close contact with the market, our customers, develop the niche products they need.
This conference offers a good opportunity for dissemination of the results of our research and also to discuss with our customers their needs for future products.
The conference will cover both fundamental and applied aspects of stainless steels, in the following topics:
• Applications and service experience of stainless steel
• New trends in stainless steel processing
• Fabrication technology
• Surface treatment and surface properties of stainless steel
• Modelling of microstructures and properties
• Corrosion, testing and performance, with and without load
• Guidelines and standards
The conference theme and papers are in good accordance with the objectives and scientific/technical and socio-economic priorities of the Research Fund for Coal and Steel, as they "…increase competitiveness and contribute to sustainable development… the development of new or improved technologies to guarantee the economic, clean and safe production of steel and steel products characterised by steadily increasing performance, suitability to use, customer satisfaction, prolonged service life, easy recovery and recycling."
Many of the conference papers also covers the current priorities of the Strategic Research Agenda of the European Steel Technology Platform (ESTEP), quoted in the RFCS Information Package 2007 The conference is organized by Jernkontoret and sponsored by most of the leading companies in this filed in Europe:
Outokumpu, Sandvik Materials Technology, ESAB, ThyssenKrupp Nirosta, ThyssenKrupp Acciai Speciali Terni, UGINE & ALZ, Nickel Institute, IMOA, International Chromium Development Association and Euro Inox.
Details can be found on the conference web site www.stainless08.com
The conference is the latest in a successful series of international conferences
* Florence in 1993
* Düsseldorf in 1996,
* Sardinia in 1999,
* Paris in 2002
* Seville in 2005.
In 2007 some conferences were held, with names rather similar to this conference. They however were concentrated on other aspects:
3rd International Conference 'Stainless Steel Markets 2007' in Moscow, in September.
That conference is mainly devoted to market, meaning in this connection financing and statistics. Science and technical research, as in our conference, is not on the agenda.
Stainless Steel World Conference 2007 in Maastricht in November is a purely commercial yearly event, mainly devoted to the application oriented technique and will not cover science as in our conference.

	Country	*Scientific person in charge*
JERNKONTORET IDEELLA FÖRENINGAR	SVERIGE	Staffan HERTZMAN

RFSR-CT-2008-00021 DUCTAFORM

New advanced ultra high strength bainitic steels: ductility and formability

Info

Type of Project	Research	Duration (months)	36
Total Budget	1480262 €	Start Date	1/07/2008
EU Contribution	888157 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25977:EN

Final Abstract The main objective of this proposal is to develop AHSS both hot rolled and annealed cold rolled bainitic steels with an optimal ductility and work hardening comparable to drawing steels, and/or keeping a suitable bending and stretching behaviour. In addition, forming processes such as roll-forming and hardening, and press-hardening were optimised to achieve a carbide free bainitic microstructure in final products such as structural safety components in the car body i.e. A-beam, roof-beams, car bumpers and side impact beams. Hot rolling of carbide free bainitic steels with 1100 MPa of yield strength and high toughness (KV(-40ºC)>30 J) was proved to be challenging. Apart of a high carbon content (~0.3wt.%), chemical composition requires of a high manganese content (~2wt.%), which leads to a high risk of banding. By contrast, annealed cold rolled bainitic steels designed for continuous annealing line achieved far higher uniform elongation, better stretching ability and formability than that in DP980 and Martensitic 1400 steels considering the same range of ultimate tensile strengths. Finally, roll-forming simulations of bainitic cold rolled steels obtained by interrupted quenching and salt bath at different temperatures showed an excellent formability without crack formation in comparison to martensitic 22MnB5 reference steel. Likewise, press-hardening trials of hat shaped profiles using a novel quench and partitioning post heat treatment of cold rolled designed steels showed promising tensile results in comparison to same commercial 22MnB5 profiles.

Partners

	Country	*Scientific person in charge*
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Francisca GARCIA CABALLERO (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Sébastien ALLAIN
GESTAMP HARDTECH AB	SVERIGE	Katarina LINDSTRÖM
LINDE + WIEMANN GMBH	DEUTSCHLAND	Eike Gerhard GÜCKER
LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Lars-Erik LINDGREN
RAUTARUUKKI OYJ	FINLAND	Jukka KÖMI

Patents WO2013006108 (A1), 2013-01-10: A METHOD OF HOT-SHAPING AND HARDENING A SHEET STEEL BLANK

Selected Publications

F.G. Caballero, J. Chao, J. Cornide, C. García-Mateo, M.J. Santofimia, C. Capdevila. Toughness deterioration in advanced high strength bainitic steels. Materials Science and Engineering A 525 (2009) 87–95. doi:10.1016/j.msea.2009.06.034.

Pasi Pekka Suikkanen, Visa Tatu Emil Lang, Mahesh Chandra Somani, David Arthur Porter, Leo Pentti Karjalainen. Effect of Silicon and Aluminium on Austenite Static Recrystallization Kinetics in High-strength TRIP-aided Steels. ISIJ International. Vol. 52 (2012) No. 3 , pp 471-476. https://www.jstage.jst.go.jp/article/isijinternational/52/3/52_3_471/_article

F.G. Caballero, S. Allain, J. Cornide, J.D. Puerta Velásquez, C. Garcia-Mateo, M.K. Miller. Design of cold rolled and continuous annealed carbide-free bainitic steels for automotive application. Materials and Design 49 (2013) 667–680. http://dx.doi.org/10.1016/j.matdes.2013.02.046.

Pasi Pekka Suikkanen, Antti-Jussi Ristola, Ari Mikael Hirvi, Puspendu Sahu, Mahesh Chandra Somani, David Arthur Porter, Leo Pentti Karjalainen. Effects of Carbon Content and Cooling Path on the Microstructure and Properties of TRIP-aided Ultra-High Strength Steels. ISIJ International. Vol. 53 (2013) No. 2 pp 337-346. https://www.jstage.jst.go.jp/article/isijinternational/53/2/53_337/_article

F.G. Caballero, S. Allain, J-D Puerta-Velásquez and C. Garcia-Mateo. Exploring Carbide-Free Bainitic Structures for Hot Dip Galvanizing Products. ISIJ International, Vol. 53 (2013), No. 7, pp. 1255–1261. DOI: http://dx.doi.org/10.2355/isijinternational.53.1255.

RFSR-CT-2008-00022 NANOBAIN

Novel nanostructured bainitic steel grades to answer the need for high performance steel components

Info

Type of Project	Research	Duration (months)	36
Total Budget	1655995 €	Start Date	1/07/2008
EU Contribution	993597 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25908:EN

Final Abstract

This report summarises the work carried out over the duration of the project. The aim of this project was to investigate the fatigue and wear properties of Si-rich nanostructured bainitic steels (Nanobain). A first phase of the project consisted in the design of different possible alloy compositions, divided into a first series tailored for the manufacture of small components using gas quenching, and a second series for the manufacture of larger sections heat-treated in a salt bath. Kinetics and basic mechanical properties were investigated on laboratory casts. During this first part, an unprecedented combination of tensile strength and ductility was achieved on a newly designed composition (UTS 2.2GPa, total elongation > 20 %). Wear rates as measured in twin-disc tests were as little as 50 % of those achieved on standard high-hardness bainitic grades. In a second phase, two industrial heats were produced on the basis of results achieved during the first part of the project. These were used to manufacture component demonstrators or actual components and test them in representative conditions. Thus, tests on a metal scrap shear were carried out on the 0.6 %C grade designed in this project and heat-treated at 280 °C. Results were promising although testing conditions make it difficult to achieve a direct comparison. METSO estimates that this could provide similar performance as largely more expensive alloys, thus bringing a 10–20 % economic improvement. Fatigue testing at Bosch also led to promising results, with fatigue performance of the 06C grades on a par with those of 100Cr6. In contrast, results achieved on 1CSi were relatively poor, possibly due to poor cleanliness of the steel.

Partners

	Country	*Scientific person in charge*
ASCOMETAL S.A.S.	FRANCE	Thomas SOURMAIL (Pr. Coord.)
ALD VACUUM TECHNOLOGIES GmbH	DEUTSCHLAND	Volker HEUER
ROBERT BOSCH GmbH	DEUTSCHLAND	Jochen SCHWARZER
AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Francisca GARCIA CABALLERO
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Jacinto ALBARRAN SANZ
LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Braham PRAKASH
METSO MINERALS OY	FINLAND	Pekka SIITONEN

Selected Publications

A. Leiro, E. Vuorinen, K.-G. Sundin, B. Prakash, T. Sourmail, V. Smanio, F. G. Caballero, C. Garcia-Mateo, R. Elvira. Wear of nano-structured carbide-free bainitic steels under dry rolling-sliding conditions. Wear 298-299 (2013), 42-47. http://dx.doi.org/10.1016/j.wear.2012.11.064

T. Sourmail, F. G. Caballero, C. Garcia-Mateo, V. Smanio, C. Ziegler, M. Kuntz, R. Elvira, A. Leiro, E. Vuorinen, T. Teeri. Evaluation of the potential of high Si high C steels nanostructured bainite for wear and fatigue applications. Mater. Sci. Technol. 2013, http://dx.doi.org/10.1179/1743284713Y.0000000242

C Garcia-Mateo, FG Caballero, T Sourmail, M Kuntz, J Cornide, V Smanio, R Elvira. Tensile behaviour of a nanocrystalline bainitic steel containing 3 Wt% silicon. Mater Sci Eng A 549 (2012), 185-192. http://dx.doi.org/10.1016/j.msea.2012.04.031

F.G. Caballero, M.K. Miller, C. Garcia-Mateo. Carbon supersaturation of ferrite in a nanocrystalline bainitic steel. Acta Materialia 58 (2010) 2338–2343. doi:10.1016/j.actamat.2009.12.020

F.G. Caballero, Hung-Wei Yen, M.K. Miller, Jer-Ren Yang, J. Cornide, C. Garcia-Mateo. Complementary use of transmission electron microscopy and atom probe tomography for the examination of plastic accommodation in nanocrystalline bainitic steels. Acta Materialia 59 (2011) 6117–6123. doi:10.1016/j.actamat.2011.06.024.

RFSR-CT-2008-00024 CRESTA

New creep resistant stable steel for USC power plant

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1976202 €	Start Date	1/07/2008
	EU Contribution	1185722 €	End Date	30/06/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26415:EN

Project web page http://portal.tugraz.at/portal/page/portal/TU_Graz/Einrichtungen/Institut

Final Abstract

"This program targeted the development of new stable martensitic steel which is able to operate at higher temperatures and in more aggressive environments in steam power plants. The main results obtained are as follows: The current available thermodynamic tools give the wrong results in predicting transformation temperatures and thermodynamic stability. Fundamental investigations need to improve databases, tools optimisation and calibration; The Z-phase steel is still not optimised: it is too brittle and the Z-phase is not stable; A more conventional steel without Nb has been developed; tests are promising, but due to late manufacturing the creep tests are currently still ongoing (extra project conclusion) (no longer than 15 000 hours); Fabricability and weldability of the Nb-free steel has been demonstrated: semi-industrial heat manufactured, thick pipe produced and steam line welded prototype realised. The target to avoid PWHT for thin weld has not been reached; The consortium lost one industrial partner; partnership decided to complete program in order to obtain the most available results and to increase the knowledge for further development of high temperature steel applications. In spite of the worldwide economic crisis, the consortium partnership appears to have the intention to continue the steel development activities. The 700 °C steam technology concept for the next generation power plant, nickel-based super alloys, is still not consolidated and an advancement in available steel technology base could generate, shortly, additional efficiency increases in coal consumption and in the reduction of CO2 generation. The consortium will propose a new RFCS program for further improvement in the composition of Nb-free steel and activities still running towards conclusion"

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Augusto DI GIANFRANCESCO (Pr. Coord.)
	L'AIR LIQUIDE SA	FRANCE	Corinne CHOVET
	ALSTOM POWER SYSTEMS GmbH	DEUTSCHLAND	Qiurong CHEN
	DALMINE SPA	ITALIA	Stefano CAMINADA
	DONG ENERGY GENERATION AS*DANKRAFT AS ELSAM INT AS ELSAM ENG AS	DANMARK	John HALD
	INDUSTEEL CREUSOT SAS	FRANCE	Sylvain PILLOT
	TECHNISCHE UNIVERSITAET GRAZ	OESTERREICH	Peter MAYR

RFSR-CT-2008-00025 ASYLECTRO

Electrical steel with improved magnetic characteristics by asymmetric hot and cold rolling

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1186510 €	Start Date	1/07/2008
	EU Contribution	711906 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25915:EN			

Final Abstract "This project has the final target of analysing the effect of asymmetric hot rolling and cold rolling on texture, and the magnetic quality of 'Non grain oriented electrical steel'. It also has the target of studying the possibility to use asymmetric rolling to produce an hot rolled strip with low thickness to drastically reduce the cold rolling phase in order to decrease the cost of the transformation process. Two types of material with different chemical compositions (one high silicon, one low silicon) to be used in the project have been selected and transformed down to the finished product, through: hot rolling both symmetric and asymmetric, optional annealing, cold rolling both symmetric and asymmetric, and final annealing. The microstructure of hot rolled sheets has shown that asymmetric rolling, if compared with symmetric, tends to refine microstructure; texture analysis has shown at mid thickness of the hot rolled strip a weakening of typical rolling plain deformation texture (?-fiber) and an increasing of Goss {110} intensity, in case of asymmetric hot rolling compared to symmetric. Crystal plasticity and recrystallisation models have confirmed such a result. After cold rolling and final annealing the differences between samples asymmetrically and symmetrically cold rolled became weak and no improvement of the magnetic quality as a direct consequence of the application of asymmetric rolling has been observed. The use of asymmetric rolling as a means to produce an hot rolled strip of reduced thickness, in order not to eliminate, but to drastically reduce, the cold rolling phase, has been verified as feasible."

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Stefano CICALE (Pr. Coord.)
	DANIELI & C. OFFICINE MECCANICHE SPA	ITALIA	Stefano MORSUT
	TECHNISCHE UNIVERSITEIT DELFT	NEDERLAND	Leo KESTENS
	VOESTALPINE STAHL GMBH	OESTERREICH	Johann SPERL

RFSR-CT-2008-00026 StrengthCONTROL

Optimal strength control by individual strip related tuning of cooling processes in the hot rolling area based on models and in-line strength measurements

Info	Type of Project	Research	Duration (months)	54
	Total Budget	1658365 €	Start Date	1/07/2008
	EU Contribution	995019 €	End Date	31/12/2012
State	Project completed, final report not published yet			

Provisional Abstract The aim of this project is to produce significant smaller material parameter deviations over the whole strip length in hot strip mills. For this purpose a new strength optimisation system is developed, which adapts the setup of the run-out table cooling strip-by-strip and meter-by-meter. Basis of the adaptation are the
online material parameter measurement and an iterative learning control concept. Higher yield, less costs for tensile testing, and a strength guaranteed along the total strip length will be achieved. To reduce scale and processing time a fast coil cooling strategy will be investigated. Furthermore, a new cooling system
will be developed to perform an additionally controlled width adaptable cooling at the coiler.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Jan POLZER (Pr. Coord.)
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Benjamin POHU
	EMG AUTOMATION GMBH	DEUTSCHLAND	Klaus HERMANN
	HOESCH HOHENLIMBURG GmbH	DEUTSCHLAND	Peter HÖFEL
	SWEREA MEFOS AB	SVERIGE	Mats KARLBERG

RFSR-CT-2008-00027 MICRODAMAGE

Micro-scale damage tolerance of AHSS steels as function of microstructure and stress/strain state

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1341862 €	Start Date	1/07/2008
	EU Contribution	805117 €	End Date	31/12/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25863:EN

Project web page nothing to declare

Final Abstract

This project investigates the effect of prestrain on the susceptibility of AHSS microstructures to void formation with the aim of developing a micro-scale damage tolerance model for use in development of new AHS steels. The work has included studies of industrially produced steels and a vast matrix of laboratory microstructures and their properties as well as development of a FEM model of micro damage tolerance. The results have shown that the strength difference in the microstructure, together with the strength level and work hardening controls the microdamage behaviour in the steels investigated here. If the strength difference is high, void nucleation starts at low strains. The volume increase of voids with increasing strain is controlled by nucleation of new voids rather than growth of already nucleated ones. Growth of voids as an important feature for damage evolution is only relevant if nucleation of new voids is limited, as in single phase material. The strength difference and the fineness of the microstructure, i.e. the number of nucleation sites, controls the volume increase of voids and hence, the damage evolution. The findings can be used to optimise microstructures in terms of work hardening and damage tolerance.

Partners		*Country*	*Scientific person in charge*
	SWEREA KIMAB AB	SVERIGE	Lena RYDE (Pr. Coord.)
	FUNDACION ITMA*INSTITUTO TECNOLOGICO DE MATERIALES	ESPAÑA	Jose Manuel ARTIMEZ
	SSAB TUNNPLÅT AB	SVERIGE	Anders HAGLUND
	TECHNISCHE UNIVERSITAET MUENCHEN	DEUTSCHLAND	Ewald A. WERNER
	VOESTALPINE STAHL GMBH	OESTERREICH	Andreas PICHLER

RFSR-CT-2008-00023 ROLLINGHASS

Novel rolling methods for advanced high strength hot rolled steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1893470 €	Start Date	1/10/2008
	EU Contribution	1136083 €	End Date	30/09/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25886:EN			

Final Abstract ROLLINGAHSS project has been focused on the evaluation and optimisation of the challenging rolling phenomena involved in advanced high strength steels (AHSS) products with good quality on production scale respect to strip flatness and geometric tolerance. This project has been carried out in collaboration among four research institutes, TECNALIA, BFI, CSM and MEFOS, one university, OULU and ArcelorMittalEspaña SA steel producer. The consortium has modelled the phenomenon occurring from the exit of the roughing mill to the exit of the run-out-table (ROT). Single models have been developed by the partners and an integration methodology has been defined to merge the single models trying to capture the interaction between the different process stages. The models have been customised to the properties of three different AHSS grades: an industrial high microalloyed grade and two laboratory grades (DP and TRIP). The characteristics of these grades have been defined through a complete testing camping in the laboratory. Validation of the models has been performed in two pilot mills and at industrial scale. The integrated model is able to reproduce the industrial process satisfactorily and has been used to evaluate the influence of the parameters which are known to affect the strip flatness and geometric tolerance. The model has allowed to identify and understand current flatness problems and to define new strategies in the cooling section. In addition, a 'virtual' ROT configuration has been proposed designed to achieve the DP and TRIP microstructure in the cooling section.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	José Ignacio BARBERO (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Luigi LANGELLOTTO
	SWEREA MEFOS AB	SVERIGE	Mats KARLBERG
	OULUN YLIOPISTO*UNIVERSITY OF OULU	FINLAND	Pekka MÄNTYLÄ
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Volker DIEGELMANN

RFSR-CT-2009-00011 MICROTOOLS

Development of microstructure-based tools for alloy and rolling process design for hot rolled steels

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1174647 €	Start Date	1/07/2009
	EU Contribution	704788 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26212:EN			

Final Abstract Project Microtools developed tools to construct processing regime maps combining temperature-time-deformation history with enhanced knowledge of the metallurgical mechanisms during hot rolling, to design improved rolling schedules and chemistries. The dependence of the austenite recrystallisation and precipitation kinetics on the elements Mn, Si, Al and Nb at levels relevant to plate and advanced high strength strip steels was studied using thermomechanical testing and detailed metallography and integrated into equations for use in hot rolling models. The softening retardation potential of the alloying elements investigated was found to decrease in the order Nb>>Al>Si. A new methodology for quantifying the recrystallised austenite fraction using EBSD maps and austenite grain reconstruction software was developed. Processing regime maps were constructed for representative plate and hot rolled strip rolling schedules from which pilot rolling trials were designed and performed to successfully validate the new models

Partners		*Country*	*Scientific person in charge*
	TATA STEEL UK LIMITED	UNITED KINGDOM	Sally PARKER (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Sebastian COBO
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Beatriz LOPEZ SORIA
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Benjamin POHU

Selected Publications

"Z. Aretxabaleta, B. Pereda, S.V. Parker, B. López, ""Static Softening Behaviour in High Aluminium Steels"", Procs. of the International Conference on Processing and Manufacturing of Advanced Materials, Thermec'2011, August 1-5, 2011, Quebec, Canada. Published in Materials Science Forum, Vols. 706-709, (2012), 2764-2769. DOI 10.4028/www.scientific.net/MSF.706-709.2764 http://www.scientific.net/MSF.706-709.2764"

"Z. Aretxabaleta, B. Pereda, S.V. Parker, B. López, ""Influence of Nb on the Critical Temperatures during Multipass Deformation of High Al Steels"", 4th International Conference in Thermomechanical Processing of Steels, TMP2012, 10-12 September 2012, Sheffield, UK"

"Z. Aretxabaleta, B. Pereda, B. López, ""Cinéticas de ablandamiento de aceros con alto contenido en Al"", XII Congreso Nacional de Materiales, Alicante, 30 Mayo – 1 Junio, 2012."

RFSR-CT-2009-00012 LUNA

Guidelines for long ultrafine grained steel production and application to the automotive sector

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1954899 €	Start Date	1/07/2009
	EU Contribution	1172939 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26176:EN			

Final Abstract "The main objectives of this project were to supply the EU Steelmaking and Automotive Industry with guidelines for the production using existing productive plants and best utilisation of ultrafine grained carbon steel long products for mechanical applications. A ferrite grain size in the range of 1÷4 ?m and a steel microstructure characterised by a mixture of ferrite-pearlite and/or martensite, bainite, microstructure, can give a very good combination of mechanical (strength, ductility, toughness, fatigue) and technological properties (machinability, cold/ warm metal forming, etc.) for final application to automotive components. In particular the project objectives were: — Definition of the most suitable thermomechanical process for long ultrafine grained (UFG) steel production; — Identification of merits, in terms of microstructural and mechanical properties of UFG long steels in as-rolled conditions and after cold/warm forming; — Production of components or component-like dummies in UFG long products and evaluation of their mechanical performances. To give guidelines for automotive UFG long products applications. On the basis of the results of the project DIFT and Heavy ? deformation mechanisms were identified as suitable to be exploited to industrially produce UFG long product steels and the main parameters that control the formation of ultrafine ferrite were assessed. The use of UFG steel showed to allow the improvement of cold forming for fastener production, while no significant advantage was found for powertrain applications since, after their fabrication, they require a further heat treatment that modifies the previous UFG microstructure"

Partners		*Country*	*Scientific person in charge*
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Ilaria SALVATORI (Pr. Coord.)
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	José Manuel MARTINEZ ESNAOLA
	CENTRO RICERCHE FIAT SCPA	ITALIA	Flavia GILI
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Jacinto ALBARRAN SANZ
	O.R.I. MARTIN - ACCIAIERIA E FERRIERA DI BRESCIA SpA	ITALIA	Natale GAUDENZI
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA

Selected Publications J Aldazabal, JL Pedrejón, I Ocaña, A Martín-Meizoso, JM Martínez-Esnaola. “Estudio de la resistencia a fatiga y tenacidad de aceros templados de grano fino y ultrafino empleados para muelles”. Anales de Mecánica de la Fractura 30, 333-337 (2013)

RFSR-CT-2010-00018 PrecHiMn

Precipitation in high manganese steels

Info	Type of Project	Research	Duration (months)	54
	Total Budget	3199558 €	Start Date	1/07/2010
	EU Contribution	1919735 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

The aim of this project is to develop a detailed physical understanding of the thermodynamic and kinetic behaviour of precipitation in high manganese austenitic steels and to provide essential data for the modelling of technologically important (iron-carbide and transition-metal-carbide) precipitation processes in this new generation of high strength alloys. No equivalent data is to be found anywhere in the existing literature. New precipitation models will be validated and published in a form which can easily be integrated with existing codes.

		Country	*Scientific person in charge*
Partners	**THYSSENKRUPP STEEL EUROPE AG**	DEUTSCHLAND	Georg PAUL (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Colin SCOTT
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Beatriz LOPEZ SORIA
	KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Malin SELLEBY
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Jochen SCHNEIDER
	THE UNIVERSITY OF GLASGOW	UNITED KINGDOM	Ian MACLAREN
	OULUN YLIOPISTO*UNIVERSITY OF OULU	FINLAND	David PORTER

Selected Publications

A.V. Khvan, B. Hallstedt, K. Chang. Thermodynamic assessment of Cr–Nb–C and Mn–Nb–C systems. Calphad 39 (2012) 54–61.

A.V. Khvan, B. Hallstedt. Thermodynamic assessment of Fe-Mn-Nb-N and Nb-C-N systems. Calphad 40 (2013) 10-15.

J. Cholewa, I. MacLaren, A.J. Craven, G. Paul. Nanocharacterisation of Nanoprecipitates in High Manganese Steels. The 7th International Conference on Physical and Numerical Simulation of Materials Processing – ICPNS'13.

G. Paul, K. Khlopkov. Precipitation Processes in High-Manganese Steels. The 7th International Conference on Physical and Numerical Simulation of Materials Processing – ICPNS'13.

L. Llanos, B. Pereda, G. Paul, B. Lopez. Physical Modelling of the Interaction Between Softening and Nb(C,N) Strain-Induced Precipitation in High Mn Steels. The 7th International Conference on Physical and Numerical Simulation of Materials Processing – ICPNS'13.

RFSR-CT-2010-00019 AUSPLUS

Austenitic steels for complex and variable stress temperature, pressure and environmental conditions of next generation ultra supercritical power plants

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2449439 €	Start Date	1/07/2010
	EU Contribution	1469663 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

The project aims to supply steelmakers and end-users with practical guidelines, sound metallurgical evidences and production routes to develop new hot corrosion/oxidation creep/creep-fatigue-resistant austenitic steels for the extreme service conditions of next generation advanced Ultra Supercritical (A-USC) pulverized coal-fired power plants, characterized by biomass co-firing up to 20% by mass, internal fluid temperatures ≥700°C, fume temperature ≥750°C and unsteady thermo-mechanical operation conditions. By combined thermodynamic and kinetic models, production of lab heats and non-standard small and medium-scale test procedures, the fundamental micro-mechanisms affecting austenitic steel performance under different and variable environmental conditions (including creep and creepfatigue) will be investigated and quantified, to be converted into alloy design strategies at the industrial level. Selected full-scale validation tests will be conducted for components supplied by the Partners and through in-field experimental campaigns.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Alessio SACCOCCI (Pr. Coord.)
	COGNE ACCIAI SPECIALI SpA	ITALIA	Chiara ANDRIANOPOLI
	CHALMERS TEKNISKA HÖGSKOLA AB	SVERIGE	Milan FRIESEL
	DONG ENERGY WIND POWER HOLDING AS	DANMARK	John HALD
	DANMARKS TEKNISKE UNIVERSITET	DANMARK	Kristian Vinter DAHL
	NPL MANAGEMENT LTD	UNITED KINGDOM	Tony FRY
	TUBACEX TUBOS INOXIDABLES SA	ESPAÑA	Alejandra LOPEZ
	UNIVERSITA DEGLI STUDI DI CASSINO	ITALIA	Nicola BONORA
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Pertti AUERKARI

RFSR-CT-2010-00020 HYDRAMICROS

Hydrogen sensitivity of different advanced high strength microstructures

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1869006 €	Start Date	1/07/2010
	EU Contribution	1121404 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract Modern advanced and ultra-high strength steels, (UHSS)-grades, face the problem of hydrogen embrittlement, especially for strength levels above 1000 MPa. In this project, three classes of strength levels (1000, 1200 and 1400 MPa) with different microstructures will be generated through laboratory heat treatments from industrial cast and rolled steels. Subsequently, the samples will be charged with hydrogen and mechanically tested. This allows a ranking of the microstructures in terms of susceptibility to hydrogen. Accurate microstructure investigations of uncharged and charged samples before and after mechanical testing are important parameters for assessing the embrittlement behaviour. Accompanying computer simulations support the experimental work and will help to gain a deeper understanding.

		Country	*Scientific person in charge*
Partners	**MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH**	DEUTSCHLAND	Tilmann HICKEL (Pr. Coord.)
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Lode DUPREZ
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Richard George THIESSEN
	AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Hannu HÄNNINEN
	VOESTALPINE STAHL GMBH	OESTERREICH	Klemens MRACZEK

RFSR-CT-2011-00017 NEWQP

New advanced high strength steels by the quencing and partitioning (Q&P) process

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2168534 €	Start Date	1/07/2011
	EU Contribution	1301120 €	End Date	31/12/2014
State	Running project			

Project web page http://newqp.ctm.com.es/

Provisional Abstract This project aims at developing new advanced high strength steel grades by means of the “Quenching and Partitioning” (Q&P) process for application in the automotive sector with improved strength, ductility and strain hardening. Q&P opens the way to develop steel microstructures based on the exceptionally advantageous combination of austenitic and martensitic phases at the industrial scale. The industrial applicability of the Q&P process will be improved in terms of compositions, treatments and properties as galvanisability and weldability to develop a controlled and reproducible production process for these materials, and be prepared for future developments.

Partners	*Country*	*Scientific person in charge*
FUNDACIO CTM CENTRE TECNOLOGIC- CTM	ESPAÑA	Pablo RODRIGUEZ CALVILLO (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Andrea DI SCHINO
FUNDACION IMDEA MATERIALES	ESPAÑA	Ilchat SABIROV
ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Cecilia FÖJER
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Richard George THIESSEN
TECHNISCHE UNIVERSITEIT DELFT	NEDERLAND	Jilt SIETSMA
UNIVERSITEIT GENT	BELGIQUE	Roumen PETROV

Selected Publications

"D. D. Knijf, R. Petrov, C. Föjer and L. Kestens ""Optimization and Characterization of a Quenching and Partitioning Heat Treatment on a Low Carbon Steel."" Steel Product Metallurgy and Applications, Pittsburgh, (2012)"

RFSR-CT-2011-00018 AHSS-PROFILE

Advanced high strength cold rolled sheet steels (AHSS) with optimised profiling properties produced through different lines

Info

Type of Project	Research	Duration (months)	42
Total Budget	1460104 €	Start Date	1/07/2011
EU Contribution	876062 €	End Date	31/12/2014

State Running project

Provisional Abstract

The performance, e.g. the properties after roll-forming, of AHSS/UHSS is a challenging task when the tensile strength level increases over 1000MPa for cold rolled sheet steel.
This project deals with the relationship between microstructure, strength, formability and other customer demands on these materials and optimising processing conditions for annealing routes.
The overall goals are to produce:
• AHSS/UHSS with Rm>1000MPa optimised for roll forming, i.e. maximise the residual formability after roll forming for post-processing operations.
• Develop guidelines to produce the material, with appropriate alloy design, and well-adjusted processing parameters through several processing routes, i.e. continuous annealing lines (gas or water quenching) and hot dip galvanising.

Partners

	Country	*Scientific person in charge*
SWEREA KIMAB AB	SVERIGE	David LINDELL (Pr. Coord.)
RUUKKI METALS OY	FINLAND	Petri JUSSILA
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
SSAB EMEA AB	SVERIGE	Ylva GRANBOM
VOESTALPINE STAHL GMBH	OESTERREICH	Florian WINKELHOFER

RFSR-CT-2012-00015 DECAWIN

New steel-grades for deep carburizing of windmill transmission components

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1678830 €	Start Date	1/07/2012
	EU Contribution	1007298 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

The aim of the proposed project is to develop and evaluate new steels tailored for the production of large gears carburized using the rapidly developing low pressure carburizing method.
Wind turbine gears (up to 1200 mm in diameter) often require deep carburizing (3-6 mm) to ensure satisfactory performance and resistance to overloading. In standard conditions, (atmospheric carburizing at 960 °C, oil quenching), cycle times of up to 80 h are not uncommon, and distortion during quenching induce significant machining costs. In contrast, vacuum carburizing can be carried out at temperatures up to 1050 °C, therefore reducing the required time to about 20 h.
Use of vacuum carburizing and gas quenching for the manufacture of large wind turbine gears would allow not only significant cost reduction (shorter cycle time, reduced distortion) but also potentially increased reliability (absence of internal oxidation during carburizing). Both may contribute to improving the standard and energy return on investment of wind turbine operations. However, such a shift in manufacturing routes requires significant improvements of the steel grades currently in use (hardenability, creep resistance, and austenite grain stability at high temperature), and joint optimisation of the manufacturing route and designed steel grades (distortion minimization). Therefore, the objectives of this project are:
• to design and produce two steel grades with the following requirements
• for both grades, grain stability and sufficient creep resistance for carburizing conditions of up to 20 h at 1050 °C
• sufficient hardenability for oil quenching (1st solution) or gas quenching (2nd solution)
• to optimise process routes in order to minimize creep deformation
• to fully evaluate the benefits of both solutions
This new route will significantly reduce the economic and ecological impact of wind turbine gearboxes manufacture, thus strengthening European manufacturers against increasing competition.

		Country	*Scientific person in charge*
Partners	**ASCOMETAL S.A.S.**	FRANCE	Marion FROTEY (Pr. Coord.)
	ALD VACUUM TECHNOLOGIES GmbH	DEUTSCHLAND	Volker HEUER
	ROBERT BOSCH GmbH	DEUTSCHLAND	Hermann AUTENRIETH
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Roberto ELVIRA EGUIZABAL
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK

RFSR-CT-2012-00016 NAMOS

Nanoparticle addition into molten steel

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1929039 €	Start Date	1/07/2012
	EU Contribution	1157424 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

In NAMOS a novel steel grade with enhanced mechanical properties is fabricated by adding ceramic nanoparticles into molten microalloyed steel. The innovation is a feasible addition technique to disperse nanoparticles into the melt with nanoparticles safe manipulation. This is industrially-scaled. NAMOS reveals
nanoparticles - steel microstructure interaction mechanisms, their influence on grain size and mechanical behaviour. New grades with better strength and toughness allow products weight reduction (reducing fuel consumption and CO2 emissions in surface transportation components) and manufacturing-time and energy saving (due to heat treatments elimination). Ceramic nanoparticles give steels high temperature strengthening, broadening their applicability to the energy sector.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	Lorena Maria CALLEJO (Pr. Coord.)
	COMDICAST AB	SVERIGE	Sven EKEROT
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Carlos GARCIA MATEO
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Zuriñe IDOYAGA
	KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Pär JÖNSSON
	AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Seppo LOUHENKILPI
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Pertti LINTUNEN

RFSR-CT-2012-00017 MECBAIN

Understanding basic mechanism to optimize and predict in service properties of nanobainitic steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1813078 €	Start Date	1/07/2012
	EU Contribution	1087847 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

Carbide free nanobainitic microstructures are made up of nanometer thick bainite laths with retained austenite.
Due to their exceptional combinations of strength and ductility, these microstructures continue to attract considerable attention worldwide. During RFCS contract 2008-22 (NANOBAIN), unprecedented combinations of strength and ductility have been achieved, and very encouraging results were obtained in terms of fatigue resistance. Parameters controlling yield strength are well understood, but it is less so for those controlling ductility or complex properties such as fracture toughness and fatigue. Therefore, in order to fully exploit the potential of these microstructures in industrial applications, a better understanding must be achieved, of the relationship between process and microstructure on the one hand, and microstructure and in service properties on the other hand. It is clear however, that microstructural parameters of interest are at a much finer level than initially investigated.
The objectives of the present proposal are thus:
- to understand and quantify the relationship between microstructure (at the nano or atomic scale), and inservice properties of nanostructured bainitic steels
- to quantify the relationship between process parameters and microstructure in view of optimizing a later production route for optimum performances of the material Because of the scale at which investigations must be performed, the consortium will regroup, in addition to enduser and steel makers, research entities equipped for investigations at the atomic scale. University teams will also assist by investigating the link between microstructure and properties using numerical simulation of model microstructures.

		Country	*Scientific person in charge*
Partners	**ASCOMETAL S.A.S.**	FRANCE	Véronique SMANIO (Pr. Coord.)
	ROBERT BOSCH GmbH	DEUTSCHLAND	Matthias KUNTZ
	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE	FRANCE	Frédéric DANOIX
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Francisca GARCIA CABALLERO
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Roberto ELVIRA EGUIZABAL
	RUHR-UNIVERSITÄT BOCHUM	DEUTSCHLAND	Rebecca JANISCH
	TECHNISCHE UNIVERSITÄT KAISERSLAUTERN	DEUTSCHLAND	Eberhard KERSCHER

RFSR-CT-2012-00018 OPTIBOS

New developments and optimisation of high strength boron treated steels through the application of advanced boron monitoring techniques

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1649492 €	Start Date	1/07/2012
	EU Contribution	989696 €	End Date	31/12/2015
State	Running project			

Project web page http://www.tecnun.es/optibos/

Provisional Abstract

This research is aimed at improving consistency of properties in B-treated ultrahigh strength plate and investigating the applicability of B additions for producing advanced multiphase cold rolled and annealed strip with high strength, formability, wear resistance and weldability atreduced cost.
An important part of the work is the investigation of the sensitivity of different characterisation techniques and the definition of the guidelines for improved monitoring of B in its different forms.
This will provide data to support investigation of including B in an existing model of recrystallisation and assessment of the accuracy of existing precipitation and transformation models.

Partners	*Country*	*Scientific person in charge*
ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Isabel GUTIERREZ SANZ (Pr. Coord.)
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Griet LANNOO
MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Dirk PONGE
ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Wei XU
TATA STEEL UK LIMITED	UNITED KINGDOM	Matthew GREEN

RFSR-CT-2012-00021 PRESSPERFECT

Prediction of stainless steel performance after forming and finishing

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2035535 €	Start Date	1/09/2012
	EU Contribution	1221321 €	End Date	31/08/2015
State	Running project			

Provisional Abstract

The goal of the project is to create a methodology to predict the performance of high quality stainless steel after forming and finishing treatments. The performance is used to link end-customer requirements to steel production conditions. This methodology is tested on three types of steel and routings:
1) martensitic stainless steel & heat treatment;
2) Austenitic stainless steel & nitrocarburising;
3) Precipitation hardening stainless steel & precipitation hardening and simultaneous nitrocarburising.
The approach is to create knowledge based constitutive models of these materials. It will be transferred to the EU by the implementation in a commercial finite element solver and workshops.

Partners		*Country*	*Scientific person in charge*
	PHILIPS CONSUMER LIFESTYLE BV	NEDERLAND	Jan POST (Pr. Coord.)
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	David SAN MARTIN FERNANDEZ
	DANMARKS TEKNISKE UNIVERSITET	DANMARK	Marcel SOMERS
	LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Lars-Erik LINDGREN
	STICHTING MATERIALS INNOVATION INSTITUTE (M2i)	NEDERLAND	Giuseppe VISIMBERGA
	AB SANDVIK MATERIALS TECHNOLOGY	SVERIGE	Fredrik SANDBERG

RFSR-CT-2013-00010 ELONHOTSTAMP

New Hot Stamping Steel with Improved Elongation

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1469272 €	Start Date	1/07/2013
	EU Contribution	881563 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

Hot stamping has received much attention as a method of producing automotive ultra high strength parts. Due to the exceptional tensile strength the safety of the passenger increases and the vehicle CO2 footprint is reduced. However, the final fully martensitic microstructure in hot stamped parts, tends to compromise the ductility and cracking may occur at relatively low strains. This proposal addresses the manufacturing of final hot stamped parts with enhanced elongation, maintaining the current tensile strength requirements. In order to meet this objective, new microstructures will be produced after the hot stamping process, mainly martensite/austenite combinations, based on the novel quenching and partitioning (Q&P) heat treatment applied just after the component hot forming. Q&P thermal treatment has been proposed recently as a new way of obtaining martensite microstructure with enhanced levels of retained austenite. In Q&P the steel is quenched to a temperature between Ms and Mf and then it is either maintained at the quenching temperature or brought to a higher temperature which aim is to stabilize the austenite present by carbon depletion of the martensite and enrichment of austenite. In the present proposal a new heat treatable steel grade will be developed, based on the current 22MnB5, suitable to undergo the partitioning stage following the press forming and quenching operations. The optimum quenching and partitioning temperature-time conditions will be defined, pursuing also a compromise with the cycle time and energy consumption. The new steel grade and the accompanying thermal cycle will be validated at semi-industrial scale and the performance of the new material will be evaluated following the in-service specifications.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	Maribel ARRIBAS (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Leopoldo RIZZO
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Thomas GERBER
	VOLKSWAGEN AG	DEUTSCHLAND	Ansgar HATSCHER

RFSR-CT-2013-00011 BESTSEAT

Development of a New Bearing Steel with Improved Life for Service Environments Near Ambient Temperature

Info

Type of Project	Research	Duration (months)	42
Total Budget	1320657 €	Start Date	1/07/2013
EU Contribution	792394 €	End Date	31/12/2016

State Running project

Provisional Abstract

The project is aimed at the development of a novel type of bearing steel for use in applications in the marine and wind energy sectors not involving exposure at elevated temperatures. The purpose will be to develop alloys which will allow a 30% increase in the load capacity of the bearings or give increases in life at existing service loads. The new material will give the potential for lightweighting, which in the marine transport sector will lead to improved energy efficiency and in sectors such as wind energy could have benefits through safer and faster commissiong of the nacelle, greater reliability, hence longer service intervals and longer lives, together with improved power generation performance. Metallurgical modelling will be used to design alloys with a large volume fraction of carbides which will give high hardness after heat treatment. Extensive testing and microstructural characterisation will be carried out on small-scale experimental melts in order to optimise composition and processing. A 5 tonne melt will then be produced for the chosen composition to allow the production and testing of full-scale bearings.

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Matthew GREEN (Pr. Coord.)
SWEREA KIMAB AB	SVERIGE	Joacim HAGSTROM
ROLLS-ROYCE PLC	UNITED KINGDOM	Martin RAWSON
SKF BV	NEDERLAND	Urszula SACHADEL

RFSR-CT-2013-00012 AUSTOUGH

Austenite reconstruction tool for low-temperature toughness control in heavy gauge steels

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1568130 €	Start Date	1/07/2013
	EU Contribution	940878 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

Although heavy gauge plates and coils are already produced at industrial scale, the market driven industrial development is now focussed on high thickness products with higher strength and high toughness. One of the current processing routes for these high thickness grades is the TMCP route, which critically depends on the austenite conditioning during hot forming at specific temperature in relation to the aimed metallurgical mechanisms (recrystallization, strain accumulation). There is, however, the limitation regarding the quantification of such mechanisms when industrial processes are considered. Currently, all the knowledge on the metallurgical evolution of the austenite is based on modelling and empirical simulations of the industrial process that hardly consider the gradient of temperature on the thickness to derive the austenite status. Moreover, most of the models consider homogeneous microstructures ahead of the phase transformation. The intention of this project is to develop a technique that allows direct observation of high-temperature austenite structures on industrially processed heavy gauge plates and coils. It is expected that such a tool will allow the fine tuning of the current TMCP parameters for plate and coil processing, pushing further the strength and toughness limits currently obtained, i.e. developing higher grades with improved toughness in higher thinness. The selected approach is (i) first to develop a high temperature phase reconstruction tool, (ii) validate the reliability of this tool on homogeneous reference specimens and (iii) apply this tool on hot rolled plates in order to extract accurate quantitative data on the parent phase microstructure including its spatial heterogeneity and (iv) apply the newly acquired information to optimally design the hot rolling process to the purpose of improving the (low-temperature) fracture toughness of the finished product.

		Country	*Scientific person in charge*
Partners	**ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.**	BELGIQUE	Nuria SANCHEZ (Pr. Coord.)
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Beatriz LOPEZ SORIA
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Elisabetta MECOZZI
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Charles STALLYBRASS
	UNIVERSITEIT GENT	BELGIQUE	Leo KESTENS

RFSR-CT-2013-00013 TOOLMART

New Metallurgical Tools for optimum design of modern Ultra High Strength Low Carbon Martensitic Steels

Info

Type of Project	Research	Duration (months)	42
Total Budget	1507986 €	Start Date	1/07/2013
EU Contribution	904791 €	End Date	31/12/2016

State Running project

Provisional Abstract

Recent developments of martensitic steels have extended the field of applications far beyond that of conventional Quenched and Tempered plate steels. New products have been developed based on strip processes: Press Hardened Steels, Low Temperature Tempered, Quenched & Partitioned and hot rolled Direct Quenched steels. They have introduced new in-use properties for ultrahigh strength steels: press formability, delayed fracture resistance and wear resistance. Current metallurgical approach describing martensite transformation, tempering reactions, microstructures development and properties show significant limitations overlooking key issues such as the role of prior austenite state and heterogeneous carbon distributions across lath structures. Developing a common approach for low carbon martensite characterization, Project TOOLMART will integrate new fundamental knowledge into a workbench of product design tools validating its industrial application on modern martensitic steels.

Partners

	Country	*Scientific person in charge*
CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Jean-Louis COLLET (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Sebastian COBO
MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Dirk PONGE
TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Stefan VAN BOHEMEN

RFSR-CT-2014-00015 TOUGH-SHEET

Measurement of toughness in high strength steels sheets to improve material selection in cold forming and crash-resistant components

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1715034 €	Start Date	1/07/2014
	EU Contribution	1029019 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

The development of lightweight designs and the use of smart materials and manufacturing processes offer the automotive industry a real chance to successfully upgrade the current vehicle standards according to the increasing demands on safety and sustainability. Steel and aluminium already dispute lightweight designs and fibre-reinforced plastics will also be used for structural part soon. But steel still represents the main choice of the total body-in-white, especially since in the two last decades developed the AHSS. The high mechanical strength of such steels makes them especially susceptible to the presence of microcracks, notches or any kind of edge irregularity. Cracks easily nucleate and propagate from these irregularities during the in-life service or after some cold forming steps (in notched areas, around punched or trimmed regions). In both situations, the property that controls crack propagation is the fracture toughness, which cannot be measured in metal sheets with conventional standards because its limited thickness (1-3mm).Thus, steel sheet developer and part manufacturers cannot use this property to design new steel grades, with improved crack tolerance or to adjust forming parameters to prevent crack propagation. Moreover, fracture toughness can also be used to understand crashworthiness of metal sheets and help developing new AHSS grades that allow further gauge reduction. Nowadays, fracture toughness can be readily measured in thin materials through the application of the Essential Work of Fracture (EWF) methodology main used in polymers. Thus the aim of this project is to determine fracture toughness in high strength steels sheets, by means of the EWF methodology, aimed at determining a useful mechanical property to develop failure criteria in sheet metal forming and crash resistant. It is expected that sheet toughness may help to improve material selection in cold forming and to assess crashworthiness of different AHSS for structural components.

		Country	*Scientific person in charge*
Partners	**FUNDACIO CTM CENTRE TECNOLOGIC- CTM**	ESPAÑA	Daniel CASELLAS (Pr. Coord.)
	CENTRO RICERCHE FIAT SCPA	ITALIA	Fabio D'AIUTO
	IDIADA AUTOMOTIVE TECHNOLOGY SA	ESPAÑA	José Manuel BARRIOS
	VOESTALPINE STAHL GMBH	OESTERREICH	Andreas PICHLER

RFSR-CT-2014-00016 BAINWEAR

Novel nano-structured bainitic steels for enhanced durability of wear resistant components: microstructural optimisation through simulative wear and field tests

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1898403 €	Start Date	1/07/2014
	EU Contribution	1139040 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

A novel method for making extremely strong and inexpensive nanocrystalline steels without using severe deformation, rapid heat-treatment or mechanical processing has been recently developed by the formation of nanostructured bainite at very low temperatures (200-300 ºC). It leads to an extremely fine microstructure, consisting in thin plates of ferrite (40-60 nm) and retained austenite (15-30 %). This new generation of steels, referred to as nanobainitic steels, are potentially one of the most significant discoveries in steel metallurgy over the past 10 years.. Nanobainitic grades have shown the highest strength/toughness combinations ever recorded in bainitic steels (2.5 GPa / 30 MPa•m1/2), and also superior potential for wear applications in large components, where a uniform microstructure free from residual stresses or complex processing is required. Nanobainitic steels show a promising and almost unique possibility to optimize both toughness and wear resistance at a reasonable cost. This will open the possibility to substitute other steel grades on applications where very high wear and fracture resistance are required. The aim of the BAINWEAR project is to develop a new family of microstructurally optimised nanobainitic steels with a unique combination of wear resistance and toughness. This will be achieved through comprehensive investigations to fully understand the mechanisms of resistance to different wear modes of nanostructured bainitic steels in terms of the relevant microstructural features such as austenite content, morphology (blocks and films), size and carbon content; and ferrite lath thickness affecting steel hardness.

		Country	*Scientific person in charge*
Partners	**FUNDACIO CTM CENTRE TECNOLOGIC- CTM**	ESPAÑA	Jaume PUJANTE (Pr. Coord.)
	ASCOMETAL S.A.S.	FRANCE	Thomas SOURMAIL
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Francisca GARCIA CABALLERO
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
	LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Braham PRAKASH
	NTN-SNR ROULEMENTS SA	FRANCE	Pierre DIERICKX
	PALLMANN MASCHINENFABRIK GMBH & CO KG	DEUTSCHLAND	Dirk DIETRICH
	ROVALMA SA	ESPAÑA	Anwar HAMASAIID

RFSR-CT-2014-00017 BaseForm

Bainite and second-phase engineering for improved formability

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1750057 €	Start Date	1/07/2014
	EU Contribution	1050033 €	End Date	30/06/2018
State	Running project			

Provisional Abstract

Despite a tremendous development in the past years, the potential of Advanced High-Strength Steels is not yet fully explored. Further optimisation requires a systematic approach combining state-of-the-art experimental characterisation and physically-based model simulations. A lot of work has been dedicated to the correlation between process parameters, bainite microstructure features and specific mechanical properties, but present models can predict only the bainite transformation kinetics during processing and not yet the microstructure morphology. Moreover a microstructure based model to handle bainite mechanical behaviour is still missing. In addition, very little attention has been paid to the impact of the very low volume fraction of martensite or MA islands in the bainitic matrix on the strength and formability. Nevertheless, recent internal results suggested that even a few percentage of martensite can affect strongly the mechanical and damage properties of the bainitic steels. The proposed project focusses on control and optimisation of the very promising combination of steel phases: bainite, martensite and retained austenite. Bainite has since long been known to form a very beneficial matrix structure, which can further be optimised by controlling martensite inclusions for enhanced strength and retained austenite for enhanced formability. By means of experimental characterisation and physical understanding of the evolution of microstructures and the relation between microstructures and mechanical properties, this project will contribute significantly to the further development of this most promising class of Advanced High-Strength Steels. In the current project the microstructure matrix under study will be bainitic, which is a constituent that allows better and more flexible control than martensite and which shows an improved balance of strength and ductility. The bainitic structure will be enriched by both martensite and austenite for optimum properties.

		Country	*Scientific person in charge*
Partners	**STICHTING MATERIALS INNOVATION INSTITUTE (M2i)**	NEDERLAND	Viktoria SAVRAN (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Kangying ZHU
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Isabel GUTIERREZ SANZ
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Stefan VAN BOHEMEN
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Frank HISKER
	TECHNISCHE UNIVERSITEIT DELFT	NEDERLAND	Jilt SIETSMA

RFSR-CT-2014-00018 SteelWind

Design and development of a new high nitrogen bearing STEEL for offshore WIND turbines with improved surface fatigue, wear and corrosion properties for in service life increment.

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1892202 €	Start Date	1/07/2014
	EU Contribution	1135317 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

Among the fields of renewable energy sources, the wind energy sector has grown significantly within the last two decades but an actual critical point is the gearboxes life expectancy. Costs associated with their failure rates reach 250 k€ per failure for a 5MW Wind Turbines (WT). The problem is heightened in offshore working. The aim of this proposal is to increase the reliability of WT, improving tribological, fatigue, surface fatigue and corrosion properties of steel bearings modifying chemical composition. 100Cr6 steel is usually used for steel bearings production. On the other hand, it is well-known that nitrogen enhances fatigue strength, wear and fatigue resistance, resistance to crevice corrosion and to pitting corrosion of austenitic steels. Moreover, nitrogen addition helps to refine the microstructure, it increases the strength of the alloy and it can be used instead of nickel as an austenite-forming. The introduction of a new high nitrogen austenitic steel can improve the critical properties of the component and reduces its cost by the increment of the service lifetime. Improvement of the hot/cold workability of the new steel will be moreover valuated as well as the optimisation a Deep Rolling process for steel mechanical surface improvement and fatigue strength enhancement. The chemical composition will be established by alloy design evaluating two production lines (with and without remelting process added to the vacuum induction melting). As consequence cost reduction of steel production will be considered. The new steel composition will be examined by a wide microstructural characterisation and mechanicals testing. Functional test rig will be developed for the evaluation of steel surface fatigue and corrosion properties mainly in offshore application. Industrial melt will be then produced for bearings prototypes manufacturing. They will be validated using full scale tests and in case of damage, mechanisms will be compared with normal failure modes.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Francesca ARCOBELLO VARLESE (Pr. Coord.)
	DANMARKS TEKNISKE UNIVERSITET	DANMARK	Grethe WINTHER
	ECOR RESEARCH S.P.A.	ITALIA	Ronaldo RIGON
	ENERGIETECHNIK ESSEN GmbH	DEUTSCHLAND	Roman RIETZENHOFF
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	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Ana Maria CABRAL
	SCHAEFFLER TECHNOLOGIES GmbH & CO KG	DEUTSCHLAND	Walter HOLWEGER

RFSR-CT-2014-00019 SuperHigh

In-use properties of Super High strength steels generated by a range of metallurgical strategies

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1780521 €	Start Date	1/07/2014
	EU Contribution	1068311 €	End Date	30/06/2018
State	Running project			

Provisional Abstract

The overall trend towards increased performance combined with optimized safety, reduced weight and cost effective manufacturing has broadened the interest in super high strength steels (SHSS). Recently, different metallurgical strategies have been proposed for the development of this new generation of hot-rolled SHSS. Many concepts are today only tested at laboratory scale and focused on dedicated applications. For them to become technologically available in a 2015-2020 horizon, a clear link between their in-use properties and potential markets is still missing. This project aims at associating these recently developed innovative microstructures to future production routes and application areas exploiting at maximum their mechanical and in-use properties. Numerous apparent technical solutions on the development of new generation SHSS have been published in the literature, but in most of the cases data are incomplete or unreliable for cross comparison. A full picture of their potential for a wide range of application areas is essential to provide steel makers the guidelines towards the most promising metallurgical routes for their future products in different application areas. This project will use the knowledge of previous research work and further explore the proposed metallurgical routes in a broader perspective. Graphs mapping several mechanical and in-use properties would complement the classical tensile strength versus elongation chart for a large variety of microstructures concepts ranging from TRIP assisted complex phase steels over ausformed martensite and maraging steels until heavy deformed high carbon steels. Those charts will assemble essential information to select the metallurgical routes of super high strength steel (SHSS) for the next decades. The knowledge of previous and running projects will be largely used in our project as most of them have set out the principals of the metallurgy that we consider.

Partners		*Country*	*Scientific person in charge*
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Isabelle TOLLENEER (Pr. Coord.)
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	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Wei XU
	TATA STEEL UK LIMITED	UNITED KINGDOM	Matthew GREEN
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RFSR-CT-2014-00032 CRESTA2

New Creep Resistant Stable Steel for USC Power Plant

Info	Type of Project	Research	Duration (months)	48
	Total Budget	2588993 €	Start Date	1/07/2014
	EU Contribution	1553393 €	End Date	30/06/2018
State	Running project			

Provisional Abstract

Project targets are know-how consolidation acquired in the CRESTA for the development of microstructurally stable Very High Chromium Martensitic Steels for Advanced Ultra-Super-Critical steels trough longer term and deeper investigations on aged specimens of compositions developed and prototype pipe and welded component realised and further tailoring of the chemical composition of both steel grades. The partnership would like to reach results targeting the EU standard requirements for approval for industrial applications in Advanced USC Power Plants with steam operating temperature in the range of 650-700°C. So far, it has not been possible to obtain sufficient creep strength in 12%Cr steels at temperature of 650°C, simply by strengthening with (V,Nb)N nitrides or addition of boron. Still, more stable coarse Cr(V,Nb)N Z-phase particles form during exposure in expense of finely distributed (V,Nb)N and result in a loss of precipitation strengthening effect and in breakdown of the long-term creep strength. An increased Cr content, to improved oxidation resistance, accelerates this formation of Z-phase nitrides. One approach is to use the more stable Z-phase itself as a strengthening phase and promote precipitation of a finely dispersed precipitation of Z-phase. The second approach is the reduction of the Nb content because this element seems the more critical to accelerate transformation of (V,Nb)N into Z-phase. There is a need for further investigations, without interruption of current activities still running, in order to consolidate so far gained knowledge. Besides, slight changes in compositions are necessary in both steels to improve fabricability (particularly for large scale industrial applications), to optimize the B and N content improving welded joint properties and reducing the type IV sensitivity, to reduce the Co addition for steel cost reduction, and finely tune heat treatment technologies to get mechanical properties able to perfectly fulfil TUV/EN.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Augusto DI GIANFRANCESCO (Pr. Coord.)
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	SOCIETA' DELLE FUCINE SRL	ITALIA	Massimo CALDERINI
	TECHNISCHE UNIVERSITAET GRAZ	OESTERREICH	Christof SOMMITSCH
	MATERIÁLOVÝ A METALURGICKÝ VÝZKUM s.r.o.	CZECH REPUBLIC	Karel MATOCHA

Technical Group Steel 7

Steel products and applications for automobiles, packaging and home appliances

The scope of TGS7 includes:

- Technologies relating to the forming, cutting, welding and joining of steel and other materials
- Design of assembled structures to facilitate the easy recovery of steel scrap and its reconversion into usable steels and techniques for recycling
- Steel-containing composites and sandwich structures
- Prolonging service life of steel products
- Standardisation of testing and evaluation methods

RFSR-CT-2003-00023 Hi-FLOW

Influence of flowforming process parameters on the fatigue behaviour of high strength steel wheel for automotive industry

Info

Type of Project	Research	Duration (months)	45
Total Budget	1232062 €	Start Date	1/09/2003
EU Contribution	739237 €	End Date	31/05/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23726:EN

Final Abstract

Lack of knowledge about the flow-forming process to wheel rim applications, and the expected results as a function of the material properties and process conditions, is a restriction to extending the use of high-strength steel with this technology to the wheel rim of new generations. The focus of this project was to increase knowledge of flow-forming behaviour of high-strength steel when applied to wheel rims, and to develop reliable numerical tools useful for both flow-forming and fatigue-life estimation, allowing for the study of the performance at the early design stage. The main subjects and results of the research project were as follows. 1. A DOE plan was defined and flow-formed rims were produced with the selected materials and different sets of process parameters (thinning, advance speed and rotational speed). 2. The results from the production campaign were extracted, contributing to greater knowledge about steels and the production process. 3. A wide campaign of testing at laboratory level on flow-formed material led to greater knowledge of the process and established differences among the various materials studied. 4. Specific knowledge has been gained on the fatigue-life of the final material as a function of the process conditions. 5. Regarding numerical analyses, FE models of the flow-forming process were developed with very effective results in assessing the material flow during the process and final plastic deformation. 6. A methodology for fatigue-life prediction of the flow-formed wheel rim was developed and implemented in a commercial code. The validation of the methodology was carried out using an industrial study.

Partners

	Country	*Scientific person in charge*
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ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	André GALTIER
ARCELOR TREASURY	FRANCE	Anne CLAD
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	María Angeles GUTIERREZ
MAGNETTO WHEELS S.P.A.	ITALIA	Giacomo GOTTA

RFSR-CT-2003-00026 LOCALHEAT

Local heat treatment of ultra high strength steel

Info

Type of Project	Research	Duration (months)	48
Total Budget	2081548 €	Start Date	1/09/2003
EU Contribution	1248928 €	End Date	31/08/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23918:EN

Project web page http://localheat.c-s-m.it (no longer active)

Final Abstract

The main topics in automobile design today are weight and safety. A possibility to reduce weight and increase safety is offered by ultra high-strength sheet steels, either cold or hot formed. There are, however, limitations in design possibilities due to the complicated manufacturing. Springback and formability can cause problems. The high strength can put a limit to the weight reduction due to the appearance of other collapse modes caused by the thinner gauge. One way around these problems can be to work with local heat treatment. The objective for cold forming is here to introduce softer, more formable regions in the blank allowing for higher deformation and control of the collapse mode. For hot forming the objective is to produce parts with varying strength within the same piece, through a varying heat treatment over the part. The pieces can be designed to be strong where needed and deformable where needed. Various suitable sheet materials have been selected and the change in properties with varying heat treatment studied. Laser, induction and salt bath were used as heating methods. Suitable parameters for those methods and the selected materials have been determined. Material properties after heating have been determined, including static and dynamic mechanical properties and formability measures. Several industrial applications have been manufactured, all of which had limitations when virgin material was used but which could be solved with local heat treatment. The components have been tested for performance. An economical and technical evaluation of the investigated cases is included.

Partners

	Country	*Scientific person in charge*
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CENTRO SVILUPPO MATERIALI SPA	ITALIA	Filippo PLACIDI
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Selected Publications

A. Weisheit, G. Vitr, K. Wissenbach, J. Zajac, H. Toors, B. Johansson, E. Ribera, J. Ariño, F.Sierra. “Local Heat treatment of Ultra High Strength Steels to Improve Formability”. IWOTE05 (International Workshop on Thermal Forming, Bremen, April 13-14, 2005)

Björn Carlsson, Lars Olsson. “Improved formability of ultra high strength steels through local heat treatment”. STC 2005, Wiesbaden, June 5-10, 2005.

II Taller Nacional – Procesado de Materiales con Láser, 24-25 Nov. 2005, AIDO, Paterna (Valencia,Spain) “Tratamientos térmicos mediante láser para la mejora de la conformabilidad de aceros de alta resistencia” A.Weisheit1 , G. Vitr1, K Wissenbanch1, J. Zajac2, H. Thoors2, B. Johansson2, J. Ariño3, E. Ribera3, F. Sierra3 1Fraunhofer-Institut Lasertechnik, 2Swedish Institute for Metals Research, 3Applus+ MPI, Campus de la UAB, 08193 Bellaterra, Spain

Björn Carlsson, Domenico Russo, Jesús Ariño. “Manufacturing of parts in Ultra High Strength Steel using Local Heat Treatment” . Proceedings of ESDA 2006, 8th Biennal ASME Conference on Engineering Systems Design and Analysis. Torino, 4-7 July 2006

F. Valente, F. Placidi, L. Rizzo. “Towards free design of structural steel components, by localised heaut treatment”. Conference on “New Developments on Metallurgy and Applications of High Strength Steels”, Buenos Aires 26-28 May 2008.

RFSR-CT-2003-00029 FLANGE CORROSION

Investigation of the corrosion mechanism in flanged joints of carbodies

Info

Type of Project	Research	Duration (months)	48
Total Budget	1428428 €	Start Date	1/09/2003
EU Contribution	857057 €	End Date	31/08/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23879:EN

Final Abstract

The objective of the project was the investigation of corrosion mechanisms in flanged joints of car bodies, in order to get a generalised description of the electrochemical parameters within gaps. At first, a basic catalogue of influencing parameters was generated. Testing parameters such as climatic chambers and flange geometries were defined and round robin tests (VDA 621-415) done. For evaluation of corrosion propagation, the percentage of red rust was determined visually and by optical evaluation systems. Besides the VDA 621-415 test, other known corrosion tests, such as PVW 1210 and ECC1, were validated. One aim was to evaluate the process of perforation corrosion using visual and optical evaluation methods (e.g. flange camera) and to characterise the chemical reaction of perforation corrosion. To get predictable facts and results for evaluating the percentage of red and white rust, the corrosion products were removed with special pickling solutions. Different pickling solutions were tested and the pickling effects and material loss were determined. In a new procedure, depths of perforation corrosion were determined using laser triangulation. The second main goal of the project was to characterise the chemical reaction of the perforation corrosion in the flange area using different methods of surface analysis. The mechanism was examined with in situ methods (e.g. microelectrode arrays). Corrosion products over the flange area were examined with a non-destructive Raman spectroscopy. This information was correlated with the visual evaluation. The influence of premature damage of Granocoat ZE and the local ageing process during testing were analysed by SEM after microtome cutting preparation.

Partners

	Country	*Scientific person in charge*
VOESTALPINE STAHL GMBH	OESTERREICH	Karl-Heinz STELLNBERGER (Pr. Coord.)
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DOC DORTMUNDER OBERFLÄCHENCENTRUM GmbH	DEUTSCHLAND	Stella JANSSEN
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TECHNISCHE UNIVERSITAET WIEN	OESTERREICH	Günter FAFILEK

RFSR-CT-2003-00032 DURATOOL

Mass production forming of high strength steel with durable tooling

Info	Type of Project	Research	Duration (months)	45
	Total Budget	1718206 €	Start Date	1/09/2003
	EU Contribution	1030922 €	End Date	31/05/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25329:EN			

Final Abstract The use of (advanced) high strength sheet (A)HSS in forming, shearing and punching applications places increasing demands upon tool materials, particularly in terms of wear performance. A range of tool and sheet steel materials has been studied within the Duratool project. Tribological tests were used to assess wear and friction in forming. High volume forming, shearing and punching trials were also conducted. The tribological findings indicate that conventional tool materials do not perform well in terms of adhesive wear or abrasive wear for steels of tensile strengths above 800 MPa and that more advanced tool materials and coatings must be considered. Tool roughness and lubrication should be controlled to minimise adhesive wear. A finite element model has been developed to predict abrasive tool wear in forming. The model can be used to simulate tool wear and changes in subsequent part geometry. Studies show that changes in part geometry due to tool wear are significant for (A)HSS. For best performance in shearing, the process should be optimised. A cutting clearance equal to 5 % of sheet thickness and a shear angle of 1 ° is suitable for all sheet strengths. High volume shearing trials show that edge quality is more dependent on sheet ductility than tool wear. High strength steels produce a good edge with small burrs simply due to their reduced ductility, despite incurring increased tool wear. In punching trials, conventional tool steels were found to work well to 200 000 strokes for low carbon and mid-range high strength steels. For more demanding AHSS grades, only PM tool steels offered acceptable performance. The results of the project have been summarised in the form of tool selection guidelines.

		Country	*Scientific person in charge*
Partners	**CORUS TECHNOLOGY B.V.**	NEDERLAND	Louisa CARLESS-ELLIOTT (Pr. Coord.)
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	TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	E. VAN DER HEIDE
	UDDEHOLM TOOLING AB	SVERIGE	Berne HÖGMAN

RFSR-CT-2003-00037 ALOAS

Applications of advanced low alloy steels for new high temperature components

Info	Type of Project	Research	Duration (months)	54
	Total Budget	1978273 €	Start Date	1/09/2003
	EU Contribution	1186964 €	End Date	28/02/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23598:EN			

Final Abstract The new low-chromium steel grades 23 and 24 are candidate materials for components of the new power and petrochemical plants, and for the refurbishment and re-powering of older plants. The mechanical and creep properties of both grades are significantly better than the parent grade 22, but long-term creep performance, microstructural evolution, welding characteristics and other properties were not fully defined and assessed. It was also important to improve knowledge of microstructural evolution in order to verify the mechanical behaviour after long-term service. The consortium has produced trial components by industrial process routes for both grades, but the activities have been focused mainly on grade 23, for commercial reasons, and on grade 24 for comparison. New consumables for welding have been developed and tested. Creep test programmes for base material and welded joints, including long-term tests, have been carried out, and some tests will continue beyond the end of the project. The data acquired will also be incorporated in the creep database of the European Creep Collaborative Committee and will be used in the coming assessments for EN standards. The parallel aim of the project was piping integrity assessment under realistic loading conditions by combined thermal and hydraulic system analysis and stress analysis using the data generated during the project. This work has shown that a P23 pipework system will be more durable than an equivalent CMV system providing that good operational practice is maintained, thereby minimising the risks of severe operational transients.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Augusto DI GIANFRANCESCO (Pr. Coord.)
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Selected Publications

Int. Conf. New Developments on Metallurgy and Applications of High Strength Steels: Buenos Aires, 26-28 May Argentina 2008. Advanced ferritic high Chromium grades for power generation applications: similar and dissimilar weldability assessment and long-term performances: E.Bauné, E.Galand, B.Leduey, G.Liberati, S.Caminada, G.Cumino, A.Di Gianfrancesco, L.Cipolla: ibidem

3rd Symposium on Heat Resistant Steels and alloys for USC Power Plants: 3-6 July 2007 Seoul, South Korea: Advanced ferritic high Chromium grades for power generation applications: similar and dissimilar weldability assessment and long-term performances E.Bauné, E.Galand, B.Leduey, G.Liberati, S.Caminada, G.Cumino, A.Di Gianfrancesco, L.Cipolla

3rd International Conference on “Integrity of High Temperature Welds” 24 - 26 April 2007 London UK (IOM)WELDABILITY AND LONG TERM PERFORMANCES OF ADVANCED GRADES FOR POWER GENERATION: G. Cumino, S. Caminada, E. Bauné, E. Galand, B. Leduey, A. Di Gianfrancesco, L. Cipolla

Advanced Welding and Micro Joining/Packaging for the 21st Century, 10-12 May 2007, Seul, Korea.Grades 92 and 23: weldability assessment and long term performances for power generation applications: G. Cumino, S. Caminada, E. Bauné, E. Galand, B. Leduey, A. Di Gianfrancesco, L. Cipolla.

7th International EPRI Welding & Repair Technology Conference. June 21-23, 2006 Ponte Vedra Beach, Florida, USA GRADE 23 TUBES, PIPES AND WELDED JOINTS PRODUCTION: MATERIALS, CONSUMABLES AND PROCESS DEVELOPMENTS: G. Cumino, A. Poli, S. Caminada, E. Bauné, E. Galand, B. Leduey, A. Bertoni, G.Liberati, A. Di Gianfrancesco, F. Cirilli

RFSR-CT-2003-00049 SYNFAB

Improving the competitiveness of the European Steel fabrication industry using synchronised tandem wire welding technology

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1460000 €	Start Date	1/09/2003
	EU Contribution	876000 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23331:EN			

Final Abstract "The SYNFAB project has delivered improved MAG welding technology to the fabrication industry, which enables higher deposition rates, deeper penetration and reduced fabrication costs, without compromising weld properties. What is more, SYNFAB demonstrates how this may be achieved without the need to invest in expensive and specialist welding equipment. Two generic types of tandem MAG welding were identified. The first with arc spacing of approximately 6 mm, a design on which most commercially available synchronised tandem MAG welding equipment is based; and the second with arc spacing above 10 mm, which had not previously been identified. With spacing below 10 mm, synchronisation of pulses was required, otherwise the arcs would interact and become unstable. However, when arc separation exceeded 10 mm, there was much more flexibility to use a variety of arc types. Three types of joint were evaluated: a lap joint using 3 mm steel, a fillet joint using 6 mm steel and a double-sided butt joint using 12 mm steel. In all cases tandem welding enabled a significant increase in welding speed whilst maintaining good weld quality. Higher total welding currents were used, which enabled productivity increases of up to 100%. The increase in welding speed and welding current were similar, such that the total heat input per unit length remained approximately constant. Thus metallography and mechanical properties were not significantly affected. FE modelling and experimental analysis of distortion were carried out. It was evident from this work that both clamping and balanced welding are capable of providing some measure of control over distortion."

Partners	*Country*	*Scientific person in charge*
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CRANFIELD UNIVERSITY	UNITED KINGDOM	David YAPP

RFSR-CT-2004-00031 PrimeForm

Formability and self-repair properties of advanced weldable primers

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1282878 €	Start Date	1/07/2004
	EU Contribution	769727 €	End Date	30/06/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23747:EN			

Final Abstract Defect formation and the reactivity of weldable zinc-rich primers induced by it were studied cooperatively. The forming process leads to de-adhesion and microcrack formation between the zinc particles and the surrounding polymeric matrix. The density and size of such defects increase with the degree of forming. Defects can penetrate the composite coating and reach the zinc coating. Microscopic as well as integral and microelectrochemical studies revealed the reactivity and repair properties of such defects. These data were correlated to corrosion studies in open and flange configuration, as well as to the processability and in-life performance. The corrosive reactivity of the defects also increases with the size of the defects. This leads to lower pore resistance values in environments containing chloride. However, during an automotive phosphatation process the kinetics of phosphate crystal formation are increased in the larger cracks and exposed zinc particles will be at least partly recovered prior to an ED-paint deposition. Such a repair process can not occur within flanges. In this case the corrosion protection properties are significantly lowered for high forming degrees. The addition of organosilane adhesion promoters at the zinc particle/binder interface did not lead to a strong reduction in the density and size of cracks. However, for small forming degrees below 5 % a slight improvement was detectable, based on the increased adhesion force at the binder/zinc interface. Organic and inorganic inhibitors and new Zn/alloy particles were incorporated in the composite coating. The leachable organic inhibitors mainly showed an inhibiting effect in the microcracks.

		Country	*Scientific person in charge*
Partners	**MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH**	DEUTSCHLAND	Guido GRUNDMEIER (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Maria Grazia SERRA
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	UNIVERSIDADE DE AVEIRO	PORTUGAL	Mário G.S. FERREIRA
	VOESTALPINE STAHL GMBH	OESTERREICH	Edwin TILL

RFSR-CT-2004-00032 STRAINHARD

Investigation of the strain hardening behaviour of modern light-weight steels considering the forming temperature & forming rate

Info

Type of Project	Research	Duration (months)	36
Total Budget	1186604 €	Start Date	1/07/2004
EU Contribution	711962 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23599:EN

Final Abstract

New lightweight steels for auto-body components have been developed to satisfy the requirements of improving passive safety, weight reduction and energy saving as well as economic mass production. Examples of these steel groups are Dualphase, TRIP and TWIP steels, which have been developed and improved by making use of microstructure design and strain-induced phase transformations. In all these steels high strength values in combination with an increase of ductility and toughness have been reached by increasing the strain-hardening behaviour. Therefore, in this project the strain-hardening behaviour has been investigated as a function of temperature, strain rate and stress state by several types of mechanical tests. The different steels were strained by tensile tests at different temperatures and strain rates (up to 1 000s-1), bulge tests and simple shear tests for the determination of the dependence of the different forming conditions on the flow curve properties. Formability studies have also been performed in laboratory samples and some components by cupping tests, the determination of FLDs and component crash tests. The influence of the different microstructure concepts on the strain-hardening behaviour has been investigated by quantitative microstructure analysis of the materials in deformed as well as in non-deformed condition. In order to foster prediction of material behaviour for each steels group, existing models for the description of the strain-hardening behaviour have been evaluated and improved. FE simulations of experimental tests making use of the different material models helped on this topic.

Partners

	Country	*Scientific person in charge*
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Philippe CUGY
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THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Dorothea MATTISSEN

Selected Publications

Bäumer A., Jimenez J.A., Bleck W. Effect of temperature and strain rate on strain hardening and deformation mechanisms of high manganese austenitic steels, International Journal of Materials Research - volume 101 (2010), issue 6, page 705-714, DOI: 10.3139/146.110333

Bäumer A., Bleck W. Strain hardening behavior of modern light-weight car body sheet steels, IDDRG - International Deep Drawing Research Group Conference, Györ, HU, 2007, ISBN: 972-8953-06-2

Bäumer, Annette: Verfestigungsverhalten von hochmanganhaltigen Stählen mit TWIP-Effekt, Berichte aus dem Institut für Eisenhüttenkunde * Band 4 (2009), Aachen: Shaker

Bäumer, Annette, Bleck, Wolfgang: Verfestigungsverhalten von Karosseriestählen, Tagung Werkstoffprüfung 2007, Neu-Ulm, 2007, ISBN 978-3-514-00753-6

RFSR-CT-2004-00033 SOLVSTIR

Solving steel welding problems by the use of friction stir

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1055107 €	Start Date	1/07/2004
	EU Contribution	633065 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24030:EN			

Final Abstract The Solvstir project (solving welding problems by the use of friction stir) was devised with the global objective of developing friction stir welding (FSW) technology (i.e. tool technology, process parameters and, if required, supporting systems) for application in steel grades categorised as 'non-weldable' or 'difficult to weld'. Additionally, the project also included the determination of joint properties and the development of steel-based, multi-material joints. Efforts in the modelling of the process and the economic aspects related to the industrial adoption of the process have also been investigated. The results have shown that the FSW process can be successfully applied to 'non-weldable' or 'difficult to weld' grades. Considering the presently available tool materials, PCBN has been selected as the most suitable and taken as baseline for the project. The tool material is a key issue in the widespread industrial use of this technology. Process parameter windows have been established for the investigated grades. A number of technology demonstrators have been produced including: ship structural components, steel tailor-welded blanks and welded sections of ballistic steel. FSW procedures for steel-Al and steel-Mg dissimilar joints have been developed. Considering the information compiled in the course of this project (referring to a prototype production) and assuming a tool life of 300 m of weld, an FSW-tailored blank can be up to 14 % cheaper than a tailor-welded blank produced by laser welding. Also based on the information collected in the course of the project, a ship panel can be 20 % cheaper than a ship panel produced by conventional welding processes.

		Country	*Scientific person in charge*
Partners	**GKSS-FORSCHUNGSZENTRUM GEESTHACHT GmbH**	DEUTSCHLAND	Jorge DOS SANTOS (Pr. Coord.)
	DANISH STIR WELDING TECHNOLOGY	DANMARK	Torben LORENTZEN
	FINCANTIERI - CANTIERI NAVALI ITALIANI S.p.A.	ITALIA	Luis Mario VOLPONE
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Ali Ihsan KORUK
	TATA STEEL UK LIMITED	UNITED KINGDOM	Lynden DREWETT
	UNIVERSITÄT DUISBURG-ESSEN	DEUTSCHLAND	Alfons FISCHER

RFSR-CT-2004-00034 TUTEMP

Plasticity at high temperature for steel and stainless tube forming applications in automotive industry

Info

Type of Project	Research	Duration (months)	39
Total Budget	1639178 €	Start Date	1/07/2004
EU Contribution	983506 €	End Date	30/09/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23878:EN

Final Abstract

During the hot metal gas forming (HMGF) process, a steel tubular part is heated up. Since the yield stress of the component decreases with the increase in temperature, the part can be formed into a complex shape using low-pressure gas and therefore reducing the need for high tonnage presses. The ferritic stainless steel EN-1.4512 showed optimal formability capabilities. It was possible to obtain a 55 % radial expansion even with no axial feeding at a pressure of 15 bars. This steel's application in the automotive industry is devoted to tubular components in exhaust systems. The boron alloyed steel 22MnB5 was also chosen as a target material, due to its special industrial interest regarding car weight reduction (after being heated, formed and quenched at specific cooling rates, Rm values around 1500 MPa can be obtained). The formability rates within the HMGF process were lower than for the EN-1.4512 steel, around 28 % radial expansion with no axial feeding. A further development or a new material concept which could join material formability and high mechanical performance after the process would be recommendable for a future study. During the project, all the parameters which affect the HMGF process were studied. Materials characterisation was performed before and after the process. The Molykote HSC+ proved to be the best lubricant according to the tribology tests. HMGF installations were manufactured at TNO, CSM and Labein facilities in order to obtain the optimised samples. Simulation made in Abaqus and FORGE codes showed good fitting with these experimentally obtained results.

Partners

	Country	*Scientific person in charge*
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	María Angeles GUTIERREZ (Pr. Coord.)
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HOLDING DE GESTION DE EMPRESAS DE TUBO S.L.	ESPAÑA	Francisco Javier RIPODAS AGUDO
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	P.J. BOLT

RFSR-CT-2004-00035

DP grades with improved formability

Info

Type of Project	Research	Duration (months)	36
Total Budget	1331269 €	Start Date	1/07/2004
EU Contribution	798761 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23862:EN

Final Abstract

"High strength steel grades with excellent formability make a remarkable contribution to the reduction of the mass of the body-in-white and, additionally, an increased crash safety for cars. The most important steel grades which fulfil these requirements are DP steels with tensile strength levels up to 1 000 MPa. For their further improvement, the fundamental understanding of the impact of microstructure on formability is essential. In the present project, different microstructures processed industrially and also in the lab are correlated with the mechanical properties, mainly yield and tensile strength, uniform and total elongation, and additionally with bendability and hole expansion behaviour. The most relevant microstructure constituents determining the formability were identified based on an accurate investigation of the microstructure and the damage during straining. These investigations were supported using basic modelling with finite element calculations. Based on the experimental work and the finite element modelling, the strength (hardness) of the inclusion was identified as the most important parameter. Generally, a higher hardness difference between matrix and inclusion resulted in high work hardening and therefore a higher uniform and total elongation; however, in only moderate bendability and moderate hole expansion values. Based on the reduction of the hardness of the inclusion, the hole expansion values and bendability could be improved remarkably. Generally, the impact of the abovementioned parameters and the arrangement of the phases were found to be more pronounced for grades with a larger fraction of the second phase."

Partners

	Country	*Scientific person in charge*
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SSAB TUNNPLÅT AB	SVERIGE	Anders HAGLUND
TECHNISCHE UNIVERSITAET MUENCHEN	DEUTSCHLAND	Ewald A. WERNER

Selected Publications

P. Tsipouridis, E. Werner, C. Krempaszky, E. Tragl: On the formability of high strength dual-phase steels: trends and alternatives. Steel research int. 77 (2006) 654-662.

A. Karelova, C. Krempaszky, E. Werner, P. Tsipouridis, E. Tragl, A. Pichler: Deformation behavior of dual-phase steels under various loading conditions: mechanisms leading to failure. In: Proc. MS&T 2006, Materials and Systems Vol. 2, L. Ruiz-Aparicio, S.R. Larrabee, J. Jennings (Hrsg.), Association for Iron & Steel and TMS, Warrendale, PA, USA (2006) 17-27.

C. Krempaszky, J. Ocenasek, V. Espinoza, P. Tsipouridis, E. Werner, T. Hebesberger, A. Pichler: Micromechanical modelling of the formability of advanced high strength steels. In: Proc. Int. Conf. on New Developments in Advanced High Strength Sheet Steels,Association for Iron & Steel, Warrendale, PA, USA (2008) 305-314.

E. Werner, P. Tsipouridis, A. Karelova, C. Krempaszky, J. Ocenasek, V. Espinoza-Cantu: Gefüge, mechanische Eigenschaften und Bruch von partiell martensitischen und Dualphasenstählen. 8. Tagung Gefüge und Bruch, Bochum, D, 2007.

C. Krempaszky, J. Ocenasek, V. Espinoza, E. Werner, T. Hebesberger, A. Pichler: Micromechanical modelling of the formability of dual-phase steels. MS&T 2007, Detroit, MI, USA 2007.

RFSR-CT-2005-00032 SpeedFat

Load spectrum lightening of fatigue tests data for time reduction of design validation

Info

Type of Project	Research	Duration (months)	36
Total Budget	1525470 €	Start Date	1/07/2005
EU Contribution	915282 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24206:EN

Final Abstract

The goal of this project was to develop procedures to reduce spectrum loadings in order to accelerate fatigue tests for the final validation of structural parts. The project aimed moreover to address the question of how to reduce loading as much as possible without significantly changing the fatigue life. Although this programme was oriented towards high-strength steel and automotive industries, the final results will also be valid for all other fatigue applications. In addressing fatigue design issues, this proposal covered safety and sustainable development issues, taking into account the three following primary considerations. (1) There are theories that describe the material damage calculation based on high-cycle fatigue or low-cycle fatigue. These need to be validated for different spectrum loadings to establish a filtering procedure. (2) Under multi-axial loading conditions, this is more complicated. Modelling is however possible and needs to be experimentally validated. (3) For spot-welds and arc-welds, modelling methods, based on structural stress, must validate — through demonstration — the procedures which will be proposed. The filtering procedures (filtering omission level) was based on material properties with a primary focus on HSS. Depending on the initial loading, the efficiency of the filtering (time reduction) was investigated to be at its optimum value, producing the same degree of damage. This indeed was the main expectation. The scientific works and the proposed procedures gathered in this project could form a strong basis for producing a future European recommendation on efficient filtering for spectrum loading reduction of steel component validation.

Partners

	Country	*Scientific person in charge*
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GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Jacinto ALBARRAN SANZ
IMA MATERIALFORSCHUNG UND ANWENDUNGSTECHNIK GmbH	DEUTSCHLAND	Anett WUENSCHE
REGIENOV	FRANCE	Eric VAILLANT

Selected Publications

R. Rennert, A. Wünsche. Equivalent amplitude and suitable omission limits for variable amplitude testing. Second International Conference on Material and Component Performance under Variable Amplitude Loading. March 23-26, 2009, Darmstadt, Germany

J-M. Postic, R. Montaudon, D. Hamel, C. Dumas, S. Bergamo. Mesure de l'endommagement de cordons de soudure soumis à un chargement cyclique à amplitude constante et amplitude variable. 28èmes Journées de Printemps JP2009, Mesures et suivi de l'endommagement en fatigue, 13-14 Mai 2009, Paris

Richard Montaudon, Sébastien Bergamo. Réduction de la durée des essais de validation. Utilisation des données matériaux, Essais et Simulations, 2010, n°103, pp.22-24

RFSR-CT-2005-00033 HI-PROF

Improving and enlarging the application field of HSS and UHSS for automotive body components by technologies based on roll forming and stretch bending processes

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1430342 €	Start Date	1/07/2005
	EU Contribution	858205 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24274:EN			

Final Abstract

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Leopoldo RIZZO (Pr. Coord.)
	E.M.A.R.C. SpA - ENGINEERING MACCHINE ATTREZZATURE RAP. CONS. SIG.	ITALIA	Massimo CERVETTI
	FUNDACION ITMA*INSTITUTO TECNOLOGICO DE MATERIALES	ESPAÑA	Manuel Armindo GUERRERO
	SWEREA KIMAB AB	SVERIGE	Lars GUNNARSSON
	SSAB EMEA AB	SVERIGE	Lars TROIVE

RFSR-CT-2005-00034 MICROFAT

Prediction of microstructure and constraint effects on fatigue behaviour in engineering applications

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1231309 €	Start Date	1/07/2005
	EU Contribution	738785 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25030:EN			

Final Abstract This project was devoted to investigating the influence of microstructure and constraint effects on the fatigue behaviour of high strength steels for engineering applications (e.g. automotive industry), with special reference to :• the development of an experimental and methodological know-how in order to establish the relationship between microstructure, constraint effects and fatigue behaviour of selected classes of high strength structural steels• its extension to real in-service load conditions, in particular when multiaxial random loads with overloads are involved.The effect of main mechanical (e.g. ultimate strength), microstructure (e.g. amount and distribution of different microstructural phases) and constraint parameters (e.g. surface roughness) on the fatigue behaviour of selected mechanical components, when crossed with realistic stress-strain fields and surface conditions, was investigated by uniaxial and multiaxial fatigue and crack propagation tests, advanced metallographic analysis and numerical models, and validated on full-scale mechanical components.Guidelines for application to design codes and quality & technical specs development were given in order to achieve the desired component fatigue targets during service.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Paolo FOLGARAIT (Pr. Coord.)
	ASCOMETAL S.A.S.	FRANCE	Pascal DAGUIER
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	José Manuel MARTINEZ ESNAOLA
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Jacinto ALBARRAN SANZ
	FIAT GESTIONE PARTECIPAZIONI SPA	ITALIA	Roberto BIGNUCOLO

RFSR-CT-2006-00026 HI-VEL

High velocity forming of steel sheets and tubes for applications in the automotive industry

Info

Type of Project	Research	Duration (months)	42
Total Budget	1420395 €	Start Date	1/07/2006
EU Contribution	852331 €	End Date	31/12/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24994:EN

Final Abstract

The main objective of the HI-VEL project is to establish the feasibility of high velocity forming methods and to quantify the enhancement achievable with these techniques in the formability of high strength steel (HSS) and stainless steel sheets and tubes for automotive applications. Electromagnetic forming (EMF) and electrohydraulic forming (EHF) processes were studied during the HI-VEL project. After a first mechanical characterisation at strain rates up to 1000s-1, the following materials were selected for the high velocity experimental testing: AISI441 (1.4509), HT800XD (DP800), Dogal800DPX (DPX800), HT700TD (TRIP700) and IF210. The materials constitutive data at high strain rates were obtained for the Johnson Cook material modelling. EMF and EHF simulations were validated with experimental high velocity tests. The fatigue behaviour of high velocity formed samples was similar to the conventionally formed ones. Due to the low electrical conductivity of the HSS and stainless steels, the EMF technology showed its viability for these materials only in the case of small forming grades applications, such as the electromagnetic sizing of U-parts in order to eliminate the elastic recovery. For any other deep drawing operation, EMF technology can be applied to steels using an electrical conductive driver that accelerates the steel part towards the die. Comparing the conventional bulge forming and the multi-impulse EHF, the obtained dome heights increased from 57 to 70 mm for TRIP700 steel and from 48.5 to 54 mm for DPX800 steel. Multi-impulse EHF increased the formability of HSS and has interesting industrial applications, such as forming undercut part designs using a split die.

Partners

	Country	*Scientific person in charge*
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Leire VADILLO (Pr. Coord.)
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Selected Publications

L. Samek, L. Vadillo, D. Bjorkstrom, A. Melander. Characterization and modelling of the influence of the strain rate on the mechanical behaviour of high strength steels and stainless steels. IDDRG 2009 International Conference, Golden, CO, USA.

A.Melander, L. Samek, L. Vadillo, A. Bjorkblad, P. Juntunen. Modelling of electrohydraulic free and die forming of steel sheets.

A.Melander, L. Samek, L. Vadillo, A. Bjorkblad, P. Juntunen, A. Delic. Finite element simulation of electrohydraulic forming.

RFSR-CT-2006-00027 MnAl-steel

Ultra high strength and ductile Fe Mn Al C light-weight steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1532597 €	Start Date	1/07/2006
	EU Contribution	919558 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25096:EN			

Final Abstract The aim of this project is to introduce and establish ultra high-strength and ductile light-weight steels containing high manganese, aluminium and carbon contents forindustrial production and applications for light-weight constructions. This class of steels is of great interest for the automotive industry as new components with reduced weight and with increased crash performance can be realised. Simultaneously, the understanding of the physical metallurgical mechanismscausing outstanding properties needs to be clarified in order tooptimise the microstructures and the resulting mechanical properties. In preceding tests at the MPIE, results demonstrated the general processabilityof six different FeMnAlC alloys. Based on this study the industrial partners AMR, TKSE and VAS then investigated the feasibility of industrial up-scaling in 100 kg-scale laboratory tests and by applying processing parameters of industrial relevance.So hot strips of all compositions were produced by conventional ingotcasting and hot rolling. These were then pickled, cold rolled, annealed and Zn-coated.The produced cold strips were characterised in detail including special in-useproperties like investigations on metal forming, fatigue, corrosion and joining,which are especially relevant for applications in the automotive sector.The feasibility of using continuous casting and strip casting as possible industrial processing routes was tested for FeMnAlC steels. The investigations were completed with simulations of crash deformations of concretecar body components and their validation with experiments performed on real partsmade of FeMnAlC steel. The conclusion is especially focused on industrialup-scaling and risk assessment.

		Country	*Scientific person in charge*
Partners	**MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH**	DEUTSCHLAND	Michael BAUSCH (Pr. Coord.)
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	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Harald HOFMANN
	VOESTALPINE STAHL GMBH	OESTERREICH	Enno ARENHOLZ

Patents DE102011000089 (A1) - Verfahren zum Herstellen eines warmgewalzten Stahlflachprodukts

WO2012095232 (A1) - Method for producing a hot-rolled flat steel product

RFS2-CT-2007-00025 INSAPTRANS

Innovative stainless steel applications in transport vehicles

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	498784 €	Start Date	1/07/2007
	EU Contribution	299270 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24218:EN			

Final Abstract The main objective of the 'Innovative stainless steel applications in transport vehicles' INSAPTRANS project was to disseminate the technical knowledge and application experience from two recently finished ECSC/RFCS-funded research projects, 'Stainless steels in bus constructions' ('Stainless steel bus') and 'Development of lightweight train and metro cars by using ultra high strength stainless steels' (DOLTRAC). The main project task was the preparation of a design handbook from the results data of the underlying projects, demonstrating the full potential of, and giving guidelines for, the application of safe and lightweight stainless steel structures in ground transport applications. The handbook was distributed, and is still available to the public free of charge in both paper and electronic forms. The second major activity was arranging a series of six regional seminars with European-wide coverage once the manual was completed. The target groups covered the whole ground transport industry sector and service supply chain in Europe. After the seminars, a workshop on an invitation basis was arranged for reviewing the seminar feedback, establishing networking actions among the European players on the field, and composing future R&D initiatives. The INSAPTRANS project as a whole was a success. All the major objectives were reached within the originally planned schedule and budget. The impression from the events was that the handbook was extremely well received by the participants. The positive attitude to the seminar arrangements and programmes could be seen especially in the feedback questionnaire results..

Partners		*Country*	*Scientific person in charge*
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	EURO INOX	LUXEMBOURG	Thomas PAULY
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Nico DE WISPELAERE
	OUTOKUMPU STAINLESS OY	FINLAND	Tero TAULAVUORI
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Selected Publications "Sirén M. (coordinator), Taulavuori T., de Wispelaere N., Rizzo L., Thys R., Vliegen R., van Hecke B., Pauly T., Kosmac A., Sánchez R., Säynevirta J., Hänninen H., Pohjanne P., Tonteri H., Ala-Outinen T. (eds.). Innovative stainless steel applications in transport vehicles. http://www.euro-inox.org/. The main outcome of the ECSC/RFCS project ""Innovative stainless steel applications in transport vehicles"" (INSAPTRANS: contract RFS2-CT-2007-00025) (2008), 125 p. Paper version available at Euro Inox, email info@euro-inox.org or at VTT, email mika.siren@vtt.fi. Electronic PDF version with extra material available for download at http://www.euro-inox.org/ drop menu selection “Transport”."

RFSR-CT-2007-00027 PROMACH

Innovative approach for steel design procedures tailored to component machining

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1790888 €	Start Date	1/07/2007
	EU Contribution	1074532 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25152:EN			

Final Abstract The objectives of the Promach project were, on the one hand, determination of microstructural effects on machinability improvement technologies for engineering steels at the same strength level, and, on the other hand, definition of a steel design procedure to minimise running costs of mechanical components of strength above 900 MPa. Steels with improved machinability by means of the control metallic/non-metallic inclusions (low S, medium S, high S, Ca treatment and lead addition) and with different microstructures (pearlitic, bainitic and tempered martensitic steels) with Rm between 900 and 1 000 MPa have been studied. A complete mechanical and metallurgical characterisation was performed on the 15 manufactured grades. The machining tests included the following. • Basic machining operations: turning V15, drilling (3D, 5D and 20D). • Screening for chip controlled breakability. • Orthogonal cutting operations: force and temperature measurements, high-speed filming and quick-stop tests. • Semi-industrial machining: tapping and autolathe tests. In tool-wear-related tests, pearlitic steels (%S 0.040–0.090 %) tend to perform the best, and also good results are obtained with bainitic steels. For all the microstructures, leaded and high S grades had the higher machinability. In chip-quality-related tests, leaded grades are the best ranked, and also steels with temp. martensitic and bainitic microstructures. A steel design procedure was developed by means of a benefit or utility analysis, using the four targets of criterion chip form, cutting force, surface quality and tool life typically more critical for machinability. Cost savings taking as reference real crankshaft production data were also calculated for turning and drilling operations.

		Country	*Scientific person in charge*
Partners	**GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.**	ESPAÑA	Maria Carmen MONTERO PASCUAL (Pr. Coord.)
	ASCOMETAL S.A.S.	FRANCE	Enrico D'ERAMO
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	SWEREA KIMAB AB	SVERIGE	Hariharan CHANDRASEKARAN
	MONDRAGON GOI ESKOLA POLITEKNIKOA J.M.A., S.COOP	ESPAÑA	Pedro José ARRAZOLA
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RFSR-CT-2007-00026 CRYO

Improvement of automotive tools and components through the applications of deep cryogenic treatments

Info

Type of Project	Research	Duration (months)	36
Total Budget	1465020 €	Start Date	1/10/2007
EU Contribution	879012 €	End Date	30/09/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25118:EN

Final Abstract

The main aim is to develop and apply deep cryogenic treatments (DCT) in order to improve wear resistance and fatigue life of: — automotive products (gears, transmission parts, bearings, engine components, etc.). This may lead to weight reduction, — metal cutting tooling (punches, dies, moulds, etc.) and machining tools (hoobs, broaches, cutters, slitting knives, etc.). This may lead to an increase in the tools' life. It will pay special attention to the microstructural changes and the fatigue behaviour improvement that takes place as a function of the cryogenic treatment route. For this purpose a set of steel grades and products has been selected and used to demonstrate the benefits of DCT. The automotive products have an improved fatigue life. The metal cutting tooling does not have any benefit on the wear resistance. The main reason is that it has been demonstrated that the DCT can introduce compression residual stresses. This has a positive impact at the high cycle fatigue life range, and only the automotive components under the study work at these conditions. Metal cutting tooling works under low cycle fatigue conditions, so the relative influence of a residual compressive stress is lower.

Partners

	Country	*Scientific person in charge*
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	José Ignacio BARBERO (Pr. Coord.)
ASOCIACION DE INVESTIGACION METALURGICA DEL NOROESTE - AIMEN	ESPAÑA	Alberto FERNÁNDEZ VICENTE
BÖHLER EDELSTAHL GmbH & Co. KG	OESTERREICH	Ziya Devrim CALISKANOGLU
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Jacinto ALBARRAN SANZ
UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Massimo PELLIZZARI
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Jochen KURZYNSKI

RFSR-CT-2008-00028 KINSREP

Prediction of the kinetics of self-repair of forming-induced defects on thin functional primers for advanced automotive applications

Info

Type of Project	Research	Duration (months)	36
Total Budget	1723197 €	Start Date	1/07/2008
EU Contribution	1033919 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25920:EN

Final Abstract

The project deals with self-healing on ultra-thin conductive primers (graphite containing) applied on electrogalvanised steel. The objectives are improved understanding of corrosion/repassivation at defects, the study of the applicability of electrochemical and spectroscopic techniques to assess micro-scale processes and the introduction of encapsulated inhibitors to the formulation, using submicron particles (nanocontainers) that might lead to smart self-healing. As nanocontainers, synthetised layered double hydroxides (LDH) — with incorporated vanadate, molybdate and nitrate anions — were implemented at laboratory scale, as well as native Halloysitenanoclay, either empty or loaded with benzimidazole or cerium nitrate, and coated with a polyelectrolyte shell for improved leaching control. Although self-healing based upon the encapsulated inhibitors in the primer formulation was not fully achieved, incorporation of the Halloysite was satisfactory and eventually improved barrier properties. Further, the effect of dissolved inhibitors was successfully studied using surface-resolved techniques, namely localised electrochemical impedance and also pH, oxygen and ionic current mapping. Friction coefficients, weldability and crack formation were characterised. Postforming phosphating occurred only above a critical elongation value and did not improve corrosion performance. A model for the ac response of the primers was developed based upon impedance results. Adsorption of nanoparticles at defects produced in a model system by microcontact printing was achieved and the better selectivity and adsorption rate were reached with LDH particles and polyelectrolyte-coated Halloysite, respectively. Micro-FTIR and imaging raman spectroscopy provided information on the location and release of inhibitor-loaded containers and detected mobilisation of LDH containers on the metal surface, triggered by the corrosive environment.

Partners

	Country	*Scientific person in charge*
INSTITUTO SUPERIOR TECNICO	PORTUGAL	Alda Maria PEREIRA SIMOES (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Maria Grazia SERRA
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Ibrahim KUTLU
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Ingo KLÜPPEL
UNIVERSIDADE DE AVEIRO	PORTUGAL	Mikhail ZHELUDKEVICH
UNIVERSITÄT PADERBORN	DEUTSCHLAND	Guido GRUNDMEIER
VOESTALPINE STAHL GMBH	OESTERREICH	Anna-Elisabeth RAAB

RFSR-CT-2008-00029 SPRINCOM

An efficient and effective methodology and simulation tools for die design and springback compensation for HSS and UHSS

Info

Type of Project	Research	Duration (months)	36
Total Budget	1780549 €	Start Date	1/07/2008
EU Contribution	1068329 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25896:EN

Final Abstract

HSS and UHSS offer high light-weighting potential for car body structural components. The large amount of springback after forming operations is currently limiting the market penetration of such steel grades, because of the large effort to be spent for tool design and tolerance satisfaction, requiring longer try out phases and increased development costs. The current research aimed at enlarging the use of UHSS in the automotive sector by developing and making available to material suppliers and automotive designers: • Deep knowledge about springback of UHSS. • Reliable and robust methods and tools for springback prediction and springback compensation by die shape modification, taking into account the effect of the steel property variability. An innovative methodology for die compensation has been successfully developed and tested based on the representation of both the die and sheet deformations in terms of particular sets of shape functions. The deep drawing tool is iteratively modified till an optimal configuration is reached, in which the final produced piece is as close as possible to the nominal one. The algorithm has proven successful in reducing springback on all the tested components of semi-industrial and industrial interest.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Leopoldo RIZZO (Pr. Coord.)
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CENTRO RICERCHE FIAT SCPA	ITALIA	Rosanna BRUN
SWEREA KIMAB AB	SVERIGE	Arne MELANDER
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
SSAB EMEA AB	SVERIGE	Lars TROIVE
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Ulrich EGGERS

Selected Publications

Broggiato G.B., Campana F., Cortese L., Mancini E. (2012). Comparison Between Two Experimental Procedures for Cyclic Plastic Characterization of High Strength Steel Sheets. JOURNAL OF ENGINEERING MATERIALS AND TECHNOLOGY, vol. 134, p. 63-72, ISSN: 0094-4289, doi: 10.1115/1.4006919

F. CAMPANA, CAMPANELLI F, CIMOLIN F, RIZZO L (2011). Robust Die Design for springback compensation of high strength steels. In: -. Tools and Technologies for Processing Ultra High Strength Materials. p. 431-442, ISBN: 9783851251678, Graz, 19-21 September 2011

F. CAMPANA, CORTESE L, MANCINI E, RIZZO L (2010). Realizzazione di un test ciclico di trazione-compressione per la caratterizzazione di lamiere da stampaggio. In: -. Atti del XXXIX Congresso Nazionale AIAS. Maratea, 7-10 settembre 2010, ISBN: 9788860930743

F. CAMPANA, E. MANCINI, L. RIZZO (2009). Ottimizzazione FEM del ritorno elastico nello stampaggio di acciai AHSS: criticità metodologiche nell'ottica dello sviluppo prodotto-processo. In: Atti del XXXVIII Convegno Nazionale AIAS. Torino:-, , Torino, 9-11 Settembre, ,2009

RFSR-CT-2009-00016 REFORM

Residual formability of preformed and subsequently welded adavnced high strength steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2199380 €	Start Date	1/07/2009
	EU Contribution	1319629 €	End Date	30/06/2012
State	Project completed			

Provisional Abstract

This proposal is situated within the scope of research and technological development of steel and its utilisation. It deals with the technologies forming, welding and joining of modern high strength steel products and applications for the automotive crash and fatigue loaded parts. Central point of investigation will be the determination of the load capability of preformed and subsequently welded parts made of high strength steels. Important subject of the project will be the numerical simulation, respectively the main influence factors at the process chain performing – assembly (welding) – service and safety (crash / fatigue) based on experimental results.

Partners		*Country*	*Scientific person in charge*
	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG e.V.	DEUTSCHLAND	Jens STANDFUSS (Pr. Coord.)
	ARCELORMITTAL ATLANTIQUE ET LORRAINE SAS	FRANCE	Laurent CRETTEUR
	CENTRO RICERCHE FIAT SCPA	ITALIA	Fabio D'AIUTO
	ESI ENGINEERING SYSTEM INTERNATIONAL GMBH	DEUTSCHLAND	Anthony PICKETT
	FIAT GROUP AUTOMOBILES SpA	ITALIA	Stefano MAGGI
	KOMPETENZZENTRUM DAS VIRTUELLE FAHRZEUG FORSCHUNGSGESELLSCHAFT MBH	OESTERREICH	Gernot TRATTNIG
	MAGNA STEYR FAHRZEUGTECHNIK AG & CO KG	OESTERREICH	Josef NEGES
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	SALZGITTER MANNESMAN FORSCHUNG GmbH	DEUTSCHLAND	Matthias HÖFEMANN
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Tony VAN DER VELDT
	TECHNISCHE UNIVERSITAET GRAZ	OESTERREICH	Robert VEIT
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Stefan WISCHMANN
	VOESTALPINE STAHL GMBH	OESTERREICH	Robert SIERLINGER

RFSR-CT-2009-00015 AUTOCORR

Corrosion of heterogeneous metal/metal assembling in the automotive industry

Info

Type of Project	Research	Duration (months)	36
Total Budget	1936906 €	Start Date	1/09/2009
EU Contribution	1162144 €	End Date	31/08/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26501:EN

Final Abstract

"An empirical catalogue of corrosion behaviour for different material couples has been established and the major problem couples identified including Mg in all couples and Al coupled to galvanised steel. The different corrosion products produced under these conditions have been identified. A numerical model for galvanic coupling has been developed and the results compared with conventional galvanic coupling experiments. In situ galvanic coupling and pH measurements were carried out for real assemblies in accelerated tests and a database of electrochemical data for different materials established as input for the model. Selective dissolution mechanisms have been investigated for Al-Zn alloys as a function of pH, potential, and aeration — three parameters which may change considerably during confined zone corrosion. Galvanic coupling between Al rich and Al poor phases have also been investigated by Volta potential microscopy. The sequences of corrosion product formation on Galfan and Galvalume have been established and the important corrosion products identified. Selected corrosion products have been synthesised in thin films and their effect on the anodic and cathodic corrosion reactions has been characterised. Simonkolleite was shown to inhibit oxygen reduction on zinc; the transformation of corrosion products into a carbonate film was shown to cause a polarity reversal in couples with steel. A number of joining methods have been investigated regarding their influence on the rate of corrosion and galvanic coupling. Several attempts to protect Al with thin organic coatings have been made but did not show significant improvement"

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Christian ALLELY (Pr. Coord.)
ECOLE NATIONALE SUPERIEURE DE CHIMIE DE PARIS	FRANCE	Polina VOLOVITCH
KUNGLIGA TEKNISKA HÖGSKOLAN - THE ROYAL INSTITUTE OF TECHNOLOGY	SVERIGE	Christofer LEYGRAF
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Wibke FRIEDHOFF
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Simone REITER
VOESTALPINE STAHL GMBH	OESTERREICH	Gerald LUCKENEDER

Selected Publications

Deliverable n°13 of AUTOCORR project. Predictive numerical model for galvanic corrosion. CIRCAB

Deliverable n°12 of AUTOCORR project. Database of galvanic corrosion behavior for Zn-Al with Zn, pure Zn, and Al and Mg. CIRCAB

J.D. Yoo, P. Volovitch , A. Abdel Aal, C. Allely. The effect of an artificially synthesized simonkolleite layer on the corrosionof electrogalvanized steel. Corrosion Science 70 (2013) 1–10

P. Qiu, C. Leygraf, I. Odnevall Wallinder. Evolution of corrosion products and metal release from Galvalume coating during short and long-term atmospheric exposures, Materials Chemistry and Physics, 133, 419– 428 (2012)

"X. Zhang, Th.-N. Vu, P. Volovitch, C. Leygraf, K. Ogle, I. Odnevall Wallinder, ""The initial release of zinc and aluminum from non-treated galvalume and the formation of corrosion products in chloride containing media"", Applied Surface Science 258 (2012) 4351–4359."

RFSR-CT-2009-00017 PROTUBEND

Flexible and cost-effective innovative manufacturing of complex 3D-bent tubes and profiles made of high-strength steels for automotive lightweight structures

Info

Type of Project	Research	Duration (months)	36
Total Budget	1025068 €	Start Date	1/09/2009
EU Contribution	591714 €	End Date	31/08/2012

State Project completed

Project web page http://www.protubend.eu/

Provisional Abstract

The realization of ultra-light, economically and ecologically oriented component structures with contour complexity in automotive industry necessitates the use of profiles and tubes from new steel grades. An unsolved problem so far is the cost-effective and reliable manufacturing of these components.
Therefore, the aim of the project is to advance two new forming processes for an industrial use capable of forming and bending load-optimised 3D-tubes and profiles made of high- and ultrahigh- strength steel. They offer the opportunity of a free selection and reliable manufacturing of the bending contour. The superposition of stresses increases the process stability and predictability by minimization of springback.

Partners

	Country	*Scientific person in charge*
TECHNISCHE UNIVERSITÄT DORTMUND	DEUTSCHLAND	A. Erman TEKKAYA (Pr. Coord.)
FUNDACIO PRIVADA ASCAMM	ESPAÑA	Benjamin CAVALLINI
ASERM- ASOCIACION ESPAÑOLA DE RAPID MANUFACTURING	ESPAÑA	Felip ESTEVE
CENTRO RICERCHE FIAT SCPA	ITALIA	Massimo TOLAZZI
FAURECIA SIEGES D'AUTOMOBILE SAS	FRANCE	Hosen SULAIMAN
RAZVOJNI CENTER ORODJARSTVA SLOVENIJE ZAVOD - TECOS	SLOVENIJA	Janez Marko SLABE

Selected Publications

"Stahl-Innovationspreis" 2012 (Steel Innovation Award): Second place in the category "Steel in research and development / Processes" for the new process combination three-dimensional bending and integrated hardening URL http://www.stahl-info.de/stahlinnovationspreis/stahlinnovationspreis_2012/Preistraeger/Institut_fuer_Umformtechnik_und_Leichtbau_TU_Dortmund/institut_fuer_umfortechnik_und_leichtbau_tu_dortmund.asp

D. Staupendahl, C. Becker, A. Weinrich, M. Hermes, A. E. Tekkaya: Innovative forming processes for tubes, profiles and sheets made of modern steel grades [Innovative Umformverfahren für Rohre, Profile und Bleche aus modernen Stahlwerkstoffen]. Stahl und Eisen (2012), 132 (8), pp. 47-54. ISSN: 03404803

C. Becker,G. Quintana , M. Hermes, B. Cavallini, A.E. Tekkaya: Prediction of surface roughness due to spinning in the incremental tube forming process. Production Engineering (2013), 7 (2-3), pp. 153-166. DOI: 10.1007/s11740-012-0424-4. URL: http://link.springer.com/article/10.1007%2Fs11740-012-0424-4

M. Hudovernik, D. Staupendahl, M. Gharbi, M. Hermes, A.E. Tekkaya, K. Kuzman, J.M. Slabe: 3D Numerical Analysis of 2D Profile Bending with the Torque Superposed Spatial Bending Method. Journal of Mechanical Engineering 59 (2013), pp. 139-147. DOI:10.5545/sv-jme.2012.483. URL: http://ojs.sv-jme.eu/index.php/sv-jme/article/view/sv-jme.2012.483

RFSR-CT-2009-00013 NEWGENHSS

Novel concepts for new generation of high strength hot dip galvanizing steel with extra formability

Info	Type of Project	Research	Duration (months)	45
	Total Budget	1955297 €	Start Date	1/10/2009
	EU Contribution	1173178 €	End Date	30/06/2013
State	Project completed, final report not published yet			

Provisional Abstract This research work addresses the European concept for lightweight car bodies. In particular, innovative steel sheet family with high yield strength (>300MPa) and moderate UTS (≥400 MPa) along with extra formability is proposed. Novel alloy chemistries based on Si, B and Al, along with innovative strengthening mechanisms (Cu reinforced IF) will be investigated. New processing options will also be exploited such as intercritical annealing to get advantage of low temperature transformed phases in terms of strength and formability. The produced steels will be tested by the industrial partners and validated by the end users.

		Country	*Scientific person in charge*
Partners	**ILVA S.P.A.**	ITALIA	Floriano FERRO (Pr. Coord.)
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Thomas SCHULZ
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	María Angeles GUTIERREZ
	TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG	DEUTSCHLAND	Rudolf KAWALLA
	UNIVERSITÁ DI PISA	ITALIA	Sandra VITOLO

Patents Thomas Schulz, Marion Calcagnotto, Norbert Kwiaton, Alexander Georgiew. Hochfester Mehrphasenstahl mit verbesserten Eigenschaften (DP600-Si-legiert). Patent submitted in 2012.

Selected Publications

A. Terzic, M. Calcagnotto, S. Guk, T. Schulz, R. Kawalla. Influence of Boron on transformation behavior during continuous cooling of low alloyed steels. à Will be published by end of 2013 in material Science and Engineering A

Marion Calcagnotto, Thomas Schulz. Novel alloy designs for hot dip galvanized dual phase steels with high formability. Proceedings of the 4th International Conference on Thermomechanical Processing of Steel (TMP) 2012, Sheffield, UK, published on CD-Rom.

RFSR-CT-2009-00018 INSTAP

Innovative steel grades for exhaust applications in automotive industry

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1625524 €	Start Date	1/10/2009
	EU Contribution	975314 €	End Date	31/03/2013
State	Project completed, final report not published yet			

Provisional Abstract The following research project will develop innovative steel solutions like lean alloyed austenitic stainless steels, Duplex and ferritic stainless steels with improved creep and corrosion resistance for exhaust system of automotive vehicles. Two components are chosen for investigations: exhaust manifold and exhaust silencer which are exposed to high temperatures, oxidation and corrosion. Tailored steel grades depending on the special requirements of each component will be developed, tested and transferred to prototypes. This will lead to an increase in competitiveness of European steel industry due to innovative steel development for exhaust components.

		Country	*Scientific person in charge*
Partners	**RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN**	DEUTSCHLAND	Wolfgang BLECK (Pr. Coord.)
	CENTRO RICERCHE FIAT SCPA	ITALIA	Giuseppe CUPITO
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Paolo FOLGARAIT
	EMCON TECHNOLOGIES GERMANY (AUGSBURG) GBMH	DEUTSCHLAND	Helmut WIESER
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Helena GOUVEIA
	OUTOKUMPU STAINLESS AB	SVERIGE	Pascale VANGELI

RFSR-CT-2010-00021 GPHS

Green press hardening steel grades

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1415208 €	Start Date	1/07/2010
	EU Contribution	849125 €	End Date	30/06/2013
State	Running project			

Project web page http://gphs.eu/en/the-project/the-project.php

Provisional Abstract Press hardened components used as automotive body structural elements fulfil two objectives, due to their exceptional mechanical strength: increment of passenger safety and reduction of vehicle CO2 footprint by reducing its weight. However, cost and energy efficiency of hot stamping processes is still far from being achieved and long manufacturing cycle times, costly heating and cooling equipment are still a drawback of this technology. The development of a new heat treatable steel grade will address these disadvantages, by reducing heating and cooling requirements and shortening the process cycle times, while ensuring the specified final part mechanical properties.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	Iñigo ARANGUREN MENDIETA (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Juan David PUERTA VELASQUEZ
	UNIVERSITA DEGLI STUDI DI PADOVA	ITALIA	Paolo BARIANI
	VOLKSWAGEN AG	DEUTSCHLAND	Michael ALSMANN

RFSR-CT-2010-00022 CHARMA

Automated material characterisation for machinability prediction

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1151018 €	Start Date	1/07/2010
	EU Contribution	690611 €	End Date	30/06/2013
State	Running project			

Provisional Abstract

The current project aims are (I) reproducible machining performance and (II) tailored cutting related data in each delivery of engineering steel bar products to the benefit of both the steelmaker, and to component manufacturers for automotive and other industries.
Objectives:
1). To develop Magnetic Barkhausen Noise analysis (MBN) and Pulse Distribution Analysis spark-OES (PDA-OES) for machinability determination in the quality control of the steel plant.
2). To extract useful material data for cutting operations in each delivery to customer, based on advanced correlation with microstructure and inclusion analysis.
3). Give guidelines with limitations of acceptable steel features for reproducible machinability.

		Country	*Scientific person in charge*
Partners	**SWEREA KIMAB AB**	SVERIGE	Thomas BJÖRK (Pr. Coord.)
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Maria Carmen MONTERO PASCUAL
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter LUNG
	UNIVERSITY OF NEWCASTLE UPON TYNE	UNITED KINGDOM	Brian SHAW

RFSR-CT-2011-00019 DURADH

Durability of adhesively bonded surfaces finished galvanised steels in corrosive environments

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1359119 €	Start Date	1/07/2011
	EU Contribution	815472 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

New steel compositions and novel surface modification technologies aim at improved mechanical properties and corrosion resistance. However, the durability of adhesive joints between these advanced materials especially in corrosive environments are mostly below expectations. This proposal aims at an improved understanding of adhesion, de-adhesion and degradation kinetics and mechanisms of adhesives by means of novel spectroscopic, microscopic and electrochemical techniques. The project moreover focuses on development of
improved failure analysis techniques targeting a mechanistic understanding to provide a basis for faster product development in the steel industry.

		Country	*Scientific person in charge*
Partners	**UNIVERSITÄT PADERBORN**	DEUTSCHLAND	Guido GRUNDMEIER (Pr. Coord.)
	INSTITUTO SUPERIOR TECNICO	PORTUGAL	Alda Maria PEREIRA SIMOES
	SIKA TECHNOLOGY AG	SUISSE	Jan Olaf SCHULENBURG
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Christian VREE
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Jennifer SCHULZ
	UNIVERSIDADE DE AVEIRO	PORTUGAL	Mikhail ZHELUDKEVICH
	VOESTALPINE STAHL GMBH	OESTERREICH	Harald HASLINGER

RFSR-CT-2011-00020 ENFASS

Enhanced formability assessment of AHSS sheets

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1831925 €	Start Date	1/07/2011
	EU Contribution	1099155 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

When bending is added to a plane stress forming condition (i.e. stretching), formability is found to exceed the limits indicated by the FLC for most steel grades and even more so for the new AHSS grades. Since the FLC is commonly used as the formability criterion, the actual formability is underestimated. The project aim is to define an experimental characterization of this enhanced formability that is acceptable to the European automotive industry, in combination with a failure
model that can be implemented in current FE codes to reliably predict formability. This approach will enhance the application of AHSS in industry.

		Country	*Scientific person in charge*
Partners	**KOMPETENZZENTRUM DAS VIRTUELLE FAHRZEUG FORSCHUNGSGESELLSCHAFT MBH**	OESTERREICH	Wolfgang WEISS (Pr. Coord.)
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	DYNAMORE GESELLSCHAFT FÜR FEM-INGENIEURDIENSTLEISTUNGEN MBH	DEUTSCHLAND	André HAUFE
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	Eisso ATZEMA
	UNIVERSITEIT TWENTE	NEDERLAND	Ton VAN DEN BOOGAARD
	VOESTALPINE STAHL GMBH	OESTERREICH	Edwin TILL

Selected Publications

Kitting, D., Ofenheimer, A., van den Boogaard, A.H., Dietmaier, P.: Deformation scenarios of combined stretching and bending in complex shaped deep drawing parts, Key Engineering Materials Vols. 554-557 (2013) pp 1252-1264. doi:10.4028/www.scientific.net/KEM.554-557.1252

RFSR-CT-2011-00022 STEELTAC

Steel sheet surfaces with enhanced tactile feel

Info	Type of Project	Research	Duration (months)	40
	Total Budget	1508345 €	Start Date	1/07/2011
	EU Contribution	905006 €	End Date	31/10/2014
State	Running project			

Provisional Abstract This work addresses the development of new and improved manufacturing technologies to create innovative steel sheet surfaces for automotive and domestic appliances. A combination of predictive simulations and experimental work is proposed by a well equipped consortium (Acerinox, Corus, Swerea-IVF, tekniker and the University of Twente) focussed on the development of designed tactility, hydrophobicity and increased formability and paint appearancefor steel sheet surfaces using laser textured cold rolling rolls. The designed tactile feel in daily interactionwith steel products will directly increase the customer satisfaction: people feel more happy using steel products!

		Country	*Scientific person in charge*
Partners	**UNIVERSITEIT TWENTE**	NEDERLAND	Emile van der HEIDE (Pr. Coord.)
	ACERINOX EUROPA SA	ESPAÑA	Rafael SANCHEZ RODRIGUEZ
	SWEREA IVF AB	SVERIGE	Boel WADMAN
	TATA STEEL NEDERLAND TECHNOLOGY B.V.	NEDERLAND	David MATTHEWS
	FUNDACION TEKNIKER	ESPAÑA	Amaya IGUARTUA

RFSR-CT-2011-00023 TESTTOOL

Wear measurement methodology and test facility to increase the efficiency of hot stamping for high performance component production

Info

Type of Project	Research	Duration (months)	42
Total Budget	1911593 €	Start Date	1/07/2011
EU Contribution	1146956 €	End Date	31/12/2014

State Running project

Project web page http://testool.ctm.com.es/

Provisional Abstract

The use of hot stamping is increasing among automotive manufacturers because it allows producing complex geometries from high performing materials. However, their industrial feasibility depends on the process efficiency, which depends on the piece cost and the tool performance. Accurately foreseeing how many parts can be produced by a tool is very appealing to steel producers, tool steel makers, part producers and surface engineering companies. This project aims at developing a methodology and test facility to accurately evaluate the tribothermo-mechanical behaviour in hot stamping, through a deep understanding of the tribological conditions and interaction of the tool and the workpiece.

Partners

	Country	*Scientific person in charge*
FUNDACIO CTM CENTRE TECNOLOGIC- CTM	ESPAÑA	Montserrat VILASECA (Pr. Coord.)
ARCELORMITTAL ATLANTIQUE ET LORRAINE SAS	FRANCE	Christine DESSAIN
GESTAMP HARDTECH AB	SVERIGE	Katarina ERIKSSON
LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Mats OLDENBURG
ROVALMA SA	ESPAÑA	Anwar HAMASAIID
UNIVERSITÄT KASSEL	DEUTSCHLAND	Kurt STEINHOFF
VOLKSWAGEN AG	DEUTSCHLAND	Michael ALSMANN

Selected Publications

J. Pujante, G. Ramirez, A. Ademaj, K. Steinhoff, C. Dessain, M. Vilaseca, D. Casellas, Measurement of adhesive wear on hot forming tools, Proceedings of the 4th International Conference on Hot Sheet Metal Forming of High-Performance steel (ISBN 978-3-942267-82-3).

M. Vilaseca, J. Pujante, G. Ramírez, D. Casellas, Adhesive wear analysis of PVD coated and uncoated hot stamping tools, Proceedings of the 15th Nordic Symposium on Tribology, 12-15 June 2012, Trondheim, Norway.

RFSR-CT-2011-00024 MAC D

Steel design and high speed machining aspects in the transition from case hardening to induction hardening of automotive transmissions

Info

Type of Project	Research	Duration (months)	42
Total Budget	1915161 €	Start Date	1/07/2011
EU Contribution	1149096 €	End Date	31/12/2014

State Running project

Provisional Abstract

The proposal addresses the replacement of case hardening by induction hardening in manufacturing of automotive transmissions. This replacement requires the adaptation of the steels to optimize the manufacturing process and for a reliable performance of the component.
The steel will be tailored to:
(I). The as-delivered microstructure, with respect to rough machining prior to induction hardening.
(II). The induction hardening sequence, with respect to finishing machining and fatigue strength of the final product.
Direct comparisons of actual transmission components manufactured through the two routes are planned, with respect to:
• Total manufacturing cost.
• Vital end-user properties as fatigue strength.

Partners

	Country	*Scientific person in charge*
SWEREA KIMAB AB	SVERIGE	Thomas BJÖRK (Pr. Coord.)
CENTRO RICERCHE FIAT SCPA	ITALIA	Anouscha HERRMANN PRATURLON
EFD INDUCTION AB	SVERIGE	Patrik OLSSON
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Maria Carmen MONTERO PASCUAL
MONDRAGON GOI ESKOLA POLITEKNIKOA J.M.A., S.COOP	ESPAÑA	Pedro José ARRAZOLA
OVAKO HOFORS AB	SVERIGE	Patrik ÖLUND
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dieter LUNG

RFSR-CT-2011-00021 AUTOFATCOR

Combined corrosion and fatigue strength of joined materials for body-in-white and structural automotive applications design

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1768888 €	Start Date	1/09/2011
	EU Contribution	1061333 €	End Date	28/02/2015
State	Running project			

Provisional Abstract For the first time, automotive assemblies will be studied under simultaneous corrosion-fatigue loading in cyclic corrosion tests designed to mimic closely service exposure conditions. The aims of the project are to provide new tools, including the combined corrosion-fatigue solicitations for the design of automotive components involving assembly made both of traditional and new steel
based materials to achieve efficient lightweighting. The project will allow a reduction of engineering, development and validation time, costs for implementation of new materials, joining techniques and corrosion protection systems. This will reduce the time to market for the steel industry.

		Country	*Scientific person in charge*
Partners	**INSTITUT DE LA CORROSION SASU**	FRANCE	Dominique THIERRY (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Laurence DOSDAT
	BAYERISCHE MOTOREN WERKE AG*BMW	DEUTSCHLAND	Michael BRAUCH
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Cristiano SCIABONI
	GESELLSCHAFT FÜR SCHWEISSTECHNIK INTERNATIONAL MBH*GSI	DEUTSCHLAND	Thomas BSCHORR
	VOESTALPINE STAHL GMBH	OESTERREICH	Gerald LUCKENEDER

RFSR-CT-2012-00019 TWIP4EU

Introducing high strength and ductility twinning induced plasticity (TWIP) steels for European automotive applications through advanced material modelling

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1375711 €	Start Date	1/07/2012
	EU Contribution	825428 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

TWIP4EU will promote the introduction of modern twinning induced plasticity (TWIP) steels as candidate material for production of lightweight automobile components. To introduce a new steel grade like high strength and ductility TWIP steel for large scale applications in industrial practice, a thorough validation of the material behaviour with useable material laws implementable in commercial finite element codes must be available since numerical simulations are used all along the production process of body parts starting from the design of forming dies through the prediction of in service performance up to the prediction of passenger safety in crash simulations.

For this purpose, this project proposes a novel and advanced approach towards modelling the complex deformation and forming behaviour of new HSD-TWIP steels to facilitate their large scale introduction in the automotive industry. The project comprises a comprehensive experimental plan combined with the development of a constitutive framework motivated from micromechanical quantities to describe the deformation behaviour of this innovative material. The implementation of the developed model into commercially available finite element software packages plays an important role in the project. The project will be concluded by validation of the developed material model on a prototype automobile component.

		Country	*Scientific person in charge*
Partners	**FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG e.V.**	DEUTSCHLAND	Alexander BUTZ (Pr. Coord.)
	DYNAMORE GESELLSCHAFT FÜR FEM-INGENIEURDIENSTLEISTUNGEN MBH	DEUTSCHLAND	André HAUFE
	ESI ENGINEERING SYSTEM INTERNATIONAL GMBH	DEUTSCHLAND	Andrew HEATH
	FAURECIA AUTOSITZE GMBH	DEUTSCHLAND	Martin KAMPCZYK
	SWEREA KIMAB AB	SVERIGE	Niclas STENBERG
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Katrin WEILANDT

RFSR-CT-2012-00020 STT

Steel tailor tubes

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1962700 €	Start Date	1/07/2012
	EU Contribution	1177620 €	End Date	30/06/2015
State	Running project			

Provisional Abstract Steel hydroformed tubular components with tailor properties, used for automotive exhaust systems, fulfil two objectives, due to their optimized mechanical properties: increment of component functionality performance and reduction of part weight. However, a cheap and efficient manufacturing process to obtain these tubular components is not yet achieved. Expensive combination of processes, low automation and long manufacturing times are great drawbacks of current technologies. The development of an innovative process, combining tube flow forming before hydroforming, with adequate steel selection, will overcome these disadvantages, by reducing the manufacturing costs and cycle times, while ensuring the specified final part tailored properties.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	Amaia ARROYO (Pr. Coord.)
	ACERINOX EUROPA SA	ESPAÑA	Julia CONTRERAS FORTES
	CENTRO RICERCHE FIAT SCPA	ITALIA	Daniele PULLINI
	INDUSTRIAS PUIGJANER SA	ESPAÑA	Máximo ALBEA
	SWEREA KIMAB AB	SVERIGE	Arne MELANDER
	VOESTALPINE TUBULARS GMBH & CO KG	OESTERREICH	Juergen KLARNER

RFSR-CT-2013-00014 INCAFAT

A novel approach for rating fatigue-initiating inclusions in highly demanding steel

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1603713 €	Start Date	1/07/2013
	EU Contribution	962229 €	End Date	31/12/2016
State	Running project			

Provisional Abstract The fatigue limit of highly demanding steels is mainly governed by surface or inner defects, being usually inclusions larger than 100µm responsible for fatigue failures. Typically macro-inclusions are detected by on-line UT, while “meso-inclusions” get these controls away and their verification is carried out by micro-cleanliness extrapolation with doubtful representativeness. Inclusion harmfulness is conditioned by loading direction, as stress intensity factor depends on defect geometry, and therefore under different loading regimes, critical inclusions can act differently. This project aims to establish the most suitable approach to characterise non-metallic inclusion populations and their effect on fatigue properties in highly demanding steel.

		Country	*Scientific person in charge*
Partners	**GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.**	ESPAÑA	Maite PEREZ ALONSO (Pr. Coord.)
	BUNDESANSTALT FÜR MATERIAL FORSCHUNG UND -PRÜFUNG	DEUTSCHLAND	Thomas HECKEL
	SWEREA KIMAB AB	SVERIGE	Irma HEIKKILÄ
	SCHAEFFLER TECHNOLOGIES GmbH & CO KG	DEUTSCHLAND	Markus DINKEL
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

RFSR-CT-2013-00015 FREQTIGUE

Influence of cycling frequency on fatigue strength and crack growth of engineering steels for demanding applications

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2305264 €	Start Date	1/07/2013
	EU Contribution	1383159 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

In-service conditions of mechanical components rank from less than 1 Hz to several kHz load frequency. Fatigue testing can be performed in a similar range of frequencies, but higher frequencies are usually preferable in order to reduce testing time. Testing and in-service load frequencies are often not corresponding. Nevertheless, the use of high frequency testing is inevitable, and increasingly used, to acquire knowledge for design use in particular high to very high fatigue life lengths. High frequency loading combined with plastic deformation at the fatigue crack tip produces a local increase of temperature, outside the crack tip in the high stress region a large volume may experience heating due to a damping effect, and in-situ mechanical properties of the steel component might change sharply. Adding to this, increasing load frequency may lead to a different stress-strain response because of strain-rate and damping effects. Generation of very long fatigue life materials data and clarification of conditions at the crack tip has a great importance for both real component fatigue life and fatigue testing validity. The overall objectives are; - Determination of fatigue strength and failure mechanisms depending of fatigue life, cyclic load frequency and steel product. - Evaluation of the local conditions at the crack initiation sites and crack tip depending of cyclic load frequency for steels of different plasticity. - Validation of fatigue testing procedures, guidelines and recommendations for suitable testing practices as a function of the frequency for time reduction and reliable data. Fatigue testing in LCF to VHCF fatigue of a wide range of steels (800 MPa to 2200 MPa strengths) at frequencies from 1 Hz to 20 kHz will be performed. Temperature measurements made directly at the crack tip, numerical models of conditions at the crack tip, including stress and heat transfer calculations, will be made. The proposal is in line with 2012 Steel Priorities.

		Country	*Scientific person in charge*
Partners	**KARLSTADS UNIVERSITET**	SVERIGE	Jens BERGSTRÖM (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Bastien WEBER
	CENTRO RICERCHE FIAT SCPA	ITALIA	Stefano PLANO
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Rafael PIZARRO SANZ
	KARLSRUHER INSTITUT FÜR TECHNOLOGIE (KIT)	DEUTSCHLAND	karl-Heinz LANG
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK
	UNIVERSITE PARIS OUEST-NANTERRE LA DEFENSE	FRANCE	Claude BATHIAS

RFSR-CT-2014-00020 IMMAC

Innovative Method dedicated to the development of a ferrite-pearlite grade regarding its MAChinability

Info

Type of Project	Research	Duration (months)	36
Total Budget	2798934 €	Start Date	1/07/2014
EU Contribution	1679357 €	End Date	30/06/2017

State Running project

Provisional Abstract

Innovative Method dedicated to the development of a ferrite-pearlite grade regarding its MAChinability. In a competitive context, automotive and engineering industries have to continuously improve their productivity, especially their machining process. Consequently, this project deals with machinability aspects of ferritic-pearlitic steel grades from 0.15%C to 0.7%C. In a recent past, increasing machining performances was driven by inclusion distributions optimization. Now, with increasing in-service properties, the microstructure itself seems to be the way of improvement. A numerical tool will be developed in order to design a machinability-improved ferritic-pearlitic grade tailored to a given machining operation. Three machining operations will be under consideration, with different cutting conditions: turning, drilling and broaching. To achieve that goal, this project lies on advanced rheological and tribological characterizations that will be performed on the selected steels. Thus, a better understanding of thermal stress-strain behaviours and contact mechanisms is required. Based on these observations, constitutive models will be developed in order to extract the influence of parameters linked to ferrite-pearlite microstructures. The identified parameters will be used as input data in numerical simulations for machining performances prediction. In parallel, experimental cutting test will be conducted on several grades to assess the influence of these microstructural parameters on machining performances. Finally, the validation of the approach will be obtained by industrial cutting tests performed on a F-P grade with an optimized microstructure tailored to a given machining operation.

Partners

	Country	*Scientific person in charge*
ASCOMETAL S.A.S.	FRANCE	Enrico D'ERAMO (Pr. Coord.)
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ECOLE NATIONALE D'INGENIEURS DE SAINT-ETIENNE	FRANCE	Joël RECH
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Maria Carmen MONTERO PASCUAL
SWEREA KIMAB AB	SVERIGE	Thomas BJÖRK
MONDRAGON GOI ESKOLA POLITEKNIKOA J.M.A., S.COOP	ESPAÑA	Pedro José ARRAZOLA
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Mustapha ABOURIDOUANE

RFSR-CT-2014-00021 HIPEBA

HIgh PErformance Steel for Safer and more Competitive Safety BArriers

Info

Type of Project	Research	Duration (months)	36
Total Budget	1711886 €	Start Date	1/07/2014
EU Contribution	1027128 €	End Date	30/06/2017

State Running project

Provisional Abstract

Road restraint systems (RRS) are safety devices installed on roadsides to contain and redirect errant vehicles, with steel as the most widely used material for their manufacturing (typically roll formed profiles, from structural steels such as S235JR). In the coming years, competition among manufacturers at an international level will be crucial for Europe's RRS manufacturing and steel supplying industries. Performance-based standards are already in force, and markets are global. In addition, there are certain facts concerning road safety that pose new technical challenges for future RRS. For instance: • Weight increase of heavier trucks (i.e. up to 60000 kg). • Lack of space available on the roadside. • The need to limit forces transmitted to bridge decks and other structures. • The need to implement RRS in urban areas with specific requirements. • Optimised performance regarding environment issues is needed. In this demanding situation, the material's choice is extremely important for a product's performance. Steel materials have traditionally been recognised as the most suitable ones for RRS due to steel's intrinsic properties. However, given the future technical requirements foreseen for RRS and also the growing competition from alternative materials, at this moment of time a thorough research work aimed at introducing higher strength steels in RRS manufacturing will mean a significant breakthrough in steel barriers' competitiveness. The main goal of HIPEBA project is to develop safer and more competitive road restraint systems by using high performance steels. To achieve this goal, a comprehensive analysis of the material characteristics that contribute to improve a safety barrier in each of the stages of its life cycle will be carried out. Product manufacturing, installation, impact response and durability will be addressed. After the study, the selected steels will be implemented into demonstration prototypes that can be tested for final validation.

Partners

	Country	*Scientific person in charge*
FUNDACION CIDAUT	ESPAÑA	José Alberto de PRADO RODRIGUEZ (Pr. Coord.)
ORGANISME IMPARTIAL DE CONTROLE DE PRODUITS POUR LA CONSTRUCTION ASBL	BELGIQUE	Kim VANDENHOEKE
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Cristiano SCIABONI
HIERROS Y APLANACIONES S.A.	ESPAÑA	Zenaida HERNÁNDEZ GARRASTACHO
INTERNATIONAL ROAD RESEARCH FORUM LTD LBG	UNITED KINGDOM	José PAPÍ
LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Esa VUORINEN
SSAB EMEA AB	SVERIGE	Eva PETURSSON

RFSR-CT-2014-00033 Toolsteel

Improvement of tool steel properties to increase hot forging efficiency and competitiveness

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1247868 €	Start Date	1/07/2014
	EU Contribution	748719 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

Hot forging is a manufacturing method widely used in the automotive sector to produce high added value components. In forging processes, an initially simple part is plastically deformed between two tools to obtain the desired final geometry. Material flow over dies and punches causes a great thermal and mechanical interaction between dies and material. This interaction is the usual origin of die failures: abrasive die-wear, thermal fatigue, mechanical cracks and plastic deformation. It is also estimated that tooling costs represent around 15-20% of the final cost of the forged parts. For this reason minimizing the dies failure and increasing tooling life is a well-known challenge for forging process designers, which must be surpassed by a suitable tool steel selection in conjunction with a correct process design. Toolsteel project will develop a new steel grade, based on the actual DIN 1.2365 tool steel used for hot forging, to overcome the failure modes that limit the lifetime of hot forming steel dies by means of a different alloying strategy. In this way, the chemical composition design will be focused on two different research lines depending on the forging die specifications: 1) toughness improvement and 2) hardness improvement. Both will be the pursued goals and in both cases higher thermal conductivity will be a must. On the one hand, tungsten content is planned to be increased in order to improve thermal conductivity. It provides higher overall thermal fatigue resistance compared when molybdenum is only present in the tool steel grade, but higher thermal conductivity and hardness can be obtained by a well balanced ratio of molybdenum and tungsten. On the other hand, nitrogen chemical modification will be explored contributing to toughness control of the tool steel and further nitruration step improvement. To check the benefits of suggested solution, industrial tests will be performed using new developed steel in real process conditions.

		Country	*Scientific person in charge*
Partners	**FUNDACION TECNALIA RESEARCH & INNOVATION**	ESPAÑA	Iñaki PEREZ (Pr. Coord.)
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Maria Carmen MONTERO PASCUAL
	SCHMIEDEWERKE GROEDITZ GMBH	DEUTSCHLAND	Stefan LACHMANN
	VOLKSWAGEN AG	DEUTSCHLAND	Lars WETTERAU

Technical Group Steel 8

Steel products and applications for building, construction and industry

The scope of TGS8 includes:

- Structural safety and design methods, in particular with regard to resistance to fire and earthquakes
- Technologies relating to the forming, cutting, welding and joining of steel and other materials
- Design of assembled structures to facilitate the easy recovery of steel scrap and its reconversion into usable steels and techniques for recycling
- Prolonging service life of steel products
- Standardisation of testing and evaluation methods

RFS2-CT-2003-00048 DIFISEK

Dissemination of structural fire safety engineering knowledge

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	458975 €	Start Date	1/09/2003
	EU Contribution	458975 €	End Date	28/02/2005
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23332:EN			

Final Abstract Primary NOx reduction with low NOx burners can be considered the best available technology for steel. The technical goal of this project has been to disseminate effectively knowledge on structural fire safety engineering — gained in numerous ECSC-funded projects over the last 15 years — in as many countries and languages as possible. Common material in the form of syllabi and PowerPoint presentations have been prepared which explain simply modern fire calculation tools such as NFSC, recently implemented in the Eurocodes. Besides the explanation of the tools, accepted or given by EN 1991-1-2, EN 1993-1-2 and EN 1994-1-2, practical design examples, real building applications and collection of available software for fire design are provided. All these data are available in English, German, French, Dutch, Spanish and Finnish. An HTML tool has been created to guide the user through these data (six times 312 PP sheets and six times 211 text pages). Public seminars and workshops have been arranged in participating countries and special workshops for authorities, architects and engineers were organised. The key target groups were designers, architects, clients, authorities responsible for fire safety validation, as well as teachers and students from universities, technical high schools and technical schools. A total of around 720 people have attended the various seminars. The information produced and distributed in this project should be useful in practical daily design work for educational purposes, as well as in performance-based fire design. Further dissemination is therefore foreseen through the Internet.

		Country	*Scientific person in charge*
Partners	**ProfilARBED S.A.**	LUXEMBOURG	Mike HALLER (Pr. Coord.)
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Daniel JOYEUX
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jesus DE LA QUINTANA
	RAUTARUUKKI OYJ	FINLAND	Jyrki KESTI
	TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	L. TWILT
	GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER	DEUTSCHLAND	Peter SCHAUMANN

RFSR-CT-2003-00010 HYBLAS

Economical and safe laser hybrid welding of structural steel

Info	Type of Project	Research	Duration (months)	46
	Total Budget	1711491 €	Start Date	1/09/2003
	EU Contribution	1026895 €	End Date	30/06/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23867:EN			

Final Abstract The Hyblas project has developed the techniques of laser hybrid welding to the level that single pass welds can be made up to 25 mm plate thickness using 20 kW of laser power at speeds of about 1 m/min. Multi-pass and dual-sided welding techniques have also been developed up to 30 mm plate thickness and fillet welds up to 20 mm steel thickness. The weldability of steels from 250 to 690 MPa yield strength from 12 to 25 mm in thickness has been quantified and operational windows for defect-free welding defined. In addition, various NDE methods have been studied for their efficiency in regard to the defect types which can occur. The fracture and mechanical properties of the joints have been shown to be perfectly good for all structural uses and an extensive fatigue testing programme has demonstrated fatigue behaviour which exceeds conventional welding expectations. Part of a full-scale industrial component has been manufactured, inspected and tested to demonstrate that the anticipated fatigue benefits are obtained, and they were. Finally, guidance regarding good practice for the industrial use of the techniques has been derived and publicised with a view to generating an agreed standard.

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Stephen WEBSTER (Pr. Coord.)
	CATERPILLAR FRANCE SAS	FRANCE	Jean-Jacques JANOSCH
	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG e.V.	DEUTSCHLAND	Dirk PETRING
	FORCE TECHNOLOGY	DANMARK	Jens Klaestrup KRISTENSEN
	INGENIEURBÜRO FÜR WERKSTOFFTECHNIK	DEUTSCHLAND	Peter LANGENBERG
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Wolfgang BLECK

RFSR-CT-2003-00017 EEBIS

Energy efficient buildings through innovative systems in steel

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1645606 €	Start Date	1/09/2003
	EU Contribution	987364 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23180:EN			

Final Abstract "Clients and building users demand energy efficient buildings, and governments at national and European level have introduced regulations to minimise energy use in new buildings to meet CO2 reduction targets. Steel construction is well placed to meet these new energy efficiency targets by developing new products and systems, which actively and passively reduce energy consumption in commercial and residential buildings. In this research, it is proposed to: - develop technologies and concepts for new steel products and systems for energy efficient buildings; - provide physical data on the performance of those innovative techniques which actively regulate energy consumption in buildings; - develop structural systems which use air and water as the medium for cooling; - provide design 'tools' for whole building energy assessments; - address certain technical issues such as cold bridging through external steelwork, which may affect local and global building performance. This work will provide the basis for marketable steel products and systems and establish their basic physical performance characteristics."

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL BELVAL & DIFFERDANGE S.A.**	LUXEMBOURG	Françoise LECOMTE-LABORY (Pr. Coord.)
	ARCELORMITTAL LIEGE RESEARCH SCRL	BELGIQUE	Laurent GERON
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Alberto BONILLA
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	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Bernd DÖRING
	THE STEEL CONSTRUCTION INSTITUTE LBG	UNITED KINGDOM	Nancy BADDOO
	TATA STEEL UK LIMITED	UNITED KINGDOM	Allan R. GRIFFIN

RFSR-CT-2003-00018 COMBRI

Competitive steel and composite bridges by innovative steel plated structures

Info

Type of Project	Research	Duration (months)	36
Total Budget	1486548 €	Start Date	1/09/2003
EU Contribution	891928 €	End Date	31/08/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23177:EN

Project web page www.uni-stuttgart.de/ke/forschung/COMBRI/

Final Abstract

Bridges are an integral part of the worldwide traffic infrastructure and long-span bridges, in particular, contribute to mobility and economy of time in travelling. The aim is to improve the steel-plated cross-sections of steel and composite bridge structures for the final and execution state. Investigations for the final state cover the bending and shear resistance of box- and I-girders with few longitudinal stiffeners. The impact of the common increase in the stiffener size and the use of a closed-section shape were studied by experimental testing and numerical simulations. The coupled instability due to local and global buckling of rectangular cross-sections in arch bridges was dealt with in the same way. Thus, recommendations are formulated which allow for an optimisation as early as the design stage. One of the most competitive construction methods for long spans is the incremental launching technique. Appropriate patch loading models taking into account the specific bridge launching conditions have been developed. Recommendations are given with regard to additional realistic aspects arising from the erection phase. In the frame of complementary investigations, a free-of-charge software tool has been developed which helps the designer to overcome difficulties often encountered in the assessment of elastic critical plate buckling stresses. However, a full numerical simulation is essential for more complex plated structures so that, amongst other input parameters, initial geometric and structural imperfections are required for which recommendations are outlined. Generally examples are given where a contribution to the theoretical background seems helpful for the reader.

Partners

	Country	*Scientific person in charge*
FORSCHUNGSVEREINIGUNG STAHLANWENDUNG e.V.	DEUTSCHLAND	Gregor NUESSE (Pr. Coord.)
AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Falko SCHRÖTER
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Yvan GALEA
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Fernando ESPIGA
LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Ove LAGERQVIST
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Gerhard SEDLACEK
SERVICE D'ETUDES SUR LES TRANSPORTS, LES ROUTES ET LEURS AMENAGEMENTS	FRANCE	Joël RAOUL
UNIVERSITE DE LIEGE	BELGIQUE	Hervé DEGEE
UNIVERSITAET STUTTGART	DEUTSCHLAND	Ulrike KUHLMANN

Selected Publications

Kuhlmann, U. et al.: COMBRI Design Manual Part I. RFCS-Project COMBRI+, 2008. http://www.uni-stuttgart.de/ke/forschung/COMBRIplus/COMBRI_Design_Manual_Part_I_English.pdf

Kuhlmann, U. et al.: COMBRI Design Manual Part II. RFCS-Project COMBRI+, 2008. http://www.uni-stuttgart.de/ke/forschung/COMBRIplus/COMBRI_Design_Manual_Part_II_English.pdf

Kuhlmann U., Zizza A., Braun B. and Degée H. (2011). New chances and developments of Eurocode 3 Part 1.5 – Bridge design aspects. Steel Construction, 4: 224–231. DOI: 10.1002/stco.201110030

Software

EBPlate It assesses the critical stresses associated to the elastic buckling of plates loaded in their plan: Plates: Rectangular plate with uniform thickness. Isotropic or orthotropic behaviour. Edges: Plate supported on its four edges for the out-of-plane direction (no free edge). Three possible conditions for the rotation of the edges : free rotation, fixed edges or elastic restraint (defined by flexural and torsional stiffnesses). Stiffening : Possible definition of several stiffeners in both longitudinal and transverse directions of the plate, with identical or different properties. Axial, flexural and torsional rigidities of stiffeners are accounted for. 5 predefined types of stiffener cross-sections, which allow a direct definition from the dimensions. Possible smearing of identical and regularly spaced stiffeners (orthotropic properties of the plate). Specific treatment of stiffener with closed cross-section, for example trapezoidal sections. URL: www.cticm.com

RFSR-CT-2003-00019 SYNPEX

Advanced load models for synchronous pedestrian excitation and optimised design guidelines for steel footbridges

Info

Type of Project	Research	Duration (months)	36
Total Budget	1218758 €	Start Date	1/09/2003
EU Contribution	731255 €	End Date	31/08/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23318:EN

Final Abstract

The aims of this project were to develop advanced load models for synchronous pedestrian excitation and to conclude the results in optimised design guidelines for steel footbridges. Based on extensive measurements on a test rig, a practical and simple spectral load model was derived that can be used for the determination of vibrations for sinusoidal mode shapes. Also a design load model for FEM (finite element method) calculations was developed that allows for different pedestrian densities and all types of mode shapes. Measurements of vibration behaviour due to different pedestrian loadings on nine lively footbridges were used to check and verify the developed load models. Moreover, questionnaires on comfort were conducted, and synchronisation effects during events were investigated. The most important outputs are several load models of differing complexity as well as the design methodology. Due to differences in complexity, and depending on the design stage, the designer can choose the most adequate load model for his purposes. As it is very difficult to specify unique comfort criteria, the definition of comfort criteria is recommended for each footbridge, with regard to the expected traffic amount and the location of the bridge. Much flexibility in the design is therefore allowed, and relevant influence factors on loading and perception and judgement of vibration should be considered. Clients and designers of footbridges now have a powerful tool (design guidelines with various load models) to more accurately specify and predict the vibration behaviour of footbridges resulting from pedestrian traffic.

Partners

	Country	*Scientific person in charge*
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Christoph HEINEMEYER (Pr. Coord.)
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Dominique SEMIN
SBP GmbH - SCHLAICH BERGERMANN & PARTNER	DEUTSCHLAND	Mike SCHLAICH
UNIVERSIDADE DO PORTO	PORTUGAL	Alvaro CUNHA

RFSR-CT-2003-00025 ACOUSVIBRA

High quality acoustic and vibration performance of lightweight steel constructions

Info

Type of Project	Research	Duration (months)	40
Total Budget	1447813 €	Start Date	1/09/2003
EU Contribution	868688 €	End Date	31/12/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23319:EN

Final Abstract

Prediction models for the acoustic and vibration behaviour of lightweight steel constructions were developed in the project. The performance of lightweight double walls in terms of sound transmission was studied both experimentally and analytically. Existing models were used, but also new models were developed in order to better understand the role of the different components (boards, cavity, studs, rails etc.) in sound transmission. An accurate and fast model has been obtained by combining the wave approach and statistical energy analysis (SEA). The European standardised prediction model for calculating all building performances including flanking, which is only valid for heavy concrete structures, has been successfully adapted to lightweight structures. Airborne sound transmission through facades was also studied and some recommendations are given for designers. A group of field- and laboratory tests and numerical analyses have been carried out in order to better understand the vibration performance of lightweight floors. The harmonised test procedure to the dynamic testing and subjective evaluations of lightweight floors are proposed. Two different approaches are introduced for the assessment of vibration acceptance of lightweight floors. Different high-performance products such as facades, partition walls and lightweight floors were developed in the framework of the project. Finally, the design guide was prepared. A set of design rules for acoustic performance and vibration performance have been developed, and are included in the guide. It demonstrates that lightweight steel construction is perfectly capable of meeting modern acoustic and vibration serviceability requirements.

Partners

	Country	*Scientific person in charge*
RAUTARUUKKI OYJ	FINLAND	Jyrki KESTI (Pr. Coord.)
CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT	FRANCE	Michel VILLOT
LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Anders AGREN
STIFTELSEN SVENSK STALBYGGNADSFORSKNING - STALBYGGNADSINSTITUTET	SVERIGE	Charlotte SVENSSON TENGBERG
THE STEEL CONSTRUCTION INSTITUTE LBG	UNITED KINGDOM	Stephen HICKS
UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)	ESPAÑA	Antonio ROGRIGUEZ FERRAN
TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Ari SAARINEN

RFSR-CT-2003-00030 FIRESTRUC

Integrating advanced three-dimensional modelling methodologies for predicting thermo-mechanical behaviour of steel & composite structures subjected to natural fires

Info	Type of Project	Research	Duration (months)	40
	Total Budget	1417868 €	Start Date	1/09/2003
	EU Contribution	850721 €	End Date	31/12/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23200:EN			

Final Abstract Coupling methodologies were developed linking computational fluid dynamics (CFD) and finite element (FE = solid phase) computer programs for assessing the performance of structures in fire. A hierarchy of modelling strategies was examined, divided broadly into those methods where information is only passed from the CFD program to the FE program, referred to as 'one-way coupling', and more elaborate treatments where the structural response is coupled back to the CFD, 'two-way coupling'. Different coupling methodologies were systematically examined using four different CFD solid phase pairs (Jasmine/SAFIR, VESTA/DIANA, FDS/ANSYS and Jasmine/STELA). A common exchange file format was established to facilitate coupling. The program pairs were applied for three test cases: a hypothetical benchmark scenario with localised fires and various steel components, an experimental scenario involving a loaded beam-column assembly in a flashed-over fire, and an open car-park structure with transient car fires under varying wind conditions. A practical design example was also used for methodology comparisons. The merits of the different methodologies were identified and detailed recommendations provided. An efficient exploitation method is to conduct mainly one-way coupling calculations, performing a full two-way coupling for the final design stage. Under many circumstances, it is permissible to omit the structural members entirely from the CFD. Another useful 'hybrid' approach is to include the main structural elements in the CFD simulation in a simplified manner, thus allowing large elements to influence the fluid flow. It was established that these techniques can provide useful practical tools for structural fire design, permitting holistic assessment of fire and structural response.

		Country	*Scientific person in charge*
Partners	**BUILDING RESEARCH ESTABLISHMENT LTD**	UNITED KINGDOM	Suresh KUMAR (Pr. Coord.)
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Daniel JOYEUX
	ProfilARBED S.A.	LUXEMBOURG	Olivier VASSART
	TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	Joris FELLINGER
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN

RFSR-CT-2003-00034 PRECIOUS

Prefabricated composite beam-to-concrete filled tube or partially reinforced-concrete-encased column connections for severe seismic and fire loadings

Info

Type of Project	Research	Duration (months)	45
Total Budget	1058877 €	Start Date	1/09/2003
EU Contribution	635326 €	End Date	31/05/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23750:EN

Final Abstract

"The 'Precious' research programme has developed fundamental data, design guidelines and prequalification of two types of fire-resistant composite beam-to-column joints endowed with: (1) partially reinforced-concrete-encased columns with I-section; (2) concrete filled tubular columns with circular hollow steel section. The project has analysed, from both an analytical/numerical and an experimental standpoint, the scenario in which a fire follows an earthquake, thus defining joint typologies for which, after being damaged by an earthquake, a residual load-bearing capacity is assured during a fire occurring after an earthquake. The design has been performed in the modern context of performance-based engineering. Both interior and exterior joints with partially reinforced-concrete encased columns, i.e. type 1 joints, have been designed to be semi-rigid and partial strength, and to exhibit high ductility and limited strength deterioration under severe seismic loadings. Moreover, they have been endowed with improved details to face elevated temperatures and satisfy relevant limit states. Conversely, type 2 joints, i.e. innovative joints with concrete filled tubular columns, have been detailed to be rigid and full strength. Thus, overstrength concepts have been used to activate plastic hinges in adjacent beams for seismic loadings; improved details have also been used to face fire loadings. In order to render such solutions cost-effective from a design and industrial viewpoint, they have been conceived as prefabricated components and prequalified by means of testing. Thus, both joint types have been endowed with slabs with high ductile rebars, electrowelded meshes and electrowelded lattice girders."

Partners

	Country	*Scientific person in charge*
UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Oreste S. BURSI (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Mike HALLER
BUILDING RESEARCH ESTABLISHMENT LTD	UNITED KINGDOM	David MOORE
FERRIERE NORD S.P.A.	ITALIA	Roberta MALLARDO
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN
UNIVERSIDAD DE NAVARRA	ESPAÑA	Eduardo BAYO
UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE

RFSR-CT-2003-00035 VERAPS

Validation and enhancement of risk assessment procedure for seismic connections

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1376212 €	Start Date	1/09/2003
	EU Contribution	825727 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22993:EN			

Final Abstract "Quantifying the performance of beam-column connections used in seismic applications is a critical requirement to ensure structural safety under earthquake loading conditions. However, performance requirements are affected by design, fabrication and mechanical properties. The objective of the VERAPS project was to develop tools for the evaluation of cyclic plastic rotation capacity of welded beam column moment connections under seismic loading. The project comprised the following activities: - assessment of previous full-scale beam-column connection tests using the IIW Seismic Risk Assessment Procedure (RAP); - design and fabrication of a series of eight full-scale beam-column test assemblies, together with mechanical property evaluation; - full-scale tests on eight connections with beams and columns of varying moment capacity and weld metal toughness to cover different categories of risk; - finite element modelling of residual stress from welding, crack initiation and propagation and overall connection behaviour; - demonstration of safety assessment approaches for evaluating connection performance by finite element modelling and fracture mechanics approaches; and - development of tools and techniques for the evaluation of connection performance under cyclic loading. Overall, the project has demonstrated the importance of optimising the design of moment connections, in particular in terms of relative moment capacities of the joint and the beam, the behaviour of the shear panel and the methods used to connect the shear tabs. Coupled with the use of low sulphur sections, weld metal of good toughness and controlled fabrication procedures, good seismic performance can be achieved. Predictive tools for evaluating such performance have been developed and validated within the project."

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Adam BANNISTER (Pr. Coord.)
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Manuel GOMES
	ProfilARBED S.A.	LUXEMBOURG	Toni DEMARCO
	UNIVERSITE DE LIEGE	BELGIQUE	André PLUMIER
	UNIVERSITÄT KARLSRUHE	DEUTSCHLAND	Helmut SAAL

RFS3-CT-2004-00039

Seismic Design of Light Gauge Steel Framed Buildings

Info	Type of Project	Accompanying measure (training)	Duration (months)	4
	Total Budget	9100 €	Start Date	1/06/2004
	EU Contribution	9100 €	End Date	30/09/2004
State	Research completed without final report			

Provisional Abstract Main research activity of the applicant is the numerical modelling of the seismic behaviour of cold-formed steel structures. This model has to be calibrated and validated by a previous testing campaign. With this stage, the applicant will participate in the testing campaign, the model will be validated and seismic design rules will be developed.

		Country	*Scientific person in charge*
Partners	**TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND**	FINLAND	Jouko KOUHI (Pr. Coord.)
	UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)	ESPAÑA	Antonio ROGRIGUEZ FERRAN

RFS2-CT-2004-00036 DryConDis

Dissemination of the knowledge in the use of steel intensive dry construction systems in housing (DryConDis)

Info

Type of Project	Accompanying measure (studies)	Duration (months)	12
Total Budget	334707 €	Start Date	1/07/2004
EU Contribution	251030 €	End Date	30/06/2005

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22849:EN

Final Abstract

The technical objective of the DryConDis project has been to effectively assess, develop and disseminate information about the use of steel-intensive dry construction systems in housing gained from previous ECSC-funded projects during 1997–2003. The project partnership has produced a text document and PowerPoint slides on dry construction system items, including a general description and design guidelines for light-weight steel floors, walls and facades and roof systems. Design examples and construction details are also included and a series of completed building projects with steel-intensive dry composite products and systems has been introduced. All documents and PowerPoint presentations were translated into Estonian, Finnish, German, Greek, Italian, Polish and Swedish, concluding with English versions in a total of over 1 400 document pages and 1 700 PowerPoint slides. Seminars on dry construction systems have been organised all over Europe targeting mainly design engineers, architects and constructors. More than 500 people - many of them researchers, teachers and staff of building authorities - also participated in the seminars.

Partners

	Country	*Scientific person in charge*
RAUTARUUKKI OYJ	FINLAND	Jyrki KESTI (Pr. Coord.)
COMPUTER CONTROL SYSTEMS SA	HELLAS	Christos SAOURIDIS
FORSCHUNGS- UND QUALITÄTSZENTRUM ODERBRÜCKE gGmbH	DEUTSCHLAND	Holger GEORGI
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Gerhard SEDLACEK
STIFTELSEN SVENSK STALBYGGNADSFORSKNING - STALBYGGNADSINSTITUTET	SVERIGE	Joakim WIDMAN
UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE
UNIVERSIDAD DE LA RIOJA	ESPAÑA	Joaquín ORDIERES MERE

RFS2-CT-2004-00037 NEWEU

Dissemination of steel based new renovation technologies into growing new EU markets (NEWEU)

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	253434 €	Start Date	1/07/2004
	EU Contribution	190075 €	End Date	31/12/2005
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22850:EN			

Final Abstract The technical objective of the NewEU project has been to disseminate several new steel-based renovation technologies — demonstrated in practice in the two earlier ECSC-funded projects — into new EU markets. The project partnership has produced a text document as well as PowerPoint slides on steel-intensive renovation systems, including a general description and design guidelines. Design examples and construction details are also included and a series of completed renovation projects has been introduced. Documents and PowerPoint slides have been translated into Estonian, Hungarian, Latvian, Lithuanian, and Polish, concluding with English versions in a total of 1 158 document pages and 543 PowerPoint slides. Seminars on steel-based renovation systems have been organised in participating countries by targeting design engineers, architects, constructors and building authorities. A total of over 400 people have attended the seminars.

		Country	*Scientific person in charge*
Partners	**RAUTARUUKKI OYJ**	FINLAND	Pekka ROIVIO (Pr. Coord.)
	FINNMAP POLSKA Sp. z.o.o.	POLAND	Lasse RAJALA
	RANNILA HUNGARY KERESKEDELMI ES SZOLGALTATO Kft.	HUNGARY	Istvan SZONTAGH
	SIA FINNMAP LATVIJA	LATVIA	Markku HUSSO
	TALLINNA TEHNIKAULIKOOL*TALLINN UNIVERSITY OF TECHNOLOGY	ESTONIA	Kalju LOORITS
	VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS	LITHUANIA	Audronis Kazimieras KVEDARAS

RFS2-CT-2004-00038 DISKX100PIPE

Dissemination of X100 steel pipes for high pressure gas transportation pipelines knowledge

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	200000 €	Start Date	1/07/2004
	EU Contribution	150000 €	End Date	31/12/2005

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22851:EN

Final Abstract "The project was dedicated to disseminating and promoting the knowledge gained in two European Coal and Steel Community-funded projects designed to assess the technical feasibility of the safe use of X100-grade steel large-diameter pipes for future high-pressure long-distance gas transmission pipelines. The specific aim was to support, based upon technical results previously achieved, the increase of the European market share in this specific worldwide business (steel products for the oil and gas industry). Collection and critical analysis of the existing available information and know-how concerning the use of large-diameter X100-grade steel pipes for gas transmission lines has been carried out with the aim of identifying potential benefits in using such a new product and technical gaps still to be addressed, highlighting the good performance of European products with respect to the main technical issues considered. Technical discussions on the various issues have been promoted involving all the relevant players in the international oil and gas industry, that is steel and pipe makers, designers, contractors and end users. Two X100 international forums have been organised with great success, involving attendees from around the world (North America, South America, Japan, etc.), and the results obtained, in terms of disseminating knowledge and promoting European products, have been positive and fully satisfactory. This final report summarises the more relevant technical information collected through the project about the safe use of X100-grade steel large-diameter pipes for gas transmission lines, showing that European products are currently well able to fully satisfy the more stringent technical requirements; at the same time the comparison with other products (such as those from Japan) demonstrates that the market is very active, since they can exhibit comparably good performances. Finally end users are considering more and more challenging projects, for example oil and gas fields further and further away from the market, crossing harsh environments (low temperatures, presence of permafrost, etc.). This means that products' technical requirements are expected to become more demanding in the near future and, as a consequence, European producers will be forced to maintain a high level of quality and innovation to improve their competitiveness."

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Giuseppe DEMOFONTI (Pr. Coord.)
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Gerhard KNAUF

RFSR-CT-2004-00040 BRIDGEPLEX

Application of duplex stainless steel for welded bridge construction in aggressive environment

Info

Type of Project	Research	Duration (months)	36
Total Budget	1365194 €	Start Date	1/07/2004
EU Contribution	819117 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23595:EN

Final Abstract

Steel bridges are increasingly using complex welded steelwork solutions. Recently, the most widespread construction type has been the orthotropic deck, used to build bridges ranging from a medium-span length (100 m) up to the longest-span suspension bridges (Akashi Kaikyo, Storebaelt East). Recently, many research projects and experimental activities have studied the in-service behaviour of these complex steelworks, all of them concentrating on traditional construction steel grades, i.e. S355. Although the basic duplex mechanical properties are well known, however, it is not enough just to promote this material for huge welded bridge construction — because of the importance of such structures, more specific investigations on structural components typical of bridge structure are needed. In order to learn more, the most critical bridge components have been selected for testing and 29 tonnes of duplex grade EN 1.4462 (UR45NMo) have been produced by Industeel. During fabrication of duplex components, welding procedure specifications have been developed and differences/difficulties arising in fabrication highlighted. The testing activity concerned material characterisation by mechanical and corrosion testing, fatigue tests on several different components also involving full-scale tests, corrosion fatigue on selected critical detail, and static tests on typical elements of steel bridges, i.e. the main longitudinal beams, also produced on a large scale. Finally, an existing bridge (the Verrand viaduct) was used for both final design and life-cycle costs analysis comparing two alternative materials: high strength low alloy S460 and duplex EN1.4462 stainless steel. Experimental and numerical activities performed during the project confirmed that duplex stainless steel satisfies the bridge-design requirements: structural safety and integrity, reliability and durability. Life-cycle costs analysis demonstrated that duplex stainless steel can also be economically attractive when considering whole service-life costs: initial capital expense is recovered after 50 years of service life.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Giuliana ZILLI (Pr. Coord.)
INDUSTEEL CREUSOT SAS	FRANCE	Lionel COUDREUSE
OMBA IMPIANTI & ENGINEERING S.p.A.	ITALIA	Emanuele MAIORANA
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Gerhard SEDLACEK
UNIVERSITE DE LIEGE	BELGIQUE	Carl VROOMEN

Selected Publications

A. Fanica(Industeel Arcelor Mittal Group, Le Creusot, France) E. Maiorana (OMBA Impianti, Torri di Quartesolo, Italy) UNS S32205 for bridge construction: an experience of application. Duplex 2007 International Conference & Expo 18-20 June 2007 Grado, Italy

G. Zilli, F. Fattorini (Centro Sviluppo Materiali, Roma, Italy) E. Maiorana (Omba Impianti, Torri di Quartesolo, Italy) Application of duplex stainless steel for welded bridge construction in aggressive environment. Duplex 2007 International Conference & Expo 18-20 June 2007 Grado, Italy

O. Hechler, M. Feldmann, T. Rauert (RWTH Aachen University, Germany) R. Maquoi (University of Liège, Belgium) G. Zilli (Centro Sviluppo Materiali, Roma, Italy) E. Maiorana (Omba Impianti & Engineering, Italy) Fatigue of welded details made of duplex stainless steel. Duplex 2007 International Conference & Expo 18-20 June 2007 Grado, Italy

O. Hechler, P. Collin. On the use of duplex stainless steels in bridge construction. Proceedings of IABMAS 2008 Bridge maintenance, Safety, Management, Health monitoring and informatics. Editors Hyun-Moo Koh & M. Fragopol. (ISBN 978-0-415-46844-2).

Stefano Sorrentino, Maurizio Fersini, Giuliana Zilli (Centro Sviluppo Materiali S.p.A. – Roma) Comparison between SAW and Laser welding for Duplex stainless steel bridge construction. Workshop of the Italian Institute of Welding, Genova, 25 -26 October 2007 (in Italian)

RFSR-CT-2004-00041 ETIB

Enhanced economy of tubular piles by improved buckling design

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1344409 €	Start Date	1/07/2004
	EU Contribution	806645 €	End Date	30/06/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23851:EN			

Final Abstract The enhanced economy of tubular piles by improved buckling design (ETIB) project focuses on the development of safe buckling design rules specific to embedded tubular piles with a view to enhancing their economic use in growth-oriented major civil engineering applications (quay walls for ports and harbours, cofferdams for deep urban excavations, etc.). The current version of Eurocode 3 requires that buckling is to be addressed in the design of those steel members resulting in a 10-20 % larger wall thickness, without allowing for the beneficial constraining effects provided by the soil into which they are embedded. Further, for a design according to the common shell buckling rules, several extremely conservative assumptions have to be made. Many years of practice, however, have revealed no bad experience with respect to buckling. The reason for the positive difference in the carrying behaviour between tubular piles and the laboratory shells arises from the complexity of the problem far beyond the basic rules of the codes. The ETIB project tackled the specifics of the buckling limit state within the framework of a physical soil structure interaction, boundary conditions and loadings, and geometrical imperfections based on extensive numerical and experimental investigations. As a result, for the case of combiwalls, improved assessment rules based on the different aspects influencing the carrying behaviour in a different way were derived and given as design proposals for improving and extending the existing design codes on shell buckling.

		Country	*Scientific person in charge*
Partners	**UNIVERSITÄT KARLSRUHE**	DEUTSCHLAND	Helmut SAAL (Pr. Coord.)
	ARCELOR	LUXEMBOURG	Alex SCHMITT
	ARCELORMITTAL LIEGE RESEARCH SCRL	BELGIQUE	Richard KERGEN
	RAUTARUUKKI OYJ	FINLAND	Hannu JOKINIEMI
	UNIVERSITE CATHOLIQUE DE LOUVAIN	BELGIQUE	Alain HOLEYMAN

RFSR-CT-2004-00042 INPREST

Integrated pre-fabricated steel technologies for the multi-storey sector

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1444367 €	Start Date	1/07/2004
	EU Contribution	866620 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23860:EN			

Final Abstract Modern steel buildings require a high degree of pre-fabrication and effective integration of key components. The concept of open building systems in steel is developed with a focus on the multi-storey residential sector. This research concentrated on providing 'enabling' or supporting technologies and on basic performance data to assist in the development of these systems. Energy has been channelled into standardising interfaces between structural and other components such as cladding, services and lifts, and on increasing customisation without compromising manufacturing efficiency. Information technology is seen as a major driver, and its role is investigated. The research will lead to the development of new systems involving skeletal, planar and modular components, including supporting design information.

		Country	*Scientific person in charge*
Partners	**RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN**	DEUTSCHLAND	Bernd DÖRING (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Olivier VASSART
	INT. COUNCIL FOR RES. AND INNOVATION IN BUILDING AND CONSTRUCTION-CIB	NEDERLAND	Frits SCHEUBLIN
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Stéphane HERBIN
	RAUTARUUKKI OYJ	FINLAND	Ilkka LEHTINEN
	THE STEEL CONSTRUCTION INSTITUTE LBG	UNITED KINGDOM	Graham K. RAVEN
	TATA STEEL UK LIMITED	UNITED KINGDOM	Colin HARPER

RFSR-CT-2004-00043 NASCENT

New application of steel in inside coating buildings considering design and acoustic criteria

Info

Type of Project	Research	Duration (months)	36
Total Budget	977828 €	Start Date	1/07/2004
EU Contribution	586697 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23620:EN

Final Abstract The purpose of this project was to conduct research into the use of steel for coating in new products and mixed steel features for cosmetic uses in wall and ceiling elements, and to focus on the latest acoustic design criteria. The project partnership has produced specific market surveys on Germany, Spain and Portugal. Since the EU enlarged during the period in question, the partnership also analysed opportunities in new Member States, such as Poland and Romania. The studies concluded that several elements were relevant, and specific tests were planned to address them. It is important to note that some partners improved their acoustic rooms in respect of low frequencies between the submission of the proposal and the actual start of the project, making it unnecessary to move samples between laboratories. The partnership therefore agreed to increase the number of sample tests from 96 to 120 as it would be much more convenient to gather information for model calibration. Even though this was not one of its initial goals, the partnership produced some specific software tools to help people with technical knowledge identify valuable solutions for acoustic performance prediction by considering all the response spectra of elements. Indeed, some software tools were developed to help designers choose materials to fit an expected tonal curve. Finally, specific design rules have been introduced to help technical users with their work, by considering specific and relevant aspects as key for obtaining the right answer, regarding the quality of solutions for customers.

Partners

	Country	*Scientific person in charge*
UNIVERSIDAD DE LA RIOJA	ESPAÑA	Joaquín ORDIERES MERE (Pr. Coord.)
ACERALIA CORPORACION SIDERURGICA S.A.	ESPAÑA	Maria José SANCHEZ
FORSCHUNGS- UND QUALITÄTSZENTRUM ODERBRÜCKE gGmbH	DEUTSCHLAND	Bernd SCHMOLKE
INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Helena GOUVEIA

Patents

P200701627 .- Published as ES2327769 A1 (19.10.2009) http://invenes.oepm.es/InvenesWeb/faces/busquedaExperto.jsp#

P200701628 .- Published as ES2327592 A1 (30.10.2009) http://invenes.oepm.es/InvenesWeb/faces/busquedaExperto.jsp#

Selected Publications

Acoustic design criteria as a relevant factor for architectural projects, Ordieres Meré J.B., Alba Elías F., Pernia Espinoza A., Vergara González E.P. IX International Congress on Project Engineering. 2005. pp 0941-095. http://www.aeipro.com/aplic/tree_congresos/detalle_remository_aeipro.php?file=163

Acoustic assessment of simulation software, Ordieres Meré J. B., Alba Elías F. Best practice Guidelines 2007. 40pp

Software

ACUSIM Acoustic simulator tool allowing to estimate 3D effects and used as specific element to validate the assessment against real case studies. URL: currently it is not maintained and it was discontinued from January 2013

RFSR-CT-2004-00044 Semi-Comp

Plastic member capacity of semi-compact steel sections - a more economic design

Info	Type of Project	Research	Duration (months)	36
	Total Budget	673890 €	Start Date	1/07/2004
	EU Contribution	404334 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23735:EN

Project web page www.stahlbau.tugraz.at/semicompplus

Final Abstract

This final report provides an overview of the work carried out and of the results achieved during a 36-month research period on the topic 'Plastic member capacity of semi-compact steel sections — a more economic design'. The research work covered the investigation of the cross-section and the member buckling resistance of the so-called 'semi-compact' profiles, i.e. the Class 3 sections according to Eurocode 3. Hot-rolled and welded H-section specimens as well as rectangular structural hollow section specimens of the semi-compact range were investigated in order to analyse whether a plastic or partly plastic resistance exists, since profiles in the Class 3 range are limited by its elastic capacity by Eurocode 3 at present. In total, 45 experiments for cross-section resistance (including 10 stub-column tests) and 24 experiments for member buckling resistance were performed. Based on the experimental results, numerical models for further numerical studies were established and verified. Based on shell element models, more than 2 600 parametric finite-element (FE-) simulations were performed. Design models were then developed to describe the elastic-plastic cross-section and member resistances. The numerical results, both on a nominal basis for accuracy studies and on the basis of random parameters for safety evaluation, were used for the statistical evaluations according to the principles of EN 1990 Annex D. The results of the new design model indicated significantly enhanced capacities in the semi-compact range. A clear documentation of the model, with increased cross-section and member buckling resistance for Class 3 sections, including design examples and its benefits, concludes this work. The design proposal has been statistically verified and is ready for future application in the European design standard for steel construction. For clarification it should be stated that plastic member capacity in the semi-compact range is related to increased resistances for the cross-section check and the member buckling check and does not justify plastic moment redistributions within the structure. In this sense the design method is based on elastic internal forces and moments.

		Country	*Scientific person in charge*
Partners	**TECHNISCHE UNIVERSITAET GRAZ**	OESTERREICH	Richard GREINER (Pr. Coord.)
	ARCELORMITTAL LIEGE RESEARCH SCRL	BELGIQUE	Emmanuel BORTOLOTTI
	FELDMANN + WEYNAND GmbH	DEUTSCHLAND	Klaus WEYNAND
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART

Selected Publications

M. Kettler. Elastic?Plastic Cross?Sectional Resistance of Semi?Compact H? and Hollow Sections, PhD thesis, Graz University of Technology, Institute for Steel Structures and Shell Structures, 2008.

A. Lechner, M. Kettler, R. Greiner, H. Unterweger. Verbesserte Bemessungsregeln für Stäbe mit Klasse 3-Querschnitt. Stahlbau 81 (2012), 265-281. DOI 10.1002/stab.201201546.

M. Kettler, R. Greiner. Ein “Overall-Konzept” für die Querschnittstragfähigkeit im elasto-plastischen Bereich. Stahlbau 78 (2009), 742–749. DOI 10.1002/stab.200910089.

Software

SemiComp Member Design Within the SEMI-COMP+ project a design software “Semi-Comp Design” has been developed for cross-section and member design, which is provided as freeware. www.stahlbau.tugraz.at/semicompplus

RFSR-CT-2004-00046 Robustness

Robust structures by joint ductility

Info

Type of Project	Research	Duration (months)	36
Total Budget	986495 €	Start Date	1/07/2004
EU Contribution	591897 €	End Date	30/06/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23611:EN

Final Abstract

In view of recent disasters and their immense economical and human consequences, more and more focus is given not only to the safety of structures — to reduce the risk to people of collapse even under exceptional loading — but to minimising the disastrous results and to enable a quick rebuilding and reuse. One crucial way to achieve this aim is the design of redundant robust structures. Robustness prevents the collapse of the total structure when only parts of the structure are damaged or destroyed. To avoid progressive failure, redundant structures with inherent sufficient ductile behaviour allowing deformations when a local failure occurs have to be built. Redundancy can be achieved by allowing force redistribution within a structural system. Therefore the single sections and joints have to be especially designed and optimised, not necessarily requiring additional fabrication costs. But until now no specific rules for robustness by ductile joints existed. The aim of the present project is to define general requirements for ductile joints as part of a structural system subjected to exceptional unforeseen loading.

Partners

	Country	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Ulrike KUHLMANN (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Toni DEMARCO
FELDMANN + WEYNAND GmbH	DEUTSCHLAND	Klaus WEYNAND
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART
UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Riccardo ZANDONINI

Selected Publications

U.Kuhlmann, J.P. Jaspart, O. Vassart, K. Weynand, R. Zandonini. Robust structures by joint ductility. In: Proceedings of IABSE Symposium Budapest 2006, Vol. 92, 2006

U. Kuhlmann, L. Rölle, J.P. Jaspart, J.F: Demonceau. Robustness - Robust Structures by Joint Ductility. Proceedings of COST C 26 Workshop Prague, 2007

N. Baldassino, R. Zandonini: Experimental Study on the Behaviour of Steel and Concrete Joint Components in Large Displacement Field, Proceedings of the 2AESE 2007-Second International Conference on Advances in Experimental Structural Engineering, Vol. 1, Shanghai, China, 4-6 December, Tongji University, pp. 73-81, 2007.

U. Kuhlmann, L. Rölle. Redundant and Robust Frame Structures by Joint Ductility. COST TU 0601 Workshop Zurich, February 2008

J.F. Demonceau, J.P. Jaspart: Robustness of structures – behaviour of composite joints, International Workshop on Connections in Steel Structures 2008, Chicago, 23-25 June 2008

RFSR-CT-2004-00047 COSIMB

Composite column and wall systems for impact and blast resistance

Info				
	Type of Project	Research	Duration (months)	42
	Total Budget	1294677 €	Start Date	1/07/2004
	EU Contribution	776806 €	End Date	31/12/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23738:EN

Final Abstract This report provides a detailed account of the work carried out within the collaborative European RFCS research project COSIMB (Composite column and wall systems for impact and blast resistance). The research deals with the behaviour and design of composite steel/concrete members under extreme loading conditions. After presenting a brief background on composite members as well as the characteristics of blast and vehicle impact loading on structures, the report describes the experimental, numerical and design studies, conducted within the project, and concludes with suggested design and architectural concepts. The results of 35 static and dynamic impact and blast tests performed on composite members of different column/wall configurations are described in detail. The testing arrangements, specimen details and material properties are presented alongside discussions of the important observations and their implications on design. The test results are used to validate and calibrate analytical and numerical studies of various levels of complexity, including detailed continuum finite element models, finite element fibre models as well as more simplified approaches. The analytical studies are also extended to examine the post-event residual capacity and fire resistance of damaged members, and to assess the interactions that take place between the dynamically-loaded composite member and the surrounding structure through a number of sensitivity and parametric investigations. Based on the experimental and analytical findings, design approaches are proposed at two distinct levels, one for advanced application and another which is more suited to idealised engineering treatments. Overall, this research substantiates the favourable and synergetic capabilities of composite members in resisting extreme loads, and puts forward verified approaches for their application in practice.

Partners		*Country*	*Scientific person in charge*
	HOCHTIEF CONSTRUCTION AG	DEUTSCHLAND	Bernhard HAUKE (Pr. Coord.)
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	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Ahmed ELGHAZOULI
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Gerhard SEDLACEK
	UNIVERSITÄT KARLSRUHE	DEUTSCHLAND	Helmut SAAL

RFSR-CT-2004-00048 SSIF

Stainless steel in fire

Info	Type of Project	Research	Duration (months)	42
	Total Budget	885229 €	Start Date	1/07/2004
	EU Contribution	531137 €	End Date	31/12/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23745:EN

Project web page www.steel-stainless.org/fire

Final Abstract The relatively sparse body of existing data on the behaviour of structural stainless steel at high temperatures suggests that stainless steel performs very well between 600°C and 800°C due to its strength and stiffness retention characteristics. This report summarises the findings of a three-and-a half-year European research project, which studied the behaviour of a range of structural stainless steel solutions subject to fire loading. The project included tests on materials, members and connections, numerical analysis and development of design guidance aligned to the Eurocodes. It aimed to identify structural solutions which give a specified period of fire resistance without any fire protection applied to the surface of the steel. The temperature development in a range of load-bearing and separating elements concepts designed to suppress temperature rise was studied. From a programme of tests and numerical analysis on RHS with slender (class 4) cross-sections, more economic design guidance was derived. Long fire resistance periods were exhibited in fire tests on concrete-filled stainless steel RHS and hybrid stainless-carbon steel composite floor beams. Strength and stiffness retention characteristics for two austenitic grades not previously studied were developed through a programme of transient state tests. The behaviour of external stainless steel columns and stainless steel columns in open car parks subject to realistic fire loads was studied numerically. Tests on welded and bolted connections in fire made it possible to produce guidance for design. An online design facility for predicting the fire resistance of cold-formed stainless steel sections was developed.

		Country	*Scientific person in charge*
Partners	**THE STEEL CONSTRUCTION INSTITUTE LBG**	UNITED KINGDOM	Nancy BADDOO (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Francesco FATTORINI
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Bin ZHAO
	OUTOKUMPU STAINLESS OY	FINLAND	Raimo VIHERMA
	STIFTELSEN SVENSK STALBYGGNADSFORSKNING - STALBYGGNADSINSTITUTET	SVERIGE	Anders OLSSON
	ARCELORMITTAL STAINLESS FRANCE	FRANCE	François CONRAD
	GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER	DEUTSCHLAND	Peter SCHAUMANN
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Ala-Outinen TIINA

Selected Publications B. Uppfeldt , T. Ala Outinen, M. Veljkovic. A design model for stainless steel box columns in fire. Journal of Constructional Steel Research, Volume 64, Issue 11, November 2008, Pages 1294–1301, International Stainless Steel Experts Seminar. http://dx.doi.org/10.1016/j.jcsr.2008.05.003

Software Design software for structural stainless steel Software for designing stainless steel sections as structural members for onshore and offshore construction. Section properties and member resistances in accordance with the Third Edition of the Design Manual for Structural Stainless Steel are calculated. Cold formed, hollow, hot rolled and laser welded sections are included. Fire resistant design included. www.steel-stainless.org/software/

RFSR-CT-2004-00045 SEISRACKS

Storage racks in seismic areas

Info	Type of Project	Research	Duration (months)	30
	Total Budget	768340 €	Start Date	1/12/2004
	EU Contribution	461004 €	End Date	31/05/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23744:EN			

Final Abstract The Seisracks project focuses on the seismic design of pallet racking systems, of the type frequently used in commercial areas open to the public. These structures are made of cold-formed thin-walled open cross-section profiles, with holes and openings to allow mechanical connections between members and rapid reconfiguration. In addition to usual local and global limit states, during an earthquake an additional limit state is represented by the sliding and fall of the pallets. At present in Europe there is no officially accepted design code for racks in seismic areas, but only the 2005 version of FEM10.2.08 (not EN). Beam-to-upright and base-plate connections were tested to characterise their behaviour. Full-scale pushover, pseudo-dynamic and dynamic shaking-table tests were performed for assessment of the actual structural response and ductility, leading to definition of possible Q factor values. Assessment of the static and dynamic friction factor was achieved through full-scale sliding tests considering different types of beams and pallets. A warehouse was continuously monitored for two years, recording accelerations caused by forklifts' accidental impacts on the structure. A numerical model including pallet sliding simulation capability was set up, allowing numerical parametric analysis of racks under seismic loading. The main outcome of the Seisracks project is a revised version of FEM10.2.08, which will lead to a more uniform quality standard in design of racks in seismic areas.

		Country	*Scientific person in charge*
Partners	**ASSOCIAZIONE FRA I COSTRUTTORI IN ACCIAIO ITALIANI**	ITALIA	Irene ROSIN (Pr. Coord.)
	INSTITUTO SUPERIOR TECNICO	PORTUGAL	Luis CALADO
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Panayotis CARYDIS
	POLITECNICO DI MILANO	ITALIA	Carlo Andrea CASTIGLIONI
	UNIVERSITE DE LIEGE	BELGIQUE	André PLUMIER

RFS3-CT-2005-00038 ENCAVI

Stage for the enrichment and calibration of a vibroacoustic model

Info	Type of Project	Accompanying measure (training)	Duration (months)	8
	Total Budget	10500 €	Start Date	1/03/2005
	EU Contribution	10500 €	End Date	31/10/2005
State	Research completed without final report			

Provisional Abstract

The tasks developed by the applicant will be the participation in the testing campaign and the study of non-deterministic methods for the prediction of vibroacoustic phenomena.
Consequently, the calibration (and enrichment with probabilistic techniques) of the numerical model, the participation in a testing campaign and the collaboration with more experienced people in vibroacoustics will be the benefits for the applicant.
Moreover, benefits for host and applicant organisations will be a better development of the testing campaign, a more solid and theoretical based knowledge of vibroacoustic phenomena and a correct interpretation of results which will lead to useful rules of acoustic design for lightweight steel structural
elements.

		Country	*Scientific person in charge*
Partners	**CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT**	FRANCE	Michel VILLOT (Pr. Coord.)
	UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)	ESPAÑA	Jordi POBLET PUIG

RFS2-CT-2005-00035 PROSSUS

Promotion of steel in sustainable and adaptable buildings

Info	Type of Project	Accompanying measure (studies)	Duration (months)	12
	Total Budget	333462 €	Start Date	1/07/2005
	EU Contribution	200078 €	End Date	30/06/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23201:EN			

Final Abstract In the ECSC demonstration project 7215-PP-058 'Steel in residential buildings for sustainable and adaptable construction', a series of five houses and residential buildings were constructed and monitored. This Type 2 project RFS2-CT-2005-00035 had the objective of presenting and disseminating information on the steel construction technologies used in these buildings and the results of the tests, as well as preparing publications on sustainability and building physics, which are seen as key documents in the development of this market. The dissemination project has resulted in a series of six four-page case studies, a 32 page full colour publication on sustainability and a 50 page publication on building physics. The case studies describe projects in Germany, France, Italy, Finland, Sweden and the United Kingdom and present the design concept, construction technology, collected test information and economic data, and the project team and other supporting information. The sustainability guide covers the background to sustainability, steel technologies used in housing and residential buildings, the application and sustainability benefits of steel, and the sustainability assessment of a six-storey residential building. The publication on building physics covers national building regulations for thermal efficiency, heat transmission, hygrothermal properties, air tightness and other key aspects of building performance. The demonstration projects were presented at national seminars organised in the participating countries.

		Country	*Scientific person in charge*
Partners	**THE STEEL CONSTRUCTION INSTITUTE LBG**	UNITED KINGDOM	Graham K. RAVEN (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Giuliana ZILLI
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Philippe BEGUIN
	FORSCHUNGSVEREINIGUNG STAHLANWENDUNG e.V.	DEUTSCHLAND	Gregor NUESSE
	RAUTARUUKKI OYJ	FINLAND	Jyrki KESTI
	STIFTELSEN SVENSK STALBYGGNADSFORSKNING - STALBYGGNADSINSTITUTET	SVERIGE	Anders OLSSON

RFS2-CT-2005-00036 VALCOSS

Valorisation project - structural design of cold worked austenitic stainless steel

Info	Type of Project	Accompanying measure (studies)	Duration (months)	12
	Total Budget	271843 €	Start Date	1/07/2005
	EU Contribution	163107 €	End Date	30/06/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23199:EN

Project web page www.steel-stainless.org/designmanual

Final Abstract When stainless steel is cold worked, it undergoes substantial strain hardening. This leads to a significant strength enhancement, whilst adequate ductility is still retained. The strength enhancement has not generally been taken into account in the practical design of structural members due to the lack of knowledge of the structural behaviour of material in this condition. This valorisation project has disseminated new design recommendations for cold-worked stainless steel from the recently completed ECSC research project Structural design of cold-worked austenitic stainless steel (Contract 7210-PR-318). The principle deliverables of this project were: - The third edition of the Design manual for structural stainless steel - A commentary on the design manual - Design examples - A web-based design facility - Eight seminars across Europe. The third edition of the Design manual for structural stainless steel was published in seven European languages. It is freely available from Euro Inox both in printed form and as a CD (www.euro-inox.org, info@euro-inox.org). The design manual, the commentary, design examples and web software can be accessed and downloaded at: www.steel-stainless.org/designmanual The seminars held in eight European countries were well attended and the discussions that took place confirmed great interest in the design manual. This valorisation project has succeeded in disseminating new design guidance on structural stainless steel to a wide audience of European structural engineers.

Partners		*Country*	*Scientific person in charge*
	THE STEEL CONSTRUCTION INSTITUTE LBG	UNITED KINGDOM	Nancy BADDOO (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Giuliana ZILLI
	UNIVERSITE BLAISE PASCAL - CUST	FRANCE	Jean-Pierre MUZEAU
	EURO INOX	LUXEMBOURG	Thomas PAULY
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	UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)	ESPAÑA	Esther REAL
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Asko TALJA

Selected Publications

Design Manual for Structural Stainless Steel, Third Edition, Euro Inox and The Steel Construction Institute, 2006, Available from www.steel-stainless.org/designmanual

Commentary to the Design Manual for Structural Stainless Steel, Third Edition, Euro Inox and The Steel Construction Institute, 2006, Available from www.steel-stainless.org/designmanual

Software Design software for structural stainless steel Software for designing stainless steel sections as structural members for onshore and offshore construction. Section properties and member resistances in accordance with the Third Edition of the Design Manual for Structural Stainless Steel are calculated. Cold formed, hollow, hot rolled and laser welded sections are included. www.steel-stainless.org/software/

RFS2-CT-2005-00037 LWO+

Large web openings for service integration in composite floors

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	290279 €	Start Date	1/07/2005
	EU Contribution	174167 €	End Date	31/12/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23173:EN			

Final Abstract "The results of the ECSC project LARGE WEB OPENINGS FOR SERVICE INTEGRATION IN COMPOSITE FLOORS have been summarised and made available to practitioners via the following documents: — Report on ""State of the art and special cases of the design of cellular beams"" in English, French, German and Swedish language — Report on ""Improved manufacturing of cellular beams"" in English, French, German and Swedish language — Full guide for the design of steel and composite beams with web openings in English and French language — Short version of the guide for the design of steel and composite beams with web openings drafted in code style in English language. Further on design aids in terms of — tables and graphs for the predesign of steel and composite cellular beams — software for the design of steel and composite beams with one or two web openings have been developed for the use in practice. Electronic versions of all documents and deliverables are available via http://lwo.steel-sci.org."

		Country	*Scientific person in charge*
Partners	**RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN**	DEUTSCHLAND	Christian MÜLLER (Pr. Coord.)
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Alain BUREAU
	LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Bernt JOHANSSON
	ProfilARBED S.A.	LUXEMBOURG	Olivier VASSART
	THE STEEL CONSTRUCTION INSTITUTE LBG	UNITED KINGDOM	Stephen HICKS

RFSR-CT-2005-00039 PLASTOTOUGH

Modern plastic design for steel structures

Info	Type of Project	Research	Duration (months)	42
	Total Budget	710769 €	Start Date	1/07/2005
	EU Contribution	426461 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24227:EN			

Final Abstract

"Plastic design is used to take advantage of stress redistributions due to plastic strains exceeding the yield strain. Steel members that are designed plastically must have sufficient strain capacity in order to plastify at the spots of high stresses before fracture occurs. However, the minimum required strain capacity still cannot be quantified. It must be determined in terms of material properties that relate to the upper shelf toughness behaviour and it must be linked with the strain demand of the member due to the plastic design rules. Thus the project objective is the quantification of an upper shelf toughness criterion to allow safe plastic design of steel structures using modern construction steels. Plastic design is applied in two areas, namely: — for structures subjected to static loads; — for structures subjected to loads varying with time, which may change the direction or magnitudes repetitively, affecting the material resistance. Within this project the solutions for adequate toughness have been developed for both cases, for monotonically loaded structures and for structures subjected to time-varying loads which are developed in particular for structures subjected to seismic actions. Both experimental and numerical studies were carried out to determine the material demand due to existing design rules and the strain capacity using analytical approaches in terms of fracture mechanics and damage mechanics. The results allow for a transfer to other fields such as offshore structures and pressure vessels."

Partners		*Country*	*Scientific person in charge*
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Dirk SCHÄFER (Pr. Coord.)
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Ioannis VAYAS
	PEINER TRÄGER GmbH	DEUTSCHLAND	Marcus LIPPE
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RFSR-CT-2005-00040 INDUCWELD

Induction assisted welding technologies in steel utilisation

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1523500 €	Start Date	1/07/2005
	EU Contribution	914101 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24462:EN			

Final Abstract The project was focused on the improvement of the welding process for high strength steels by integrating an additional induction-based heat treatment step into the welding process. In the major part, metal sheets within a thickness range of 3-17 mm have been welded using different welding technologies: Laser welding, GMA welding, laser-GMA hybrid welding, laser welding combined with submerged arc welding. The main criteria for evaluating the improvement of the welding process were the mechanical properties: hardness, tensile strength, toughness and fatigue behaviour. Another criteria was an increased process speed. In addition to high strength steels, a low cost steel was investigated accounting for a background in the ship building industry. Reliable mechanical properties at increased process speed is a major concern related to welding in this industrial sector. Further, hardenable steels have been investigated, as they naturally involve heat treatment and thus have a high potential for an induction-assisted welding process. The process fundamentals have been investigated in basic experiments for linear weld seams (mostly in butt joint configuration) by different project partners. In addition, theoretic modelling of the induction-assisted welding process was done (FEM simulations). The simulation results were used by the process developers to optimise their welding processes. New welding hardware was developed comprising process specific inductor geometries and integrated process heads for 1- and 2-dimensional welding. Theoretical simulations proved to be a useful tool for optimising the hardware layout. Finally, the knowledge acquired during the basic experiments was used to realise demonstrators of real application cases.

		Country	*Scientific person in charge*
Partners	**LASER ZENTRUM HANNOVER e.V.**	DEUTSCHLAND	Dirk HERZOG (Pr. Coord.)
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	MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	HAROLDO PINTO
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RFSR-CT-2005-00041 INTAB

Economic and durable design of composite bridges with integral abutments

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1477233 €	Start Date	1/07/2005
	EU Contribution	886340 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24224:EN

Project web page http://www.bridgedesign.de

Final Abstract

In the design and construction of bridges, questions of sustainability, maintenance and durability are becoming more and more important for European road administrations, in addition to safety and serviceability issues. Therefore integral abutment bridges are becoming highly attractive to designers, constructors and road administrations, as they tend to be less expensive to build, easier to maintain and more economical to own over their life time. Bearings and joints are main sources of maintenance costs during a lifetime. These costs vanish because the bridges are joint- and bearing-free. However, this very advantage complicates the design compared to conventional bridges in some crucial respects. Combined with the fact that most European countries have only limited experience with integral bridges to date, this leads to a reluctance of road administrations to use this bridge type. Thus the main objective of the project is to experimentally and theoretically investigate the behaviour of critical points of integral abutment bridges. Regarding the soil-structure interaction, recommendations are elaborated based on monitoring results as well as previous research and monitoring campaigns. Conventional HP piles and sheet piles are investigated as a foundation. Furthermore a hinged HP connection is developed to decrease the stresses in the pile system. An investigation of the design and construction of the slab to pavement approach is also carried out to avoid major damages to the structure. Finally the most important information is condensed into the essential features in form of a 'Design guide for composite bridges with integral abutments'.

Partners		*Country*	*Scientific person in charge*
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Daniel PAK (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicoleta POPA
	LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Lennart ELFGREN
	RAMBÖLL SVERIGE AB	SVERIGE	Tore LUNDMARK
	UNIVERSITE DE LIEGE	BELGIQUE	René MAQUOI

Selected Publications See project INTAB+ (RFS2-CT-2009-00019)

RFSR-CT-2005-00042 FATHOMS

Fatigue behaviour of high strength steels welded joints in offshore and marine systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1334134 €	Start Date	1/07/2005
	EU Contribution	800480 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24214:EN			

Final Abstract Recently the technological evolution in structural steels, particularly in the area of offshore and marine applications, points towards an increasing use of high-strength weldable steels with the aim of guaranteeing high-quality/high-strength welded joints for lightweight structures, reducing both weight and cost. The need to develop specific knowledge on the fatigue behaviour of high-grade steel-welded joints, considering the consistent improvement in mechanical properties of consumables and in welding technologies, is becoming a more crucial issue. The FATHOMS project was aimed at improving the knowledge on this matter, contributing to potential upgrades of the design criteria. The activity carried out highlights the conservativeness of the current design standards in force in the offshore area in predicting the fatigue performances of welded joints when high-steel grades, together with improved and innovative welding techniques, are used, in particular for the girth welds on pipes made from one side usually penalised by the codes. The conservativeness of the standards was highlighted both in terms of S-N design curves and in terms of limit values for the accumulated fatigue damage in conditions similar to the in-service ones. The beneficial effect in fatigue performances of the use of high-strength steels, new welding technologies and post-welding treatments was outlined. In particular promising behaviour was shown in terms of fatigue strength of laser hybrid welding technology when applied in the root pass in single-side welds, which allows fatigue performances to be reached that are comparable with double-side good quality welds.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Elisabetta MECOZZI (Pr. Coord.)
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Helena GOUVEIA
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Marion ERDELEN-PEPPLER
	TATA STEEL UK LIMITED	UNITED KINGDOM	M. LARGE
	PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Philip C. PERDIKARIS

RFSR-CT-2006-00028 COSSFIRE

Connections of steel and composite structures under natural fire conditions

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1091421 €	Start Date	1/07/2006
	EU Contribution	654852 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25046:EN			

Final Abstract During the last decade, the fire performance of the joints of steel structures has become a concern with the application of global structural analysis in fire safety engineering. In consequence, the present project is aimed to get firstly, through detailed experimental and numerical investigations, deep knowledge about the fire behaviour of both steel and composite steel and concrete joints under natural fire and structural conditions and to provide then practical design rules as well as simple construction details for joints of steel and composite structures. In order to achieve the above objectives, various fire tests have been carried out within the scope of this project, during which the following features were investigated in detail: • fire performance of key joint components, such as bolt and weld under natural fire conditions, that is both heating and cooling phases. • fire behaviour of the most three common types of joints under natural fire conditions as well as restrained effect. • sfire resistance of connection between edge steel members and composite slab in case of global steel and concrete composite floor systems. In addition, various analytical analysis and numerical studies were conducted on the basis of the above experimental investigation, which have led to the following outstanding results: • stength reduction factors and detailed material models for both bolt and weld under natural fire conditions. • simple design rules for steel and composite joints for fire situation. • economic and efficient construction details for connection between edge steel members and composite slab in case of global steel and concrete composite floor systems. • spractical design guidance for steel and composite joints and connections under fire situation.

		Country	*Scientific person in charge*
Partners	**CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE**	FRANCE	Bin ZHAO (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Giuliana ZILLI
	EFECTIS NEDERLAND B.V.	NEDERLAND	Kees BOTH
	TATA STEEL UK LIMITED	UNITED KINGDOM	Allan R. GRIFFIN
	TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	Joris FELLINGER
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN

RFSR-CT-2006-00029 FIBLAS

Improvement in steel utilisation by recent break-through in high-power fibre laser welding

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1518566 €	Start Date	1/07/2006
	EU Contribution	911139 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25060:EN			

Final Abstract The aim of the Fiblas project was to conduct innovative research to generate knowledge and technology to increase industrial efficiency in major load-bearing welded steel structures, exploiting the specific advantages of high-power fibre laser welding. Different material grades for the use of pipe and shipbuilding applications were joined with fibre laser-based autogenous and hybrid welding processes. Process parameters for welding with high-power fibre lasers were established and welding equipment was developed fordifferent welding tasks. An extensive assessment of samples welded with different processes from ship steel and pipe steel was carried out.The capability of the fibre laser-based welding processes for different applications was demonstrated. This includes T-joint welding for shipbuilding applications, longitudinal welding for pipe making, and girth welding for onshore and offshore pipe laying. Economic benefits for the industrial users arise, for example, from the saving of filler wire, increased welding speed and avoiding SAW processes, all of which contribute to increased productivity. On the technical side, the heat input of the laser-based processes is reduced compared with SAW processes. Therefore, the mechanical properties of theHAZ can be improved and distortion can be reduced. Exploitation has included the transfer of Fiblas results into full-scale industrial applications for welding in shipyards. Thus, the project can be seen as very successful.

		Country	*Scientific person in charge*
Partners	**BIAS - BREMER INSTITUT FÜR ANGEWANDTE STRAHLTECHNIK GMBH**	DEUTSCHLAND	Thomas SEEFELD (Pr. Coord.)
	L'AIR LIQUIDE SA	FRANCE	Francis BRIAND
	CORINTH PIPEWORKS PIPE INDUSTRY AND REAL ESTATE	HELLAS	Athanassios TAZEDAKIS
	GKSS-FORSCHUNGSZENTRUM GEESTHACHT GmbH	DEUTSCHLAND	Mustafa KOÇAK
	INGENIEURTECHNIK UND MASCHINENBAU GMBH	DEUTSCHLAND	Stephanie MÜLLER
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Ali Ihsan KORUK
	SERIMAX SAS	FRANCE	Damien ROLLOT
	SCHWEISSTECH. LEHR- UND VERSUCHSANSTALT MECKLENBURG-VORPOMMERN GmbH	DEUTSCHLAND	Ulf JASNAU
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Steffen-Erich BRUENINGS
	CRANFIELD UNIVERSITY	UNITED KINGDOM	David YAPP
	VIETZ GMBH	DEUTSCHLAND	Markus SCHLOSNECK
	VYSKUMNY USTAV ZVARACSKY - PRIEMYSELNY INSITUT SR	SLOVAKIA	Peter BERNASOVSKY

RFSR-CT-2006-00030 PrECo-Beam

Prefabricated enduring composite beams based on innovative shear transmission

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1396401 €	Start Date	1/07/2006
	EU Contribution	837841 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25321:EN			

Final Abstract Composite structures are gaining in importance due to the economic and versatile application. A new form of shear transmission — the composite dowel — permits composite girders without an upper steel flange and with enduring shear connection. The composite dowel is produced by cutting a rolled beam with a determined cutting-line into two parts. Due to the high degree of automation and of prefabrication shorter construction times and less amount of work are possible. However, few experiences with continuous shear connectors have been gained so far. In the frame of the project 'Prefabricated Enduring Composite Beams based on Innovative Shear Transmission' the economic efficiency of these composite girders — Preco-Beams — is evaluated. The bearing behaviour is analysed by Finite Element Analysis on the one hand and wide-ranging test series concerning static and cyclic bearing behaviour as well as the resistance to fire on the other hand. The results are composed in a design guide containing design rules for composite dowels in girders under bending loads in accordance with the Eurocode. It includes recommendations for the performance of Preco-Beams concerning geometry, reinforcement and fire resistance. Several applications in practice are investigated and some pilot projects are realised which leads to first references in practice.

		Country	*Scientific person in charge*
Partners	**SSF INGENIEURE AG**	DEUTSCHLAND	Günter SEIDL (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicoleta POPA
	RAMBÖLL SVERIGE AB	SVERIGE	Peter COLLIN
	SERVICE D'ETUDES SUR LES TRANSPORTS, LES ROUTES ET LEURS AMENAGEMENTS	FRANCE	Jacques BERTHELLEMY
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN
	UNIVERSITÄT DER BUNDESWEHR MÜNCHEN	DEUTSCHLAND	Sascha BURGER
	POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Wojciech LORENC

RFSR-CT-2006-00031 HISTWIN

High-strength steel tower for wind turbines

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1393722 €	Start Date	1/07/2006
	EU Contribution	836234 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25127:EN			

Final Abstract Innovative solutions for assembling joints of a tubular tower for wind turbines were studied and the project provides a background for design. This solution is simpler to produce and 80 % less expensive than traditional flange connection. Our feasibility study at the production plant indicates that the towers would be easy to assemble in situ. In addition to the direct cost savings due to the technical simplicity of the solution, the higher fatigue endurance than that of the flange connection is experimentally established. Further reduction of costs due to optimal use of higher-strength steel grades, especially in the bottom segments of the tower where the stiffening of the door opening is costly, is shown in the report. The total reduction of the costs for tower is estimated at about 10–15 % compared to the traditional tower. The project objectives are achieved in following sequences. • Experimental activities of the friction connection: small-scale tests to establish resistance of the friction connection for a variety of faying surfaces and bolt types, accompanying testing to ensure realistic input data for FEA, long-term testing to establish loss of pretension forces during the lifetime and fatigue tests.• Bending test of the friction and flange connection in a down-scaled tower. • Feasibility of production of the tower segments in the laboratory and at the production plant. • Monitoring of the existing tower to access a stress variation during the operation. • FEA analysis of experimental results and a complete case study of the monitored tower. Numerical examples for design of the friction connection are given for the sake of illustration and to encourage use of the new connection.

		Country	*Scientific person in charge*
Partners	**LULEÅ UNIVERSITY OF TECHNOLOGY**	SVERIGE	Milan VELJKOVIC (Pr. Coord.)
	ARTISTOTLE UNIVERSITY OF THESSALONIKI	HELLAS	Charalampos BANIOTOPOULOS
	GERMANISCHER LLOYD INDUSTRIAL SERVICES GmbH	DEUTSCHLAND	Torsten FABER
	REPOWER PORTUGAL - SISTEMAS EÓLICOS SA	PORTUGAL	António PONTES
	RAUTARUUKKI OYJ	FINLAND	Juha NUUTINEN
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
	UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA

RFSR-CT-2006-00032 DETAILS

Design for optimal life cycle costs (LCC) of high speed railway bridges by enhanced monitoring systems

Info

Type of Project	Research	Duration (months)	36
Total Budget	2633572 €	Start Date	1/07/2006
EU Contribution	1580142 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25075:EN

Final Abstract

"Steel-concrete composite solutions have been more and more exploited in the new high speed lines of European railway networks. The adoption of new steel concrete composite solutions has been favoured for a number of reasons: the greater possibility and savings given by the high elastic limits reached by thermo-mechanically controlled rolling process; the use of very thick steel plates; the advanced numerical methods and code design approaches; the reduction of maintenance costs by using weathering steels and new paint products; the great increase in transport and assembling capacity that allowed the reduction of 'on site' works; the improvements in welding technologies with the introduction of new methods. Nevertheless these new design solutions, introduced during a period of quick expansion of railway networks, amplified open problems related to dynamic effects and interaction phenomena, fatigue loadings, structural modelling, fatigue life and exercise conditions. The experimental and theoretical analyses performed in the Details project permitted the investigation of some of the uncertainties actually affecting design and management of railway composite bridges, focusing research activities on the investigation of resonance phenomena, train-bridge interaction effects, global and local dynamic loads, fatigue behaviour, modelling techniques, traffic spectra and exercise conditions. To this end, an innovative global approach for the structural assessment was developed and calibrated on suitable case studies, representative of steel-concrete composite solutions currently adopted in European high-speed railway lines. Results permitted the clarification of many of the aforementioned open problems, establishing important guidelines for the correct assessment of composite bridges"

Partners

	Country	*Scientific person in charge*
ILVA S.P.A.	ITALIA	Aurelio BRACONI (Pr. Coord.)
AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG	DEUTSCHLAND	Falko SCHRÖTER
BAUHAUS-UNIVERSITÄT WEIMAR	DEUTSCHLAND	Christian BUCHER
KATHOLIEKE UNIVERSITEIT LEUVEN	BELGIQUE	Guido DE ROECK
LMS INTERNATIONAL NV	BELGIQUE	Bart PEETERS
METHODES INGENIERIE OUVRAGES	FRANCE	Wasoodev HOORPAH
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Benno HOFFMEISTER
UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE
VCE HOLDING GMBH	OESTERREICH	Helmut WENZEL

Selected Publications

Giuseppe Chellini, Francesco Vittorio Lippi & Walter Salvatore (2012): A multidisciplinary approach for fatigue assessment of a steel–concrete high-speed railway bridge on Sesia river, Structure and Infrastructure Engineering: Maintenance, Management, Life-Cycle Design and Performance, DOI:10.1080/15732479.2012.719527 URL http://dx.doi.org/10.1080/15732479.2012.719527

Chellini, G., Nardini, L., & Salvatore, W. (2011). Dynamical identification and modelling of steel–concrete composite high-speed railway bridges. Structure and Infrastructure Engineering, 7(11), 823–841. DOI: 10.1080/15732470903017240 URL http://dx.doi.org/10.1080/15732470903017240

K. Liu, E. Reynders, G. De Roeck, and G. Lombaert. Experimental and numerical analysis of a composite bridge for high speed trains. Journal of Sound and Vibration, 320(1-2):201-220, 2009.

W.W. Guo, H. Xia, G. De Roeck, and K. Liu. Integral model for train-track-bridge interaction on the Sesia viaduct: dynamic simulation and critical assessment. Computers and Structures, 112-113:205-216, 2012.

H. Zhou, K. Liu, G. Shi, Y.Q. Wang, Y.J. Shi, G. De Roeck. Fatigue assessment of a composite railway bridge for high speed trains. Part I:Modeling and fatigue critical details. Journal of Constructional Steel Researc, 82, 234–245, 2013.

RFS2-CT-2007-00028 WiSH

Workpack design for steel house

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	456929 €	Start Date	1/06/2007
	EU Contribution	274158 €	End Date	30/11/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24220:EN			

Final Abstract This report provides an overview of the work carried out over an 18-month project on the topic of a 'Work pack design for the steel house' (WiSH). The gap between the use of light steel framing in Europe (less than 1 %) compared to America (20 %) or Japan (15 %) is partly due to the lack of common tools and awareness of benefits of light steel construction in the building industry. The aim of the WiSH project is to increase the use of light steel framing in housing by a new fully validated comprehensive and user-friendly design package, initially called the 'prescriptive method' and today the WiSH method. The WiSH method is an easy-to-use design tool for low-rise cold-formed steel buildings such as single family houses or office buildings having a basic ground and first floor with an attic. It is based on the Eurocodes and addressed to architects, builders and design offices. The WISH method consists of: — a handbook with a set of clear conception rules for design, — an easy-to-use online tool for calculation based on Eurocodes, — a library of construction details. The objective of this project was the promotion and dissemination of the design package starting with Belgium, France and Spain through the means of workshops, training sessions and IT-based communication.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL LIEGE RESEARCH SCRL**	BELGIQUE	Chistine ETZENBACH (Pr. Coord.)
	CENTRE SCIENTIFIQUE ET TECHNIQUE DU BATIMENT	FRANCE	Emmanuel DAVID
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Patrick LE CHAFFOTEC
	EUROPEAN LIGHT STEEL CONSTRUCTION ASSOCIATION	BELGIQUE	Natividad PASTOR TORRENTE
	UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)	ESPAÑA	Antonio HUERTA

RFS2-CT-2007-00029 EUROBUILD+

Dissemination of EUROBUILD in steel

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	495333 €	Start Date	1/07/2007
	EU Contribution	297200 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24215:EN

Project web page www.eurobuildinsteel.com

Final Abstract

It is recognised that 'Eurobuild in steel' was an important project because it was concerned with the next generation of buildings that respond to various well-defined trends. Steel technologies lead to benefits at a social and sustainability level, as they are fast to construct, highly pre-fabricated, flexible and adaptable in use, have a long life and are recyclable. These advantages have been explored in the best practice guidance and in the case studies, and have been covered by the content of the national seminars. The documents prepared in the framework of the project represents the state of the art of best European building practice while representing different building systems that are used throughout Europe as well as some national best practices. At first it can be used to promote economic and most suitable systems for a given building type. Some additional systems that are for the time being only used on a national market could be promoted in other European countries as well. Architects and designers not familiar with steel and composite construction will be informed about the various steel solutions that exist for each sector. The case studies included present national, realised projects, reflecting best building practice, while highlighting the advantages of each of the given structures. It could be seen as complementary information to the best practice documents while showing buildings of excellence that have been realised in different European countries.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicoleta POPA (Pr. Coord.)
BOUWEN MET STAAL	NEDERLAND	Mic BARENDZS
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Philippe BEGUIN
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jose Antonio CHICA
STIFTELSEN SVENSK STALBYGGNADSFORSKNING - STALBYGGNADSINSTITUTET	SVERIGE	Joakim WIDMAN
THE STEEL CONSTRUCTION INSTITUTE LBG	UNITED KINGDOM	R. Mark LAWSON
TECHNISCHE UNIVERSITÄT DORTMUND	DEUTSCHLAND	Dieter UNGERMANN

Selected Publications

Best Practice in Steel Construction - Commercial Buildings. URL http://www.arcelormittal.com/sections/fileadmin/redaction/4-Library/2-Steel_research_reports/4-Best_practice/Eurobuild/Commercial_EN_lowres.pdf

Best Practice in Steel Construction - Industrial Buildings. URL http://www.arcelormittal.com/sections/fileadmin/redaction/4-Library/2-Steel_research_reports/4-Best_practice/Eurobuild/Industrial_EN_Lowres.pdf

Best Practice in Steel Construction - Residential Buildings. URL http://www.arcelormittal.com/sections/fileadmin/redaction/4-Library/2-Steel_research_reports/4-Best_practice/Eurobuild/Residential_EN_Lowres.pdf

RFS2-CT-2007-00030 DIFISEK+

Dissemination of structural fire safety engineering knowledge throughout Europe

Info

Type of Project	Accompanying measure (studies)	Duration (months)	18
Total Budget	722149 €	Start Date	1/07/2007
EU Contribution	433289 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24223:EN

Project web page www.difisek.eu

Final Abstract

The broad technical objective of this project is to disseminate effectively Structural Fire Safety Engineering Knowledge gained in numerous ECSC funded projects during the last about 20 years into practical use as widely as possible in various countries in various languages. This project is a second phase of DIFISEK that covered some European countries (GE, FR, Fl, LU, NL and SP) and will now cover the major European countries. The objective is to update the material for fire design prepared in the first project while adding National Annexes of each country. All data will be translated and seminars will be organised in the following countries, Austria, Belgium, Czech Republic, Estonia, France, Germany, Greece, Hungary, Italy, Lithuania, Poland, Portugal, Romania, Slovenia, Spain, Sweden and the United Kingdom. Together with the seminars that have been held in the frame of the DIFISEK project, the major countries of EU25 are covered. In front of the seminars the new partners will be trained in order to be able to disseminate through the seminars the fire safety engineering (FSE) tools according to the latest Eurocodes. In parallel to the seminars each partner will select 1 or 2 design offices in each country, which will be trained more in detail regarding the use of FSE tools. For this aim Work-Shops will be organised during which some selected fire design software will be educated. The drafting of NA has well progressed and show that most of the countries strongly derivates from the EN versions of the Eurocodes. Another novelty is that besides presenting the FSE concepts during seminars, designers will realise an interactive training in order to be able to apply fire engineering in practice after the workshop.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Olivier VASSART (Pr. Coord.)
ARTISTOTLE UNIVERSITY OF THESSALONIKI	HELLAS	Charalampos BANIOTOPOULOS
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Bin ZHAO
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jose Antonio CHICA
STIFTELSEN SVENSK STALBYGGNADSFORSKNING - STALBYGGNADSINSTITUTET	SVERIGE	Björn UPPFELDT
STRUCTURA ENGINEERING SRL	ITALIA	Sandro PUSTORINO
TALLINNA TEHNIKAULIKOOL*TALLINN UNIVERSITY OF TECHNOLOGY	ESTONIA	Kalju LOORITS
UNIVERSIDADE DE AVEIRO	PORTUGAL	Paulo VILA REAL
GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER	DEUTSCHLAND	Peter SCHAUMANN
UNIVERZA V LJUBLJANI	SLOVENIJA	Darko BEG
CITY UNIVERSITY	UNITED KINGDOM	Kuldeep VIRDI
MISKOLCI EGYETEM*UNIVERSITY OF MISKOLC	HUNGARY	Karoly JARMAI
POLITECHNIKA POZNANSKA*POZNAN UNIVERSITY OF TECHNOLOGY	POLAND	Maciej SZUMIGALA
CESKE VYSOKE UCENI TECHNICKE V PRAZE*CZECH TECHNICAL UNIV. IN PRAGUE	CZECH REPUBLIC	Frantisek WALD
UNIVERSITATEA POLITEHNICA DIN TIMISOARA	ROMANIA	Raul Dan ZAHARIA
TECHNISCHE UNIVERSITAET WIEN	OESTERREICH	Ulrich SCHNEIDER
VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS	LITHUANIA	Audronis Kazimieras KVEDARAS

Selected Publications

Guidelines on thermal and mechanical action : Indication of fire scenarios : Nominal fire, parametric temperature time curve, zone models, CFD, mechanical actions in the fire situation. Available from http://www.difisek.eu

Guidelines on thermal response : Indication of fire scenarios : Thermal conductivity, shadow effect, thermal material properties of steel and concrete, Natural fire safety concept. Available from http://www.difisek.eu

Guidelines on mechanical response : Mechanical material properties of steel and concrete, member verification, analysis of entire structure, constructional details, characteristics of natural fire. Available from http://www.difisek.eu

Handbooks on worked example : Worked examples for fire scenarios, heating of members, member verification. Available from http://www.difisek.eu

Software

Handbooks on complete buildings : Completed Buildings with special regard on the fire safety concept. Available from http://www.difisek.eu

Software for fire design Free available software, description and evaluation for different field of application http://www.difisek.eu

RFS2-CT-2007-00031 COMBRI+

Valorisation of knowledge for competitive steel and composite bridges

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	408085 €	Start Date	1/07/2007
	EU Contribution	244851 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24175:EN

Project web page http://www.uni-stuttgart.de/ke/forschung/COMBRIplus/index.html

Final Abstract

Bridges are an integral part of the worldwide traffic infrastructure and long-span bridges especially contribute to mobility and economy of time in travelling. Improvements of the steel-plated cross-sections of steel and composite bridge structures help to enhance the competitiveness of such bridges. Herein the aims are the valorisation and dissemination of the knowledge and results which have been acquired within the preceding RFCS research project 'Competitive steel and composite bridges by improved steel plated structures — Combri' for practitioners with regard to plate buckling verifications. The outcome is the Combri design manual consisting of two parts which provide clearly arranged and concise documents for daily use. Part I 'Application of Eurocode rules' covers two composite bridge structures — a twin-girder and a box-girder bridge — on the basis of worked examples for which the knowledge is written down in a descriptive manner and references are given to current Eurocode rules. Part II 'State-of-the-art and conceptual design of steel and composite bridges' presents the current practice in several European countries and common bridge types as well as unusual bridges for special purposes or development projects. Improvements which can be provided to the design of steel and composite bridges are discussed and the possibilities and restrictions given by the current Eurocode rules are highlighted. In this report, proposals are also formulated to implement the newly gained state-of-the-art knowledge into standardisation via nationally determined parameters (NDP), non-contradictory complementary information (NCCI) and suggestions for the next revision of the Eurocodes.

Partners

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Selected Publications

Kuhlmann, U. et al.: COMBRI Design Manual Part I. RFCS-Project COMBRI+, 2008. http://www.uni-stuttgart.de/ke/forschung/COMBRIplus/COMBRI_Design_Manual_Part_I_English.pdf

Kuhlmann, U. et al.: COMBRI Design Manual Part II. RFCS-Project COMBRI+, 2008. http://www.uni-stuttgart.de/ke/forschung/COMBRIplus/COMBRI_Design_Manual_Part_II_English.pdf

Kuhlmann, U., Zizza, A., Braun, B. and Degée, H. (2011), New chances and developments of Eurocode 3 Part 1.5 – Bridge design aspects. Steel Construction, 4: 224–231. DOI: 10.1002/stco.201110030

Software

EBPlate EBPlate is a piece of software with a partial funding of the European Research Fund for Coal and Steel (RFCS). It assesses the critical stresses associated to the elastic buckling of plates loaded in their plan. The scope of the program is the following: - Plates : Rectangular plate with uniform thickness, - Isotropic or orthotropic behaviour. - Edges : Plate supported on its four edges for the out-of-plane direction (no free edge). Three possible conditions for the rotation of the edges : free rotation, fixed edges or elastic restraint (defined by flexural and torsional stiffnesses). - Stiffening : Possible definition of several stiffeners in both longitudinal and transverse directions of the plate, with identical or different properties. Axial, flexural and torsional rigidities of stiffeners are accounted for. 5 predefined types of stiffener cross-sections, which allow a direct definition from the dimensions. Possible smearing of identical and regularly spaced stiffeners (orthotropic properties of the plate). Specific treatment of stiffener with closed cross-section, for example trapezoidal sections. www.cticm.com

RFS2-CT-2007-00032 FS+

Fire safety of industrial hall - valorisation project

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	352181 €	Start Date	1/07/2007
	EU Contribution	211308 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24222:EN

Final Abstract New fire safety regulations for single-storey buildings have appeared in several countries (Belgium, Spain and France) that could significantly reduce the application of steel in this type of building. In order to provide strong technical arguments and solutions to avoid the introduction of excessive fire resistance requirements in the single-storey field throughout Europe, an ECSC research project 'Fire safety of industrial halls and low-rise buildings' has been carried out, with completion in 2007. The project clearly demonstrated that a steel structure, if designed appropriately, fulfils the safety requirements in case of fire in terms of 'non-progressive collapse' and 'non-dangerous failure type'. On the basis of a series of parametric studies, several simple design rules and some key construction details have been proposed in order to help engineers to design safe steel structures for single-storey industrial buildings. Dissemination of these results was an important aim of the project. Therefore the following actions have been taken. - The simple design rules and construction details worked out for single-storey industrial buildings have all been summarised in a design guide. - A background document has been created in order to give more detailed information from previous research, provide a summary of several European national requirements in fire regulation and include a survey of real fire cases. - User-friendly 'LUCA' software has been developed for more efficient application of the design guide. - Technical seminars have been organised in order to communicate all the abovementioned design tools to engineers in several European countries Additionally, a simplified method to evaluate heat flux depending on the distance from the façade is reported on in this project. The method has been developed within a French national project, and includes large number of real scale fire tests in order to validate the methodology.

		Country	*Scientific person in charge*
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Selected Publications Fire Safety of Industrial Halls – Design Guide and Background Document (EN/FR/ES). URL http://www.arcelormittal.com/sections/library/steel-research-reports/fire-resistance.html, http://www.infosteel.be/fr/fsPlusNA.php, http://www.infosteel.be/nl/fsPlusNA.php

Software LUCA "LUCA" is software accompanying a design guide for industrial halls in fire conditions. This tool calculates displacements and additional horizontal forces that appear in industrial halls during fire enabling the engineers to consider their effect in the design in order to avoid collapse or risk of human life. Software was developed within RFCS project RFS2-CR-2007-00032. http://www.arcelormittal.com/sections/download-center/design-software/fire-calculations.html

RFS2-CT-2007-00033 HiVoSS

Human induced vibration of steel structures

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	369384 €	Start Date	1/07/2007
	EU Contribution	221630 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24183:EN			

Final Abstract European guidelines for vibration design have not previously been available. Two European projects investigated the effects of human-induced vibration and guidelines have been drafted from this research. This project aims to disseminate the knowledge gained in the two European research projects, which both dealt with the human-induced vibration of steel structures. This design problem becomes more relevant as the slenderness of structures increases, due to the increased use of high-strength steels. The conclusions of the previous research projects (draft guidelines for vibration design of floors and footbridges) have been refurbished and accompanying background documents for vibration design have been elaborated. The resulting guidelines are the first European guidance for the vibration design of structures. The guideline and background documents have been translated into different languages and published on a project web page (www.stb.rwth-aachen.de/projekte/2007/HIVOSS/download.php) that may be easily found by an Internet search for 'Hivoss'. At this site the guideline and background documents can be downloaded as a free PDF. This download page has received a lot of interest, resulting in 1 900 downloads of the footbridge guideline and 1 000 downloads of the floor guideline up to 30 March 2009. In addition to the documents, presentations and seminars were arranged to increase the knowledge about vibration and to introduce the guidelines. These seminars were attended by designers, consulting engineers and authorities. The guidelines have also been presented to the relevant CEN bodies to be considered for implementation in design codes.

Partners		*Country*	*Scientific person in charge*
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RFSR-CT-2007-00035 JOINTEC

Innovative and competitive new joining technology for steel pipes using adhesive bonding

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1548637 €	Start Date	1/07/2007
	EU Contribution	929183 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25991:EN			

Final Abstract The aim of the JoinTec project was the development of a new joining technology for steel pipes using adhesive bonding. To reach this aim, an adhesive was developed, which meets the requirements in pipe bonding concerning strength and processability. A joint geometry was developed, which can be used easily on construction sites and which is tolerant against misalignments resulting from processing. Basing on this geometry, improvements have been developed to advance the strength of bonded pipe joints and the behaviour under corrosive media. A surface pre-treatment was chosen, which preserves the adherent from contamination and corrosion and which enhances the adhesion of the adhesive on the adherent. The developed joining method was enlarged successfully to be able to join pipeline pipes with diameters of 168.3 mm and 508 mm. A method for non-destructive testing could be developed, which can detect voids in the adhesive layer and adhesion problems. Destructive tests show that the strength of the adhesive joints reaches the yield strength of the pipe materials. Burst pressure tests qualified pipe bonding for low pressure applications. Cost comparison shows that adhesive pipe bonding can nearly compete with Manual Metal Arc Welding when small diameter pipes are used. When compared with automated welding processes, adhesive bonding will not be able to compete with welding. Research work done shows that main applications of adhesively bonded steel pipelines, which can be set into reality in near future, are water transport and applications in the field of low pressure gas transportation.

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RFSR-CT-2007-00036 INNOGLAST

Development of innovative steel-glass-structures in respect to structural and architectural design

Info

Type of Project	Research	Duration (months)	42
Total Budget	881196 €	Start Date	1/07/2007
EU Contribution	528717 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25316:EN

Project web page http://www.stb.rwth-aachen.de/projekte/2007/INNOGLAST/INNOGLAST.

Final Abstract

The Innoglast project addresses the development of new and innovative steel-glasstructures. Hybrid steel-glass beams, comprising of steel flanges and a glass web, and steel-supported glazing facade systems for buildings were considered. The solutions proposed are based on utilising adhesive connections to obtain the optimal structural interaction between steel and glass. For hybrid steel-glass beams, analytical design procedures have been developed which are verified by experimental and numerical studies. These design procedures have been simplified, presenting accurate analytical calculations which can be used in engineering practices. These analytical tools enable safe and economical designs to be prepared when estimating the bearing behaviour of hybrid steel-glass structures with semi-rigid shear connections, bonded together by polymer adhesives. For steel-supported glazing facade structures, an analytical model has been developed. This model enables the inherent in-plane stiffness of steelsupported glass facade panels to be calculated, and to be used in providing vertical bracing to multi-storey buildings. The model, which is based on results obtained from physical tests and finite element modelling, enables the horizontal forces acting on the building from wind loading and sway effects to be apportioned between the glazing facade and the steel vertical bracing, thereby potentially reducing the size of steel bracing members that form part of the overall building frame. This report summarises theoretical investigations, background testing and numerical modelling that have been performed and presents design guidance which can be used for the design of hybrid glass beams and steel-supported glass facades.

Partners

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Selected Publications

Ungermann, Dieter, Preckwinkel, Eva. Structural behavior of hybrid steel-glass beams. Feldmann M., Abeln B., Baitinger M. Analysis of bonded hybrid steel-glass-beams by small scale tests. Experimental and Numerical Analysis of the Glued Steel-Glass Joint. Proceedings of the Conference on Architectural and Structural Applications of Glass (Challenging Glass 2), Delft, Netherlands, May 2010.

Netusil Michal, Eliasova Martina: Investigation and modeling of the glued steel-glass connection used in hybrid beam. Proceeding of the fourth international conference “Advances and Trends in Structural Engineering, Mechanics and Computation”, Cape Town, South Africa, 6-8.9.2010, ISBN 978-0-415-58472-2

Abeln B., Preckwinkel E. Entwicklung hybrider Stahl-Glas-Träger (Development of hybrid steel-glass beams). Stahlbau 80 (2011), Issue 4. DOI 10.1002/stab.201101410.

Feldmann M., Abeln B., Preckwinkel E.: Characterization of Adhesive Joints for Hybrid Steel-Glass Beams by Means of Simplified Small Scale Tests. In: Journal of ASTM International, 1 (2012). DOI 10.1520/JAI104079.

RFSR-CT-2007-00037 ESE

Economics of steel framed buildings in Europe

Info				
Type of Project	Research	Duration (months)	36
Total Budget	645282 €	Start Date	1/07/2007
EU Contribution	387169 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25124:EN

Final Abstract The introduction of the Eurocodes has provided designers with a wide range of approaches for the design of steel-framed buildings. However, information on the costbenefits of steel solutions has been lacking. This report summarises the work and output from a 3-year European project to develop software and information to provide designers with the tools to obtain budget costs of common types of residential, commercial and industrial buildings and to help them approach the design in such a way as to achieve an economic outcome.The project has delivered a cost tool (ACE) which is available online to architects, engineers and procurers of buildings to calculate the cost of preliminary schemes. The cost tool is supported by detailed advice for structural arrangements and floor systems so that an economic strategy can be adopted for design. An exemplar building in each category was identified as part of the project, and their costs are fully documented in the report. They were used to test the tool and assist in its development. All this informationis made available online to be used as supporting documentation and demonstration examples. This report summarises the background work in developing the cost tool, including the identification of the parameters that affect building costs and the development of the costing methodology. The necessary component prices and rates were obtained for materials, labour and transport, etc. for several countries in Europe, and these are summarisedin the report and incorporated in the cost tool. They can be updated in the software by the user.

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Selected Publications

Strategies for steel framed buildings in Europe. http://www.arcelormittal.com/sections/fileadmin/redaction/4-Library/2-Steel_research_reports/1-Steel_structures_EC/ESE/ESE_Strategies_Report_EN.pdf

Exemplar buildings (case studies). http://www.arcelormittal.com/sections/fileadmin/redaction/4-Library/2-Steel_research_reports/1-Steel_structures_EC/ESE/ACE_Exemplar_buildings_EN.pdf

Software manual. http://www.arcelormittal.com/sections/fileadmin/redaction/4-Library/2-Steel_research_reports/1-Steel_structures_EC/ESE/ACE_Getting_Started_EN.pdf

Software

ACE Software (Cost Estimation for Steel Structures). http://www.arcelormittal.com/sections/download-center/design-software/cost-estimator.html

RFSR-CT-2007-00038 PRECASTEEL

Prefabricated steel structures for low-rise buildings in seismic areas

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2026994 €	Start Date	1/07/2007
	EU Contribution	1216196 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25871:EN			

Final Abstract Low-rise buildings are used for industrial and commercial activities. Most of these buildings are built by prefabricated-concrete elements characterised by low efficiency of connections and a lower ductility performance when subjected to earthquake loading. The proposal aim is defining prefabricated steel solutions for single-storey and low-rise buildings in earthquake-prone areas for industrial and commercial activities. The selection of structural solutions is performed via statistical analyses in different European countries about solutions requested by the market. Industrial and commercial solutions are optimised in terms of structural performance and of construction costs and two of those (technologically advance and high-performing) are experimentally tested. The solution selected for commercial activities is a dissipative device working in series with prefabricated RC-Wall and pendulum steel-structure. The solution selected for industrial activities is a warehousing system using cold-formed profiles acting compositely with ribbed steel sheeting as girder web.

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RFSR-CT-2007-00039 OPUS

Optimizing the seismic performance of steel and steel-concrete structures by standardizing material quality control

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1394388 €	Start Date	1/07/2007
	EU Contribution	836634 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25893:EN			

Final Abstract "Despite modern seismic standards, like Eurocode 8, admit ductile design of steel and composite structures, current European production standards do not provide adequate limitations on steel mechanical properties limiting free application of such approach. Additional safety factors and design checks, aiming to guarantee optimal plastic hinges' location, must be foreseen, reducing practical applicability and possible advantages of seismic ductile design. The proposal investigated the influence of material scattering on structural performance of a set of case studies designed according to Eurocodes. These structures were probabilistically analysed and used as applicative case studies in order to quantify: ? the benefit of introducing upper limits on yielding stress —Re,H (fy) — at the production plant. ? the effective contribution of ?OVfactor in the capacity design formula. ? the effectiveness of EN1998-1-1 seismic design procedure. ? the assessment of the harmonisation level between production and structural standard. These analyses were performed adopting a Monte Carlo simulation technique based on the following parts: ? materials' properties probabilistic model able to represent actual scattering of European steel production. ? executive protocol for a profitable application of incremental dynamic analysis technique on case studies; ? probabilistic procedure for analysing all results obtained from IDA simulations. More than 106 of non-linear dynamic analyses were carried out during the project. Moreover, the proposal defined preliminary guidelines for the planning of a future harmonisation between structural standards and production standards able to maintain actual high safety levels of steel and steel-concrete structures against seismic actions."

Partners	*Country*	*Scientific person in charge*
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RFSR-CT-2007-00040 OPTISTRAIGHT

Optimisation and improvement of the flame straightening process

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1108870 €	Start Date	1/07/2007
	EU Contribution	665322 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25120:EN			

Final Abstract Flame straightening is a manufacturing process for achieving geometry of elements and members made up of structural steel. The technical background on flame straightening in the workshops of steel constructors is often based only on empirical knowledge, if it exists at all. As a consequence, the straightening of steel construction elements to achieve the required geometrical shape absorbs a large part of the manufacturing costs. This is due to uncertainty about the correct flame straightening process and the lack of background knowledge on its effects. Even though in scientific circles there is some knowledge on the mechanisms of flame straightening for different temperatures, holding times and steel grades, the knowledge is scattered, not well documented and has not been transferred to complex steel structures, sections, stiffness and real (extended) geometries. Also, application techniques, flame straightening procedures and an insight parameter clarification in particular for high strength steels do not exist at all. This report presents the results of the European research project Optistraight. Through experimental, numerical and analytical investigations, the mechanisms of different flame straightening processes have been clarified. Together with the available, but scattered, knowledge on this fabrication process the results give an in-depth view of the flame straightening process. Based upon this knowledge, prediction means have been developed to estimate the straightening result beforehand and to avoid expensive 'trial-and-error' tests, detrimental impacts on the material or excessive energy inputs.

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RFSR-CT-2007-00041 LINESPEC

Special components and strain based requirements for high strength high pressure pipeline applications

Info

Type of Project	Research	Duration (months)	36
Total Budget	2174118 €	Start Date	1/07/2007
EU Contribution	1304471 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25363:EN

Final Abstract

"The project general objectives are the development of new high performance pipe components and specific technical know-how about the in-service behaviour of material for the reliable design of ultra high grade (? X100, YS ? 690 MPa) large diameter gas pipelines to work at pressures at or above 15 MPa. At the end of this project 'new tubular products' from the European Steel Industries for the global oil and gas market will be available, together with relevant know-how and/or experimental results about the performance in very 'hard' onshore remote areas. These products are not available on the market at present. The results will give an innovative contribution: to the steel industries, in fact a new metallurgical criteria/thermomechanical process will be available to improve also the flexibility of the steel industry with regard to the new future requirements of the market; and to the gas companies/contractors that, thanks to this new class of higher performances/pipes and tubular components, can make use of innovative solutions to exploit remote oil and gas fields."

Partners

	Country	*Scientific person in charge*
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TATA STEEL UK LIMITED	UNITED KINGDOM	Anthony HORN
UNIVERSITEIT GENT	BELGIQUE	Rudi DENYS

RFSR-CT-2007-00042 FICEB

Fire resistance of long span cellular beam made of rolled profiles

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1621359 €	Start Date	1/07/2007
	EU Contribution	972816 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25122:EN			

Final Abstract The aim of this project is to develop uniform European design rules for protected and unprotected cellular beams (CB) constructed of rolled sections subjected to fire. The use of cellular beams (CB) will be increased by minimising and optimising the cost of fire protection and by allowing a wider use of unprotected CB. This will greatly benefit long span construction, and increase the market share of steel. These results will be achieved based on the development of a new design code of single CB subjected to fire as well as an extended methodology considering the whole floor structure and the beneficial effects of the adjacent members. The reliability of the developed tools will be based on large-scale tests in order to provide a cost-effective design methodology. A set of practical design recommendations will be developed in order to satisfy all the requirements of fire-safe engineering.

		Country	*Scientific person in charge*
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	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN
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RFSR-CT-2007-00043 ROBUST

Renovation of buildings using steel technologies

Info

Type of Project	Research	Duration (months)	36
Total Budget	1286507 €	Start Date	1/07/2007
EU Contribution	771904 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25335:EN

Project web page www.steel-renovation.org

Final Abstract

Robust addresses the renovation and improvement of existing residential, industrial and commercial buildings using steel-based technologies, focusing on techniques such as over-cladding, over-roofing and roof-top extensions. Steel-intensive renovation techniques currently on the market were reviewed. Performance criteria were developed for over-cladding systems meeting current regulatory standards, with guidelines on how to achieve appropriate levels of air-tightness.

Partners

	Country	*Scientific person in charge*
THE STEEL CONSTRUCTION INSTITUTE LBG	UNITED KINGDOM	R. Mark LAWSON (Pr. Coord.)
ARCELORMITTAL LIEGE RESEARCH SCRL	BELGIQUE	Clarisse MEES
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Stéphane HERBIN
POLITECHNIKA RZESZOWSKA IM. I. LUKASIEWICZA - RZESZOW UNIV OF TECHN.	POLAND	Aleksander KOZLOWSKI
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
TATA STEEL UK LIMITED	UNITED KINGDOM	Allan R. GRIFFIN
TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Jyri NIEMINEN

Software

Steel Renovation Economic Justification Tool. A multi-criteria tool to support developers' decisions regarding whether to demolish or renovate a building. The tool estimates the potential cost savings arising from over-cladding and/or over-roofing and/or constructing a roof-top extension using steel technologies. It includes issues such as savings in heating bills, reduced maintenance costs, improved visual aspects, increased rental value and the benefit of a longer building life. http://steel-renovation.org/work_package_5.html

RFSR-CT-2007-00044 UCoSiF

Unbraced composite structures in fire

Info

Type of Project	Research	Duration (months)	36
Total Budget	1058939 €	Start Date	1/07/2007
EU Contribution	635363 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26181:EN

Project web page www.stahlbau.uni-hannover.de

Final Abstract

Designers paid to date little attention to unbraced composite frames as a structural system for buildings. Two main reasons hindered a more frequent application. First, normative regulations lack simplified methods for the fire design of unbraced composite frames. This can be attributed to their sway and the linked P-?-effects that complicate the design compared to non-sway structures. Second, it is demanding to construct external composite joints for the regarded one-bay frames. Thus, even in composite constructions external joints are mostly constructed as mere steel joints. Nevertheless, unbraced composite frames offer important advantages. These include increased usable space, fast construction times, and inherent fire resistance. Thus, these frames are particularly interesting for one-bay office buildings with three storeys at most, where most European building codes require the fire rating R60. To meet these requirements, a design concept for fire-exposed unbraced composite frames was established in this project. This concept was verified by test series on columns, joints, and frames at both room temperature and under fire-exposure. Accompanying numerical studies further deepened the understanding of the frames' fire performance. Overall, results showed that unbraced composite frames are a serious alternative to traditional load-bearing structures in low- and medium-rise buildings. In this project, technical foundations were laid for a new type of construction for office buildings with one to three storeys. Aiming at high share of prefabrication of the frames, the proposed design concept results in fast, economical, and reliable construction times

Partners

	Country	*Scientific person in charge*
GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER	DEUTSCHLAND	Peter SCHAUMANN (Pr. Coord.)
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Christophe RENAUD
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jose Antonio CHICA
HOCHTIEF CONSTRUCTION AG	DEUTSCHLAND	Bernhard HAUKE
CITY UNIVERSITY	UNITED KINGDOM	Kuldeep VIRDI

Selected Publications

Bahr, O. Numerical and Experimental Investigations on Unbraced Composite Frames in Fire, Leibniz Universität Hannover, Institut für Stahlbau, Shaker, 2011

P. Schaumann and O. Bahr. Fire design of external semi-rigid composite joints. In 13th International Symposium on Tubular Structures, 2010.

P. Schaumann and O. Bahr. A numerical model for unbraced composite frames in fire. In SiF'2010 - 6th International Conference Structures in Fire, 2010.

P. Schaumann, B. Zhao, O. Bahr, and C. Renaud. Fire performance of external semi-rigid composite joints. In SiF'2010 - 6th International Conference Structures in Fire, 2010.

Software

Simplified design method for unbraced composite frames in fire. To extend the application of unbraced composite frames as load-bearing structures of buildings, a simplified design method is proposed. This method bases on the separate design of the beam and the columns in the fire-exposed storey of the unbraced composite frames. This procedure is feasible because the introduction of the local forces from the beam in the joint is considered in detail. www.stahlbau.uni-hannover.de

RFSR-CT-2007-00050 STEELRETRO

Steel solutions for seismic retrofit and upgrade of existing constructions

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2214354 €	Start Date	1/07/2007
	EU Contribution	1328613 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25894:EN			

Final Abstract The majority of existing buildings are in need of seismic retrofit. The main reasons are: the original design was not optimised with respect to the required safety level, poor construction quality, modifications or enlargements of buildings during their life and increase in the requirements of the seismic design. Even if steel solutions can often be more efficient and economic, their possibilities are practically unknown and their application has been limited to a few particular cases. The aim of the research proposal focused to set up steel solutions for the seismic retrofit of existing buildings, furnishing design and construction methodologies, tools for dimensioning of elements and connections.

		Country	*Scientific person in charge*
Partners	**RIVA ACCIAIO SPA**	ITALIA	Aurelio BRACONI (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Mike HALLER
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Sandra ESTANISLAU
	REGIONE TOSCANA	ITALIA	Maurizio FERRINI
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Benno HOFFMEISTER
	SHELTER ANONYMOS VIOMICHANIKI ETAIRIA EPENDYSEON KAI KATASKEVON	HELLAS	Prokopis TSINTZOS
	UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE
	UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"	ITALIA	Franco BRAGA
	PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Spyros A. KARAMANOS
	UNIVERSITATEA POLITEHNICA DIN TIMISOARA	ROMANIA	Dan DUBINA
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Ludovic FULOP

RFSR-CT-2007-00051 InFaSo

New market chances for steel structures by innovative fastening solutions

Info	Type of Project	Research	Duration (months)	39
	Total Budget	773439 €	Start Date	1/07/2007
	EU Contribution	464063 €	End Date	30/09/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25100:EN

Project web page http://www.uni-stuttgart.de/ke/forschung/InFaSo/index.html

Final Abstract

The objective of Infaso is to promote and encourage the wider use of steel in buildings where until now only concrete has been used. This will be achieved by simple, efficient joints allowing for quick and easy connection of steel beams or columns to concrete structures. Nowadays in most European countries there is a strong market dominance of concrete as a building material. One important reason is that engineers in practice are often not used to design steel joints. Also some structural elements such as foundations or staircases have to be made of concrete. Due to a gap between the design of fastenings in concrete and steel design and missing standardised joint solutions, designers often find the easiest solution is to realise the whole structure in concrete, although an innovative steel-to-concrete solution would be the better choice according to the performance of the materials. Therefore new market possibilities for steel structures as a building material can be generated by developing innovative fastening solutions between steel and concrete for mixed building structures which profit from the advantages of steel as a very flexible and applicable material. Out of a range of possible solutions, three standardised solutions have been developed which show high loading capacity and sufficient ductility and allow for easy fabrication and quick erection. As a specific enhancement to existing design, increased capacity by additional reinforcement can now be taken into account. Thus Infaso's aim of developing an economic and consistent design model for such steel-to-concrete joints which considers the needs of steel and concrete for designers and helps to increase the implementation of steel composite structures has been reached.

Partners

	Country	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Ulrike KUHLMANN (Pr. Coord.)
GABINETE DE INFORMATICA E PROJECTO ASSISTIDO POR COMPUTADOR LDA	PORTUGAL	Luis SIMOES DA SILVA
GOLDBECK WEST GmbH	DEUTSCHLAND	Rolf HEDDRICH
STAHL + VERBUNDBAU GESELLSCHAFT FÜR INDUSTRIELLES BAUEN MBH	DEUTSCHLAND	Norbert SAUERBORN
CESKE VYSOKE UCENI TECHNICKE V PRAZE*CZECH TECHNICAL UNIV. IN PRAGUE	CZECH REPUBLIC	Frantisek WALD

Selected Publications

Ožbolt A., Kuhlmann U., Henriques J., da Silva L.S.. Behaviour of Steel-to-Concrete Joints, in "Steel Construction", Volume 3, Ernst & Sohn Verlag, Berlin, August 2012.

Ožbolt A, Berger W., Henriques J., Kuhlmann U., Eligehausen R., da Silva L.S. Behaviour of Steel-to-Concrete Joints I – Pinned Joint of a Steel Beam to a Reinforced Concrete Wall, Proceedings of "Eurosteel – 6 th European Conference on Steel and Composite Structures", 2011.

Henriques J., Ožbolt A., Žižka J., Kuhlmann U., da Silva L.S., Wald F.: Behaviour of Steel-to-Concrete Joints – Moment Resistant Joint of a Composite Beam to a Reinforced Concrete Wall, in "Steel Construction", Volume 4, Ernst&Sohn Verlag, August 2011

Berger W., Hofmann J., Kuhlmann U.: Connections between Steel and Concrete, Proceedings of "Eurosteel – 6 th European Conference on Steel and Composite Structures", 2011.

Kuhlmann U., Ožbolt A.: Anchor Plates with Headed Studs as Fastening Solutions between Steel and Concrete, Proceedings of the 18th IABSE Congress "Innovative Infrastructures – Towards Human Urbanism", Seoul, Korea, 2012.

Software

Design tool for moment resistant joint of composite beams. Within the INFASO project a new innovative connection between a composite beam and reinforced concrete wall has been proposed, where the composite beam is sitting on an anchor plate. With this Excel based tool the user is able to design this joint according to the component model developed within the project. URL: http://www.uni-stuttgart.de/ke/forschung/InFaSo/index.html

Design tool for anchor plates with headed studs for joints of columns and or beams to supporting concrete members This Excel based tool allows a design of columns to concrete foundations as well as joints of beams to reinforced concrete walls, according to the new developed design model for headed studs in reinforced concrete members. URL: http://www.uni-stuttgart.de/ke/forschung/InFaSo/index.html

RFS2-CT-2008-00030 SECHALO

Facilitating market development for sections in industrial halls and low-rise buildings

Info	Type of Project	Accompanying measure (studies)	Duration (months)	20
	Total Budget	797061 €	Start Date	1/07/2008
	EU Contribution	478236 €	End Date	28/02/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25056:EN

Project web page http://www.arcelormittal.com/sections/library/design-manuals-steel-buil

Final Abstract This project has been developed by steel makers in response to the market need for harmonised design guidance to support architects and engineers with practical application of the Eurocodes for steel and composite construction. The latter provide greater coverage of types of steel construction than many of the national standards which they replace, in particular in the areas of single-storey and low-rise multi-storey industrial buildings, which currently have the greatest scope for market growth. Solutions for single-storey and low-rise multi-storey buildings have already been developed within many previous RFCS projects. Based on these achievements, a fully comprehensive guide has now been created for architects and designers which delivers added value in the form of simple, comprehensive and harmonised design guidance. It contains state-of-the-art best practice and, in cooperation with national IPOs (independent steel promotion centres), facilitates compliance with national regulations. Much of the project work has concentrated on preparation of material for the design guides and identifying and capturing best practice from across Europe. Activities included detailed discussions with designers and fabricators from various European countries. Noticeable differences in common practice, especially in regard to multi-storey buildings, have been established and an appropriate strategy for agreeing preferred solutions has been reached. The same diversity applies to the range of sections and steel grades usedin different countries. In conclusion, the project partners have reached a common understanding whereby endorsement has been given to those standardised solutions which are recognised as the most simple and economic. At the same time, however, they allow designers flexibility of choice in respect of alternative, less favourable solutions.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL BELVAL & DIFFERDANGE S.A.**	LUXEMBOURG	Renata OBIALA (Pr. Coord.)
	PEINER TRÄGER GmbH	DEUTSCHLAND	Kai BOHMBACH
	TATA STEEL UK LIMITED	UNITED KINGDOM	Richard DIXON

Selected Publications

The documents were translated internally by ArcelorMittal into Polish and Spanish, http://www.arcelormittal.com/sections/library/design-manuals-steel-building-in-europe.html

New European project was based on SECHALO, with an aim to create teaching modules, Project SKILLS: http://skills.cticm.org/

The Polish translation is planned to be published on CD by a publisher ELAMED. The CDs will be sold together with the magazine “Nowoczesne hale” with a price covering the cost of production.

RFS3-CT-2008-00031

Investigation into fracture mechanics and ductile fracture propagation in fibre laser welded high strength steel

Info

Type of Project	Accompanying measure (training)	Duration (months)	12
Total Budget	24750 €	Start Date	1/07/2008
EU Contribution	24750 €	End Date	30/06/2009

State Project suspended, no final report published

Provisional Abstract

The main research objectives devised to provide fracture mechanics behaviour of the fibre laser welded high strength steel
- to select and/or develop alternative method for the fracture mechanics of the fibre laser welded hig strength steel
- to implement local fracture mechanics rules in welded materials to be used in conjunction with fibre laser welded high strength steel
- to establish a relationship between welding procedure (fibre laser parameters, clamping, pre-heat, etc.) and fracture initiation in fibre laser welded high strength steels
- to develop fibre laser welding process parameters allowing joining of high steels with satisfactory fracture and metallurgical properties
- to elaborate a catalogue of metallurgical, mechanical properties of fibre laser welds in modern high strength steels, allowing the establishment of structure/property relationships
- to describe material solidification in fusion zone as a function of fibre laser welding process characteristics and its structural integrity.

	Country	*Scientific person in charge*
GKSS-FORSCHUNGSZENTRUM GEESTHACHT GmbH	DEUTSCHLAND	Mustafa KOÇAK

RFSR-CT-2008-00032 FUSEIS

Dissipative devices for seismic resistant steel frames

Info	Type of Project	Research	Duration (months)	36
	Total Budget	741351 €	Start Date	1/07/2008
	EU Contribution	444810 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25901:EN			
Project web page	http://fuseis.ntua.gr/			

Final Abstract

Earthquakes lead frequently to a large amount of damage. Conventional frames (moment resisting, concentric/eccentric braced frames) are not well positioned with regard to reparability. It is therefore advisable to develop structural systems that are simple to repair, i.e. to introduce the reparability as a new property. Two innovative systems of seismic resistant steel frames with dissipative fuses were developed. (1) Fuseis1 consists of two closely spaced strong columns, rigidly connected to multiple beams. The beams run from column to column or alternatively are interrupted and connected by short pins. (2) Fuseis2 devices are seismic fuses for steel and composite steel–concrete moment resisting frames. The fuse is obtained by means of plates bolted/ welded to the web and the flanges of the beam. In case of strong earthquakes damage concentrates only in the fuses, which are exchangeable. Repair work after a strong seismic event, if needed, is limited only to replacing the fuses. The Fuseis system is able to dissipate energy by means of inelastic deformation and combines ductility and architectural transparency with stiffness. Experimental and theoretical investigations were performed to study the response of the fuses and the overall frames to cyclic loading. The investigations conclude with a design guide for practical application, including design examples. The optimal design for the dissipative fuse fulfils the following functional objectives: (a) ease of fabrication of the fuse. (b) maximum energy dissipation in cyclic behaviour. (c) minimum number of exchangeable parts. (d) reduction of the weight, cost and difficulty of replacement of the fuse parts.

Partners		*Country*	*Scientific person in charge*
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Ioannis VAYAS (Pr. Coord.)
	INSTITUTO SUPERIOR TECNICO	PORTUGAL	Luis CALADO
	POLITECNICO DI MILANO	ITALIA	Carlo Andrea CASTIGLIONI
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Christian MÜLLER
	SIDENOR SA	HELLAS	Dimos KALTEZIOTIS

Selected Publications

Carlo A. Castiglioni , Alper Kanyilmaz , Luis Calado. Experimental analysis of seismic resistant composite steel frames with dissipative devices. Journal of Constructional Steel Research 76 (2012) 1–12 . URL http://www.sciencedirect.com/science/article/pii/S0143974X12000922

D. Dimakogianni, G. Dougka, I. Vayas, Ph. Karydakis. Innovative seismic-resistant steel frames (FUSEIS 1-2) – Experimental analysis. Steel Construction: Design and Research, Vol. 5 (2012), Issue 4, p. 212-221. DOI: 10.1002/stco.201210026, URL http://onlinelibrary.wiley.com/doi/10.1002/stco.201210026/pdf

Luís Calado , Jorge M. Proença , Miguel Espinha., Carlo A. Castiglioni. Hysteretic behaviour of dissipative bolted fuses for earthquake resistant steel frames. Journal of Constructional Steel Research 85 (2013) 151–162 , URL http://www.sciencedirect.com/science/article/pii/S0143974X13000709

D. Dimakogianni, G. Dougka, Ph. Karydakis, I. Vayas, L. Calado & C.A. Castiglioni – Innovative energy dissipation systems (FUSEIS 1). Stessa 2012, January 9-11, 2012, Santiago, Chile.

G. Dougka, D. Dimakogianni, Ph. Karydakis, I. Vayas – Energy dissipation systems (FUSEIS1) to seismic loading. Eurosteel 2011, August 31- September 2, 2011, Budapest, Hungary

RFSR-CT-2008-00033 BRiFaG

Bridge fatigue guidance - meeting sustainable design and assessment

Info

Type of Project	Research	Duration (months)	36
Total Budget	1396096 €	Start Date	1/07/2008
EU Contribution	837657 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25866:EN

Final Abstract Fatigue analysis of new and existing steel structures is generally based on the notion of nominal stress and on standardised S-N curves with corresponding fatigue classes for typical details. Such an approach is constrictive because of an ever increasing number of structural details and loading situations resulting in a limited number of possible treatable design cases. Moreover, in current codes of practice, certain loading situations may be treated in an unconservative manner. Traditional fatigue procedures can also make it difficult to obtain the correct bridge condition assessment and the most appropriate maintenance strategy. Furthermore, a fracture-mechanics-based approach is needed in order to address the all-important issue of inspections. This project aims at covering some of the gaps that a practising engineer might face when carrying out fatigue design or assessment using current fatigue rules on the following subjects chosen by the project partners: • Specific fatigue rules for bridges (bridges with steel deck, composite road bridges, existing railway bridges). • Extension of common fatigue rules (slender bridge elements, hotspot stress method, multiaxial stresses). Through four different series of fatigue tests, through extensive finite element modelling with different qualities of meshing and comparison with the measurements, through calibration of random fracture mechanics parameters on a real bridge cracked detail for the constant amplitude loading and through a proposed probabilistic maintenance and cost optimisation procedure, extra rules in addition to the existing standards and recommendations are thus developed.

Partners

	Country	*Scientific person in charge*
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Mladen LUKIĆ (Pr. Coord.)
CHALMERS TEKNISKA HÖGSKOLA AB	SVERIGE	Robert KLIGER
USTAV TEORETICKE A APLIKOVANE MECH * INST OF THEOR. AND APPLIED MECH.	CZECH REPUBLIC	Shota URUSHADZE
RAMBÖLL SVERIGE AB	SVERIGE	Peter COLLIN
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
UNIVERSITY OF SURREY	UNITED KINGDOM	Boulent IMAM

Selected Publications

G. Kaliyaperumal, B. Imam and T. Righiniotis. Advanced Dynamic Finite Element Analysis of a Skew Steel Railway Bridge. Engineering Structures 33/1 (2011), 181-190. DOI 10.1016/j.engstruct.2010.10.003. URL http://dx.doi.org/10.1016/j.engstruct.2010.10.003

Sh. Urushadze, L. Frýba, M. Škaloud and M. Zörnerová. Fatigue Behaviour of Steel Bridges. In: Proc. of the 4th International Conference on Steel & Composite Structures, Sydney, 2010, 671-676. DOI 10.3850/978-981-08-6218-3_BS-Th039. URL http://dx.doi.org/10.3850/978-981-08-6218-3_BS-Th039

M. Aygül, M. Bokesjö, M. Heshmati and M. Al-Emrani. A comparative study of different fatigue failure assessments of welded bridge details. International Journal of Fatigue 49 (2013), 62–72. DOI 10.1016/j.ijfatigue.2012.12.010. URL http://dx.doi.org/10.1016/j.ijfatigue.2012.12.010

M. Aygül, M. Al-Emrani and S. Urushadze. Modelling and fatigue life assessment of orthotropic bridge deck details using FEM. International Journal of Fatigue 40 (2012), 129-142. DOI 10.1016/j.ijfatigue.2011.12.015. URL http://dx.doi.org/10.1016/j.ijfatigue.2011.12.015

Mattias Nilsson. Secondary Strain in Web Stiffeners in Steel and Composite Bridges. Licentiate Thesis. Luleå University of Technology. URL http://pure.ltu.se/portal/files/41508575/Mattias_Nilsson.pdf

RFSR-CT-2008-00034 AFINOPRO

Analysis of fitting noise propagation in steel lightweight constructions and design solutions for their prevention

Info	Type of Project	Research	Duration (months)	36
	Total Budget	802397 €	Start Date	1/07/2008
	EU Contribution	481438 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26011:EN			

Final Abstract This project aimed at studying systematically the propagation of sound generated by fitting noise in light gauge walls and their basic combinations following EN ISO 38221 'Laboratory tests on noise emission from applications and equipment used in water supply installation' using an installation noise standard (INS). An important result concerns the propagation of fitting-induced vibration energy through light gauge walls, which do not run face to face from the wall as expected but mainly over the top and bottom U-profile of the wall. The practical target consisted in finding solutions for material and mass combinations as well as optimal connection between walls creating rooms so that the sound propagation of noise generated by commercial non-classified fittings is reduced to less than 30 dB, the sound level value of whisper. Non-classified customary fittings, the most common group, produce a sound level of 36 dB at a flow of 25 l/min Using the results of the project the noise level can be reduced to 30 dB and better independence created for the expenditure wanted and an improved wall design. The project results offer the possibility to lower the input noise level by 16.8 dB. Therefore the sound level of a customary non-classified source of 36 dB should be reduced to less than 20 dB, the sound level of low breathing. By integrating an all-steel primary silencer developed in the project directly behind the fitting an additional reduction of 6.3 dB can be achieved

		Country	*Scientific person in charge*
Partners	**FORSCHUNGS- UND QUALITÄTSZENTRUM ODERBRÜCKE gGmbH**	DEUTSCHLAND	Alvaro CASAJUS (Pr. Coord.)
	ARCELORMITTAL CONSTRUCCION ESPANA SL	ESPAÑA	Maria José SANCHEZ
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Ana BICKER
	UNIVERSIDAD DE LA RIOJA	ESPAÑA	Joaquín ORDIERES MERE
	UNIVERSIDAD POLITECNICA DE MADRID	ESPAÑA	Joaquin B. ORDIERES MERE

RFSR-CT-2008-00035 HITUBES

Design and integrity assessment of high strength tubular structures for extreme loading conditions

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1432497 €	Start Date	1/07/2008
	EU Contribution	859497 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25903:EN			

Final Abstract

"High-strength steel (HSS) characterized by a yield strength ranging between 500 MPaand 700 MPa has been available for many years. However, its use in onshore engineering is quite restricted. Reasons were threefold: (i) Eurocodes covered steels with a yield strength up to 460 MPa; (ii) higher costs than regular steel; (iii) lack of conceptual design with HSS. Nonetheless, very recently, there has been a growing trend for the use of HSS in tubular structures due to Eurocode 3 Part 1-12 (2006), which extended its scope to steel grades up to S690/S700MC. In this context, the Hitubes project intended to develop performance-based designs and assessment procedures to make full use of HSS tubes up to S700MC for structures subject also to extreme repeated loads; in fact, Eurocode 3 Part 1-12 imposes many limitations at the material, structural and design levels. The ambitious targets are to increase the performance of tubular structures and reduce weight, construction and operating costs. The project covered the period 1 July 2008 to 31 December 2011, and the main research work focused on several aspects listed herein: literature survey, selection of finite element-based and identification dynamic analysis codes, selection of realistic case studies and FE analysis for the evaluation of actions and stresses, structural identification and health monitoring of a cable-stay and arch footbridges, test planning and execution, including welding procedure specifications, simulations of welded and bolted connections under monotonic, low-cycle and high-cycle fatigue loadings, simulation of case studies and reliability analysis for quantification of realistic performance scenarios, and SWOT analysis and monitoring of project activities."

Partners	*Country*	*Scientific person in charge*
UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Oreste S. BURSI (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Giuliana ZILLI
INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Helena GOUVEIA
FUNDACION ITMA*INSTITUTO TECNOLOGICO DE MATERIALES	ESPAÑA	Maria CABAÑAS
SWEREA KIMAB AB	SVERIGE	Rachel PETTERSSON
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART
PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Spyros A. KARAMANOS

Selected Publications

Bursi O.S., Bonelli A., Ceravolo R., Tondini N., Ussia A. (2011) " Dynamic and aeroelastic behaviour of a twin deck curved cable-stayed footbridge equipped with passive devices", Engineering Mechanics Institute 2011, ASCE, Conference Boston, USA

Bursi O.S., Pucinotti R., Zanon G., (2012), "Design of hollow steel joints and structures", (in Italian), Flaccovio, ISBN 978-88-579-0158-9, Sponsored by Italian Foundation for Steel Promotion

Ceravolo R., Tondini N., Abbiati G., Kumar A. (2011), "Dynamic characterization of complex bridge structures with passive control systems", Struct. Control Health Monit., Published online in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/stc.450

Varelis G.E., Pournara A., Karamanos S. A. (2011) "Strength and stability of high-strength steel tubular beam-columns under static and cyclic loads", EUROSTEEL 2011 conference, Budapest, Hungary

Long H.V., Demonceau J.-F., Jaspart J.-P.(2013), "Behaviour of flange bolted joints under monotonic, high cycle fatigue and low cycle fatigue loadings, I: Experimental investigation". 85: 1-11, DOI: 10.1016/j.jcsr.2013.02.011.

RFSR-CT-2008-00036 ROBUSTFIRE

Robustness of car parks against localised fire

Info

Type of Project	Research	Duration (months)	36
Total Budget	1253895 €	Start Date	1/07/2008
EU Contribution	752337 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25864:EN

Final Abstract The increase of the market shares for steel and composite car parks in Europe is somewhat limited by the lack of information on how these structures behave under exceptional localised fire resulting from the burning of cars. In the present project, a general philosophy for the design of robust structures against exceptional events is developed and practical design guidelines for its application to car parks under localised fire are derived. To achieve it, the following project objectives were identified: — Review current practice and state of the art in the design and assessment of car parks subject to localised fire, and propose potentially robust structural schemes for subsequent investigation. — Develop and validate detailed numerical models as well as simplified analytical models of the fire response of critical structural components, including columns, connections and beams. — Propose a system level approach for simplified analytical modelling of steel composite car parks under localised fire, and verify against validated numerical modelling. — Develop a robustness assessment approach for steel composite car parks under fire, to be event independent as far as possible, and propose relevant and practical design guidance. — Demonstrate using a real case study the accuracy and practicality of the developed analytical models, robustness assessment approach and corresponding design guidance. In the publishable report, it is demonstrated how these objectives have been achieved, using experiences gained from previous or ongoing RFCS projects related to various individual aspects (temperature distribution, joint behaviour…) and performing new and innovative experimental, numerical and analytical developments.

Partners

	Country	*Scientific person in charge*
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Olivier VASSART
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IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Bassam IZZUDDIN
UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA

Selected Publications

Robustness of car parks against localised fire - Deliverable II: Experimental tests and development of sophisticated behavioural models. http://orbi.ulg.ac.be/handle/2268/126845

Robustness of car parks against localised fire - Deliverable V: Practical behavioural models for car park structures towards design practice. http://orbi.ulg.ac.be/handle/2268/126848

Robustness of car parks against localised fire - Deliverable III: Development of simplified behavioural models. http://orbi.ulg.ac.be/handle/2268/126851

Robustness of car parks against localised fire - Deliverable IV: Development of FEM model for car parks under localised fire. http://orbi.ulg.ac.be/handle/2268/126849

Robustness of car parks against localised fire - Deliverable VI: Development of design recommendations, critical appraisal and application to a study case. http://orbi.ulg.ac.be/handle/2268/126850

RFSR-CT-2008-00037 ATTEL

Performance-based approaches for high strength tubular columns and connections under earthquake and fire loadings

Info

Type of Project	Research	Duration (months)	42
Total Budget	1148829 €	Start Date	1/07/2008
EU Contribution	689297 €	End Date	31/12/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25867:EN

Final Abstract

The use of high strength steel (HSS) circular hollow sections (CHS) is still limited in the construction industry despite their excellent structural and architectural properties and the fast development of end-preparation machines. The lack of information about the design of HSS elements may however not be considered as a brake on innovation. Indeed, EC3-1-12 gives design recommendations allowing the extension of the scope of Eurocode 3 to steel grades up to S690/ S700MC. Nevertheless, it is widely recognised that the EC3-1-12 extended rules are not allowing full benefit from all the strength potentialities of the HSS elements. The project ATTEL intended to develop both analytical and experimental know-how in order to support new design criteria for the exploitation of HSS and steel-concrete composite circular hollow sections for columns and connections subjected to exceptional loads, like earthquakes and fire. Experimental, analytical and numerical investigations have been achieved in ATTEL so as to allow practitioners to make full use of high strength steels ranging from S500Q/S500MC to S690Q/S700MC which represents nowadays an upper limit for structural applications. The main achievement of the project is the proposal of design rules and design recommendations for structures using HSS tubular columns and for structural elements made of HSS such as steel/composite columns, beam-to-column joints and column bases in fire conditions and/or under moderate/strong seismic actions. Besides that, the field of economical application of HSS CHS solutions has also been identified for the various above-mentioned loading situations.

Partners

	Country	*Scientific person in charge*
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STAHLBAU PICHLER SRL	ITALIA	Daniele MAIO
PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Spyros A. KARAMANOS
UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Fabio FERRARIO

Selected Publications

Design Guidelines and proposal for EC3, EC4 and EC8. http://orbi.ulg.ac.be/handle/2268/126852

D.5.1.: Definition of stability curves D.5.2. : D5.2: simulation data relevant to the selected typologies of base-joints, of HSS-CHS columns and HSS-CFT columns and of HSS-concrete composite beam-to-column joints D.5.3. : Report on parametric numerical analyses. http://orbi.ulg.ac.be/handle/2268/126853

Fire test data. http://orbi.ulg.ac.be/handle/2268/126854

D2.1: Report on the design of specimens. D2.2: Definition of practical solutions for the selected typologies of column bases, of HSSCHS columns and HSS?CFT columns and of HSS?concrete composite beam?to?column joints. http://orbi.ulg.ac.be/handle/2268/126528

Work Package 1? Deliverable1
State?of?the?art report on collection and evaluation of experimental test data and design procedures. http://orbi.ulg.ac.be/handle/2268/126527

RFSR-CT-2008-00038 ETHICS

Energy and thermal improvements for construction in steel

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1668390 €	Start Date	1/07/2008
	EU Contribution	1001033 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26010:EN			

Final Abstract ETHICS is concerned with evaluating, measuring and making improvements in the thermal and energy performance of steel-clad and steel-framed buildings. It addresses basic building physics performance at a laboratory and full-scale level, and the preparation of design guidance for commercial, industrial and residential buildings. It includes the development of design tools to assist users in assessing whole-building performance, and calibrates these tools against whole-building measurements, which will be obtained from this research. Opportunities for renewable energy and other energy-saving features will be assessed. This project focuses on objectives that are of particular interest for the design of new steel constructions regarding energy efficiency. ETHICS investigates the as-built performance by on-site tests regarding air tightness and heat transfer properties of the building envelope and by monitoring the energy consumption and thermal comfort of selected up-to-date steel buildings. As energy efficiency is a key requirement for design and construction of buildings in the future, this project provides well-founded scientific data, which prove the high energy performance of current steel constructions and work out details for further improvements to maintain and extend the position of steel products in the construction sector.

		Country	*Scientific person in charge*
Partners	**RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN**	DEUTSCHLAND	Markus KUHNHENNE (Pr. Coord.)
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RFSR-CT-2008-00039 ELEM

Composite bridges with prefabricated decks

Info

Type of Project	Research	Duration (months)	36
Total Budget	1494588 €	Start Date	1/07/2008
EU Contribution	896752 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25897:EN

Final Abstract

Bridges are of vital importance to the European infrastructure and composite bridges already became a popular solution in many countries and a well established alternative to concrete bridges. To improve the competitiveness of composite bridges, as a consistent next step not only the steel girders, but also the concrete deck needs to be pre-fabricated, which results in a reduction of the number of site operations and a substantial saving in the construction time and a shorter disruption of traffic flow respectively. Although already successfully built in France and Sweden, the critical details (mainly of the slab and its connections) need to be identified, proper solutions need to be found and the applicability, durability and sustainability of this composite bridge type must be proven in order to make the concept cost efficient. The major objectives of the ELEM project are to improve the overall competitiveness of this upcoming composite bridge type. Furthermore matters of safety during construction will be highlighted. The research aims at making bridges with pre-fabricated deck elements competitive not only for short and medium spans but also for multi spans, which will lead to an increase in the use of steel in bridges. The project includes both intensive theoretical and experimental investigations on steel components, concrete slab and connections, including the testing and monitoring of a composite bridge constructed with prefabricated deck elements.

Partners

	Country	*Scientific person in charge*
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POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Wojciech LORENC

Selected Publications

N.N.. Design of Composite Bridges With prefabricated Decks. ELEM project design Guide. URL http://www.stb.rwth-aachen.de/projekte/2008/ELEM/design_guide_elem.pdf

RFS2-CT-2009-00019 INTAB+

Economic and durable design of composite bridges with integral abutments

Info				
	Type of Project	Accompanying measure (studies)	Duration (months)	12
	Total Budget	265230 €	Start Date	1/07/2009
	EU Contribution	159138 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25045:EN

Project web page http://www.bridgedesign.de

Final Abstract

In the design and construction of bridges, questions of sustainability, maintenance and durability become more and more important for European road administrations in addition to safety and serviceability issues. Therefore integral abutment bridges become highly attractive to designers, constructors and road administrations as they tend to be less expensive to build, easier to maintain and more economical to own over their lifetime. However in Europe less experience in building integral bridges has been gained so far. Therefore in 2005 the European RFCS-projects INTAB has been launched. Within the scope of the project, universities, consulting engineering companies as well as steel producers worked together to develop economic and safe solutions for composite bridges with integral abutments. Significant knowledge has been gained and cost-effective, environmentally friendly and sustainable bridge structures have been developed. Furthermore their durability has been proven to obtain competitive composite bridges for small and medium spans. The outcome of that project was reworked within the scope of the current project to make it available to a larger number of practitioners. To disseminate the knowledge, two workshops have been organised. A design guide was written and translated into German and French. It was completed by a design example as well as CEN-recommendations regarding actual Eurocodes. A software tool was written to help designers to perform some calculations regarding the design of integral abutment bridges. Finally a website was set up to establish a sustainable presence on the web where all information will be available in the future as well.

Partners		*Country*	*Scientific person in charge*
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicoleta POPA
	LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Milan VELJKOVIC
	SSF INGENIEURE AG	DEUTSCHLAND	Günter SEIDL

Selected Publications

Feldmann, M., Pak, D.: Zu Verbundbrücken mit integralen Widerlagern, Stahlbau, Jg.: 78, Nr.12, Berlin (D): Ernst und Sohn, 2009, S.907-915 (DOI: 10.1002/stab.200910106)

Pak, D., Feldmann, M.: Design temperature load spectrum for fatigue verification of composite bridges with integral abutments, Proceedings of the 7th International Conference on Composite Construction in Steel and Concrete, CCVII, Palm Cove, 28.07.-31.07.2013

Markus Feldmann, Johannes Naumes, Daniel Pak, Milan Veljkovic, Jörgen Eriksen, Oliver Hechler, Nicoleta Popa, Günter Seidl, Anton Braun. Design guide - Economic and Durable Design of Composite Bridges with Integral Abutments. URL http://www.bridgedesign.de/

Markus Feldmann, Johannes Naumes, Daniel Pak, Milan Veljkovic, Jörgen Eriksen, Oliver Hechler, Nicoleta Popa, Günter Seidl, Anton Braun. Handbuch INTAB - Wirtschaftliche und dauerhafte Bemessung von Verbundbrücken mit Integralen Widerlagern. URL http://www.bridgedesign.de/

Software

Markus Feldmann, Johannes Naumes, Daniel Pak, Milan Veljkovic, Jörgen Eriksen, Oliver Hechler, Nicoleta Popa, Günter Seidl, Anton Braun. Guide de Conception - Conception économique et durable des ponts mixtes avec culées intégrales. URL ttp://www.bridgedesign.de/

TEQUILA Pre-design software tool for composite bridges with integral abutments with deep foundations URL: http://www.bridgedesign.de

RFSR-CT-2009-00020 SBRI

Sustainable steel-composite bridges in built enviornment

Info

Type of Project	Research	Duration (months)	36
Total Budget	1459864 €	Start Date	1/07/2009
EU Contribution	875918 €	End Date	30/06/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26322:EN

Project web page "http://www.arcelormittal.com/sections/en/library/steel-research-report

Final Abstract

In this research project a holistic approach has been applied to steel-composite bridges by combining analyses of Lifecycle Assessment (LCA), Lifecycle Costs (LCC) and Lifecycle Performance (LCP). Under the perspective of sustainability an entire lifespan, from the construction to the demolition of a bridge, is regarded. A valuable collection of data on LCA, LCC and LCP is obtained and life cycle scenarios are described including maintenance strategies. By postponing and pre-drawing of measurements optimisation towards cost-effectiveness and low environmental impact is achieved. Three representative types of road bridges were chosen and analysed. A differentiation between small motorway bridges, crossings of motorways and big motorway bridges is made. Complete case studies were performed throughout all aspects. In a second step variations and optimisation were applied. The behaviour of each component of bridges is affected by degradation processes such as fatigue, corrosion and carbonation. To capture the process of degradation is the basis of the description of the life cycle of each specific detail. In own tests for fatigue details (transverse stiffener and horizontally lying shear studs) and corrosion degradation models have been updated. In order to allow for comparisons and elaboration of advantages a multitude of variants were studied including also typical concrete solutions to identify the chances and advantages of steel-composite bridges. A workshop of experts was organised in Paris and gave a positive feedback to the project. Finally a user-friendly software tool and a handbook showing the methods' application to users have been prepared

Partners

	Country	*Scientific person in charge*
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SERVICE D'ETUDES SUR LES TRANSPORTS, LES ROUTES ET LEURS AMENAGEMENTS	FRANCE	Joël RAOUL
UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA

Selected Publications

Sustainable Steel-Composite Bridges – SBRI-Handbook. URL http://www.arcelormittal.com/sections/en/library/steel-research-reports/bridges.html

Maier P., Kuhlmann U., Tardivel Y., Robert N., Raoul J., Perdigão V., Martins N., Barros P., Friedrich H., Krieger J. Steel-composite bridges – holistic approach applied to European Case Studies. In: Proceedings of the 6th International Conference on Bridge Maintenance, Safety and Management. Stresa, Italy, July 8-12, 2012.

Gervásio, H., Simões da Silva, L., Perdigão, V., Barros, P., Orcesi, A., Nielsen, K. Lifecycle analysis of highway composite bridges. In: Proceedings of the 6th International Conference on Bridge Maintenance, Safety and Management. Stresa, Italy. July 8-12, 2012.

Maier P., Kuhlmann U., Popa N., Willms R., Optimizing bridge design by improved deterioration models through fatigue tests. In: Proceedings of the 6th International Conference on Bridge Maintenance, Safety and Management. Stresa, Italy. July 8-12, 2012.

Kuhlmann U., Maier P. (2011). Sustainable Steel-Composite Bridges, In: Proceedings Final Conference COST C25, Innsbruck.

Software

SBRI-tool The developed methodology is implemented in the SBRI-tool which enables the calculation of LCA and LCC for bridges, and the comparison of alternative solutions by means of a multi-criteria decision analysis. In addition the program incorporates the databank developed in relation to environmental and costs data of materials and processes.
http://www.arcelormittal.com/sections/en/library/steel-research-reports/bridges.html

RFSR-CT-2009-00021 COMPFIRE

Design of composite joints for improved fire robustness

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1578814 €	Start Date	1/07/2009
	EU Contribution	947289 €	End Date	30/06/2012
State	Project completed			

Provisional Abstract

The objective is to develop a comprehensive component-based design methodology for composite joints against fire, particularly joints between composite beams and the most common composite columns (concrete-filled hollow sections and partially encased open sections). This will enable composite joints to be fire-engineered to the same level as the frame, offering substantial savings while maintaining safety levels.
Fire testing is included on composite joint components, isolated composite joints, composite structural subassemblies and demonstration structures, Numerical analyses of temperature development in protected and unprotected composite joint components in natural fires and coupled thermo-structural analyses will foster development of the integrated component-based model, consistent with Eurocode procedures, for composite joints.

Partners	*Country*	*Scientific person in charge*
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TATA STEEL UK LIMITED	UNITED KINGDOM	George KOUTLAS
THE UNIVERSITY OF MANCHESTER	UNITED KINGDOM	Yong C. WANG
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THE UNIVERSITY OF SHEFFIELD	UNITED KINGDOM	Ian BURGESS

Selected Publications

Huang S.S., Burgess I.W. and Davison J.B.: 'A Structural Fire Engineering Prediction for the Veseli Fire Tests, 2011', Acc.Journal of Structural Fire Engineering. DOI: 10.1260/2040-2317.4.1.1

Huang S.S., Davison J.B. and Burgess I.W.: 'High-Temperature Tests on Joints to Steel and Partially-Encased H-Section Columns', Acc. Journal of Constructional Steel Research, 2013, vol 80, pg 243-251. http://dx.doi.org/10.1016/j.jcsr.2012.09.006

Elsawaf S., Wang Y.C., Mandal P.: 'Numerical modelling of restrained structural subassemblies of steel beam and CFT columns connected using reverse channels in fire', Engineering Structures 33 (2011) 1217–1231. http://dx.doi.org/10.1016/j.engstruct.2010.12.043

Elsawaf S., Wang Y.C.: 'Methods of improving the survival temperature in fire of steel beam connected to CFT column using reverse channel connection', Engineering Structures 34 (2012) 132–146. http://dx.doi.org/10.1016/j.engstruct.2011.09.004

Elsawaf S., Wang Y.C.: 'Behaviour of restrained structural subassemblies of steel beam to CFT column in fire during cooling stage', Engineering Structures 46 (2013) 471–492. http://dx.doi.org/10.1016/j.engstruct.2012.08.023

RFSR-CT-2009-00022 INDUSE

Structural safety of industrial steel tanks, pressure vessels and piping systems under seismic loading

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1773060 €	Start Date	1/07/2009
	EU Contribution	1063836 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26319:EN

Project web page http://www.mie.uth.gr/induse

Final Abstract

"Liquid storage tanks, pressure vessels and industrial piping are steel structural systems, present in all industrial facilities (chemical and petrochemical industries, and power plants). Safeguarding their structural integrity against earthquakes constitutes a key issue towards increased safety and unhindered operation of the industrial facility. Their structural behaviour, and in particular seismic design, is quite different than steel buildings and has several particularities, requiring a combined civil and mechanical engineering expertise. The particularities stem from their shape and geometry, the presence of high internal pressure, and the dynamic behaviour of the enclosed liquid, which may affect significantly their load and deformation capacity. The design of those structures has been dominated by the use of American standards (API 650, ASME VIII and B31.3). Nevertheless, for the case of seismic design, those standards (especially ASME standards for pressure vessels and piping) contain very limited provisions, referring mainly to structural design codes and specifications. European specifications (EN 14015, 13445, 13480) also contain limited provisions for the earthquake-resistant design of industrial equipment. An effort has been made in Eurocode 8 (EN 1998-4), which concerns almost exclusively vertical-cylindrical liquid storage tanks. Nevertheless, those rules do not cover all possible limit states and, furthermore, they need significant improvement to reach a level of applicability for design practice. The program consists of an interdisciplinary research effort INDUSE that combines civil and mechanical engineering expertise, for the purpose of developing guidelines, which can be used for the seismic design of liquid storage tanks, pressure vessels and piping, within the Eurocode design framework. Towards this purpose, extensive experimental, analytical, and numerical work has been conducted within the INDUSE project with the synergy of academic units, research centres and industrial partners. The guidelines are novel and unique, incorporating modern aspects of earthquakeresistant design, and are aimed at: ? expanding EN 1998-4 provisions towards an integrated seismic design of liquid storage tanks and attached equipment, incorporating some special features and all possible failure modes (WP5) and ? extending the applicability of Eurocode 8 (EN 1998) concepts for the cases of industrial pressure vessels (WP6), and piping systems (WP7). The following intermediate goals have been achieved within the INDUSE project: ? A basic comparison has been performed between current seismic design provisions in European and American standards together with an assessment of seismic damages in industrial facilities (WP1). ? Taking into account the particularities of each structural system, seismic actions have been determined (WP2). ? Extensive experimental testing has been conducted on key piping components (e.g. nozzles, pipe connections/branches and elbows) under strong cyclic loading; furthermore a piping system has been tested under pseudo-dynamic loading (WP3). ? Finite element analyses on these components have been performed, simulating the experiments and covering a wide range of geometric, material and loading parameters (WP4). The results of the above investigations are summarised below, demonstrating the achievements of INDUSE project objectives, work package per work package"

Partners

	Country	*Scientific person in charge*
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UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Oreste S. BURSI

Selected Publications

J. Ferino, Experimental testing of structural components of critical importance under strong cyclic loading. INDUSE project deliverable 3. URL http://www.mie.uth.gr/induse/Site/Workpackage3.html

M. Vathi, S. A. Karamanos, I. Doukas, P. Pappa, F. Paolacci. Design recommendations / guidelines for the seismic analysis & design of liquid storage tanks. INDUSE project deliverable 5.2. URL http://www.mie.uth.gr/induse/Site/Workpackage5.html

M Wieschollek, K. Diamanti, M. Pinkawa, B. Hoffmeister, Development of design recommendations / guidelines for the seismic design & analysis of industrial pressure vessels. INDUSE project deliverable 6.2. URL http://www.mie.uth.gr/induse/Site/Workpackage6.html

G. Dijkstra, F. Paolacci, N. Gresnigt, O. S. Bursi. M. Wieschollek, G. E. Varelis, Development of design recommendations / guidelines for the seismic analysis & design of industrial piping systems. INDUSE project deliverable 7.2. URL http://www.mie.uth.gr/induse/Site/Workpackage7.html

G.E. Varelis, S.A. Karamanos, A.M. Gresnigt. Steel Elbow Response Under Strong Cyclic Loading. Journal of Pressure Vessel Technology, ASME, Vol. 135, No.1, Article Number: 011207, February 2013. URL http://pressurevesseltech.asmedigitalcollection.asme.org/article.aspx?articleid=1678512

RFSR-CT-2009-00023 RUSTEEL

Effects of corrosion on low-cycle fatigue (seismic) behaviour of high strength steel reinforcing bars

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1356703 €	Start Date	1/07/2009
	EU Contribution	814022 €	End Date	30/06/2012
State	Project completed			

Provisional Abstract

Modern codes allow the design of ductile composite steel-concrete and r.c. structures able to dissipate seismic energy. This required the development of high performance reinforcing steels guaranteeing the necessary plastic resources through hysteretic cycles. Unfortunately, a lot of problems on low-cycle fatigue behaviour of re-bars still exist.
In addition, recent studies underlined the detrimental effects of corrosion on ductility, making such problems even worst.
Aim of the research is to solve problems related to the assessment of performance of steel reinforcing bars under seismic loadings and to evaluate the influence of corrosion phenomena on their tensile and low-cycle fatigue properties.

Partners		*Country*	*Scientific person in charge*
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	FERRIERE NORD S.P.A.	ITALIA	Loris BIANCO
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	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Sandra ESTANISLAU
	RIVA ACCIAIO SPA	ITALIA	Aurelio BRACONI
	UNIVERSITY OF PATRAS* PANEPISTIMIO PATRON	HELLAS	Charis APOSTOLOPOULOS

RFSR-CT-2009-00024 HSS-SERF

High strength steel in seismic resistant building frames

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1763026 €	Start Date	1/07/2009
	EU Contribution	1057815 €	End Date	30/06/2013

State Project completed, final report not published yet

Project web page http://www.ct.upt.ro/articole/files/HSS-SERF_Workshop.pdf

Provisional Abstract

The aim of the project is to investigate and evaluate the seismic performance of dual-steel building frames, realised from two different steel grades: Mild Carbon Steel (MCS) and High Strength Steel (HSS). Dual-steel structural systems, in which MCS is used in dissipative members while HSS is used in non-dissipative “elastic” members, can be very reliable and cost efficient. The main outcomes of the project will consist in coherent performance based design methodology and relevant design criteria for ductility and overstrength of both members and joint components, as well as joint detailing rules.

Partners

	Country	*Scientific person in charge*
UNIVERSITATEA POLITEHNICA DIN TIMISOARA	ROMANIA	Dan DUBINA (Pr. Coord.)
GABINETE DE INFORMATICA E PROJECTO ASSISTIDO POR COMPUTADOR LDA	PORTUGAL	Luis SIMOES DA SILVA
RIVA ACCIAIO SPA	ITALIA	Alberto TREMEA
RAUTARUUKKI OYJ	FINLAND	Jyrki KESTI
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART
UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II	ITALIA	Raffaele LANDOLFO
UNIVERZA V LJUBLJANI	SLOVENIJA	Darko BEG
UNIVERSITAET STUTTGART	DEUTSCHLAND	Ulrike KUHLMANN
TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Ludovic FULOP

Selected Publications

Raffaele Landolfo, Mario D’Aniello, La Manna Ambrosino G., Francesco Portioli, Andre Tenchini, Carlos Rebelo, Luis Simoes da Silva, Miguel Serra, Ludovic Fulop. Report on Seismic Performance of Dual-Steel Structures and Evaluation of q-Factors Associated with Different Performance Levels. HSS-SERF project deliverable D2.

Ulrike Kuhlmann, Andreas Kleiner, Darko Beg, Blaž Cermelj, Jean-Pierre Jaspart, Jean-Francois Demonceau, Hoang Van Long, Alberto Tremea, Jyrki Kesti. Report on Performance of Welded Details and T-stubs, and Recommendations of Welding Procedures to be used in Dual-Steel Structures for Welded Connections between HSS and MCS. HSS-SERF project deliverable D3.

Jean-Pierre Jaspart, Jean-Francois Demonceau, Hoang Van Long, Alberto Tremea, Ulrike Kuhlmann, Andreas Kleiner, Jyrki Kesti. Prequalification Criteria for Bolted Beam-to-Column Joints in Dual-Steel Frames. HSS-SERF project deliverable D4.

Darko Beg, Blaž Cermelj, Klemen Rejec, Jože Lopatic, Dan Dubina, Cristian Vulcu, Aurel Stratan, Adrian Ciutina, Alberto Tremeea, Ulrike Kuhlmann, Andreas Kleiner, Jyrki Kesti. D5 - Prequalification Criteria for Welded Beam-to-Column Joints in Dual-Steel Frames. HSS-SERF project deliverable D5.

Cristian Vulcu, (2013), Seismic Performance of Dual-Steel Frames of CFRHS and Welded Beam-to-Column Joints – PhD thesis, Editura Politehnica, Timisoara, ISBN: 978-606-554-631-8, ISSN: 1842-581X.

RFSR-CT-2009-00026 INAREIS

Industrial application of electro-osmosis to reduce environmental impact of steel sheet piles via reuse

Info

Type of Project	Research	Duration (months)	36
Total Budget	1092082 €	Start Date	1/07/2009
EU Contribution	655248 €	End Date	30/06/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26422:EN

Project web page www.inareis.eu

Final Abstract

The aim of the project is the promotion of the re-use of sheet piles embedded in clayey soils by applying electro-osmosis in order to facilitate extraction. Practical guidelines for the application in practice should be the outcome of the project. Laboratory element and model tests, field trials, and numerical simulations should be synthesized for this purpose. Appropriate soils were identified throughout Europe, and material was collected and tested in the laboratory. The relevant mechanical and electro-kinetic material properties have been determined for a variety of clays. Small scale model tests demonstrated the efficiency of the method. A numerical electro-kinetic model for a cathode-anode set-up has been established whereby the transmitting medium is characterized by bulk properties as determined from the laboratory tests. Typical configurations have been studied in an extensive parametric study in order to assess the extension and intensity of the electrical field. Sheet piles of variable length have been installed in a test field in England. The envisaged pull-out tests have been planned, and custom-made special devices have been designed and manufactured. However, the permission to carry out the field trials was not granted due to health and safety concerns about the induced current in the ground. As an alternative large scale model tests were designed and executed in the laboratory. Several tests series have been carried out. The results clearly demonstrate the beneficial effects of the application of electrical current. Based on the experience gained during the negotiations with the authorities, on the results of the large scale tests and of the numerical simulations, guidelines have been prepared to be used during the future application of this novel method in practice

Partners

	Country	*Scientific person in charge*
TECHNISCHE UNIVERSITÄT KAISERSLAUTERN	DEUTSCHLAND	Christos VRETTOS (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Michel BOURDOUXHE
DEW PILING LTD	UNITED KINGDOM	David THOMPSON
ELSYCA NV	BELGIQUE	Lies CASSEAU
GEOTECHNICAL CONSULTING GROUP LTD	UNITED KINGDOM	Kelvin HIGGINS

RFSR-CT-2009-00027 FADLESS

Fatigue damage control and assessment for railways bridges

Info				
Type of Project	Research	Duration (months)	36
Total Budget	2343850 €	Start Date	1/07/2009
EU Contribution	1406310 €	End Date	30/06/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26419:EN

Final Abstract "The functionality maintenance of infrastructures like bridges is acquiring more and more importance due to the huge economic losses related to the interruption of their regular service. In particular, fatigue represents one of the more diffused failure modes occurring in steel and composite steel-concrete bridges: in fact, about 80 to 90 % of failures in steel structures are related to fracture and fatigue. Railway bridges endure millions of stress cycles during their life and they are expected to be highly vulnerable to such phenomena. The fatigue assessment of railway bridges; both considering the design of new bridges and the assessment of existing ones, is one of the main issues in current practice. In fact, phenomena like 'vibration induced' and 'distortion induced' fatigue are still not completely covered by current design codes and represent a critical aspect for the assessment of steel bridges. The objective of the project was the development of a modern procedure for the evaluation of the structural integrity of steel railway bridges which may be affected by fatigue damage under the application of a large number of load cycles during their lifetime. To this aim, an innovative methodology for advanced fatigue assessment was developed and calibrated on six suitable case studies which were representative of typical European steel solutions for railway bridges subjected to vibration/distortion phenomena. The application of the proposed methodology to case studies confirmed its capabilities in providing reliable and extensive information concerning the current fatigue damage and the remaining life of bridge components"

Partners		*Country*	*Scientific person in charge*
	CONSORZIO PISA RICERCHE SC ARL	ITALIA	Walter SALVATORE (Pr. Coord.)
	BAUHAUS-UNIVERSITÄT WEIMAR	DEUTSCHLAND	Carsten KÖNKE
	KATHOLIEKE UNIVERSITEIT LEUVEN	BELGIQUE	Guido DE ROECK
	LMS INTERNATIONAL NV	BELGIQUE	Bart PEETERS
	RIVA ACCIAIO SPA	ITALIA	Aurelio BRACONI
	UNIVERSIDADE DO PORTO	PORTUGAL	Alvaro CUNHA
	VCE HOLDING GMBH	OESTERREICH	Helmut WENZEL

Selected Publications

Francesco V. Lippi, Michele Orlando & Walter Salvatore (2011): Assessment of the dynamic and fatigue behaviour of the Panaro railway steel bridge, Structure and Infrastructure Engineering, DOI:10.1080/15732479.2011.625955. URL http://dx.doi.org/10.1080/15732479.2011.625955

"CUNHA, A., CAETANO, E., MOUTINHO, C. & MAGALHÃES, F. (2013) - ""Continuous dynamic monitoring of bridges: different perspectives of application"", Keynote Lecture, 6th ECCOMAS Conference on Smart Structures and Materials, SMART 2013, Torino, Italy"

"CUNHA, A., CAETANO, E., MAGALHÃES, F. & MOUTINHO, C. (2012) - ""Monitorização Dinâmica e Identificação Estrutural de Pontes e Estruturas de Grande Vão"", XXXV Jornadas Sul-Americanas de Engenharia Estrutural, Keynote Lecture, Rio de Janeiro, Brasil"

"MARQUES, F., MOUTINHO, C. & CUNHA, A. (2012) - ""Local fatigue analysis using a long-term monitoring system at Trezói railway bridge"", Eighth International Conference on Engineering Computational Technology Dubrovnik, Croatia"

"MOUTINHO, C., MARQUES, F. & CUNHA, A. (2012) - ""Implementation of a dynamic monitoring system at Trezói railway bridge"", 5th European Conference on Structural Control, EACS 2012, Genoa, Italy."

RFSR-CT-2009-00025 DUPLEXTANK

Duplex stainless steel in storage tanks

Info

Type of Project	Research	Duration (months)	40
Total Budget	1381030 €	Start Date	1/09/2009
EU Contribution	828618 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26320:EN

Final Abstract Corrosion resistance of austenitic-ferritic (duplex) stainless steels (DSS) in atmosphere in presence of chloride deposits was studied in order to promote their safe application for construction of storage tanks and other facilities. Laboratory tests of pre-stressed specimens demonstrated clear superiority of DSSs over reference austenitic stainless steel (ASS) grades in terms of the resistance to stress corrosion cracking (SCC). SCC initiated at temperatures as low as 20 and 30 °C in ASS grades EN 1.4306 (304L) and EN 1.4404 (316L), respectively, whereas the only occurrence of SCC in duplex stainless steel samples was recorded at 70 °C. It was found that the initiation of SCC and selective/pitting corrosion is governed by the equilibrium chloride concentration in solution formed in contact of chloride surface deposits with air at given relative humidity. The propagation rate of selective corrosion of the ferritic phase in duplex stainless steel structures was maximal at the chloride concentration between 6 and 9 mol/L and it increased with the pH of the salt solution. Threshold levels of chloride concentrations and relative humidity in presence of specific deposits leading to localised corrosion were defined. Additional experiments and results of field exposures showed that deposits formed on real structures under washing conditions were benign in terms of the SCC initiation in view of both the surface chloride concentration and composition. If storage tanks are designed properly, DSSs are optimal materials for their construction due to superior corrosion resistance, mechanical properties and lower life cycle cost

Partners

	Country	*Scientific person in charge*
INSTITUT DE LA CORROSION SASU	FRANCE	Tomas PROSEK (Pr. Coord.)
BELGISCH INSTITUUT VOOR LASTECHNIEK VZW	BELGIQUE	Eddy DELEU
INDUSTEEL CREUSOT SAS	FRANCE	Jérome PEULTIER
OUTOKUMPU STAINLESS AB	SVERIGE	Anna IVERSEN
STOLT TANKERS BV * STOLT TANKERS & TERMINALS	NEDERLAND	Tom SNAUWAERT
TOTAL PETROCHEMICALS France SA	FRANCE	François DUPOIRON

Selected Publications

S. Le Manchet, E. Johansson, T. Prosek. Guidelines for industry on application of duplex stainless steels in storage tanks construction and life cycle cost analysis. DUPLEXTANK project deliverable D14. 2013.

T. Prosek. Safe application for construction of storage tanks. Corrosion News 4 (2013), 14-17. URL http://www.swerea.se/Global/Swerea%20KIMAB/Publikationer/Corr_News%20nr%204-2013_LR.pdf

T. Prosek, A. Le Gac, S. Le Manchet, E. Johansson, C. Lojewski, A. Fanica, F. Dupoiron, T. Snauwaert, F. Maas, B. Droesbeke, D. Thierry. Application limits of austenitic and duplex stainless steels in presence of chloride deposits in atmospheric conditions. Stainless Steel World Conference, November 14–16, 2013, Maastricht, The Netherlands.

T. Prosek, A. Le Gac. Threshold levels, application limits, and engineering diagrams for application of duplex stainless steels in non-washing conditions. DUPLEXTANK project deliverable D12. 2013.

T. Prosek, T. Snauwaert, F. Dupoiron. Report on performance of duplex stainless steel grades in service environments of storage tanks applications. DUPLEXTANK project deliverable D8. 2013.

RFS2-CT-2010-00023 SEMI-COMP+

Valorisation action of plastic member capacity of semi-compact steel sections - a more economic design

Info

Type of Project	Accompanying measure (studies)	Duration (months)	18
Total Budget	333637 €	Start Date	1/07/2010
EU Contribution	200182 €	End Date	31/12/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25913:EN

Project web page www.stahlbau.tugraz.at/semicompplus

Final Abstract

The objective of this project is the dissemination of knowledge gained through the former European research project SEMI-COMP on semi-compact steel sections. The obtained results demonstrated substantial reserves in load-carrying capacity, which so far cannot be utilised by a designer using the current Eurocode 3. Considering increasing use of high-strength steel grades, the problem becomes more severe. Implementation into amended design rules of codes seems to be a subject of priority.

Partners

	Country	*Scientific person in charge*
TECHNISCHE UNIVERSITAET GRAZ	OESTERREICH	Richard GREINER (Pr. Coord.)
EUROPEAN CONVENTION FOR CONSTRUCTIONAL STEELWORK	BELGIQUE	Luis SIMOES DA SILVA
FELDMANN + WEYNAND GmbH	DEUTSCHLAND	Klaus WEYNAND
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART

Selected Publications

Design Guidelines for cross-section and member design according to Eurocode 3 with particular focus on semi-compact sections. URL www.stahlbau.tugraz.at/semicompplus

Background information to Design Guidelines. URL www.stahlbau.tugraz.at/semicompplus

Software

SemiComp Member Design Within the SEMI-COMP+ project a design software “Semi-Comp Design” has been developed for cross-section and member design, which is provided as freeware. www.stahlbau.tugraz.at/semicompplus

RFSP-CT-2010-00024 ECOBRIDGE

Demonstration of economical bridge solutions based on innovative composite dowels and integrated abutments

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	1286404 €	Start Date	1/07/2010
	EU Contribution	643202 €	End Date	31/12/2013
State	Running project			

Provisional Abstract

The knowledge gained in the frame of RFCS projects INTAB and PRECOBEAM has enabled us to elaborate cost effective, environmental friendly and sustainable bridge structures.
The objective of this project is the construction of three composite bridges with integral abutments and/ or innovative form of shear transmission – composite dowels. The targeted countries are: Germany, Romania and Poland.
The bridges will be instrumented with a variety of strain gages, displacement sensors, and thermocouples to monitor and help in the assessment of structural behaviour, for future application of integral abutment bridges and/or composite dowels.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicoleta POPA (Pr. Coord.)
COMPANIA NATIONALA DE AUTOSTRAZI SI DRUMURI NATIONALE DIN ROMANIA SA	ROMANIA	Horatiu SIMION
ENERGOPOL SZCZECIN - SA	POLAND	Krzysztof CHARSZLA
EUROPROJEKT GDANSK SPZOO	POLAND	Krzysztof CHARSZLA
CONSTRUCCIONES PROVIERA SPANIA JAEN, MANCHA REAL - SUCCURSALA	ROMANIA	Adrian Cornel PARFENE
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
SSF INGENIEURE AG	DEUTSCHLAND	Günter SEIDL
SSF RO SRL	ROMANIA	Edward PETZEK
TWT SANIERUNGSGESELLSCHAFT mbH	DEUTSCHLAND	Mirko SCHERPE
UNIVERSITATEA POLITEHNICA DIN TIMISOARA	ROMANIA	Radu BANCILA
POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Wojciech LORENC

Software

ACOBRI - ArcelorMittal Composite Bridge The purpose of the ACOBRI software is to help in the pre-design of the rolled-steel main beams of composite steel and concrete bridges, in accordance with different codes. The software interface is generally simple and user-friendly, but because of its very specific purpose, it is vital that users have the requisite knowledge on the design of composite bridges and are familiar with the relevant design rules. It is the responsibility of the user to ensure that the software is consistent with the problem to be solved by referring to the scope of application defined in this manual. ACOBRI can be used only at the pre-design stage, in order to compare different technical solutions. In so far as the program does not take sufficient account of all the parameters involved in the design of a composite bridge, the results cannot be used directly in the final substantiation of bridge design. http://www.arcelormittal.com/sections/download-center/design-software/bridges.html

RFSR-CT-2010-00025 INNO-HYCO

Innovative hybrid and composite steel-concrete structural solutions for building in seismic area

Info

Type of Project	Research	Duration (months)	36
Total Budget	1458818 €	Start Date	1/07/2010
EU Contribution	875291 €	End Date	30/06/2013

State Project completed, final report not published yet

Provisional Abstract

Composite structures are widely used in building construction in seismic areas whereas hybrid solutions are less diffused and require further investigation. The two main hybrid systems considered in the proposal, namely hybrid coupled shear walls and steel frames with reinforced concrete infill walls, suffer from drawbacks due to the damage localization and the connections' complexity.
The proposal aims to define innovative steel-r.c. hybrid systems for the construction of feasible and easy repairable earthquake-proof buildings characterised by effective dissipative mechanisms and excellent serviceability performance.
The new systems will be applied to case studies and a complete design procedure will be proposed.

Partners

	Country	*Scientific person in charge*
UNIVERSITA DEGLI STUDI DI CAMERINO*UNIVERSITY OF CAMERINO	ITALIA	Andrea DALL'ASTA (Pr. Coord.)
CONSORZIO PISA RICERCHE SC ARL	ITALIA	Walter SALVATORE
OCAM SRL* OFFICINA CARPENTERIA METALLICA	ITALIA	Paolo BONI
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Benno HOFFMEISTER
SHELTER ANONYMOS VIOMICHANIKI ETAIRIA EPENDYSEON KAI KATASKEVON	HELLAS	Prokopis TSINTZOS
UNIVERSITE DE LIEGE	BELGIQUE	Hervé DEGEE
UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE

Selected Publications

A. Zona, G. Leoni, A. Dall'Asta, C. Braham, T. Bogdan, H. Degée. Behaviour and design of innovative hybrid coupled shear walls for steel buildings in seismic areas. Proceedings of 15th World Conference on Earthquake Engineering, 24-28 September 2012, Lisbon, Portugal, paper 2737.

G. Leoni, A. Zona, A. Dall'Asta, H. Bigelow, B. Hoffmeister, G. Varelis. Behaviour and design of innovative steel frames with RC infill walls. Proceedings of the XV Italian Conference on Earthquake Engineering, 30 June - 4 July 2013, Padova, Italy, paper F4.

T. Bogdan, A. Zona, G. Leoni, A. Dall'Asta, C. Braham, H. Degée. Design and performance of steel-concrete hybrid coupled shear walls in seismic conditions. Proceedings of COMPDYN 2013 4th ECCOMAS Thematic Conference on Computational Methods in Structural Dynamics and Earthquake Engineering, 12–14 June 2013, Kos Island, Greece, paper 1295.

RFSR-CT-2010-00026 SAFSS

Structural applications of ferritic stainless steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1312481 €	Start Date	1/07/2010
	EU Contribution	787488 €	End Date	30/06/2013
State	Project completed, final report not published yet			

Provisional Abstract

Ferritic stainless steels are low cost, price-stable, corrosion-resistant steels. Although widely used in the automotive and domestic appliance sectors, structural applications are scarce.
Ferritic stainless steels are only partially covered by European structural standards. This project will develop the information needed for comprehensive guidance to be included in relevant parts of the Eurocodes and other accompanying standards/guidance.
Although the research has general applicability to the use of ferritic stainless steel, there is a particular focus on the following structural application:
lattice roof trussed and space frame structures,
exposed decking in composite floor systems,
signage and security structures.

		Country	*Scientific person in charge*
Partners	**THE STEEL CONSTRUCTION INSTITUTE LBG**	UNITED KINGDOM	Nancy BADDOO (Pr. Coord.)
	ACERINOX EUROPA SA	ESPAÑA	Maria Victoria MATRES
	INSTITUT ZA KOVINSKE MATERIALE IN TEHNOLOGIJE	SLOVENIJA	Matjaz TORKAR
	OUTOKUMPU STAINLESS OY	FINLAND	Jukka SÄYNÄJÄKANGAS
	OVE ARUP & PARTNERS LTD	UNITED KINGDOM	Graham GEDGE
	ARCELORMITTAL STAINLESS FRANCE	FRANCE	Laurent FAIVRE
	UNIVERSITAT POLITECNICA DE CATALUNYA (UPC)	ESPAÑA	Esther REAL
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Asko TALJA

Selected Publications

Antilla S., Karjalainen P. and Lantto S. (2013). Mechanical properties of ferritic stainless steel welds in using type 409 and 430 filler metals. Journal of Welding in the World, Feb 2013 DOI : 10.1007/s40194-013-0033-7

Generalized multistage mechanical model for nonlinear metallic materials. Petr Hradil , Asko Talja, Esther Real, Enrique Mirambell, Barbara Rossi. http://dx.doi.org/10.1016/j.tws.2012.10.006. Thin-Walled Structures, Volume 63, February 2013, Pages 63–69

Hradil, P., Fulop, L. Talja, A. (2012). Global stability of thin-walled ferritic stainless steel members. Thin-Walled Structures . Vol. 61 (2012), p. 106 - 114. http://dx.doi.org/10.1016/j.tws.2012.05.006

Antilla S., Karjalainen P. and Lantto S. (2013). Mechanical properties of ferritic stainless steel welds in using type 409 and 430 filler metals. Journal of Welding in the World, Feb 2013 DOI : 10.1007/s40194-013-0033-7

RFSR-CT-2010-00028 SAFETOWER

Develop tailored manufacturing safe methods for wind towers erected in remote areas based on an integrated tower concept and optimal use of high strength steels

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1876050 €	Start Date	1/07/2010
	EU Contribution	1125631 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

The project intends to study new manufacturing solutions for wind steel towers using High Strength Steels (HSS) already used in other applications and newly developed ones. Thus, the project aims to prove that modular, field-assembled panel tower design eliminates transportation restrictions and therefore allows for a much more efficient tower design and steel use. With this design, tower panels can be added to increase the tower base diameter which also enbales the use of thinner wall thickness in larger wind towers. In addition, new tailored manufacturing procedures and mobile factory layout shall be developed to prove tower design feasibility in remote onshore areas.

		Country	*Scientific person in charge*
Partners	**INSTITUTO DE SOLDADURA E QUALIDADE**	PORTUGAL	Eduardo Manuel DIAS LOPES (Pr. Coord.)
	A. SILVA MATOS ENERGIA SA	PORTUGAL	Sergio RODRIGUES
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Elisabetta MECOZZI
	GAMESA INNOVATION AND TECHNOLOGY SLU	ESPAÑA	Enrique REAL
	FUNDACION ITMA*INSTITUTO TECNOLOGICO DE MATERIALES	ESPAÑA	Ricardo LEZCANO
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Philippe THIBAUX
	SIAG SCHAAF INDUSTRIE AG	DEUTSCHLAND	Axel KAISER
	GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER	DEUTSCHLAND	Peter SCHAUMANN

RFSR-CT-2010-00029 DiSTEEL

Displacement based seismic design of steel moment resisting frame structures

Info

Type of Project	Research	Duration (months)	42
Total Budget	1198278 €	Start Date	1/07/2010
EU Contribution	706988 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract

New seismic design methods are required in order to control the damage expected from earthquakes.
DiSTEEL is a research project on the Displacement Based Seismic Design of STEEL Moment Resisting Frame Structures. The main product of the research will be a set of practical performance-based design guidelines for steel moment-resisting frame structures that include performance criteria and a displacement-based design procedure capable of considering different beam-column joint typologies. The research will use existing experimental data and numerous analytical studies to verify the guidelines. The findings will improve confidence in the steel construction industry and increase utilisation of steel in Europe.

Partners

	Country	*Scientific person in charge*
CENTRO EUROPEO DI FORMAZIONE E RICERCA IN INGEGNERIA SISMICA	ITALIA	Gian Michele CALVI (Pr. Coord.)
CMM - ASSOCIACAO PORTUGUESA DE CONSTRUCAO METALICA E MISTA	PORTUGAL	Luis SIMOES DA SILVA
CONSORZIO PISA RICERCHE SC ARL	ITALIA	Walter SALVATORE
UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II	ITALIA	Raffaele LANDOLFO
UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE

Selected Publications

G. Terracciano , G. Della Corte, G. Di Lorenzo, R. Landolfo. Displacement Based Design of Moment Resisting Frame Structures with semi rigid connections: A preliminary study on connection modeling, Proceedings of the XXV Italian Conference on Steel Structures, Ischia, Italy, (2011).

H. Augusto, C. Rebelo, L. Simões da Silva, J.M. Castro. Modelling of the Dissipative Behaviour of Partial-Strength Beam-to-Column Steel Connections, Proceedings of the 15th World Conference of Earthquake Engineering, Lisbon, Portugal, (2012) paper 2325.

H. Augusto, J.M. Castro, C. Rebelo, L. Simões da Silva. Numerical Simulation of Partial-Strength Steel Beam-to-Column Connections under Monotonic and Cyclic Loading, Congress on Numerical Methods in Engineering, CMN 2013, June 25-28, Bilbao, España, (2013) paper 207.

T.J. Sullivan, M. Quaini , T. Maley, G.M. Calvi. Seismic response of steel moment resisting frames designed using a Direct DBD procedure, Proceedings of the 8th International Conference on Structural Dynamics, Eurodyn2011, Leuven, Belgium, (2011) paper No.730.

T.J. Sullivan, M. Quaini , T. Maley, G.M. Calvi. Deformed Shapes of Steel Moment Resisting Frames Subject to Earthquake Actions, Eurosteel 2011 - 6th European Conference on Steel and Composite Structures, Vol.B, ISBN:9789291471034, Budapest, Hungary, (2011) paper No.322.

RFSR-CT-2010-00030 ADBLAST

Advanced design methods for BLAST Loaded steel structures

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1359469 €	Start Date	1/07/2010
	EU Contribution	815682 €	End Date	30/06/2013
State	Running project			

Provisional Abstract

Steel structures and components can provide ideal systems for blast resistance, yet this potential has not been adequately utilised due to lack of appropriate investigations. This project aims to develop fundamental design guidance for blast resistant steel structures, with emphasis on procedures suitable for typical industrial buildings. The work will involve realistic blast tests on key non-structural and structural assemblages, coupled with complementary dynamic material characterisation, nonlinear analyses and comparative quasi-static tests. Findings from the experimental and numerical studies will be used, in conjunction with appropriately assessed loading scenarios and carefully selected structural configurations, to offer reliable performancebased design procedures.

Partners		*Country*	*Scientific person in charge*
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Benno HOFFMEISTER (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Renata OBIALA
	CONSORZIO PISA RICERCHE SC ARL	ITALIA	Walter SALVATORE
	HOCHTIEF CONSTRUCTION AG	DEUTSCHLAND	André DÜRR
	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Ahmed ELGHAZOULI
	PATRIMONY OF THE ROYAL MILITARY ACADEMY - VERM VAN DE KONINK MILIT SCH	BELGIQUE	Johnny VANTOMME
	TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	Ton VROUWENVELDER
	UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE

RFSR-CT-2010-00032 FATWELDHSS

Improving the fatigue life of high strength steel welded structures by post weld treatments and specific filler material

Info

Type of Project	Research	Duration (months)	42
Total Budget	1825436 €	Start Date	1/07/2010
EU Contribution	1095263 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract This project will develop techniques for improving the performance of welded, high-strength steels (yield strengths of 700 and 960 MPa) at thicknesses of 5-20 mm, for use in fatigue-loaded, welded structures, e.g., construction equipment, transportation vehicles and lifting devices. High frequency impact peening, weld toe laser dressing and low transformation temperature filler material will be examined. Experimental and analytical procedures will assess the benefits and limitations of the selected methods. Full-scale testing will demonstrate industrial viability and cost benefits. Practical implementation guidelines and design recommendations will be disseminated.

Partners

	Country	*Scientific person in charge*
ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Sofie VANROSTENBERGHE (Pr. Coord.)
BUNDESANSTALT FÜR MATERIAL FORSCHUNG UND -PRÜFUNG	DEUTSCHLAND	Thomas KANNENGIESSER
BELGISCH INSTITUUT VOOR LASTECHNIEK VZW	BELGIQUE	Johan VEKEMAN
LINCOLN SMITWELD BV	NEDERLAND	Vincent VAN DER MEE
SSAB TUNNPLÅT AB	SVERIGE	Joachim LARSSON
STRESSTECH OY	FINLAND	Markus LAAKKONEN
TWI LTD	UNITED KINGDOM	Stephen MADDOX
AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Gary MARQUIS
VOLVO CONSTRUCTION EQUIPMENT AB*BOLINDER MUNKKTELL VCE	SVERIGE	Yang SHIN

Selected Publications

Jonsson B, Barsoum Z and Sperle JO. Weight optimization and fatigue design of a welded bogie beam structure in a construction equipment. Engineering Failure Design 2012. 19: 63-76. DOI: 10.1016/j.engfailanal.2011.09.006.

G. Marquis, E. Mikkola, H. C. Yildirim and Z. Barsoum. Fatigue Strength Improvement of Steel Structures by High Frequency Mechanical Impact: Proposed Fatigue Assessment Guidelines, Welding in the World, July 2013. http://link.springer.com/article/10.1007%2Fs40194-013-0075-x#

G. Marquis and Z. Barsoum. Fatigue Strength Improvement of Steel Structures by High Frequency Mechanical Impact: Proposed Procedure and Quality Assurance Guidelines. Welding in the World, June 2013. DOI 10.1007/s40194-013-0077-8. http://link.springer.com/article/10.1007/s40194-013-0077-8#

Yildirim, H. C., Marquis, G. B.: Overview of fatigue data for high frequency mechanical impact treated welded joints, Welding in the World, Vol. 57, issue 7/8, 2012 p 82 – 96. http://link.springer.com/article/10.1007/BF03321368

Bhatti AA and Barsoum Z. : Development of efficient three-dimensional welding simulation approach for residual stress estimation in different welded joints. Journal of Strain Analysis for Engineering Design 2012, 47: 539-552. doi: 10.1177/0309324712463866.

RFSR-CT-2010-00027 SB_Steel

Sustainable building project in steel

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1338407 €	Start Date	1/10/2010
	EU Contribution	803043 €	End Date	30/09/2013
State	Running project			

Provisional Abstract

The proposal aims at improved competitive capacity of the steel construction sector by providing concepts and methods of sustainable steel-intensive building. A science-based approach to sustainability-conscious decision-making will be developed for the early building project phases that are crucial for value and performance of the completed building (predesign/ concept phase), and for the choice of design scheme (preliminary design).
The work consists of identification of key indicators of value and performance (emphasising sustainability), methodology to cope with life-cycle performance criteria (incl safety, security, user-comfort), benchmarking and validation of methods, and software both for investigative work and dissemination of results.

Partners	*Country*	*Scientific person in charge*
TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Heli KOUKKARI (Pr. Coord.)
ACCIONA INFRAESTRUCTURAS S.A.	ESPAÑA	Patricia MARCOS HUIDOBRO
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Olivier VASSART
ARCELORMITTAL LIEGE RESEARCH SCRL	BELGIQUE	Giorgia CAROLI
ARTISTOTLE UNIVERSITY OF THESSALONIKI	HELLAS	Charalampos BANIOTOPOULOS
EUROPEAN CONVENTION FOR CONSTRUCTIONAL STEELWORK	BELGIQUE	Milan VELJKOVIC
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jose Antonio CHICA
MOSTOSTAL WARSZAWA S.A.	POLAND	Pawel PONETA
UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA
UNIVERSIDADE DO MINHO	PORTUGAL	Luís BRAGANÇA-LOPES
UNIVERSITATEA POLITEHNICA DIN TIMISOARA	ROMANIA	Viorel UNGUREANU

RFSR-CT-2010-00031 HISTWIN2

High steel tubular towers for wind turbines

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1205051 €	Start Date	1/11/2010
	EU Contribution	723030 €	End Date	31/10/2013
State	Running project			

Provisional Abstract

The use of steel tubular towers for larger wind turbines and higher hub-heights is limited by economical and technological barriers in view of recent advances of the concrete industry. In the present project, new solutions for steel and hybrid towers' stability and foundations with micro steel piling will be developed. To achieve this goal, experience from the RFCS project HISTWIN (RFS-PR-05111, 2006-2009) on optimal bolted connection for the particular implementation will be used. Experimental, numerical and analytical study will lead to new market opportunities for tubular towers, where the solution with dominant use of the concrete is competitive nowadays.

		Country	*Scientific person in charge*
Partners	**LULEÅ UNIVERSITY OF TECHNOLOGY**	SVERIGE	Milan VELJKOVIC (Pr. Coord.)
	ARTISTOTLE UNIVERSITY OF THESSALONIKI	HELLAS	Charalampos BANIOTOPOULOS
	MARTIFER ENERGIA - EQUIPAMENTOS PARA ENERGIA, SA	PORTUGAL	Antonio PONTES
	RUUKKI METALS OY	FINLAND	Juha NUUTINEN
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
	UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA

RFS2-CT-2011-00025 MACS+

Membrane action in fire design of composite slab with solid and cellular steel beams - valorisation

Info

Type of Project	Accompanying measure (studies)	Duration (months)	18
Total Budget	1018709 €	Start Date	1/07/2011
EU Contribution	611226 €	End Date	31/12/2012

State Project completed

Project web page www.macsfire.eu

Provisional Abstract

The technical objective is to disseminate methodology for design of partially protected composite slabs for fire conditions with a focus on the connections and on Cellular Beams. Number of tests performed in various countries under natural and ISO fire enabled to gain good understanding ofthe behaviour of such structures. The project will be addressed to practicing engineers in various
countries and aims to transfer knowledge about utilisation in their designs of membrane effect, which is created in the reinforced slab during fire.
This project will extend recent RFCS project FICEB+ and COSSFIRE. The first one comprised a large scale natural fire test on a compartment based on composite Cellular beams. Within the second project, among other small scale tests, one large scale furnace test activating the membrane action with a prescriptive ISO fire has been performed.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Olivier VASSART (Pr. Coord.)
ARTISTOTLE UNIVERSITY OF THESSALONIKI	HELLAS	Charalampos BANIOTOPOULOS
BAUFORUMSTAHL E.V.	DEUTSCHLAND	Bernhard HAUKE
BOUWEN MET STAAL	NEDERLAND	Ralph HAMERLINCK
CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Bin ZHAO
INSTYTUT TECHNIKI BUDOWLANEJ	POLAND	Grzegorz WOZNIAK
STIFTELSEN SVENSK STALBYGGNADSFORSKNING - STALBYGGNADSINSTITUTET	SVERIGE	Björn ASTEDT
STRUCTURA ENGINEERING SRL	ITALIA	Sandro PUSTORINO
TALLINNA TEHNIKAULIKOOL*TALLINN UNIVERSITY OF TECHNOLOGY	ESTONIA	Ivar TALVIK
FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jesus DE LA QUINTANA
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN
UNIVERSIDADE DE AVEIRO	PORTUGAL	Paulo VILA REAL
UNIVERZA V LJUBLJANI	SLOVENIJA	Darko BEG
MISKOLCI EGYETEM*UNIVERSITY OF MISKOLC	HUNGARY	Karoly JARMAI
CESKE VYSOKE UCENI TECHNICKE V PRAZE*CZECH TECHNICAL UNIV. IN PRAGUE	CZECH REPUBLIC	Zdenek SOKOL
UNIVERSITATEA POLITEHNICA DIN TIMISOARA	ROMANIA	Raul Dan ZAHARIA
UNIVERSITY OF ULSTER	UNITED KINGDOM	Ali NADJAI
VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS	LITHUANIA	Audronis Kazimieras KVEDARAS
ASD WESTOK LIMITED	UNITED KINGDOM	Michael HAWES

Selected Publications

VASSART O., ZHAO B. Fire resistance assessment of partially protected composite floors, Engineering background. Edition 2012-1, www.macsfire.eu (available in 17 languages)

VASSART O., ZHAO B. Fire resistance assessment of partially protected composite floors, Design Guide. Edition 2012-1, www.macsfire.eu (available in 17 languages)

VASSART O., ZHAO B. Membrane action of composite structures in case of fire. ECCS Book n°132, 2013. www.steelconstruct.com

Software

MACS+ This software designs composite floor slabs at elevated temperatures by taking into account the enhancing effects of the membrane action in slab. MACS+ also checks perimeter beams and provides a limiting temperature for each of them http://www.macsfire.eu

RFS2-CT-2011-00026 PRECO+

Prefabricated enduring composite beams based on innovative shear transmission

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	413783 €	Start Date	1/07/2011
	EU Contribution	248271 €	End Date	31/12/2012
State	Project completed, final report not published yet			

Provisional Abstract

The Proposal refers to the finished RFCS-project “Prefabricated Enduring Composite Beams based on innovative Shear Transmission (PreCoBeam)”. Aim of the project was to deliver detailed knowledge on composite girders using the innovative technology of composite dowels to transmit shear forces. The project started in July 2006 and has been finalised in June 2009.
Objectives of the proposal:
- review the knowledge gained, prepare state of the arts reports, design guides and design tools
- translate the documents into German, Polish, Swedish, French and Spanish
- promote the knowledge to practitioners by conferences, workshops, internet and publications in (inter)national journals

		Country	*Scientific person in charge*
Partners	**SSF INGENIEURE AG**	DEUTSCHLAND	Günter SEIDL (Pr. Coord.)
	ACCIONA INFRAESTRUCTURAS S.A.	ESPAÑA	Carlo PAULOTTO
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicoleta POPA
	FORSCHUNGSVEREINIGUNG STAHLANWENDUNG e.V.	DEUTSCHLAND	Gregor NÜSSE
	RAMBÖLL SVERIGE AB	SVERIGE	Ali FARHANG
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN
	POLITECHNIKA WROCLAWSKA - WROCLAW UNIVERSITY OF TECHNOLOGY	POLAND	Wojciech LORENC

RFSR-CT-2011-00027 GIPIPE

Safety of buried steel pipelines under ground-induced deformations

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1821289 €	Start Date	1/07/2011
	EU Contribution	1092774 €	End Date	30/06/2014
State	Running project			

Project web page www.mie.uth.gr/gipipe

Provisional Abstract

Buried steel pipelines often pass through harsh-environment regions, sometimes close to densely populated areas, and can be subjected to large plastic deformations due to landslides, ground settlements, liquefaction, or fault movement. In the context of strain-based design, consideration of pipe-soil interaction is fundamental for determining extreme ground-induced actions (strain demand), towards pipeline safety. GIPIPE is a multi-discipline project on buried
steel pipelines subjected to ground-imposed permanent deformations, through an integrated approach that considers soil-pipe interaction. It involves novel experimental and numerical work, and aims at developing design guidelines, which complement existing design practice, towards ensuring pipeline integrity against geohazards, reducing the risk to the population and the envinronment, increasing pipeline operational reliability, and safeguarding the unhindered
transportation of energy (oil & gas) and water resources.

Partners

	Country	*Scientific person in charge*
PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Spyros A. KARAMANOS (Pr. Coord.)
CORINTH PIPEWORKS PIPE INDUSTRY AND REAL ESTATE	HELLAS	Antonios PERGIALIOTIS
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Jan FERINO
NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Georgios GAZETAS
TEBODIN NETHERLANDS BV - TEBODIN CONSULTANTS & ENGINEERS	NEDERLAND	Gert J. DIJKSTRA
TECHNISCHE UNIVERSITEIT DELFT	NEDERLAND	Frans S.K. BIJLAARD

Selected Publications

Aggelos Tsatsis, George Gazetas, Gert Dijkstra, Ioannis Anastasopoulos, Jan Ferino, Nol Gresnigt, Panos Dakoulas, Polynikis Vazouras, Sjors van ?s, Spyros Karamanos, Vasileios Drosos, Wouter Huinen. Evaluation of strain based pipeline design procedures, research work and damages under ground induced deformations. GIPIPE project deliverable 1. URL www.mie.uth.gr/gipipe/ deliverables

Aggelos Tsatsis, George Gazetas, Gert Dijkstra, Ioannis Anastasopoulos, Jan Ferino, Nol Gresnigt, Panos Dakoulas, Polynikis Vazouras, Sjors van ?s, Spyros Karamanos, Vasileios Drosos, Wouter Huinen . Development of numerical techniques for determining ground-induced actions on buried steel pipelines. GIPIPE project deliverable 2. URL www.mie.uth.gr/gipipe/deliverables

Vazouras, P., Karamanos, S. A., and Dakoulas, P.,(2012) “MECHANICAL BEHAVIOR OF BURIED STEEL PIPELINES IN ACTIVE FAULT AREAS”, Soil Dynamics & Earthquake Engineering, 41 (12), 164-180. URL: http://www.sciencedirect.com/science/article/pii/S0267726112001078

Vazouras, P., Karamanos, S. A., and Dakoulas, P., “PIPE-SOIL INTERACTION AND PIPELINE PERFORMANCE UNDER STRIKE-SLIP FAULT MOVEMENTS”, Bulletin of Earthquake Engineer, 2013 (in press). URL http://link.springer.com/journal/10518

RFSR-CT-2011-00028 TABASCO

Thermal bridging atlas of steel construction for improved energy efficiency of buildings

Info	Type of Project	Research	Duration (months)	36
	Total Budget	955122 €	Start Date	1/07/2011
	EU Contribution	573074 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

TABASCO will create a European database of the performance of a wide range of thermal bridges in steel cladding, light steel and modular constructions and steel primary structures. This will involve up to 200 thermal analyses using thermal parameters defined in EN ISO standards.
Improvements to current practice will be investigated, including development of thermally broken solutions. Results will be compared to test data in order to calibrate the design parameters.
The information will be presented as a compendium of linear and point thermal bridging values for generic steel details with parametric variations, such as steel and insulation thickness

		Country	*Scientific person in charge*
Partners	**THE STEEL CONSTRUCTION INSTITUTE LBG**	UNITED KINGDOM	Michael SANSOM (Pr. Coord.)
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Amor BEN LARBI
	RUUKKI CONSTRUCTION OY	FINLAND	Jyrki KESTI
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
	OXFORD BROOKES UNIVERSITY	UNITED KINGDOM	Raymond G. OGDEN

RFSR-CT-2011-00029 ULCF

Ultra low cycle fatigue of steel under cyclic high-strain loading conditions

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2215070 €	Start Date	1/07/2011
	EU Contribution	1329042 €	End Date	30/06/2014
State	Running project			

Project web page http://www.ulcf-project.org/

Provisional Abstract

Steel members subjected to extreme loading conditions (e.g. earthquakes, hurricanes, support settlements, industrial plant shutdown) undergo large deformations, associated with widespread yielding, leading to fracture, either due to monotonic loading or ultra-low-cycle fatigue (ULCF).
This project aims at developing innovative computational methodologies that simulate steel material fracture under ultra-low-cycle fatigue following a multiscale approach, with calibration from both micro and macroscale testing. The project focuses on base steel material only and on pipeline applications. Project results (experimental/numerical), will be used to develop design guidelines for strain-based ULCF design, amending current fatigue design practice (EC3, EC8).

		Country	*Scientific person in charge*
Partners	**UNIVERSIDADE DO PORTO**	PORTUGAL	Antonio Augusto FERNANDES (Pr. Coord.)
	CONSORCI CENTRE INTERNACIONAL DE METODES NUMERICS EN ENGINYERIA	ESPAÑA	Sergio OLLER
	CONSORZIO PISA RICERCHE SC ARL	ITALIA	Walter SALVATORE
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Tommaso COPPOLA
	ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Filip VAN DEN ABEELE
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Aida NONN
	UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE
	PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Spyros A. KARAMANOS

Selected Publications

Lucia G. Barbu, Sergio Oller, Xavier Martinez and Alex H. Barbat. Stepwise advancing strategy for the simulation of fatigue problems. Complas XII, Barcelona, 3-5 September 2013

Xavier Martinez, Sergio Oller, Lucia G. Barbu and Alex H. Barbat. Analysis of Ultra Low Cycle Fatigue problems with the Barcelona plastic damage model. Complas XII, Barcelona, 3-5 September 2013

RFSR-CT-2011-00030 FIDESC4

Fire design of steel members with welded ot hot-rolled class 4 cross-section

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1349851 €	Start Date	1/07/2011
	EU Contribution	809910 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

Steel members with H or I shape class 4 (thin-walled) cross sections, owing to their lightness, are one of the most commonly used structural members in steel constructions. However, their fire design according to actual Eurocode 3 is proved to be very conservative and too approximate. In consequence, within the scope of this project, more accurate and practical fire assessment tools are to be developed for such type of steel members on the basis of both experimental and numerical investigations. These assessment tools not only can improve
significantly the simple fire design but will also provide efficient solutions for global structural analysis of steel structures comprising class 4 cross section members with help of advanced fire engineering tools.

		Country	*Scientific person in charge*
Partners	**CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE**	FRANCE	Bin ZHAO (Pr. Coord.)
	DESMO a.s.	CZECH REPUBLIC	Petr VELDA
	LINDAB SA	LUXEMBOURG	Andrej BELICA
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jesus DE LA QUINTANA
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN
	UNIVERSIDADE DE AVEIRO	PORTUGAL	Paulo VILA REAL
	CESKE VYSOKE UCENI TECHNICKE V PRAZE*CZECH TECHNICAL UNIV. IN PRAGUE	CZECH REPUBLIC	Zdenek SOKOL

RFSR-CT-2011-00031 SEISRACKS2

Seismic behaviour of steel storage pallet racking systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1442116 €	Start Date	1/07/2011
	EU Contribution	865269 €	End Date	30/06/2014
State	Running project			

Project web page ftp://ftp.stru.polimi.it

Provisional Abstract European Racking Federation (ERF) is currently developing a preliminary normative document (prFEM 10.2.08) on the base of recent research works. However this document is still far from becoming a Euronorm (EN), in particular due to remaining lacks of knowledge leading to conservative design rules and consequently to strong technical limitations when designing static steel pallet racks with respect to seismic safety. The objective of the proposal is to solve these limitations by increasing knowledge on actual structural behaviour and ductility and to assess
design rules for earthquake conditions by full-scale testing and numerical simulation

		Country	*Scientific person in charge*
Partners	**POLITECNICO DI MILANO**	ITALIA	Carlo Andrea CASTIGLIONI (Pr. Coord.)
	COMPUTER CONTROL SYSTEMS SA	HELLAS	Ioannis PALAMAS
	FRITZ SCHÄFER GMBH	DEUTSCHLAND	Eugen TALMANN
	MODULBLOK SPA	ITALIA	Leo ROVERE
	NEDCON MAGAZIJNINRICHTING BV	NEDERLAND	Jan-Willem FREDERIKS
	NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	George IOANNIDIS
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Christoph HEINEMEYER
	SCL ING STRUTTURALE DI STEF CALZOL, S.LACAVALLA, S. SESANA, ING ASSOC	ITALIA	Stefano CALZOLARI
	STOW INTERNATIONAL NV	BELGIQUE	Denis JEHIN
	UNIVERSITE DE LIEGE	BELGIQUE	Hervé DEGEE

Selected Publications

Stefano Sesana, Barbara Orsatti. Report on weaknesses of FEM 10.2.08 v.1.04, May 2011 and comparison with RMI-2008. SEISRACKS2 project deliverable WP1.1

Stefano Sesana, Barbara Orsatti. Report on design case-studies. SEISRACKS2 project deliverable WP1.

Nikos Papadopoulos. Scientific algorithms technical description document. SEISRACKS2 project deliverable WP7.1

RFSR-CT-2011-00032 ZEMUSIC

Zero energy solutions for multifunctional steel intensive commercial buildings

Info	Type of Project	Research	Duration (months)	36
	Total Budget	928652 €	Start Date	1/07/2011
	EU Contribution	557191 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

The broad commercial objective of this project is the sustainable value creation in steel building technology by addressing the ways in which significant energy reductions can be made in the operation phase of multi-storey commercial buildings. This is achieved by a combination of energy conservation and energy generation through which energy is collected, stored, transformed and combined with renewable energy sources. The focus will be on systems where the building fabric and structure participates actively in the energy balance of the building. The
innovative objective is to integrate mechanical and electrical systems (M&E) with new innovative structural systems, and by this, the building design can be optimized as one functional system.
The project will address the technical development of integrated systems and will act as the focus for product development.

		Country	*Scientific person in charge*
Partners	**RUUKKI CONSTRUCTION OY**	FINLAND	Jyrki KESTI (Pr. Coord.)
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
	DEBRECENI EG, UNIVERSITY OF DEBRECEN - SCHOOL OF INDEPENDENT FACULTIES	HUNGARY	Tamás CSOKNYAI
	UNIVERSITY OF SURREY	UNITED KINGDOM	Robert LAWSON
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Jyri NIEMINEN

RFSR-CT-2011-00033 SARCO2

Requirements for safe and reliable CO^2 transportation pipeline

Info	Type of Project	Research	Duration (months)	48
	Total Budget	1774879 €	Start Date	1/07/2011
	EU Contribution	1064928 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

Proposal aim is to develop know-how to enable the determination of steel pipe requirements for anthropogenic CO2 pipelines.
Specific goals are:
- Definition of toughness requirements of base material to control running ductile fracture propagation.
- Definition of requirements to control crack initiation event also considering corrosion and stress corrosion cracking phenomena.
- Collect experimental data related to the release of CO2 during a pipeline failure.

Full scale testing on real sections of pipeline will be carried out. The proposal will provide sensible improvements to the application of “Carbon Capture, Transportation and Sequestration technology” to reduce Green House Gases emission

Partners		*Country*	*Scientific person in charge*
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Massimo DI BIAGIO (Pr. Coord.)
	CORINTH PIPEWORKS PIPE INDUSTRY AND REAL ESTATE	HELLAS	Antonios PERGIALIOTIS
	ENI SPA	ITALIA	Carlo Maria SPINELLI
	EUROPIPE GMBH	DEUTSCHLAND	Christoph KALWA
	GDF SUEZ SA	FRANCE	Samuel SAYSSET
	NATIONAL GRID CARBON LTD	UNITED KINGDOM	Russell COOPER
	SALZGITTER MANNESMANN LINE PIPE GMBH	DEUTSCHLAND	Holger BRAUER
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Marion ERDELEN-PEPPLER
	VALLOUREC DEUTSCHLAND GmbH	DEUTSCHLAND	Tanja SCHMIDT

RFSR-CT-2011-00034 COMBITUBE

Bending resistance of steel tubes in combiwalls

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1413246 €	Start Date	1/07/2011
	EU Contribution	847948 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

The present design rules of Eurocode 3 for tubes in CombiWalls lead to over-conservative and uneconomical designs, because the rules for local buckling are inadequate.
Experimental and numerical investigations will be carried to find the bending strength and deformation capacity of spiral welded tubes that are commonly used in CombiWalls, taking proper account of the influences on local buckling of the material behaviour, the structural detailing and the load introduction.
Parameter studies will be carried out and safe and economical design rules will be developed that are suitable for implementation by and are available to the relevant Eurocode 3 committees.

Partners		*Country*	*Scientific person in charge*
	TECHNISCHE UNIVERSITEIT DELFT	NEDERLAND	Frans S.K. BIJLAARD (Pr. Coord.)
	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Marc MEYRER
	BAM INFRACONSULT BV - DEN HAAG INFRADESIGN DONGEN INFRASTR ADVIES	NEDERLAND	Willem GALL
	KARLSRUHER INSTITUT FÜR TECHNOLOGIE (KIT)	DEUTSCHLAND	Thomas UMMENHOFER
	THE UNIVERSITY OF EDINBURGH	UNITED KINGDOM	Michael ROTTER
	PANEPISTIMIO THESSALIAS*UNIVERSITY OF THESSALY	HELLAS	Spyros A. KARAMANOS

Selected Publications

S.H.J. van Es, A.M. Gresnigt, M.H. Kolstein, F.S.K. Bijlaard. Local buckling of spirally welded tubes – Analysis of imperfections and physical testing. Proceedings of the 2013 International Offshore and Polar Engineering Conference (ISOPE), Anchorage, Alaska, June 30-July 5, 2013 (http://www.isope2013.org/).

"A.J. Sadowski, J.M. Rotter (2013). ""Solid or shell finite elements to model thick cylindrical tubes and shells under global bending"". International Journal of Mechanical Sciences, 74C, 143-153. http://dx.doi.org/10.1016/j.ijmecsci.2013.05.008"

"A.J. Sadowski, J.M. Rotter (2013). ""On the relationship between mesh and stress field orientations in linear stability analyses of thin plates and shells"". Finite Elements in Analysis and Design, 73C, 42-54. http://dx.doi.org/10.1016/j.finel.2013.05.004"

RFSR-CT-2011-00035 FRAMEUP

Optimization of frames for effective assembling

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1557277 €	Start Date	1/07/2011
	EU Contribution	934367 €	End Date	30/06/2014
State	Running project			

Provisional Abstract

The project objectives are to develop a concept and make feasibility tests of a new type of execution technique for skeletal system including structurally integrated 3D modules and to establish structural performances of novel joints.
The new execution technique starts with assembling of the roof and top floor to realize a rigid body that will be lifted up by lift towers and jacks. This method protects the structure from precipitation and moisture damage during the assembling phase.
The research will define limits of applications where the concept is competitive compared to existing building alternatives taking into account complete sustainability assessment.

		Country	*Scientific person in charge*
Partners	**LULEÅ UNIVERSITY OF TECHNOLOGY**	SVERIGE	Milan VELJKOVIC (Pr. Coord.)
	ACCIONA INFRAESTRUCTURAS S.A.	ESPAÑA	Carlo PAULOTTO
	PARTCONSTRUCTION AB	SVERIGE	Nils LUNDHOLM
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART
	UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA
	VALLOUREC DEUTSCHLAND GmbH	DEUTSCHLAND	Ole JOSAT

RFS2-CT-2012-00022 INFASO+

Valorisation of knowledge for innovative fastening solutions between steel and concrete

Info	Type of Project	Accompanying measure (studies)	Duration (months)	24
	Total Budget	574993 €	Start Date	1/07/2012
	EU Contribution	344996 €	End Date	30/06/2014
State	Running project			

Project web page www.steelconstruct.com/site/

Provisional Abstract Within RFCS project INFASO design models for innovative, practically relevant steel-to-concrete joints with new concrete components have been developed including electronic tools. This proposal aims at the valorisation and the dissemination of these results to reach a wide audience among designers and engineers in order to assure the application of the outcome. Design Manuals for the engineers in practice are prepared including worked examples. They will be presented and handed out in the frame of several seminars. The implementation of these
models in a future revision of Eurocode is prepared to create a basis for easy application by all European designers.

		Country	*Scientific person in charge*
Partners	**UNIVERSITAET STUTTGART**	DEUTSCHLAND	Ulrike KUHLMANN (Pr. Coord.)
	EUROPEAN CONVENTION FOR CONSTRUCTIONAL STEELWORK	BELGIQUE	Milan VELJKOVIC
	GABINETE DE INFORMATICA E PROJECTO ASSISTIDO POR COMPUTADOR LDA	PORTUGAL	Luis SIMOES DA SILVA
	GOLDBECK BAUELEMENTE BIELEFELD GMBH	DEUTSCHLAND	Rolf HEDDRICH
	STAHL + VERBUNDBAU GESELLSCHAFT FÜR INDUSTRIELLES BAUEN MBH	DEUTSCHLAND	Norbert SAUERBORN
	CESKE VYSOKE UCENI TECHNICKE V PRAZE*CZECH TECHNICAL UNIV. IN PRAGUE	CZECH REPUBLIC	Frantisek WALD

RFSR-CT-2012-00023 LOCAFI

Temperature assesment of a vertical steel member subjected to localised fire

Info	Type of Project	Research	Duration (months)	36
	Total Budget	951918 €	Start Date	1/07/2012
	EU Contribution	571150 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

The final objective of this project is to provide designers with scientific evidence, put in design models and, in the future, in the regulations (Eurocodes) that will allow them to design steel columns subjected to localised fires such as those which may arise, for example, in car parks. In fact, at the time being, such evidence, models and regulations exist for beam located under the ceiling, but nothing is available for columns, and this situation may lead to unnecessary and excessive thermal insulation that jeopardizes the competitiveness of whole steel projects.
More precisely, the objectives are to provide:
1) Scientific evidence about the thermal attack imposed on a steel column that is surrounded by a local fire or attacked by a local fire situation at a distance from the column, namely the emissivity of the flames of the fire source as a function of the thickness (diameter) of the source and the temperatures in the steel columns. The equations that provide the temperature along the centreline of the source will also be verified;
2) Design equations that allow reproducing this thermal attack as well as the temperatures induced in the column, these depending on the time but also on the elevation in the column. These design models will be published and made available in the public domain, but they will also be implemented in existing software such as OZone and SAFIR for an easier utilisation in design offices. The existing nationally determined parameters will be implemented in OZone which will guarantee easier acceptance of this software in all member states (see objective 3);
3) Rules that form the base of the design equations in order to have them implemented in European regulations (Eurocodes), which will make the models automatically accepted without discussion by the authorities of thedifferent Member States.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL BELVAL & DIFFERDANGE S.A.**	LUXEMBOURG	Olivier VASSART (Pr. Coord.)
	CENTRE TECHNIQUE INDUSTRIEL DE LA CONSTRUCTION METALLIQUE	FRANCE	Christophe THAUVOYE
	UNIVERSITE DE LIEGE	BELGIQUE	Jean-Marc FRANSSEN
	UNIVERSITATEA POLITEHNICA DIN TIMISOARA	ROMANIA	Raul Dan ZAHARIA
	UNIVERSITY OF ULSTER	UNITED KINGDOM	Ali NADJAI

RFSR-CT-2012-00024 HYBRO

Safe laser hybrid welding of structural steel by robust systems

Info

Type of Project	Research	Duration (months)	42
Total Budget	1580997 €	Start Date	1/07/2012
EU Contribution	948598 €	End Date	31/12/2015

State Running project

Project web page https://fronter.com/ltu/main.phtml

Provisional Abstract

For thick section and high strength steel structures, hybrid laser-arc welding offers advantages with respect to precision, metallurgy, controllability, automation or speed and in turn quality and costs. However, earlier projects have shown that the promising new generation of fibre- and disc-lasers suffers from narrower process windows than the traditional CO2-lasers. Based on high speed imaging observations and interaction modelling, the consortium identified that the much shorter laser wavelength and its absorption characteristics can cause instable melt pool movements and poor quality, confining the process window. An innovative laser beam and arc shaping technique will be developed to widen the robustness, accompanied by a new camera-based procedure to track quality defects completely back to their joint edge origins. The consideration and understanding of severe geometrical and metallurgical joint edge variations under production conditions is regarded as a key aspect.
The proposal addresses the widening of the robustness of hybrid welding for two large scale demonstrators with challenging joint edge variations, an excavator part and a truck component. In addition the process window for disc- or fibre-lasers up to 20 kW, along with the new robust shaping technique, will be explored for a steel thickness range up to 30 mm, for different join types, and for steel grades up to 790 MPa. Beside comprehensive process parameter development, technique options comparison and process analysis, the study and testing of the fatigue and toughness behaviour of the welds is of importance. Two steel makers, one welding equipment and wire supplier, one construction equipment manufacturer, one truck manufacturer and two academic partners also have the ambition to generalize the findings by developing welding process guidelines and fatigue design rules, to promote efficient welding of steel structures through an advanced, new generation hybrid welding technique.

Partners

	Country	*Scientific person in charge*
LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Alexander KAPLAN (Pr. Coord.)
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ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.	BELGIQUE	Christoph GERRITSEN
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Ulrich JANSEN
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THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Maik BOGATSCH

Selected Publications

Jan Frostevarg, Alexander F.H. Kaplan, Javier Lamas. Comparison of CMT with other arc modes for laser arc hybrid welding of 7 mm steel. Welding in the World (2013).

J FROSTEVARG, A. F. H. KAPLAN. DIFFERENCES BETWEEN ARC MODES IN LASER HYBRID ARC WELDING UPON WELD BEAD STABILITY AND UNDERCUT FORMATION. Accepted for presentation at Nolamp 14 Conference, Sweden, Aug.2013.

Torbjörn Ilar, Ingemar Eriksson, Alexander F. H. Kaplan. SIMULTANEOUS TOP AND ROOT HIGH SPEED IMAGING ON DROPLET FORMATION IN LASER WELDING. Accepted for presentation at ICALEO 2013, US, Oct, 2013.

Jesper Sundqvist1, Ingemar Eriksson1, Alexander F. H. Kaplan1, Markku Keskitalo2, Kari Mäntyjärvi2, Jan Granström1, Karl-Gustaf Sundin1. Measuring the influence of laser welding on fatigue crack propagation in high strength steel. Accepted for presentation at ICALEO 2013, US, Oct, 2013.

I. Eriksson, J. Powell, A. F. H. Kaplan. Guidelines in the choice of parameters for hybrid laser arc welding with fiber lasers. Physics Procedia.41, s. 119–127.9 s. http://dx.doi.org/10.1016/j.phpro.2013.03.059

RFSR-CT-2012-00025 FRISCC

Fire resistance of innovative and slender concrete filled tubular composite columns

Info

Type of Project	Research	Duration (months)	36
Total Budget	1659613 €	Start Date	1/07/2012
EU Contribution	995768 €	End Date	30/06/2015

State Running project

Project web page http://friscc.blogs.upv.es/

Provisional Abstract

Concrete-filled steel tubular (CFST) members are commonly used as composite columns in modern buildings.
However, current guidelines for member design in fire (EN1994-1-2) have been proved to be unsafe once the relative slenderness is higher than 0.5. In addition, the simplified design methods of Eurocode 4 are limited to circular or square CFST columns, while in practice columns with rectangular and elliptical hollow sections or any of the new innovative cross-sections types (hollow steel section with embedded core steel profiles) are being increasingly used because of their architectural aesthetics.
Therefore, this project will seek to definitely improve the existing situation by means of the following relevant actions:
- First of all, a full understanding of the fire behavior of slender concrete-filled hollow steel section columns of circular and square cross-section will be obtained on the basis of a full range of experimental and numerical investigations. Furthermore, the fire resistance of rectangular and more innovative cross-sections as the elliptical shapes or CFST columns with embedded steel core profiles will be also studied. However, prior to the above investigation, specific preparation works will be conducted in order to ensure the consistency of the scientific approaches to be used in this project.
- Secondly, a solid technical background document will be created to support the improved design methods to be included in the future fire part of Eurocode 4 for the fire design of these structural members.
- Thirdly, a user-friendly design tool will be developed within the scope of this project in order to facilitate in an enormous way the daily design work of engineers of such type of steel members in fire.
Thanks to the new solid design basis which will be produced through the results of this research, the design of slender CFST columns without fire protection will be facilitated what will contribute to extend their usage.

Partners

	Country	*Scientific person in charge*
UNIVERSITAT POLITÈCNICA DE VALÈNCIA	ESPAÑA	Manuel L. ROMERO (Pr. Coord.)
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IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Leroy GARDNER
UNIVERSIDADE DE COIMBRA	PORTUGAL	Joao Paulo RODRIGUES
GOTTFRIED WILHELM LEIBNIZ UNIVERSITÄT HANNOVER	DEUTSCHLAND	Peter SCHAUMANN

Selected Publications

Cristophe Renaud, Giselle Bihina, Manuel L. Romero, Ana Espinós, Peter Schaumann, Inka Kleiboemer, Gorka Iglesias. “Review of the existing usage”. FRISCC project deliverable 1.1. URL http://friscc.blogs.upv.es/files/2013/05/FRISCC-Deliverable-1.1_prot.pdf

RFSR-CT-2012-00027 HIPERCUT

High performance cut edges in structural steel plates for demanding applications

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1029948 €	Start Date	1/07/2012
	EU Contribution	617969 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

Many fabrication and design standards place restrictions on the use of cut edges, particularly where the application involves fatigue loading, and do not reflect the capabilities of modern cutting techniques such as laserbeam and plasma-arc. These techniques have advantages in terms of cut edge quality, tolerances, speed and cost. The objective of this project is to quantify the effect of laser and plasma-arc cut edge quality on the fatigue and fracture resistance of HSLA plates. This will enable the optimisation of these cutting processes for demanding applications. Guidance to optimise edge quality and service performance of cut edges specifically for the yellow goods (lifting & excavating) and construction sectors will be developed, although the results will be applicable across all sectors.

In the project a range of structural steel plates of 355-890MPa yield stress and thickness 8-25mm will be cut using laser, plasma arc and conventional flame cutting methods, all with varying process parameters. Edge cut quality will be evaluated in terms of HAZ depth and morphology, hardness, surface roughness, micro-cracks and residual stress. The fatigue performance of the edges will be evaluated using a range of specimen designs and SN curves for the different cutting methods/process parameters will be determined. Interrupted fatigue tests will also be carried out followed by electron microscopy to determine the initiating features. Inherent fracture toughness of the HAZ of the cut edges will be measured using a novel laminated specimen design and the initiation, propagation and fracture arrest properties also evaluated. The plastic strain capacity of cut edges will also be determined.

Recommendations for a suitable acceptance specification for cut edges will be provided for inclusion in fabrication and design codes.

		Country	*Scientific person in charge*
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	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Antonio MARTIN MEIZOSO
	SILESIAN UNIVERSITY OF TECHNOLOGY - POLITECHNIKA SLASKA	POLAND	Andrzej KLIMPEL
	UNIVERSIDAD DE CANTABRIA	ESPAÑA	Sergio CICERO GONZALEZ

RFSR-CT-2012-00028 HILONG

High strength long span structures

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1602389 €	Start Date	1/07/2012
	EU Contribution	922797 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

The use of high strength steel (HSS) can lead to a significant reduction in the weight of a steel structure. A lighter structure requires smaller foundations, shorter transportation and construction times, and leads to lower CO2 emissions and energy use. Although HSS have found application in machinery and automotives, they are not widely used in construction because the benefit of reduced weight struggles to outweigh the disadvantages of higher price/tonne, reduced availability and different weld procedures.

The purpose of the proposed work is to investigate innovative structural arrangements, design methods and cross-sections which enable the benefit of high strength to be maximised by suppressing buckling and reducing deflection. The study will have a particular focus on long span applications such as stadia, auditoria, exhibition halls etc.

The research programme will be informed by close consultation with designers of long span structures throughout the project.

The grades of HSS to be studied are S460 and S690.

The technical objectives of the work are:

1. To develop more cost-effective design methods which suit the specific material characteristics of HSS
2. To develop design methods for HSS prestressed cable-stayed columns and post-tensioned trusses which enable a greater proportion of the higher strength to be utilised by suppressing buckling and limiting deflection
3. To investigate the structural performance of innovative U-shaped and semi-closed polygonal cross-sections which enable joints to be fabricated more easily
4. To develop comparative designs for two functionally equivalent long span structures, one using HSS and one using conventional structural steel, which demonstrate the potential savings possible using HSS in terms of weight, cost, energy and CO2 emissions
5. To prepare a series of design examples for members and joints which demonstrate the design methods developed.

		Country	*Scientific person in charge*
Partners	**THE STEEL CONSTRUCTION INSTITUTE LBG**	UNITED KINGDOM	Nancy BADDOO (Pr. Coord.)
	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Leroy GARDNER
	LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Milan VELJKOVIC
	S2 CORPORATION PTY LTD	AUSTRALIA	Murray ELLEN
	SWECO STRUCTURES AB	SVERIGE	Lars CEDERFELDT
	THE UNIVERSITY OF BIRMINGHAM	UNITED KINGDOM	Charalampos BANIOTOPOULOS
	UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA
	VALLOUREC DEUTSCHLAND GmbH	DEUTSCHLAND	Christian REMDE

RFSR-CT-2012-00029 ROBUSTIMPACT

Robust impact design of steel and composite building structures

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1493344 €	Start Date	1/07/2012
	EU Contribution	896008 €	End Date	30/06/2015
State	Running project			

Project web page http://www.steelconstruct.com/site/ (see Projects--> Member Projects-->

Provisional Abstract Within the proposal a new concept for impact design of steel/composite members, which combine the residual strength and the alternate load path method, will be developed. These two fundamental design strategies are integrated in a stepwise procedure to ensure a better resistance against progressive collapse. Within the codes the existing concept for impact design based on stiff member behaviour like for massive concrete columns and ignores the advantages of ductile materials like steel. The main outcome consists in guidelines and tools for advanced impact design of steel/composite structures. Thereby redundancy and safety of steel structures are increased and the application of steel is encouraged in view of future demands.

Partners	*Country*	*Scientific person in charge*
UNIVERSITAET STUTTGART	DEUTSCHLAND	Ulrike KUHLMANN (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Renata OBIALA
INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE RENNES	FRANCE	Mohammed HJIAJ
MATERIALS AND SYSTEMS FOR SAFETY AND SECURITY SPRL*MS3	BELGIQUE	Sébastien FLAWINNE
RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Markus FELDMANN
UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART
UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Riccardo ZANDONINI

RFSR-CT-2012-00030 DISCCO

Development of improved shear connection rules in composite beams

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1533463 €	Start Date	1/07/2012
	EU Contribution	920077 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

This project will develop more economic shear connection rules for use in the design of modern long span composite beams which can be adopted as future changes to EN 1994-1-1. This objective will be achieved by a test programme on composite beams that will be analysed by advanced numerical models, using realistic non– linear material properties and load –slip relationships of the shear connectors. These models will be used to develop new shear connection rules for un-propped beams, highly asymmetric beams, cellular beams and other practical cases not covered by EN1994-1-1. A standard push out test will be devised to determine the resistance and deformation capacity of shear connectors in composite slabs , which will be correlated against the beam tests.
Tests on 15m span asymmetric beams with partial shear connection will provide information on the effect of end slip as a function of the bending utilisation of the beam. A related factor is the amount of transverse reinforcement that is needed to control longitudinal splitting along the line of shear connectors. Membrane effects in floor plates will be investigated as they provide a confining effect which can reduce the required amount of reinforcement, particularly for primary beams.

		Country	*Scientific person in charge*
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	ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Renata OBIALA
	UNIVERSITY OF BRADFORD	UNITED KINGDOM	Dennis LAM
	UNIVERSITE DU Luxembourg	LUXEMBOURG	Christoph ODENBREIT
	UNIVERSITAET STUTTGART	DEUTSCHLAND	Ulrike KUHLMANN

RFSR-CT-2012-00032 SEQBRI

Performance-based earthquake engineering analysis of short-medium span steel-concrete composite bridges

Info

Type of Project	Research	Duration (months)	36
Total Budget	1401959 €	Start Date	1/07/2012
EU Contribution	841176 €	End Date	30/06/2015

State Running project

Project web page www.seqbri.it

Provisional Abstract

Nowadays, short-medium span steel-concrete composite I-girder bridges made of hot rolled steel beams are very popular, owing to their short construction time and reduced costs. Moreover, they are very adequate for seismic areas for their limited weight. With regard to static loading, these bridges can be designed based on recent Guidelines; however, seismic loading has not been yet investigated, and thus, they may exhibit damages even in low-seismicity zones. SEQBRI aims at applying the PBEE methodology to these bridges with S355M/N-S460M/N fine grain steels, to provide the foundation for a new generation of European seismic codes and to extend EN1998-1 and EN1998-2.

Partners

	Country	*Scientific person in charge*
UNIVERSITA' DEGLI STUDI ROMA TRE	ITALIA	Fabrizio PAOLACCI (Pr. Coord.)
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Nicoleta POPA
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RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Benno HOFFMEISTER
SERVICE D'ETUDES SUR LES TRANSPORTS, LES ROUTES ET LEURS AMENAGEMENTS	FRANCE	Christian CREMONA
UNIVERSITA DEGLI STUDI DI TRENTO	ITALIA	Oreste S. BURSI

RFSR-CT-2012-00033 BATIMASS

Building in active thermal mass into steel structures

Info

Type of Project	Research	Duration (months)	36
Total Budget	1351784 €	Start Date	1/07/2012
EU Contribution	811070 €	End Date	30/06/2015

State Running project

Provisional Abstract

Thermal inertia (or thermal mass) of the building fabric can reduce internal temperature variations within buildings, depending on the occupancy pattern, and can lead to savings in primary energy consumption. This proposal will investigate the ways in which the thermal inertia of steel structures can be increased by various additional measures, including embedded water pipes in composite floor slabs and use of phase change materials within floors and walls of light steel construction. The sectors of interest are commercial (office) buildings in which cooling to counteract heat gains represents a high proportion of energy use, and residential buildings, where control of over-heating in highly insulated but lightweight building fabric is important. The ways in which thermal inertia can be included in whole building energy models will be investigated. Structural and heat flow tests will be carried out to evaluate the effects of embedded pipes on the performance of composite floors.
Whole building tests will be carried out to correlate with the laboratory tests.

Partners

	Country	*Scientific person in charge*
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OXFORD BROOKES UNIVERSITY	UNITED KINGDOM	Raymond G. OGDEN
TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Jyri NIEMINEN

RFSR-CT-2012-00035 BIOGASS

Innovative and competitive solutions using SS and adhesive bonding in biogas production

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1316653 €	Start Date	1/07/2012
	EU Contribution	789992 €	End Date	30/06/2015
State	Running project			

Project web page www.biogassproject.eu

Provisional Abstract Biogas production is essential for effective environmental management and rural development as it is a truly renewable energy source which recycles and valorises waste by producing biogas and bio-fertilizers. In this context, the BiogaSS project intends to go further in making this renewable energy source more sustainable by developing cost effective solutions using stainless steels which, in themselves, are recyclable materials relative to concrete (the most currently used material in biodigesters). Systematic corrosion testing of existing SS grades combined with innovative designs and joining methods are at the core of this research project, thus strengthening the position of SS in the market.

		Country	*Scientific person in charge*
Partners	**METALOGIC AI TECHNOLOGIES & ENGINEERING NV**	BELGIQUE	Erik THOMAS (Pr. Coord.)
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	WELTEC BIOPOWER GMBH	DEUTSCHLAND	Robert THOLEN

RFSR-CT-2012-00036 RUOSTE

Rules on high strength steel

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1563366 €	Start Date	1/07/2012
	EU Contribution	938021 €	End Date	30/06/2015
State	Running project			

Provisional Abstract

The use of high strength steels in civil engineering has been mainly limited to special applications like offshore drilling rigs, pipelines and heavy industrial plants, occasional for bridges and long span trusses.
These steels offer many advantages that could be utilized more widely in construction industry: because of weight savings, the carbon footprint is reduced and the reduced material consumption often compensates for the higher raw material price. Additionally, thinner sections mean less welding work, which reduce transportation and fabrication costs.
The main objective of Ruoste project is to enhance the competitiveness and provide requirements for larger use of steel grades up to S 960 in a new type of multi-story buildings and industrial halls. Steel grades higher than S 460 and up to S 700 are regimented in EC3-1-12, but some rules are very conservative and hard to fulfil. A special part of the EC3 for HSS has been seen as an obstacle for wider application.
Rules limiting the application areas are mainly coming from ductility requirements: the requirements are not completely justified with physical background but proposed based on best available engineering judgement. Tests adequate specimens are evaluated to define the realistic limits of applications. The high demands regarding joints and especially welded connections in EC will be examined, to propose the most economical and sustainable solutions.
Advantages of HSS regarding stability issues are taken into account to allow for slender structures and allow for competitive practical applications.
In case studies the developed recommendations as well as the actual status of EC will be compared and evaluated focusing on the complete assessment of relevant sustainability.
All results achieved will be collected in a design guide with solved numerical examples, to provide comprehensive design aids to structural engineers. Recommendations will be given to widen scope of EC3-1-12 for steel grades up to S 960.

		Country	*Scientific person in charge*
Partners	**RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN**	DEUTSCHLAND	Markus FELDMANN (Pr. Coord.)
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	LULEÅ UNIVERSITY OF TECHNOLOGY	SVERIGE	Milan VELJKOVIC
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	LAPPEENRANTA UNIVERSITY OF TECHNOLOGY - LAPPEENRANNAN TEKNILLINEN YL.	FINLAND	Timo BJÖRK
	VOESTALPINE KREMS GMBH	OESTERREICH	Alfred SEYR

Selected Publications

Report on criteria and choice of case studies (D.1)

Report on material costs and fabrication costs defined by measuring

RFSR-CT-2012-00026 S+G

Innovative steel glass composite structures for high-performance building skins

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1553800 €	Start Date	1/09/2012
	EU Contribution	932280 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

High-innovation of products is a worldwide key-competitive factor. The most important technological achievements in modern architecture are attained by constructing smart building skins, usually by combining glass and metal (so far mainly aluminum). S+G project studies composite Steel+Glass systems for highperformance skins using revolutionary adhesive junctions meeting requirements of: energetic/structural efficiency, aesthetical high value (free-form design), reuse and recycling. Because of differential thermal expansion with glass, those adhesive junctions are compatible with steel only. This is a keyfactor in the inter-material competition (steel vs. aluminium) and for the competitiveness of the European steel and building industry throughout the world.

		Country	*Scientific person in charge*
Partners	**UNIVERSITA DEGLI STUDI DI PARMA**	ITALIA	Gianni ROYER CARFAGNI (Pr. Coord.)
	ACCIAI SPECIALI TERNI SpA	ITALIA	Gianluca GIGLI
	DOW CORNING EUROPE SA	BELGIQUE	Patrick VANDEREECKEN
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Björn ABELN
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	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE	UNITED KINGDOM	Mauro OVEREND
	UNIVERSITÁ DI PISA	ITALIA	Walter SALVATORE

Selected Publications

L. Galuppi, G. Manara, G. Royer-Carfagni. Practical expressions for the design of laminated glass. Comp. Part B – Eng. 45 (2013), 1677–1688. DOI 10.1016/j.compositesb.2012.09.073. URL www.sciencedirect.com/science/article/pii/S1359836812006245

L. Galuppi, G. Royer-Carfagni. The design of laminated glass under time-dependent bending. Int. J. Mech. Sci. 68 (2013), 67–75. DOI 10.1016/j.ijmecsci.2012.12.019. URL http://www.sciencedirect.com/science/article/pii/S0020740313000052

L. Galuppi, G. Royer-Carfagni. The effective thickness of laminated glass: inconsistency of the formulation in a proposal of EN-standards. Comp Part B - Eng 55 (2013), 109–118. DOI 10.1016/j.compositesb.2013.05.025. URL http://www.sciencedirect.com/science/article/pii/S1359836813002795

L. Galuppi, G. Manara, G. Royer-Carfagni. Enhanced effective thickness method for laminated glass. A case study. XXVII A.T.I.V. Conference, Parma (Italy), 15-16 November 2012

L. Galuppi, G. Royer-Carfagni. The Enhanced Effective Thickness method for Laminated Glass. GPD (Glass Performance Days) 2013, Tampere (Finland), 13-15 July 2013.

RFSR-CT-2012-00031 SMARTCOCO

Smart composite components - concrete structures reinforced by steel profiles

Info

Type of Project	Research	Duration (months)	36
Total Budget	1458639 €	Start Date	1/09/2012
EU Contribution	875183 €	End Date	31/08/2015

State Running project

Provisional Abstract

The project studies the behaviour of composite steel concrete components in which steel profiles are used to reinforce concrete structures, such as in concrete columns reinforced by several steel sections or in concrete columns reinforced by steel sections over only one storey. Those real world situations are not currently covered by codes. A generic design approach will be proposed and then used to devise experiments which will afterwards serve to validate and calibrate the method. The outcome will be design guidance implementable in Eurocode 2 or 4, as appropriate.

Partners

	Country	*Scientific person in charge*
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IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE	UNITED KINGDOM	Ahmed ELGHAZOULI
INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE RENNES	FRANCE	Mohammed HJIAJ

RFSR-CT-2012-00034 JOINOX

Guidelines for use of welded stainless steel in corrosive environments

Info	Type of Project	Research	Duration (months)	42
	Total Budget	990487 €	Start Date	1/09/2012
	EU Contribution	594292 €	End Date	29/02/2016
State	Running project			

Project web page http://www.joinox.com/

Provisional Abstract During welding of stainless steels thermal oxides form and may, unless removed, cause severe reduction in corrosion resistance. They are often the underlying cause behind structural failures and in many applications it is necessary to remove them through combination of cleaning operations. Typical is mechanical cleaning in
combination with chemical cleaning, which is time consuming and has a negative environmental impact. Current European standards do not provide specific recommendations on acceptance criteria of weld oxides for specific environments or suggestions on cleaning operations. This project aims to develop a scientifically based guideline to determine fitness for purpose weld oxide surface and suggest appropriate post-weld cleaning strategies.

		Country	*Scientific person in charge*
Partners	**SWEREA KIMAB AB**	SVERIGE	Nuria FUERTES CASALS (Pr. Coord.)
	BÖHLER WELDING HOLDING GmbH	DEUTSCHLAND	Martin LARÉN
	FUNDACIO CTM CENTRE TECNOLOGIC- CTM	ESPAÑA	Anna GIRONES
	MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Michael ROHWERDER
	OUTOKUMPU STAINLESS AB	SVERIGE	Rachel PETTERSSON
	AB SANDVIK MATERIALS TECHNOLOGY	SVERIGE	Mette FRODIGH
	TWI LTD	UNITED KINGDOM	Marcio MILITITSKY

RFS2-CT-2013-00016 LVS3

Large Valorisation on Sustainability of Steel Structures

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	1168645 €	Start Date	1/07/2013
	EU Contribution	701187 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

The technical objective is to disseminate the knowledge acquired in the recent years about the environmental impact assessment of steel and composite buildings. During the last decade, a lot of research projects have been funded to develop methodologies, systems and products aiming at improving the thermal efficiency as well as the global environmental footprint of steel buildings. The new standard EN15804 intended for environmental calculation of buildings takes now into account the fact that steel is a recyclable material (Module D). Within this project, documents such as leaflet and design guides and software ... will be created and disseminated amongst Europe by the organisation of workshops.

Partners	*Country*	*Scientific person in charge*
ARCELORMITTAL BELVAL & DIFFERDANGE S.A.	LUXEMBOURG	Olivier VASSART (Pr. Coord.)
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BAUFORUMSTAHL E.V.	DEUTSCHLAND	Bernhard HAUKE
BOUWEN MET STAAL	NEDERLAND	Ralph HAMERLINCK
CLUB ASTURIANO DE LA INNOVACION	ESPAÑA	Patricia GARCÍA ZAPICO
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INSTYTUT TECHNIKI BUDOWLANEJ	POLAND	Michal PIASECKI
NATIONAL TECHNICAL UNIVERSITY OF ATHENS	HELLAS	Maria FOUNTI
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UNIVERSITE DE LIEGE	BELGIQUE	Jean-Pierre JASPART
UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II	ITALIA	Raffaele LANDOLFO
UNIVERSIDADE DE COIMBRA	PORTUGAL	Luis SIMOES DA SILVA
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VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS	LITHUANIA	Audronis Kazimieras KVEDARAS

RFSR-CT-2013-00017 SCIENCE

SC for Industrial, Energy and Nuclear Construction Efficiency

Info	Type of Project	Research	Duration (months)	45
	Total Budget	2311188 €	Start Date	1/07/2013
	EU Contribution	1386712 €	End Date	31/03/2017
State	Running project			

Provisional Abstract

A steel-concrete-steel composite (SC) structure is constructed by placing concrete between two steel plates that serve as permanent formwork. Studs welded on the inner surface of the steel plates are embedded in the concrete to tie the concrete and steel plates together and transfer shear between them. SC leads to faster construction and cost saving in industrial sectors currently dominated by reinforced concrete (e.g. nuclear power plant, foundations to offshore wind towers, bridges and marine structures). The advantages are largely derived from (i) the elimination of formwork, (ii) the elimination of reinforcing bars, (iii) the ability to support equipment anywhere on the steel plate without the need for special attachments and (iv) from moving a considerable amount of work from site to fabrication shops. The design of SC structures is not covered by the Eurocodes. The project will generate data on the behaviour of SC structures at ambient and elevated temperature using a combination of design studies, advanced numerical analysis and a series of test programmes. It will study (i) the behaviour of elements and connections; (ii) the effect of thermal actions (due to extended exposure to temperatures between 100° and 170°C) on SC structures and the behaviour of the structure after cooling (this is relevant to applications in the nuclear sector); (iii) hybrid SC panels comprising carbon and stainless steel used in certain corrosive environments; and (iv) the behaviour of SC elements in fire. It will lead to (a) effective properties or equivalent shell elements that can be used for practical design office use of FE analysis of SC structures; (b) comparative design studies between SC and equivalent reinforced concrete structures; and (c) design rules that will fill a gap in the Eurocodes. The project will add value by creating a new significant market in fabricated steel and stainless steel plate construction for the steel sector.

		Country	*Scientific person in charge*
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	KARLSRUHER INSTITUT FÜR TECHNOLOGIE (KIT)	DEUTSCHLAND	Harald MÜLLER
	UNIVERSITY OF SURREY	UNITED KINGDOM	Marios CHRYSSANTHOPOULOS
	TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Ludovic FULOP

RFSR-CT-2013-00019 PROINDUSTRY

Seismic protection of industrial plants by enhanced steel based systems

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1567913 €	Start Date	1/07/2013
	EU Contribution	940749 €	End Date	31/12/2016
State	Running project			

Provisional Abstract Objective of the proposal is the development of enhanced seismic protection systems for process plants, process units, storage units, pipeline and pipe systems, through innovative antiseismic techniques: seismic isolation systems and energy dissipation systems. The systems shall be suitable for both the retrofit of existing industrial structures and the design of new ones. Particular attention will be given to the self-centring capacities of the systems as it will constitute an innovative and efficient ability that will rise up the protection against the earthquake, avoid interruptions of production after the seismic event and make easier repairs of the structure.

		Country	*Scientific person in charge*
Partners	**UNIVERSITÁ DI PISA**	ITALIA	Walter SALVATORE (Pr. Coord.)
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	NEAPOLIS UNIVERSITY	CYPRUS	Carlo Andrea CASTIGLIONI
	UNIVERSITA DEGLI STUDI DI ROMA "LA SAPIENZA"	ITALIA	Franco BRAGA

RFSR-CT-2013-00020 BASIS

Blast Actions on Structures in Steel

Info	Type of Project	Research	Duration (months)	45
	Total Budget	1509577 €	Start Date	1/07/2013
	EU Contribution	905747 €	End Date	31/03/2017
State	Running project			

Provisional Abstract

Previous work on design of buildings to withstand actions due to explosions focused on response under gravity load following local damage were sudden column loss has been adopted as an accident-independent scenario. In a major industrial explosion, a “global” action acts on the building. Response is influenced by magnitude, rise time and duration of these actions and there is a strong coupling between the action and the structure due to reflection and diffraction effects. Once the building envelope fails, pressure distribution can be amplified by multiple reflections and acts upwards on slabs at lower levels. Focus in this project is on global response of low to medium rise buildings to actions due to industrial explosions. Explosion tests representing industrial accidents involving different substances will be performed on a building scale model to quantify the nature and distribution of the actions. Computational Fluid Dynamics tools will be validated and used to generate actions for subsequent tests and numerical studies. The response of sub-assemblies (cladding/frame, beam-column connections and floor systems) will be studied in large scale tests. Explosion loading in the tests will act upwards on the slabs and connections, a situation for which they are not designed under normal conditions. Static tests will be used to quantify the effect of explosion damage on a floor’s ability to contribute to the building’s stability. Using numerical models, validated against the tests, the global collapse behaviour of buildings will be studied. Numerical analysis will also be used to explore structural retrofitting possibilities for existing buildings. Design guidance will be developed which can be used to fill gaps in the Eurocodes. A simplified analysis tool suited for design office use will be developed. A reference building will be used throughout to evaluate the actions, analyse global response, consider retrofitting strategies and provide design examples.

		Country	*Scientific person in charge*
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	INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE RENNES	FRANCE	Mohammed HJIAJ
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jesus DIEZ

RFSR-CT-2013-00021 EQUALJOINTS

European pre-QUALified steel JOINTS

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1642713 €	Start Date	1/07/2013
	EU Contribution	985628 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

The proposed research project is concerned with the pre-qualification of all-steel Beam-to-Column joints in steel structures and it is aimed at introducing a codified practice currently missing in Europe. Although other research investigations have been early carried out on the seismic behaviour of steel Beam-to-Column joints at European level, none was aimed at prequalifying specific configurations on the basis of parametric experimental investigations. This is mainly evident in the case of dissipative beam-to-column connections, where many issues still remain open. At the present time, there are no reliable design tools able to predict the seismic performance of dissipative Beam-to-Column connections in order to meet code requirements. With this regard, EC8 prescribes design supported by experimental testing, which results in impractical solutions within the time and budget constraints of real-life projects. On the other hand, also for full-strength joints reliable design tools are necessary. Since, owing to the variability of steel strength, these connections could not have enough overstrength and in such cases their plastic rotation capacity must be prequalified by relevant test and numerically based procedures. The use of prequalified joints is a common practice in US and Japan. Nevertheless, the standard joints pre-qualified according to codified procedures in US and Japan cannot be extended to Europe. The proposed research project aims to fill all these gaps. This project is planned and finalized as a pre-normative research aiming to propose relevant criteria for the next version of EN 1998-1. In detail, the research will focus on the standardization of design and manufacturing procedures on the basis of different geometric and mechanical parameters of selected joint typologies. Hence, a large experimental programme supported by theoretical and numerical analyses is proposed to provide reliable standard joints that can be easily used by designers.

		Country	*Scientific person in charge*
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RFSR-CT-2013-00022 Meakado

Design of steel and composite structures with limited ductility requirements for optimized performances in moderate earthquaKe areas

Info

Type of Project	Research	Duration (months)	36
Total Budget	1305025 €	Start Date	1/07/2013
EU Contribution	783015 €	End Date	30/06/2016

State Running project

Provisional Abstract

The global aim of the proposed research is to develop specific design methodologies for steel and steel-concrete composite structures in regions characterised by a low to moderate seismic activity, with an appropriate reliability level. The objective is to find an optimal balance between safety and economical concerns. Two parallel ways are proposed. The first one is based on the exploitation of dissipative phenomena that are commonly not considered while the second one consists in investigating the possibilities of adequately adapting the requirements provided by existing seismic codes to moderate seismicity.

Partners

	Country	*Scientific person in charge*
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POLITECNICO DI MILANO	ITALIA	Carlo Andrea CASTIGLIONI
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FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Jose Antonio CHICA

RFSR-CT-2013-00023 SAFEBRICTILE

Standardization of Safety Assessment Procedures across Brittle to Ductile Failure Modes

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1098196 €	Start Date	1/07/2013
	EU Contribution	658918 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

Currently, safety assessment is not consistently considered throughout the many parts of Eurocode 3, mainly due to a lack of guidance and lack of existing databanks containing information on the distribution of the relevant basic variables and steel properties. Therefore, in SAFEBRICTILE an objective and consistent assessment procedure for the safety assessment of the various failure modes that are relevant for steel structures is developed. The unified procedure will result in codified procedures for inclusion in the structural eurocodes and is able to cover: • ductile failure modes (driven by plasticity), • semi-ductile failure modes (driven by stability) and • brittle failure modes (driven by fracture). One of the main goals in Eurocode 3 development is therefore achieved in future versions – consistent safety level throughout the many parts. A complementary and required task to accomplish this is also carried out within this project and consists of the conceptual development and further maintenance of an European database of steel properties resulting from experimental tests. In addition, several rules in Eurocode 3 covering the failure modes treated in the project are reassessed in order to fulfil the developed safety assessment procedures. The results of this project will lead to major competitiveness gains: (1) faster time-cycle in the development of new design procedures able to cope with innovation; (2) increased reliability in the accuracy of new design models; (3) major savings in R&D costs by avoidance of major duplication of work.

		Country	*Scientific person in charge*
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	UNIVERSITAET STUTTGART	DEUTSCHLAND	Ulrike KUHLMANN

RFSR-CT-2013-00024 MATCH

Material Choice for Seismic Resistant Structures

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1394599 €	Start Date	1/07/2013
	EU Contribution	836759 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

In civil and mechanical engineering, damage caused by load cycles with large plastic amplitudes are frequently reported. A typical failure mechanism is the fracture due to ultra-low-cycle-fatigue in case of seismic events. As reported from the devastating earthquakes in Northridge and Kobe such failures were often the result of insufficient deformation capacity in combination with non-appropriate toughness properties of the steel material. Eurocode 3 provides a procedure for the choice of steel material in the lower part of the toughness-temperature-diagram to avoid brittle fracture. Concerning plastic design, there are some empirical rules in EC3 and 8 for monotonic and cyclic loading, but these rules are related to ductility and are not justified by toughness considerations. All these recommendations are rather general and need a mechanical justification or a substitution by substantiated realistic material requirement. As a consequence EC3 and 8 need extension in terms of toughness-related demands for plastic design. First promising attempts by means of innovative damage mechanics on how to ensure a sufficient ductile behaviour related to toughness demands have been developed in the RFCS-Project PLASTOTOUGH. The original nature of damage mechanics is physically based and related to the micromechanical processes in the metallic structure. This method has been successfully applied to welded beam-column-connections in combination with the effective plastic strain concept acc. to Ohata and Toyada. However, recent research has shown that the damage model needs extension in case of dominant shear stress by considering the third invariant of the stress deviator. To verify this new approach its application to components with a high portion of shear stress is to be investigated. As damage mechanics based quantities do not constitute appropriate material properties the definition of a minimum Charpy impact value as toughness parameter in the upper shelf would be suitable.

		Country	*Scientific person in charge*
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RFSR-CT-2013-00025 SBD-SPipe

Strain-based design of spiral-welded pipes for demanding pipeline applications

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1910794 €	Start Date	1/07/2013
	EU Contribution	1146475 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

Oil and gas operating companies are nowadays more and more interested in using spiral welded pipes for transportation of energy resources over long distance pipelines. A series of spiral welded (HSAW) pipelines are already built, under construction or planned for the future, and there exist a considerable number of HSAW pipe producers, especially in Europe and Asia. The recent advancements in the metallurgical and manufacturing process of spiral-welded pipes are quite promising for their use in demanding pipeline applications, especially in terms of structural integrity issues, in both on- and off-shore scenarios. However, the use of such pipes in demanding pipeline applications is generally limited, especially for offshore pipelines, due to lack of reliable technical data. On the other hand, there is strong demand on investigating this matter, in order to convince oil and gas operating companies to extend the range of applicability of spiral-welded pipes. The general aim of the SBD-SPipe project is to generate specific know-how concerning the development and possible use of HSAW pipes for demanding application both onshore and offshore, requiring good performance under application of large strains. The outcome of this project can also be used as technical basis for improving standards and guidelines for O&G pipelines, addressing design and safety of spiral-welded pipelines. The following issues will be accounted for: plastic collapse by external pressure, local plastic instability due to biaxial loading conditions, failure due to axial tension at weld joints. Numerical and experimental activities will be carried out. In particular small and fullscale laboratory testing programmes will be carried out on spiral welded pipes (and their girth welded butt joints) in steel grade in the range API X60 - X80 and outer diameter ranging from 24” to 48”, with adequate wall thickness so that the resulting geometry is representative for both on and offshore applications.

		Country	*Scientific person in charge*
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RFSR-CT-2013-00026 BASSE

Building Active Steel Skin

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1082687 €	Start Date	1/07/2013
	EU Contribution	649612 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

The project is based in the consortium's awareness about society's concern in the use of more environmentally friendly technologies and that the building sector has to contribute significantly by a drastic and significant reduction of its energy consumption. In this context, there are many solar capturing technologies to reduce the carbon footprint of a building. Many experiences in the application of these technologies in the construction sector demonstrate that they can contribute to a more sustainable building industry. Despite these technological progresses, the reality is that the application of these techniques is limited, as most of them need of specific engineering and adaptation for each constructive project, leading to elevated costs, technical complexities, and defaults in the application of these systems. For most advanced solutions, the existing case studies are mainly forced by research experiences and are not being implemented in the market with the expected rhythm to achieve the energy reduction goals. In this context, the project aims to push technological innovation in steel manufacturing forward by developing a new energy generation steel skin, based in a well-established steel product such as sandwich panels, and robust and increasingly used heat pumping system, which will be integrated and pre-engineered, for plug & play integration in buildings. This will strongly impulse the introduction of energy saving strategies in the building envelope market. Key areas of work intended within this proposal are reflected in EU strategic research agendas and EU platform visions, such as the ESTEP 2050 vision for energy efficient construction, which stipulates migration trends from traditional construction to off-site manufactured construction whilst also pursuing the energy efficiency goals under the roadmap development themes of Energy Efficiency, Energy Effectiveness, Energy Optimisation and Contributory buildings specifically the EU's Low Carbon

		Country	*Scientific person in charge*
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RFSR-CT-2013-00018 GRISPE

Guidelines and Recommendations for Integrating Specific Profiled steel sheets in the Eurocodes

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1414553 €	Start Date	2/09/2013
	EU Contribution	848732 €	End Date	31/08/2016
State	Running project			

Provisional Abstract

GRISPE intends to contribute to the on-going evolution of the Eurocodes and in particular EN 1993-1-3 (priority 2.8 of the 2012 RFCS Programme). The research will develop technical guidelines and background information and draft annexes for a number of commercially and industrially relevant steel profiles not included in the current version of the Eurocodes, ready for implementation in the process of revision which is due to be concluded by 2017. No harmonised design exists for these profiles as they have appeared on the market in very recent years to answer the needs of the modern industrial buildings and to meet the new regulation relating in particular to sustainability, energy efficiency and environmental issues. The types of profiles which have been selected for the project include new shapes of decks/special deck profiles for composite slabs, corrugated sheeting, liner trays with widths in excess of 600 mm and with spacers at a distance of more than 1m, curved roof or cladding sheeting. A number of structural issues is also be addressed including the impact of embossment/indentation on the tension, bending and shear resistance of steel sheeting, the impact of holes which are drilled or cut on site during the installation of profiles and the impact of perforation of profiles to improve their acoustic performance or for the passage of services. To prepare the inclusion of the selected profiles into EN 1993-1-3, the project will carry out a detailed pre-codification research programme which will include: the preparation of a comprehensive critical review of the state of the art, the carrying out of an extensive experimental programme, the preparation of easy to use design Excel software sheets, a series of Briefing Workshops targeted at stakeholders (manufacturers, architects, builders, regulators, consultants,etc...), the development of a Post-project strategy to ensure the continuous incorporation of the results into the Eurocodes beyond the end of the RFCS

Partners		*Country*	*Scientific person in charge*
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RFS2-CT-2014-00022 STEEL-EARTH

Steel-based applications in earthquake-prone areas

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	1045186 €	Start Date	1/07/2014
	EU Contribution	627106 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

Steel-earth is born on the needs to develop practical tools and documents to exploit results obtained in 3 lucky RFCS research projects: Opus, Steelretro, Precasteel. Aforementioned projects aimed at improving earthquake resisting steel structural solutions in different fields: the design of new constructions, the rehabilitation of existing structures and the modern design standards. Steel-earth is the first valorisation project in RFCS on earthquake engineering and summarise the efforts in last years aiming at the development of enhanced constructive, design and pre-normative solutions. The proposed dissemination activities are of paramount importance to transfer obtained results in current design practice and standards

		Country	*Scientific person in charge*
Partners	**UNIVERSITÁ DI PISA**	ITALIA	Silvia CAPRILI (Pr. Coord.)
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	CENTRO EUROPEO DI FORMAZIONE E RICERCA IN INGEGNERIA SISMICA	ITALIA	Timothy SULLIVAN
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RFS2-CT-2014-00023 HISTWIN_Plus

High-Strength Steel Tower for Wind Turbine

Info	Type of Project	Accompanying measure (studies)	Duration (months)	18
	Total Budget	478496 €	Start Date	1/07/2014
	EU Contribution	287095 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

The objectives of this proposal for accompanying measures are to promote and disseminate the knowledge gained in the RFCS project “High Strength Steel Tower for Wind Turbine (HISTWIN)”. This research project focused on the improvement of competitiveness of steel tubular towers for wind turbines by optimizing the performance of the whole structure, and assembling connection in particular. Instead of using very thick flanges, often between 100-200 mm thick, welded at the end of the tower segments, a friction connection between overlapping ends of the segments is proposed, Design guidance text will be developed and software solutions to make use of to the new connection concept and the tower design easy to use and reliable. Mobile and web-based applications will be developed. The web-based application will be accessible over the webpage.This application will be adapted to run on smartphones and other mobile devices (the mobile application). Both of these tools will follow the existing application developed by ECCS for design of steel members. A Design Manual, consisting of worked examples and short practical background information, for example the link to the design or execution codes, will be prepared. A proposal to implement the “HISTWIN connection” (the friction connection with long oval open slotted holes) will be prepared in format suitable for inclusion in a future revision of Eurocode, EN1993-1-8. The dissemination material will be distributed at several seminars and via web site www.histwin.eu to reach the widest possible use. The HISTWIN project is promoted as one of the success stories on http://cordis.europa.eu/coal-steel-rtd/stories_en.html, for the introduction of innovative connection details and improved design practices for Steel Wind Towers.

Partners	*Country*	*Scientific person in charge*
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RFSR-CT-2014-00024 SIROCO

Execution and reliability of slip resistant connections for steel structures using CS and SS

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1960215 €	Start Date	1/07/2014
	EU Contribution	1176127 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

The present rules in EN 1090-2 for the determination of the slip factor in slip-resistant bolted connections are detailed but not always clear, leading to complex tests and unreliable results. Slip-resistant connections are required, when deformations in bolted connections must be limited to pre-defined values either for serviceability or ultimate limit reasons. Typical applications can be found in bridges, cranes, radio masts and towers of wind turbines, which are loaded by alternate loading and / or fatigue or where functional requirements make slip-resistant connections necessary. Essential characteristics of these connections are the level of preload in the bolts and the surface roughness of the clamped plates. For this reason, the level of preload has to be guaranteed over the whole service life of the structure and loss of preloading due to relaxation and creep effects either because of e. g. geometrical tolerances of the clamped plates or creep due to plastic deformation of applied coatings has to be sure avoided. Whereas slip-resistant connections have been used for carbon steel connections for several decades, albeit with high costs, no design and execution rules exist for preloading of stainless steel bolts and subsequently, no slip factors are defined in standards. The SIROCO project intends (a) to provide more clear and improved procedures to increase the cost effectiveness of slip-resistant connections, (b) to develop innovative surface preparation systems and preloading methods (lock bolts, H360 bolts, DTIs) for carbon steel connections, (c) to enhance the use of injection bolts as an economical alternative for slip-resistant connections, (d) to close information gaps for hot-dip galvanized steel connections, (e) to solve the lack in knowledge in the design of slip-resistant connections in stainless steel to increase the competitiveness of stainless steel structures.

		Country	*Scientific person in charge*
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RFSR-CT-2014-00025 INDUSE-2-SAFETY

Component fragility evaluation and seismic safety assessment of "special risk" petrochemical plants under design basis and beyond design basis accidents

Info

Type of Project	Research	Duration (months)	36
Total Budget	1702267 €	Start Date	1/07/2014
EU Contribution	1021357 €	End Date	30/06/2017

State Running project

Provisional Abstract

The INDUSE-2-SAFETY proposal is the direct continuation of the RFSR INDUSE project (2009-2012) focussing on onshore industrial plants at the system level inside the scope of EN 1998. In detail, INDUSE-2-SAFETY aims at developing a quantitative risk assessment methodology for seismic loss prevention of “special risk” petrochemical plants and components, e.g., support structures, piping systems, tanks and pressure vessels, flange and tee joints, etc. The proposed probabilistic-based methodology will ensure safe functioning/shutdown under ground motions of increasing spectral acceleration through extensive analytical, FE and experimental investigations. Related harmonized importance factors γI and limit state probabilities will provide a uniform hazard versus a uniform risk basis for EN 1990/EN 1998. In particular, the following main goals will be pursued: - quantification of the actual risk for seismic loss prevention of potentially dangerous “special risk” petrochemical plants. - Development of a Seismic Probabilistic Risk-based Evaluation (SPRE) procedure capable of providing damage exceedance occurrence frequency for a representative prototype case study of a “special risk” petrochemical installation. - Evaluation of fragility curves of main structures and components needed for the SPRE analysis, e.g. for support structures, piping systems, tanks, slim vessels, vertical cylinders, spherical storage tanks, flange and tee joints, etc. - Experimental investigation of steel storage tanks without/with floating roofs, piping network substructures, flange joints and tee joints by means of cyclic, real-time/pseudo-dynamic and shaking table tests. - Issuing of risk assessment provisions for seismic loss prevention of onshore “special risk” petrochemical facilities within the scope of EN 1998. - Enhanced design recommendations for the improvement of several European standards and codes, including EN 1990, EN 1998, EN 13480-3 and EN 1591.

Partners

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RFSR-CT-2014-00026 OPTIBRI

Optimal use of High Strength Steel grades within bridges

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1772026 €	Start Date	1/07/2014
	EU Contribution	1063214 €	End Date	30/06/2017
State	Running project			

Provisional Abstract

The project aims to develop welded bridges using High Strength Steel where it is required (mainly in highly stressed web). As usually the fatigue resistance of the welded joint as well as stability issues reduce the interest of using HSS in bridges, the project studies: the optimal welding and post welding treatment in order to have a high fatigue resistance, as well as, the buckling behaviour of multiaxially stressed plates. The quantification of the interest of HSS welded bridge from the point of view of cost and environment is performed on a 20 m wide highway bridge spans 80 m. Three designs of the same bridge are compared through Life cycle environmental assessment (LCA), Life cycle cost (LCC) analysis, Life cycle performance (LCP). The first bridge design (A) is classical and uses only standard S355 steel grade when the second design (B) uses HSS S690 QL steel, however with the current Eurocode state which does not account of the steel grade in many issues. Finally the third design (C) is performed relying on the real HSS behaviour and HFMI post treated welds or welds with LTT material filler. This third design and more generic case study demonstrate the need of updating of Euro Codes. The 20 m wide highway bridge spans 80 m has a large place on the market. It presents clear fatigue problems and some stability issues (need of enhanced rules for buckling of multiaxially stressed plates) that the project addresses. The research will provide a window example to inform the Civil Engineering community about the interest of using HSS within bridges. In addition, a comparison between the HFMI post treated welds and welds with LTT material filler will allow a ranking of these two possibilities to increase fatigue strength of welded joints.

		Country	*Scientific person in charge*
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Technical Group Steel 9

Factory-wide control, social and environmental issues

The scope of TGS9 includes:

- Instrumentation, control and automation including artificial intelligence and information technologies
- Analytical techniques
- Working conditions and quality of life at the work place
- Energy, water and material flow management
- Ergonomic methods
- Occupational health and safety
- Reduction of exposure to occupational emissions
- Standardisation of testing and evaluation methods
- New processes for sustainable steel production
- Recovery and valorisation by-products
- Techniques for classification and preparation of steel scrap
- Control and protection of the environment in and around the workplace
- Restoration of steelwork sites
- Recovery of spent liquors
- Water treatment
- Life cycle assessment and sustainable products

RFSR-CT-2003-00001 ERAMAC

Emissions reduction through analysis, modelling and control

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2756856 €	Start Date	1/09/2003
	EU Contribution	1654113 €	End Date	28/02/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23333:EN			

Final Abstract "The main objectives of ERAMAC were to: - develop methods for the characterisation of organic emissions from coke-making and EAF steelmaking processes; - characterise air quality in the vicinity of steelworks; - identify priorities for emission control; - develop predictive emission monitoring systems (PEMS) for CO, NOx and S02 emissions in coke making, of pollutant emissions in EAF steelmaking and for improved control of reheating furnaces; - investigate the use of an Amazone contactor for removal of S02 and NOx in sintering emissions. The methods developed and applied to characterise organic emissions from coke plants revealed that fugitive emissions from coke oven doors and from by-products plant storage tanks were the main priorities for improved control measures. For ambient air monitoring, an Opsis differential optical absorption spectrometry system was used to carry out real-time measurements of benzene, toluene and xylene for reverse dispersion modelling estimates of releases. Predictive emission monitoring systems (PEMS) were developed for the measurement of CO, NOx and S02 emissions in coke making and for predicting organic emissions from EAF steelmaking. Although PEMS were shown to be potentially useful for improving the control of reheating furnaces, implementation requires individual control of air/fuel flows to burners. The Amazone contactor was inadequate for the desulphurisation of sinter waste gas owing to massive evaporation losses of glycerol and the consequent fire risk. However, partial waste gas denitrification was feasible at low temperatures with ozone as an oxidant and aqueous sodium hydroxide as an absorbent. Strong recommendations are made for further work to implement and enhance techniques developed in ERAMAC."

		Country	*Scientific person in charge*
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	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Javier CIRIZA
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Joao Fernando GOMES
	LECES	FRANCE	Florence BERHO
	SWEREA MEFOS AB	SVERIGE	John NISKA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert LINK

RFSR-CT-2003-00004 RAPCOAT

Rapid, reproducible and accurate analysis techniques for coating systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1455443 €	Start Date	1/09/2003
	EU Contribution	873265 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23197:EN			

Final Abstract

The basic objective of this project is to improve the process control and product quality of coil-coated products, by means of development of fast, reproducible and robust methods of coating characterisation based on fast chemical and depth profiling analysis. Of primary interest are multi-coating systems with thick organic topcoats. Examples of such coatings are polyester or epoxy urethane, PVDF and PET with various thicknesses of 5 to 30 microns. Glow discharge optical emission spectroscopy (GD-OES) has been further established as a 'reference' technique for relatively fast and well resolved chemical depth profile analysis of all coating types of interest. Investigation of molecular emission has significantly improved the ability to interpret GD-OES data. Two very fast methods with limited depth information but giving a large amount of chemical information have been developed and evaluated: laser ablation optical emission (LIBS) and modern X-ray fluorescence (XRF) systems with detectors for light elements. A more advanced laser method using a femtosecond (fs) laser combined with inductively coupled plasma mass spectrometry (ICP-MS) has also been developed. Wet chemical and combustion methods have been adopted for analysis of polymer coatings, mainly for characterisation of reference materials. An expert system based on advanced methods of computational statistics has been further developed and adapted to data from several instrumental techniques. It has been demonstrated that the expert system is capable of detecting minor but statistically significant differences in the analytical data in an automatic fashion. This will be a very useful tool both in process development and quality inspection of coated products.

Partners		*Country*	*Scientific person in charge*
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RFSR-CT-2003-00006 CATIA

Development of catalytic metal filters for simultaneous removal of organic compounds and particulate matter from EAF fumes

Info

Type of Project	Research	Duration (months)	48
Total Budget	1306279 €	Start Date	1/09/2003
EU Contribution	783767 €	End Date	31/08/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23737:EN

Final Abstract

The aim of this project was to develop new catalytic media filters in order to remove at high temperature dust and organic compounds from the fourth hole of an electric arc furnace (EAF). Such a filtration could improve the cost-efficiency of dedusting equipment by reducing the energy needed for cooling fumes and simplifying the layout of the dedusting device. A major aspect of this project was the development and the laboratory testing of new catalytic filtering media composed mainly of FeCrAl alloys. Among the large combination of materials tested, the most promising seems to be metal fibres treated by reactive vapour. Cartridge devices of such media have been developed and tested on an electric arc furnace. Four months of tests were carried out connecting a pilot unit on the exhaust gas stream of an EAF in a steel plant. The results achieved show that the media can reduce organic emissions from the furnace, but some improvement should be made in the manufacturing of the cartridges in order to reduce side effects, such as clogging of the media. For new developments in industry, an industrial pilot unit will be necessary to optimise several components of the system and to test these components for a longer period.

Partners

	Country	*Scientific person in charge*
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RFSR-CT-2003-00014 TREES

Most appropriate treatments to control environmental impact of effluents in iron and steel industry

Info

Type of Project	Research	Duration (months)	40
Total Budget	1828448 €	Start Date	1/09/2003
EU Contribution	1097069 €	End Date	31/12/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23179:EN

Final Abstract

The water framework directive has given new emphasis to the protection of the ecological status of receiving waters, as well as their chemical status. This emphasis on ecological quality is the principal driver for the TREES project, which is focused on both the toxicity of steel industry effluents and the reduction of this toxicity by innovative treatment techniques. Traditionally, the impact of iron and steel industry streams on the aquatic environment has been evaluated by comparing the concentration of the pollutant in the receiving water with environmental quality standards defined by current legislation. This method, unfortunately, does not provide information on how the effluent affects the biodiversity of the receiving waters. That is achieved only through ecotoxicological tests. The selection of the most suitable tests for assessing the ecotoxicity of steel works' effluents and understanding their effects on the aquatic environment has been analysed in great detail. Recently, attention has been focused on untreated/treated wastewater toxicity and on appropriate treatments to reduce this toxicity. Advanced oxidation and electrochemical techniques (as stand alone or in combination with biological treatment) have been tested and analysed in order to reduce specific classes of pollutants and improve water quality from both chemical and ecological points of view. Consequently, both aspects — the industrial responses to water pollution issues through wastewater treatment and the introduction of measures promoting health and ecosystem protection — have been investigated and verified in the ambit of this project.

Partners

	Country	*Scientific person in charge*
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Selected Publications

P. Rutarova, A. Essing, H.M. Kuss and K. Florian “Analysis of organic pollutants in industrial wastewater” - Proceeding of 7th international Workshop “Progress in analytical chemistry in the steel and metals industry”, 16-18 May 2006, Luxembourg, pag.59-64

J.-S. Hodges and S.-L. Pearson “Water framework directive - Quality of Corus effluents” - Revue de Métallurgie / Volume 105 / Issue 09 / 2008, pp 436-442, DOI: http://dx.doi.org/10.1051/metal:2008062

M.I.Pistelli, D.Mirabile, T.Beone, M.Serra, S.Zanlucchi “Approccio DOE per acque di cokeria” – AIDIC NEWS N.4 2012, pag. 14-19, http://www.aidiccentro.it/uploads/AIDIC4-12.pdf

RFSR-CT-2003-00038 IPCDS

Integrated process control & diagnostics system for hot rolling mills based on comparison of physical data & mathematical process-models by using artificial intelligence

Info

Type of Project	Research	Duration (months)	36
Total Budget	1962341 €	Start Date	1/09/2003
EU Contribution	1177404 €	End Date	31/08/2006

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23198:EN

Final Abstract

The aim of this multinational research project is to construct a generic, intelligent, sophisticated, portable, modular and configurable monitoring and diagnosis system for HSMs and other similar processes in steel plants with a view to improve the process control strategy. To incorporate as much as possible the multitude of scenarios prevailing in mills and for developing generalised strategies, four research locations were identified to carry out the three main tasks of the collaborative project. The main goal to be achieved at TKS and Corus is the earlier detection of faults and malfunctions of the measuring devices to greatly reduce mill downtime, periods of unnoticed non-optimal production and product quality problems. The general aim of the Arcelor part was to implement an intelligent diagnosing system to improve the width performances in the HSM. At Ilva, regaining the performance of the mill pacing, which had been downgraded by the revamping activities in the past decade, was the main target. The fault detection system developed using neural network algorithms, filter functions and descriptive statistics which has been implemented at TKS and Corus has significantly reduced the routine unnoticed malfunctions of pyrometers and other gauges. Additionally, some application-oriented and case-specific diagnosis routines for the furnace thermocouples were implemented at Corus. At Arcelor, a supervisory system for width gauge performances and several models to improve the width quality of strips were developed and installed. The new mill pacing strategy developed at Ilva using a modified material-flow control scheme reduces the gap time considerably and consequently increases annual production by about 7 %.

Partners

	Country	*Scientific person in charge*
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RFSR-CT-2003-00041 FACTMON

Factory-wide and quality related production monitoring by data-warehouse exploitation

Info	Type of Project	Research	Duration (months)	40
	Total Budget	1379590 €	Start Date	1/09/2003
	EU Contribution	827754 €	End Date	31/12/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA22992:EN			

Final Abstract The concept of a factory-wide and quality-related production monitoring system has been studied and three different possible solutions have been investigated, designed, implemented and evaluated. Three software systems have been realised and implemented: - the advanced state SPC system by Arcelor España (ASSPC), - the Data Monitoring system by BFI implemented at Arcelor Eisenhuttenstadt (DATAMON), and - the operating practice system by CSM implemented at TKAST (OP). In Arcelor España, the project has been applied to monitor a tinplate line. The objective is to provide different views of the line state and its influence on product quality — according to users' needs — production, quality and maintenance staff. The system at Arcelor Eisenhuttenstadt encompasses the production stages from the steel-making plant to the finishing lines. DATAMON will improve data monitoring activities qualitatively and increase them quantitatively. As a result of simple handling, the day-today work efficiency of engineering staff will increase. Those in charge of the process will obtain support, allowing a greater focus on avoiding process deviations and increasing product quality. CSM has focused on the annealing and pickling line for stainless steel black coil. Connection to the automation level makes it possible to check the status of application of operative practices during the process. Because of this work, staff responsible for quality control add more information to flow material process knowledge. This allows for immediate identification of possible causes of quality defects when process parameter limits are not applied.

		Country	*Scientific person in charge*
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RFSR-CT-2003-00043 AVAS

Feasibility of a fast vacuum slag analysis by laser OES in secondary steelmaking

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1155608 €	Start Date	1/09/2003
	EU Contribution	693364 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23174:EN			

Final Abstract The feasibility of a fast slag analysis at the vacuum degasser for better production control in secondary steelmaking is demonstrated with the emphasis on SiO2, CaO and Al2O3. A laser-OES instrument with a closed cabinet (1.0 x 1.8 x 1.7 metres) was installed about 10 metres away from the vacuum degasser plant, with stability being achieved for 7 months. Sampling procedures produced suitable samples from an automatic lance system of the vacuum degasser and from the electro steel plant. Process slag samples were characterised by SEM with respect to their inhomogeneities and defects. Phase analysis could identify calcium-aluminium-oxides, periclase, anatase, and quartz phases. An adapted laser-OES method with a new beam shape was developed for enhanced spatial averaging. For measurement the steel worker has to push a button, place the sample — without any prior preparation — at the sample plate and close the sample stand. The measurement starts automatically, and after 80 seconds the analysis result is transmitted to the control unit. The root mean square error of prediction with multivariate PLS1 analysis is determined at 0.20 wt.-%,1.0 wt.-%, and 1.5 wt.-% for SiO2, CaO, and Al2O3. The RSD(c) are 0.52 %, 0.80 %, and 0.83 % for CaO, SiO2, and Al2O3. The analytical performance regarding short and long term stability, robustness and on-site usability were evaluated under routine-like conditions. The comparability with XRF measurements (directly on casted slags and/or after preparation) was investigated by performing a round robin trial within the partners.

		Country	*Scientific person in charge*
Partners	**AKTIEN-GESELLSCHAFT DER DILLINGER HÜTTENWERKE AG**	DEUTSCHLAND	Hans-Uwe SCHMITZ (Pr. Coord.)
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	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG e.V.	DEUTSCHLAND	Volker STURM
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RFSR-CT-2003-00044 METHODOWEAR

Innovative wear test methodologies for the simulation of in service behaviour of tool steels

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1457608 €	Start Date	1/09/2003
	EU Contribution	874565 €	End Date	31/08/2006
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23204:EN			

Final Abstract This project intends to contribute to the development of new testing methodologies to assess the wear behaviour of tool steels in the field of cold forming and deep drawing. Guidelines for laboratory activities are included in the report. A preliminary characterisation was performed on industrial process tools, revealing the surface damage typology of the steel tools. The results of this characterisation and the FEM process analyses were used as a basis to design a group of experiments carried out by a set of tribometers available to the research group. Two test procedures were selected and validated by a comparative analysis among the surface analyses results of the plant tools and those from the tested samples, the lab wear and the process wear data of the tools collected by the industrial project partner. Furthermore, a wear assessing model has been developed for flow and roll forming. The model can be used to evaluate the wear amount on a steel roll using as input variables the number of work pieces produced, the contact pressure and the sliding speed between the roll and the sheet. The model for the deep drawing, based on the image analysis technique, was not completely successful, in spite of dedicated efforts in terms of studies and the innovative approach of adopted tribological variables able to quantify steel galling. The study results are very interesting for their potential use in other industrial fields such as steel rolling.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Domenico STOCCHI (Pr. Coord.)
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	GIANETTI RUOTE SpA	ITALIA	Andrea FINZI
	Fundación INASMET	ESPAÑA	Felix PENALBA DIAZ
	SWEREA KIMAB AB	SVERIGE	Johan SUNDSTRÖM

RFSR-CT-2003-00045 AUTOCHECK

Enhancement of product quality and production system reliability by continuous performance assessment of automation systems

Info

Type of Project	Research	Duration (months)	42
Total Budget	1491299 €	Start Date	1/09/2003
EU Contribution	894779 €	End Date	28/02/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23205:EN

Final Abstract

Novel strategies and systems have been developed and tailored for the performance assessment of control loops in steel processing plants. The methods have been implemented, adapted and applied to a complex structured temperature control and a zinc layer thickness control at hot-dip galvanising lines. The control performance tools created for both applications are integrated into the mill infrastructure and allow the responsible personnel to do performance analysis on demand. Retuning suggestions have been implemented for temperature control, and results show a remarkably improved control performance, also identified by the performance indices. A system for performance supervision of the different functions of automatic gauge control has been developed and installed in a hot strip mill. The system is now well proven as a powerful and useful tool to contribute to the maintainability of the hot strip mill AGC system. A powerful, friendly and configurable user graphical interface makes the results very easy to understand and permits the configuration of the supervisory system and the creation of specific user-defined analysis. A supervision system for continuous monitoring of the set-up system in a hot strip mill has been developed. The system is integrated in the process control architecture and analyses the trend/behaviour of the most relevant mill set-up model parameters, detecting inconsistencies and suggesting suitable countermeasures to technicians. The supervision system is entered via an intranet address allowing easy sharing of information elaborated. The application proved to be useful for 'model basic updates', thus improving rolling stability and performance.

Partners

	Country	*Scientific person in charge*
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ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Michael BREITNER
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FORSCHUNGS- UND QUALITÄTSZENTRUM BRANDENBURG GmbH	DEUTSCHLAND	Ramona KLÖPPEL

RFSR-CT-2003-00047 SURFQUALDEV

The measurement and prediction of surface quality by new developments in EMATS and scarfing and the effect of scarfing on surface defects through the mills

Info

Type of Project	Research	Duration (months)	42
Total Budget	1010005 €	Start Date	1/09/2003
EU Contribution	606003 €	End Date	28/02/2007

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23176:EN

Final Abstract

This report details work undertaken to correlate data obtained from inspection systems in the casting plant, scarfing area and rolling mills in order to track product quality throughout the steel mills. The project was a collaboration between Corus UK Teesside Technology Centre (the coordinator), Arcelor and Scuola Superiore Sant' Anna (SSSA). Two main inspection systems were tested for use in the continuous casting plant. The first was conoscopic holography, which was developed from an industrial prototype into a system where the entire slab top and bottom faces were inspected. The second was a hybrid laser-EMAT (electromagnetic acoustic transducer) system and was tested at pilot plant scale. Significant work was conducted to analyse data automatically so that a real-time, online inspection system could be conducted on plant. Slabs were inspected in the slab yard using a variety of techniques which were compared. This inspection work was used to measure how well the caster was performing, by data mining plant signals and, for Arcelor, equating these with the conoscopic holography readings. Slabs were successfully tracked through the steel mill by the partners. Comparisons were made from upstream inspection to the downstream Parsytec system and inspection of the final product. Different scarfing practices were compared and it was found that scarfing was no longer necessary for some steel grades. Metallographic work was undertaken to assess defects in steel samples to determine the cause of cracking. Upon recommendations from this project, plant practices were changed and the defects no longer arose.

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Iain BAILLIE (Pr. Coord.)
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Fernando SANCHO MENDEZ
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

RFSR-CT-2004-00049 ULTRAFINE

Characterisation of emission and impact of ultrafine particulate

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2042583 €	Start Date	1/07/2004
	EU Contribution	1225550 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23877:EN			

Final Abstract The aim of this project was to provide understanding of emissions and environmental impacts of fine (inferior 2.5 ?m) and ultrafine (inferior 0.1 ?m) particulate matter (PM) from iron and steelmaking processes enabling abatement strategies to be focused in the most appropriate areas. This is needed because of increasing evidence of adverse health effects from such particulate leading to greater legislation on air quality. A major aspect of this project was to develop a method for novel sampling using analytical techniques. Real-time in situ techniques were used including the Dekati electrical low pressure impactor (ELPI) for analysis of size-segregated particle mass and number concentrations. Aerosol mass spectrometry techniques that deliver size-resolved aerosol composition with high time-resolution were used including the TSI aerosol time-of-flight mass spectrometer (TSI ATOFMS) and new aerodyne time-of-flight aerosol mass spectrometer (ToF-AMS). The ToF-AMS was characterised in the laboratory and data processing algorithms were developed, allowing successful deployment to analyse aerosol emissions and impacts. Offline and online particle analysis based on laser-induced breakdown spectroscopy (LIBS) provided elemental analysis of size-fractionated size fractionated PM. A new analytical method was developed to measure PAHs by thermal desorption — gas chromatography — mass spectrometry (TD-GC-MS) in size-segregated PM collected with an ELPI. These techniques were applied to characterise fugitive and primary emissions, as well as ambient air samples. Source apportionment was applied to a combined TSI ATOFMS and Aerodyne ToF-AMS dataset. The processes associated with ironmaking and slag processing contributed the most to local ultrafine PM concentrations. Fine particulate was dominated by the transport of aged aerosol to the region, whereas ultrafine particulate concentrations were highly influenced by blast furnace and sintering processes.

		Country	*Scientific person in charge*
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	LECES	FRANCE	Philippe LE LOUER
	MAX PLANCK GESELLSCHAFT ZUR FÖRDERUNG DER WISSENSCHAFTEN e.V.	DEUTSCHLAND	Frank DREWNICK

RFSR-CT-2004-00050 DECFLAQ

Decision support system for the comprehensive assessment of flat products quality

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1318371 €	Start Date	1/07/2004
	EU Contribution	791023 €	End Date	30/06/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23892:EN			

Final Abstract Producing in a competitive way is not always an easy task. Enterprises are increasingly incorporating advanced information systems which reflect the reality of the company in order to be capable of taking decisions in the most appropriate way for profit. One of these widely emerging technologies is decision support systems (DSSs). During the project, such a DSS was developed to support the production personnel in their daily work. The DSS provides reliable and reproducible information based on the following three areas. - Using a catalogue containing the requirements of the customer as well as the final use of the product, the requirements are compared in time with the conditions of the actual produced product. - The costs of the production of flat steel products were calculated in an increased granularity level from a periodical total production cost per tonne to an in-line single product costing estimation. The results of several cost indicators are presented to the operator. - The certain production conditions of a single product are used by grading methods to evaluate the product quality. Together with border values individually selected for each customer/order the evaluation of a set of rules is used to provide information to the operator to support his decision how to proceed with the actual produced product. Such a DSS was successfully developed during the project and implemented on several production plants. The experience of the operators was used for the system tuning.

		Country	*Scientific person in charge*
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	ACCIAI SPECIALI TERNI SpA	ITALIA	Ezio DE BERNARDI
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Maria MURRI
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RFSR-CT-2004-00051 TRESOR

Technique for remediation of steel-works polluted sites

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1836373 €	Start Date	1/07/2004
	EU Contribution	1101824 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23594:EN			

Final Abstract The main goal of the project has been to develop a methodology for selecting the most appropriate remediation technologies for polluted steelworks sites. The ability to remediate polluted land successfully and cost effectively depends mainly on the construction of an accurate conceptual model, capable of quantifying the impact of contaminants on soil quality both before and after remediation. As such, an essential part of this research was to tailor the use of site characterisation techniques to polluted steelworks sites for setting up and calibrating a mathematical model. Through the characterisation of soil samples taken from three different industrial plants (Sidenor, Corus and Vítkovice), the effect of steelworks activities on selected sites has been quantified. The reduction of this impact has been demonstrated by using appropriate treatments (soil washing, thermal treatment and bioremediation). Soil samples were treated at laboratory and pilot scale to determine main process parameters and remediation effectiveness. The technologies applied were evaluated in terms of pollutant-removal efficiency, toxicity reduction and sustained costs. A system has been developed which forecasts the fate of environmental pollutants on steelworks sites. The parameter of pollutant concentration in steelworks sites was incorporated within a conceptual model developed from non-invasive and invasive site investigation studies. Moreover, leaching tests have been performed to study the ability of pollutants to migrate and impact on neighbouring environmental receptors (both before and after remediation treatment). The conceptual model has been translated into a mathematical model and the fate of the pollutants predicted. The results of experimental trials have been used to validate the mathematical model.

Partners	*Country*	*Scientific person in charge*
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INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Joao Fernando GOMES
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TATA STEEL UK LIMITED	UNITED KINGDOM	Shaun McKENNA
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RFSR-CT-2004-00052 SensoCont

Sensor based on-line-control of pickling lines

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1212048 €	Start Date	1/07/2004
	EU Contribution	727229 €	End Date	31/12/2007
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA23872:EN			

Final Abstract The main aim of the project was the development of a new sensor-based control technology for operating pickling lines. Pickling is the most important step to remove surface scale layers and is strongly dependent on the exactly controlled pickling liquor composition. When the project started, there was no feasible system available for online control of pickling lines. Within this project, new methods for online analysis of the pickling liquors were tested and implemented into pickling process control. As a result of this, the pickling line staff will be enabled to control the process with all the up-to-date process knowledge they need. Work started with the assessment of actual operating situations of pickling lines and the definition of optimum pickling process parameters. Operational and laboratory trials were performed to determine suitable sensor applications. Data acquired from those trials with operational and artificial pickling solutions were investigated for mathematical modelling. Sensors were developed and the establishment of communication between different modules of process control was considered. In order to apply sensors on site, operational measurements were performed. Suitable processes and locations were fixed for future installations. Finally, the partners reviewed optimum pickling process parameters to programme the aspired process control. The results achieved were verified in comprehensive operational trials.

Partners		*Country*	*Scientific person in charge*
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Burkhard SCHMIDT (Pr. Coord.)
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RFSR-CT-2005-00043 REAL

Development of inclusion reference materials and simultaneous determination of metals and non-metallic inclusions by rapid libs analysis in steel samples

Info

Type of Project	Research	Duration (months)	42
Total Budget	1314057 €	Start Date	1/07/2005
EU Contribution	788434 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24190:EN

Final Abstract

"Increasingly, steel is becoming a commodity material. Consequently, production is being switched to locations nearer to the sites of extraction of raw materials, generally outside Europe. In order to retain jobs within the European steel sector, products with higher added value and consistent high quality must be produced. Control practices to ensure quality and consistency involve several different analytical techniques to obtain metal and non-metal analysis during and after the process of steelmaking, resulting in high investment and operation costs. Also, some characterisations such as the cleanness of steel are still too time-consuming to obtain results in a time frame short enough for remedial action during production, or are still limited to relatively small sample areas to provide a high level of confidence regarding the results obtained. This project looked into the feasibility of the rapid and simultaneous measurements of metals' chemistry and inclusion characterisation by laser-induced breakdown spectroscopy (LIBS). This involved two main tasks: firstly, the development of methods for the fabrication of reference materials with well-defined inclusion population to enable the quantification of inclusion in steel by spectroscopic techniques; secondly, the development of LIBS to enable simultaneous measurement of metals and non-metallic inclusions. Two methods of production of 'inclusion standards' were developed and gave very satisfactory results. The parameters influencing LIBS sensitivity were studied for the detection of low concentration levels; an approach to characterise non-metallic inclusions was tested and validated against SEM-EDX data, which is one of the conventional cleanness characterisation methods, and provided satisfactory results for inclusions with diameters above approximately 10 ?n. Faster electronics for the data acquisition were developed that significantly increased the measurement speed of LIBS. A graphical user interface was developed that enabled a rapid visualisation of the LIBS measurements, and some preliminary manipulations on the data. Finally, LIBS-LIF was tested in an attempt to improve further the limits of quantification for trace levels, but no significant improvement was obtained in comparison with LIBS."

Partners

	Country	*Scientific person in charge*
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RFSR-CT-2005-00044 PLATEND

Combined ultrasound and micromagnetic measurements for non destructive assessment of textured heavy plate properties

Info

Type of Project	Research	Duration (months)	42
Total Budget	1442855 €	Start Date	1/07/2005
EU Contribution	865714 €	End Date	31/12/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24358:EN

Final Abstract

Heavy plates for pipes require a thermomechanically controlled hot rolling strategy which brings the last passes in the intercritical domain. As a result, the plates are textured, with an enhancement at the extremities because of natural cooling gradients. Such areas — so-called 'cold ends' — will end in unacceptable local properties, which presently require cropping from destructive characterisations. Combining ultrasonic and magnetic measurements should allow outlining such cold ends and non-destructively identifying the limit to crop, without having to sample an extremity coupon. The potential benefits are estimated to be over EUR 2.5 million/year if the whole European steel industry were able to avoid cutting such extra lengths at plate extremities. For this purpose, a consortium led by ArcelorMittal Maizières Research, with FhG-IzfP Dillinger HW and TKS as partners, identified the technological options to be used, and combined them for substantial in-plant measurements, investigating several types of plates. The findings allowed validating of the principle for such thermomechanical heavy plates, while they were not so convincing for other plate types.

Partners

	Country	*Scientific person in charge*
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RFSR-CT-2005-00045 PERMESS

Plant wide error messaging system based on new communication technologies

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1237246 €	Start Date	1/07/2005
	EU Contribution	742347 €	End Date	30/06/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24251:EN			

Final Abstract A few years ago — when the idea of Permess was born — it was expected to be of large interest to set up an automatically working messaging system, based on the request for high efficiency of production and quality assurance as well as environmental points of view. The increasing existence of communication technologies had been expected, being a good set of tools for the implementation of Permess. Today, many components are commercially available which are useful for a realisation of such systems. In fact, this is the proof of the basic idea being right and important. The real market has made it easier to develop messaging tools as there are very important tools, widely spread and easy to use and adapt to special tasks. The use of instant messaging technologies is even part of general operating systems and is in general use today. Different open software protocols and tools such as Jabber or Java show very useful features and are easy to adapt for their use in messaging tools. PDA and hand-held computers are getting more and more powerful and bring extraordinary possibilities to deliver fault information in a ubiquitous and immediate manner. Nevertheless, the project has shown the high amount of information to be processed and what has to be taken into account to build a well defined system. Special requirements of industrial partners must be considered as well as the necessities coming from statistical data mining and security aspects from IT departments. Results from project have been very positive regarding the operation of Permess systems as well as they show a large amount of tasks remaining even in the future.

		Country	*Scientific person in charge*
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RFSR-CT-2005-00046 SIMUSTEEL

Optimization of stocks management and production scheduling by simulation of the continuous casting, rolling and finishing departments

Info

Type of Project	Research	Duration (months)	36
Total Budget	1641825 €	Start Date	1/07/2005
EU Contribution	985095 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24969:EN

Final Abstract

A tailored simulation including the raw materials, steel melting shop, rolling and finishing facilities, considered in a global perspective with its production curves and the input and output functions, which create the production chain for several products (hot, cold, galvanising, tinplate …), has been developed. Once this simulation was done, several policies have been implemented on it leading to an optimum flexible production with minimised costs. The project deals with the development of a software tool which implements a methodto solve problems of the production flows of a modern steel plant. It is based on an intelligent system consisting of schedulers and simulators of the flows of materials. The schedulers are able to formulate the best production plan that optimises different parameters (for example, minimise operating time between various machines, maximise working time of some elements …), while the material flow simulations are utilised for validation of the plan. The tool is provided with an innovative user interface, based on web technology, thusnaturally conceived for the use and distribution of the results on the steel works network. In this manner, the operators on the pulpits of the lines can be updated in real time concerning the variations in the production flows caused, for example, by non-programmed situations. As a final statement for the project, the global situation of the whole steel supply chain has been analysed and some final conclusions to avoid bullwhip effect have been obtained.

Partners

	Country	*Scientific person in charge*
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RFSR-CT-2005-00047 eTipo

Factory wide e-training for steel human resource improvement and meeting process objectives

Info

Type of Project	Research	Duration (months)	36
Total Budget	1669829 €	Start Date	1/07/2005
EU Contribution	1001897 €	End Date	30/06/2008

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25058:EN

Final Abstract

"The aim of the project was the development and application of suitable strategy for the application of e-learning methods considering the special requirements of the steel works. These requirements were evaluated beside suitable learning-management systems. E-learning contents, methodological-didactical aspects, aspects of co-determination, learning time — working time concepts, schedules and learning results have to be evaluated. The results from these investigation activities were introduced into a concreteand practicable realisation of learning contents considering methodological and educational aspects. Different training modalities have been taken into account, being the specific characteristics of the subject and the trainees which finally determine the most appropriate approach in each case. In this project, four application examples have been developed :• computer based training (asynchronous e-training) applied to health and safety (BFI at Salzgitter) ;• a community of practice (collaborative learning environment) in the subject of safety (voestalpine) ;• a performance support tool for process operators based on an advanced reporting system (CSM/TK-AST) ;• synchronous e-training (virtual classroom) applied to maintenance (ArcelorMittal España/Labein).Knowledge data bases for managing learning contents have also been developed for the different approaches."

Partners

	Country	*Scientific person in charge*
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VOESTALPINE STAHL GMBH	OESTERREICH	Angelika MITTELMANN

RFSR-CT-2005-00048 THINFILM

Characterisation of thin films on rough steel substrates

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1203482 €	Start Date	1/07/2005
	EU Contribution	722090 €	End Date	31/12/2008
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24250:EN			

Final Abstract

"During this project three different coatings were studied, dealing with three levels of analytical difficulties: — CrIII passivation layers, which are inorganic wet applications; Cr is a relatively easy element to analyse and the layer is inorganic, making this coating rather easy to analyse; CVD SiO2 layers, which are inorganic vapour-deposited layers; due to their inorganic nature and their homogeneous distribution across the surface, they are fairly easy to analyse; silane layers, which are organic wet applications; because of their organic nature and their heterogeneous distribution across the surface, they are very difficult to study. Generally it was proven that vapour-deposited coatings are homogeneous in thickness regardless of the roughness. Wet applications of coatings tend to yield more heterogeneous distributions with higher coating thicknesses in the valleys of the roughness. A broad variety of techniques was used to study them. In general the techniques can be divided into two classes: local analysis techniques and bulk techniques. Both are indispensable because the information they give is complementary. Quantification is difficult and remains dependent on the presence of good standard samples. Due to its low cost, rapid analysis and low matrix-dependent quantification for thin coatings, XRF is put forward as the most applicable technique for industry."

		Country	*Scientific person in charge*
Partners	**ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL N.V.**	BELGIQUE	Chris XHOFFER (Pr. Coord.)
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RFSR-CT-2006-00033 CONOX

Control of nitrogen oxide emission at the electric arc furnace

Info

Type of Project	Research	Duration (months)	36
Total Budget	1092865 €	Start Date	1/07/2006
EU Contribution	655719 €	End Date	30/06/2009

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25078:EN

Final Abstract

The CONOX project has been focused on investigating the electric steelmaking process in the EAF and, as a special case, the Consteel EAF with regards to NOx emissions. The investigations were carried out by a consortium of research institutes (RWTH, CSM) and three electric steelmaking plants (DEWG, ORI Martin, RIVA Verona) with a wide range of produced steel grades and EAF technologies (oxygen, dust, and coal injectors, gas burners, CoJets, scrap preheating, slag foaming). The project was based on the combination of experimental investigations of the NOx formation in EAFs at industrial plants as well as pilot plant EAFs at well defined conditions and modelling of the NOx formation in the EAF. The general objective was to elaborate guidelines to reduce NOx emissions from the Consteel process (CSM, ORI) as well asstandard EAFs employing various EAF technologies (RWTH, DEWG, RIVA).The activities of CSM and ORI have been focused on the investigation of the Consteel process. A semi empirical model of NOx emissions has been developed based on literature data, pilot furnace tests and industrial measurements. Plant measurements carried out permitted to quantify the amount of NOx generated in the EAF and downstream in the tunnel and provided data for model refining and application. The model has beenapplied to support the definition of improved guidelines to decrease NOx emissions. The activities of RWTH, DEWG and RIVA have been focused on the experimental investigation and modelling of different process conditions and a deduction of predictions regarding NOx formation. These predictions have been further investigated and validated by industrial plant measurement. Eventually best practices to reduce NOx emissions have been derived from the combined results of modelling and industrial measurements.

Partners

	Country	*Scientific person in charge*
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Selected Publications

T. Echterhof, H. Pfeifer. Nitrogen Oxide Formation in the Electric Arc Furnace - Measurement and Modeling. Metallurgical and Materials Transactions B 43 (2012), 163-172. DOI 10.1007/s11663-011-9564-8. URL http://link.springer.com/article/10.1007%2Fs11663-011-9564-8

T. Echterhof, H. Pfeifer. Measurement and Control of NOx Emissions at Two AC Electric Arc Furnaces. ISIJ International 51 (2011) 1631-1636. DOI 10.2355/isijinternational.51.1631. URL https://www.jstage.jst.go.jp/article/isijinternational/51/10/51_10_1631/_article

T. Echterhof, J. Gruber, H. Pfeifer. Measurements and Simulation of NOx Formation in the Electric Arc Furnace. 2nd International Conference Clean Technologies in the Steel Industry, 26.-28. September 2011, Budapest, Hungary

RFSR-CT-2006-00034 ADCTEC

Advanced characterisation techniques for novel zinc-based alloy coatings

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1940348 €	Start Date	1/07/2006
	EU Contribution	1164208 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25079:EN			

Final Abstract A wide variety of alloyed Zn-based coatings of both PVD and HDG types have been produced for the project. All materials have been thoroughly investigated by several advanced analytical techniques and wet chemical reference methods. A LIBS demonstrator system for online trials has been developed. This system has been installed and tested in a pilot plant with good results. Accelerated corrosion tests on all project materials have been carried out. The tests confirm the strongly positive influence of Mg on the corrosion resistance. No significant differences were found between HDG and PVD coating types in terms of corrosion resistance. All very thin coatings < 4 ?m showed poor corrosion properties, in spite of high Mg content. A breakthrough in intelligent data processing has been achieved in correlating a limited set of analytical data to corrosion properties.

		Country	*Scientific person in charge*
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RFSR-CT-2006-00035 LCS

Laser-induced breakdown spectroscopy for advanced characterisation and sorting of steel scrap

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2093982 €	Start Date	1/07/2006
	EU Contribution	1256389 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24968:EN			

Final Abstract The use of laser-induced breakdown spectroscopy (LIBS) for scrap analysis and sorting has been industrially evaluated in this project. A LIBS prototype was developed and installed for scrap analysis at the output of an industrial shredder (conveyor belt velocity 1 m/s) and at a pendulum conveying trough (0.3 to 5.5 m/min, width x depth approx. 2 m x 1 m) feeding an electrical arc furnace (EAF). The steel scrap throughput in both applications is within the range of 10 to 100 tonnes per hour, typically. The capability of the developed prototype for robust automated chemical scrap analysis in an industrial environment was shown. For example, the online measurement of silicon content shows good agreement with slag and steel analysis of the EAF melt, although the developed prototype detected only a fraction of the scrap load surface, due to the restricted measuring volume of 600 × 600 × 180 mm3. Increasing the measuring volume should further improve the performance. Furthermore, sorting trials were carried out with a lab-scale LIBS sorting system at 3 m/s with a projected throughput of 10 tonnes per hour to evaluate its sorting potential. The technique's high capability to recover FeMn steels from a flow of stainless steel and also the ability to sort out objects containing copper from a ferrous iron flow was demonstrated. Expert systems for scrap classifications have been investigated and the algorithms show high fidelity for sorting applications.

		Country	*Scientific person in charge*
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RFSR-CT-2006-00036 IRSIS

Improved utilisation of results from automatic surface inspection systems

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1796870 €	Start Date	1/07/2006
	EU Contribution	1078122 €	End Date	30/06/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25070:EN			

Final Abstract With respect to customers' ever-increasing surface quality requirements, automatic surface inspection systems (ASIS) have become more and more popular within the European flat steel sector over the last few years. As ASIS tuning formerly had the main focus, nowadays the in-depth utilisation of the results comes more to the fore, but there is no generalised approach on how to handle the data and improve their utilisation. That issue is addressed by this project.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Jens BRANDENBURGER (Pr. Coord.)
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Selected Publications

J. Ordieres-Meré, A. González-Marcos, F. Alba-Elías, C. Menéndez-Fernández. Advanced predictive quality control strategy involving different facilities. The International Journal of Advanced Manufacturing Technology 2012, 1-12. DOI 10.1007/s00170-012-4562-9. http://dx.doi.org/10.1007/s00170-012-4562-9

A. González-Marcos, J. Ordieres-Meré, F. Alba-Elías, F. J. Martínez-de-Pisón and M. Castejón-Limas. Advanced predictive system using artificial intelligence for cleaning of steel coils. Accepted in IronMaking & SteelMaking.

J.Brandenburger, M.Stolzenberg, F.Ferro, J Diaz-Alvarez, B.Vanderoost, R.Piancaldini, J. Ordieres Mere: "Improved utilization of results from automatic surface inspection systems" proceedings of ISIS 2011, Düsseldorf, Germany

J.Brandenburger, M.Stolzenberg, E.Romano, M.Nevot de Martino, G.Pratolongo, R.Piancaldini, J. Ordieres Mere: "Improving the usage of results from automatic surface inspection systems" proceedings of ISIS 2008, Amsterdam, Netherlands

M.Stolzenberg, E.Romano, M.Nevot de Martino, G.Pratolongo. Defect catalogue with typical surface defects and their causes. IRSIS project deliverable 1.3.

Software

BFIDataProSIS. Usage of ASIS data requires a post-processing to filter significant information, verify the detected surface defects and merge massive defect clusters to single aggregation defects. DataProSIS can manages ASIS data of different vendors and converts it to useful information for further applications. www.bfi.de

BFIDataStudio. BFIDataStudio is a flexible framework designed to support any kind of data processing activity. Within the IRSIS project modules for the visualisation and tracking of surface inspection results through the production chain were integrated. www.bfi.de

RFSR-CT-2006-00037 LINECOP

Line-coordinated optimisation of strip geometry and surface properties by using model-based predictive technologies

Info

Type of Project	Research	Duration (months)	48
Total Budget	1217169 €	Start Date	1/07/2006
EU Contribution	730301 €	End Date	30/06/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25858:EN

Final Abstract

Within the present project, different strategies have been considered in order to establish a coordinated approach to the coil processing with the focus on the product through different facilities. Different features and tools have been developed for analysing, monitoring and optimisation of strip flatness from entry of cold rolling to the exit of galvanising lines. A flatness measurement system has been improved and adapted to the circumstances at the entry of a galvanising line to quantify the post-rolling flatness and compare it with online flatness during the cold rolling process. Physically based as well as data-based models have been developed for predicting the evolution of strip flatness through the considered steel processing chain. Control features (disturbance compensation, interstand flatness prediction, coiler draw-down compensation, length-dependent flatness reference adaptation) were developed, implemented and tested at the industrial site to improve the flatness quality. The coiling process has been found to have a major effect on the cold-rolled strip flatness. To ensure optimal post-rolling flatness is a prerequisite for achieving uniform zinc thickness over the whole strip length. Also focus was kept on defect prediction in downstream production as well as to predict cleanness capability. Specific tools for coil grading application have been produced, making it possible to compare prediction of defects as well as defects finally found, and it will be considered as a key component for allowing reconfiguring the operating conditions in order to reduce the reprocessed material. Scientific knowledge was produced and disseminated too.

Partners

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RFSR-CT-2006-00038 FREEZE

Avoiding water and acid consumption in chemical scale removal by innovative combined process

Info	Type of Project	Research	Duration (months)	42
	Total Budget	744360 €	Start Date	1/07/2006
	EU Contribution	446616 €	End Date	31/12/2009
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA24991:EN			

Final Abstract

The objective of Freeze was to develop a new process consisting of cryo-concentration, metal salt crystallisation and pure metal recovery, with a focus on the reduction of waste water quantities and metal salt loads from mixed acid pickling processes (HF/HNO3). During investigation of the cryo-concentration process the dependency of the ice crystal formation on acid and metal concentration was detected. This process is extremely reliant on the concentration of hydrofluoric acid. By exceeding the defined concentration ranges no pure water can be separated. Nevertheless, since the energy necessary for cryo-concentration is significantly lower than that for evaporation, cryo-concentration is a promising process to concentrate liquids with low fluoride concentration, to recover acid and pure water as rinsing water. The investigations concerning metal salt crystallisation focused on the dependencies between temperature, time and agitation mode. These parameters were optimised to achieve a selective metal salt crystallisation. Finally, pure metal recovery was investigated. Electrolysis was not applicable as the aggressive liquid destroyed the electrodes and hydrogen formation dominated the process. Metal recovery by pyrohydrolysis is a suitable process. The technical scale trials and the optimisation trials verified the lab results for the cryoconcentration process and optimised the Freeze process. Due to metal fluoride precipitation, the process is not economical to treat pickling acids with high fluoride concentration, but is promising for the treatment of low acid containing liquids, e.g. mixed acids for ferritic steel pickling, rinsing water, advanced treatment of pre-treated pickling acids, to concentrate other plating baths, or to crystallise metal salts.

Partners

	Country	*Scientific person in charge*
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Patents

DE 10 2004 018 143.8-09 „Verfahren und System zum Aufbereiten von metallhaltigen, sauren Abwässern“, 2008

Selected Publications

M. Sartor, D. Buchloh, F. Rögener, T. Reichardt: Removal of iron fluorides from spent mixed acid pickling solutions by cooling precipitation at extreme temperatures. Chemical Engineering Journal 153 (2009), S. 50-55, DOI 10.1016/j.cej.2009.06.008

M. Sartor, D. Buchloh, F. Rögener, T. Reichardt: Comparison of different analytical systems for stainless steel pickling solutions based on mixed acids, Vergleich verschiedener Analysensysteme für Edelstahlbeizlösungen auf Basis von Mischsäuren, Stahleisen, 11/2010, SP70-73, http://www.stahleisen.de/Content/Produkte/Zeitschriften/stahleisen/AktuelleAusgabe/tabid/175/sclmid/487/v/A/iid/157/aid/0ca836d0-1c48-467b-b620-efa80ee168af/language/en-US/Default.aspx

Sartor, M., Buchloh, D., Rögener, F., Reichardt, T.: Verringerung von Abwassermengen und Metallsalzfrachten aus Beizprozessen durch Gefrierkonzentration und Fällungskristallisation Gemeinschaftsveranstaltung DECHEMA/DWA, Fulda, 2009, S. 93-104 (incl. Presentation)

RFSP-CT-2007-00045 BOFDEDUST

Development of effective dedusting of converters by innovative concepts and constructive optimization

Info

Type of Project	Pilot&Demonstration	Duration (months)	42
Total Budget	684629 €	Start Date	1/07/2007
EU Contribution	273852 €	End Date	31/12/2010

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25907:EN

Final Abstract

This study is a collaborative work between VDEh-Betriebsforschungsinstitut GmbH (BFI) and ArcelorMittal Bremen GmbH (AMB). It was the aim of the project to compare different types of suction hoods (with and without swirl), to elaborate which are most effective for the given case of fume emission. Additionally effective techniques for fume suppression should be developed. During the project plant data were stored in an operational database and missing data was measured. The data were analysed and input variables for the present physical system were determined. These were used as boundary conditions for the following physical and numerical modelling work. As a result it was shown that the fume capture performance can be improved by modification of the present hoods and fume suppression. The fume capture efficiency increases according to the simulation results from 42 % with the actual hood to 100 % with an optimised hood for the planned flow rate of 750 000 m3/h (STP). After flooding the converter vessel with inert gas before and during scrap charging, the pouring time during hot metal charging could be reduced by 30 %. The new equipment for fume suppression by CO2 injection was tested successfully under real-life conditions. An outcome of the research was an innovative concept to achieve an improved environmental performance in a cost effective way. Optimised emission control can improve the working conditions in many European steel plants and prevent pollution of the environment.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Kersten MARX (Pr. Coord.)
ARCELORMITTAL BREMEN GMBH	DEUTSCHLAND	Michael WOLLENBERG

Selected Publications

Marx, K., Rödl, S.: Efficient optimization of steelplant dedusting. The 6th European Oxygen Steelmaking Conference Stockholm 2011, Programme No. 7-1

Marx K., Rödl S. Efficient optimization of steelplant dedusting. Stahl und Eisen 132 (2012) No. 6, pp. 61-71

Marx K., Rödl S. New approaches for efficient dedusting of basic oxygen furnaces. Journées Siderurgiques Internationales - Paris 2012, Session 2

RFSP-CT-2007-00046 SensorControPilot

Implementation of sensor based online control of pickling lines

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	814561 €	Start Date	1/07/2007
	EU Contribution	325825 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25320:EN			

Final Abstract In this project, two stand-alone approaches from the preceding research endeavour were combined to add increased controllability to pickling lines, which were by now controlled only by adaptation of strip speed. A model-based control concept to calculate strip speed set points in pickling lines, developed by UniOvi, and an online concentration measurement based on ultrasonic technology, developed by BFI, were implemented at the pickling line of TKS-RA in-line to obtain a demonstration installation for sulphuric acid pickling lines. Furthermore, both technologies were combined: online concentration data are used as relevant data to calculate strip speed set points. The control concept helps to improve strip quality and increases productivity by determining set points for the optimum strip speed with minimum strip defects. The information about the maximum optimal strip speed predicted by the neural net prototype-based model is shown on a display in the strip inspection room. With the information from the display and actual surface quality observation the operator is able to adjust the actual optimum strip speed. The potential of the demonstration installation was estimated by TKS-RA and fixed with an increase of steel throughput of nearly 1 %. With an occurrence of 50 %, strip speed can be improved on average by about 1.5 m/min. Furthermore, the savings of sulphuric acid and additives were estimated at about 3 %.

		Country	*Scientific person in charge*
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RFSP-CT-2007-00047 NitrateBio Demo

Operational demonstration of innovative and sustainable nitrate elimination in stainless steel pickling by higher power biological denitrification technique

Info	Type of Project	Pilot&Demonstration	Duration (months)	36
	Total Budget	684985 €	Start Date	1/07/2007
	EU Contribution	273994 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25126:EN			

Final Abstract In this pilot project biological denitrification was proved to be a reliable environment friendly and cost-saving alternative for the disposal of the nitrate-rich pickling process water from the steel industry. In the operational trials a new carbon source on a glycerine basis was considered the best for this application. A novel low-fouling polymer membrane was developed and produced. Its permeability (10.3 L/(m²*h*bar)) was lower than that of the commercially available membranes (31 to 202 L/(m²*h*bar)). The costs for the developed membrane (34 €/m²) were lower than for the commercial polymer (95 €/m²) or ceramic membranes (1000 €/m³) but the high filtration area needed diminished the financial advantages. Chamber filter press and membranes showed the best biomass separation performance. By the sludge dewatering, the chamber filter press was optimised to reach the dry matter content of 73 %. For a stable pilot plant operation, a reactor feed strategy with a constant nitrate load was developed. The optimisation of the overall process control took place by specially configured automatic nitrate-measuring devices in the influent and the effluent. The nitrate measurement was enhanced by an exclusively designed sample pre-cleaning on a sedimentation basis. In the long term trials with the pilot treatment plant at the DEW site stable nitrate elimination rates > 95% were observed. The industrial application of the developed nitrate elimination process is completely new and innovative. With this process the steel industry possesses a tool for implementation of a zero nitrate emission strategy in pickling lines with nitric and hydrofluoric acid. It saves water resources and reduces disposal costs.

		Country	*Scientific person in charge*
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RFSP-CT-2007-00048 RAMSCI

Process based steel cleanliness investigations and rapid metallurgical screening of inclusions by modern PDA techniques

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	1766145 €	Start Date	1/07/2007
	EU Contribution	706458 €	End Date	31/12/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25153:EN			

Final Abstract The main objective of this project is to improve the methods for control of metallurgical processes, by introducing online determination of non-metallic inclusion characteristics based on OES-PDA. The work has included method development, software development and several plant trial campaigns. Within the first part of the project, process sampling was developed and tested to a stage where representative sampling with respect to inclusion characteristics was assured. The instrumental parameters, data acquisition and data evaluation were investigated and standardised to a large extent. With these objectives realised, extensive plant trial campaigns could be carried out. The results of these have been evaluated and served as a basis for general recommendations on how to use OES-PDA in practical online applications. In an iterative process, the methods for data acquisition and data evaluation have progressively been improved during the project, and implemented in user-friendly software, also available to all partners on a web-based server. In addition, a set of reference material (RM) has been produced and certified for verification of analytical results. The result of these achievements is that OES-PDA is now implemented as part of routine analysis in several steelworks, using significantly improved and nearly standardised analytical procedures. In addition it should be pointed out that this project has provided an excellent example of cooperation in the spirit of 'the European dimension'. This has of course contributed very much to the success of the project.

Partners		*Country*	*Scientific person in charge*
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	RIVA ACCIAIO SPA	ITALIA	Nicola VENERI
	SSAB EMEA AB	SVERIGE	Rolf DIDRIKSSON
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RFSR-CT-2007-00049 O-Chess

On-line chemistry of the steel surfaces

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1120367 €	Start Date	1/07/2007
	EU Contribution	672260 €	End Date	30/06/2010
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25876:EN			

Final Abstract Online detection of defects or in homogeneity based on oxides, organic and salt contamination, is a key issue for steel industry. Spectrometric techniques in ultraviolet (UV), visible, near infrared and mediumand long-wave infrared (MWIR and LWIR) have proved in laboratories their capacities to give information on the chemical nature of surfaces. These techniques are already used in the steel industry in single point measurements for thickness applications. The challenge is then to extend their capacity to give access to the fingerprint patterns of the mineral and organic residues and to develop sensors able to map defects of thin films. Hyperspectral cameras developed initially for earth observation satisfied these specifications: online acquisition of a chemical cartography of industrial surfaces. Three cameras were then tested in UV, MWIR and LWIR on two pilot lines dedicated to organic coil coating and to vacuum deposition. These trials required important analytical work in order to identify the spectral patterns of the selected applications and the best optical configuration of cameras and sources. Results have shown that the detection and identification of nanometric scale residues on the millimetric scale are accessible at 100 m/min, especially in the IR range. But important R & D work is still required to improve the sensors (dark correction, thermal stability, optimisation of the source, better frequency of acquisition and resolutions, robustness) and the data processing (online treatment of the data). This technology has real potential to improve quality during the critical downstream processes in the steel industry.

		Country	*Scientific person in charge*
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RFSP-CT-2008-00041 SCRAP PROBE

On-line bulk composition analysis of steel scrap using PGNAA

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	2070834 €	Start Date	1/07/2008
	EU Contribution	828333 €	End Date	31/12/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26180:EN			

Final Abstract The principal aims of this project were to develop PGNAA-based system technology for the on-line bulk composition analysis of steel scrap, its full chemical characterisation and the implementation of a scrap composition analyser in a field trial. Monte Carlo neutronics modelling and simulation were performed for the design of the analyser, and gamma spectroscopy methods for the application of PGNAA and PFTNA techniques to bulk metal-scrap units were developed. New linear shaped high intensity neutron generators emitting 2.5 MeV and 14 MeV neutrons, respectively were developed and tested. Well established LIBS technology was adapted to make available a standard technique for inter-comparison and validation of the Scrap Probe analyser. Spectroscopic characteristics of several gamma detectors were evaluated. Different prototypes of the analyser were constructed, extensive trial measurements were performed and improvement suggestions proposed. Synthetic and industrial steel scrap have been analysed in different geometries to characterise various elements. Due to inadequacies of the gamma detectors used as well as other major electronics problems, the targeted accuracies have not been achieved yet. In the case of 800 kg scrap in a 1 m3 container, a detection limit of <2 % was achieved for copper when PGNAA was applied using NaI(Tl) detectors. The full capabilities of PFTNA could improve the limits for certain elements. Standardisation could not be accomplished. Preliminary validation has been done. A tremendous amount of knowledge has been acquired and needs more effort to bring it fully into practice. Though expensive, high resolution Ge-detectors are necessary for achieving targeted detection limits and accuracies

		Country	*Scientific person in charge*
Partners	**CETTO AG**	DEUTSCHLAND	Scaria MANNANAL (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Luis Antonio RODRIGUEZ LOREDO
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Philippe RUSSO
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	GUY MONTFORT
	NSD-FUSION GmbH	DEUTSCHLAND	John SVED
	UNIVERSITY OF LIVERPOOL	UNITED KINGDOM	Paul NOLAN

RFSR-CT-2008-00040 OMC

Online material characterisation at strip production

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2115877 €	Start Date	1/07/2008
	EU Contribution	1269526 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25879:EN			

Final Abstract

During the last years in the steel industry the necessity has grown steadily to tune the production process to a minimum of waste, optimum of efficiency and just-in-time production of the ordered steel grade. Tools and methods therefore have to be found to fulfil these requirements. The most important step to this point is a thorough understanding and modelling of the production processes to find the optimum processing parameters. An important base for all modelling is the provision of reliable information about the actual material state. These data could only be gained by advanced methods of material characterisation online during production. The general aim of this research project is to test methods of non-destructive material characterisation for the determination of characteristic values of the material structure like texture, phase mixture, precipitation, void and dislocation density and grain size. The parameters measured online will give valuable input to material models to predict the final product quality from the present status and to find measures for correction at deviations. Furthermore the combination of the basic quantities characterising the material state and the data characterising the related process conditions can be used to optimise product quality, output and consumption of resources and direct process control. The consortium has structured the approach of the proposal into four main working tasks for comprehensive investigation, in detail system specifications, definition of starting level, application of electromagnetic material characterisation, material characterisation by ultrasonic techniques, determination of the main disturbing influences in production lines and assessment of the results.

Partners

	Country	*Scientific person in charge*
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Mathias STOLZENBERG (Pr. Coord.)
ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Rene SCHMIDT
ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Ane MARTINEZ DE GUEREÑU
FORSCHUNGS- UND QUALITÄTSZENTRUM ODERBRÜCKE gGmbH	DEUTSCHLAND	Alvaro CASAJUS
SWEREA KIMAB AB	SVERIGE	Eva LINDH-ULMGREN
TATA STEEL NEDERLAND TECHNOLOGY BV	NEDERLAND	Henk T. PLOEGAERT
THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Thomas KEBE
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert HOLZKNECHT

Selected Publications

Different electromagnetic online methods and their evaluation methods to characterise material micro structure, TKS, AMEH, SZMF, FQZ, CEIT, BFI, Tata Steel, Project Deliverables

New electromagnetic Method for high temperature measurements at hot strip on the rollout table (MFIA), Tata Steel, UoM, Project Deliverables

Recommendations for the use of the different measuring methods at specific production line types, all Partners, Project Deliverables

Analytical /mathematical tools to derive micro structural parameters from measurement and improve of the accuracy, all Partners, Project Deliverables

Identification of the most important structural parameters at different production lines for use in prediction models, all Partners, Project Deliverables

RFSR-CT-2008-00042 AUTODIAG

Supporting process and quality engineers by automatic diagnosis of cause-and-effect relationships between process variables and quality deficiencies using data mining technologies

Info

Type of Project	Research	Duration (months)	36
Total Budget	1318378 €	Start Date	1/07/2008
EU Contribution	791027 €	End Date	30/06/2011

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26179:EN

Final Abstract

The through-process detection of cause-and-effect relationships by investigation of process and quality data with data mining techniques has been proved to be a powerful possibility to decrease quality deficiencies. Nevertheless this method is not used area-wide in the companies because of its complexity, the necessary specific knowledge which only few people in the company have and the missing adaptation of the tools to the specific problems of the steel production. These are the reasons to develop, implement and test robust, practicable and easy-to-use solutions which are specialised to steel quality problems. A generic common framework based on a well-known software tool (RapidMiner) was developed and implemented. Each industrial partner has developed individual interfaces to databases at the one hand and to the user interface on the other hand. For the data mining solutions different approaches were investigated: • brute force • individual adapted • smart components For each approach an investigation of an actual problem was performed to be able to show the usability of the developed solution and to analyse the requirements for the transferability. After a training of the personnel the systems were rolled out for daily usage. The experience of the target users was analysed and used for improvements. During the project it could be shown that the developed system can be used in an industrial environment. The increasing number of users, the number of investigations made by them as well as the request to integrate additional data sources show that the system is fully accepted by the users

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert HOLZKNECHT (Pr. Coord.)
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Valentin TORRE SUAREZ
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SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

RFSR-CT-2008-00043 ZINCANA

In-situ analysis of hot dip galvanizing baths

Info	Type of Project	Research	Duration (months)	36
	Total Budget	896744 €	Start Date	1/07/2008
	EU Contribution	538046 €	End Date	30/06/2011
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA25870:EN			

Final Abstract The objective of the Zincana project is to develop a method for zinc bath composition measurements based on the LIBS system, adapted for main and traces elements analysis and optimised for precipitates characterisation. Hot Dip Galvanizing bath modelling has also been developed and used for industrial configuration to understand dross precipitation. The knowledge acquired is used to propose actuator to limit this phenomenon critical for coated product quality. From a lab experiments point of view, we show that solid LIBS is a reliable technique to measure compositions of zinc-based samples, either for main elements (Zn, Fe, Al) or for low concentration elements (Sb, Sn, Pb) with contents above 100 ppm. GalvaLIBS technology has also been used successfully during lab trials to measure main elements composition and lower concentrated elements. We show that galvaLIBS can also be used to characterise lab pot cleanliness, more qualitatively than quantitatively. Industrial trials performed during the project with galvaLIBS are less convincing. The system shows indeed unstable signals and was not reliable from one day to the other. The last part of the project devoted to the modelling of HDG bath has been realised by the development of models based on fluid mechanics calculations coupled to chemical equilibrium calculations. Interesting data can be extracted from 3D model, for example to propose process adaptation to minimise dross precipitation and contribute to the optimisation of the process. To conclude, galvaLIBS remains an interesting and innovative technology to control and manage zinc bath composition and new equipment would deserve testing in industrial environments to check the reliability of the measurements.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Marie SIMONNET (Pr. Coord.)
	CENTRALE RECHERCHE SA	FRANCE	Marie-Laurence GIORGI
	SWEREA KIMAB AB	SVERIGE	Thomas BJORK
	TECNAR AUTOMATION LTEE	CANADA	Alexandre NADEAU
	UNIVERSIDAD DE MALAGA	ESPAÑA	Javier LASERNA

RFSP-CT-2009-00028 SLASORB

Using slag as sorbent to remove phosphorus from wastewater

Info	Type of Project	Pilot&Demonstration	Duration (months)	42
	Total Budget	1264492 €	Start Date	1/07/2009
	EU Contribution	632244 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26412:EN

Project web page http://www.emn.fr/z-ener/slasorb/index.php?page=home

Final Abstract The Slasorb project aimed at developing the use of slag in full-scale filters designed to remove phosphorus (P) from wastewaters. Considering the recent evolution of EU legislation concerning P removal from wastewaters, the challenges of this project were to define the technical and economical feasibility of field-scale filters filled with slag and how to handle slag after P-saturation, including rejuvenation and valorisation as fertilisers. The project was divided into six work packages (WPs). In WP1, a screening of slag available in Europe was first conducted. In WP2, column lab experiments and field applications were set up in Germany and France using the selected slag. In WP3, the monitoring of slag in use for P retention was presented. In WP4, the treatment performances of the two demonstration-scale filters were assessed, and in WP5, saturated slag reuse as a fertiliser was performed. The content of Slasorb's final scientific report is a summary of all the work performed with an emphasis on the last work package: the technical and economical feasibilities of using full-scale filters (WP6). During the project, the main activities were monitoring the P-removal performances of two demonstration-scale systems. Design guidelines have been proposed based on pilot-scale results. Results from the phosphate-saturated slag analyses have shown good plant availability. As presented in WP6, results highlighted that P removal by using steel slag as filter media was a valuable technology, competitive under specific conditions (proximity to steel factory, medium P discard targets). It appears that further work is required especially at the industrial commercialisation level

		Country	*Scientific person in charge*
Partners	**ASS. POUR LA RECHERCHE ET LE DEV. DES METHODES ET PROC. IND., ARMINES**	FRANCE	Florent CHAZARENC (Pr. Coord.)
	AKUT UMWELTSCHUTZ INGENIEURE BURKARD UND PARTNER*TH BURK JORG LAUER P.	DEUTSCHLAND	Stefan VOGEL
	ARCELORMITTAL ATLANTIQUE ET LORRAINE SAS	FRANCE	Marc FIXARIS
	ARBEITSGEMEINSCHAFT HÜTTENKALK E.V. - ARGE	DEUTSCHLAND	Martin REX
	SARL EPUR NATURE	FRANCE	Dirk ESSER
	FEhS - INSTITUT FÜR BAUSTOFF-FORSCHUNG e.V.	DEUTSCHLAND	Peter DRISSEN

Selected Publications

Barca C, Troesch S, Meyer D, Drissen P, Andres Y, Chazarenc F. Steel slag filters to upgrade phosphorus removal in constructed wetlands: Two years of field experiments.Environmental Science and Technology. 2013, 47(1):549-56. DOI: 10.1021/es303778t

Barca C, Gérente C, Meyer D, Chazarenc F, Andrès Y. Phosphate removal from synthetic and real wastewater using steel slags produced in europe. Water Res. 2012. 46(7):2376-84. DOI: 10.1016/j.watres.2012.02.012

RFSR-CT-2009-00029 ASEMIS

Assessment of emissions and impact of steel production processes

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1502621 €	Start Date	1/07/2009
	EU Contribution	901573 €	End Date	31/12/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26318:EN			

Final Abstract The aim of this project was to provide improved understanding of steelworks' emissions and their impacts on the ambient air quality. Novel methods and strategies to characterise airborne particulate matter were developed and implemented. A combination of real-time and off-line techniques was investigated, developed and successfully applied in situ, in several cases for the first time on a steelworks, such as LIDAR, mobile measurements, and on-line morphology analysis. An inventory of particulate emissions originating from fugitive sources has been built using comprehensive data collected in the sampling trials carried out in this project, together with earlier RFCS projects. The inventory covers a wide range of parameters for particulate matter such as number, mass, size distribution, morphology, chemical composition, and temporal trends and can be used as a database for further studies within the steel industry. The ambient air quality in the surroundings of integrated steelworks has been assessed at both UK and Spanish steelworks sites. Using a combination of complementary approaches, dispersion maps of the pollutants were produced that showed that the environmental impact of steelmaking operations was localised in the close vicinity of the site. Dispersion modelling demonstrated that fugitive sources of PM10 (particles with an aerodynamic diameter less than 10 ?m) were much more significant than primary sources with respect to emissions. Statistical tools were also applied to PM10 in ambient air and these identified the main contributors to be a mixture of steelworks' and nonsteelworks' related sources. The contributions of various sources and hence the priorities for improved abatement will differ from one steelworks to another. As the recommendations from the European Best Available Technologies Reference Document are applied, which mostly tackles primary sources, it will become more important to minimise diffuse and fugitive emissions though a range of cost-effective methods to improve local air quality, helping create a sustainable future for European steelmaking

		Country	*Scientific person in charge*
Partners	**TATA STEEL UK LIMITED**	UNITED KINGDOM	Diane CIAPARRA (Pr. Coord.)
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	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Silvia GARCIA
	MAX PLANCK GESELLSCHAFT ZUR FÖRDERUNG DER WISSENSCHAFTEN e.V.	DEUTSCHLAND	Frank DREWNICK

Selected Publications

Dzepina, K., Drewnick, F., Ciaparra, D., Schofield, N. and Borrmann, S., 2011. Characterization of emissions and ambient air in the vicinity of an integrated steelmaking site with a Mobile Laboratory. Poster presented at the European Geophysical Union General Assembly, Vienna, April 2011

F. Drewnick, T. Böttger, S.-L. von der Weiden-Reinmüller, S.R. Zorn, T. Klimach, J. Schneider, and S. Borrmann: Design of a mobile aerosol research laboratory and data processing tools for effective stationary and mobile field measurements. Atmospheric Measurement Techniques 5, 1443-1457, 2012 doi:10.5194/amt-5-1443-2012

Ciaparra, D., 2011. Development of a new method for the determination of particle bound PAHs based on direct thermal extraction - gas chromatography - mass spectrometry. In: Proceedings from the CETAS conference on Progress in Analytical Chemistry in the Steel Industry, Luxembourg, 18th-19th May 2011

S.M. Almeida, J. Lage, M.C. Freitas, A.I. Pedro, T. Ribeiro, A.V. Silva, N. Canha, M. Almeida-Silva, T. Sitoe, I. Dionisio, S. Garcia, G. Domingues, J.Perim de Faria, B. González Fernández, D. Ciaparra (2012) Integrated approach for air quality assessment in an industrial area located in the coastal of central Asturias, Spain. International Congress on Environmental Health 2012, Lisbon, Portugal, 29 May – 1 June

S.M. Almeida, M.C. Freitas, A.I. Pedro, T. Ribeiro, J. Lage, A.V. Silva, N. Canha, M. Almeida-Silva, T. Sitoe, I. Dionisio, S. Garcia, G. Domingues, J.Perim de Faria, B. González Fernández, D. Ciaparra (2011) Integration of biomonitoring and instrumental techniques to assess the air quality in an industrial area located in the coastal of central Asturias, Spain. CAPAC II - International Conference on Air Pollution and Control, 2011, Antalya – Turkey, 19-23 September

RFSR-CT-2009-00030 HYDRAS

Hydrogen assessment in steel products and semi-products

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1949940 €	Start Date	1/07/2009
	EU Contribution	1169964 €	End Date	30/06/2012
State	Project completed			
Final Report	http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26397:EN			

Final Abstract The main aim of the study is the development of tools able to predict hydrogen content in steel and to assess the best practices to keep it below the critical threshold. A survey of current hydrogen detection methods both for liquid and solid steel have been carried out and the most reliable methods have been established. The potential hydrogen sources during the whole steelmaking process have been highlighted, also the influence of vacuum degassing parameters on hydrogen content has been investigated. Two vacuum degassing models, which are able to simulate bubbles by means of Euler–Euler method and Euler–Lagrange method respectively, have been developed and customised to industrial partners' facilities. Both models have allowed us to point out the main factors affecting hydrogen removal during vacuum degassing like argon stirring, pressure and time under deep vacuum. On the basis of the results of this model, analytical formulas for hydrogen control in steel have been exploited. A thermal and hydrogen diffusivity model has been developed and applied to the cooling strategy adopted by industrial partners. In order to assess final hydrogen content, hydrogen diffusivity data determined by laboratory test has been used. The model results have been compared with experimental data showing good agreement. Moreover, the critical hydrogen content for each steel grade has been determined by means of SSRT and hydrogen cracking susceptibility tests. Finally, on the basis of the study on hydrogen sources and model results, guidelines for obtaining a final hydrogen content below the critical value have been established for each process stage

		Country	*Scientific person in charge*
Partners	**RIVA ACCIAIO SPA**	ITALIA	Stefano BARAGIOLA (Pr. Coord.)
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Zuriñe IDOYAGA
	SWEREA MEFOS AB	SVERIGE	Hakan LUNDBÄCK
	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Juan PALACIOS
	AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Seppo LOUHENKILPI
	UNIVERSITÁ DI PISA	ITALIA	Renzo VALENTINI
	VOESTALPINE STAHL DONAWITZ GmbH	OESTERREICH	Axel SORMANN

Selected Publications S. Louhenkilpi, S. Yu. Numerical Simulation of Dehydrogenation of Liquid Steel in the Vacuum Tank Degasser. Metallurgical and Materials Transactions B Volume 44 Issue 2 pp 459-468. DOI 10.1007/s11663-012-9782-8. URL http://link.springer.com/article/10.1007%2Fs11663-012-9782-8

RFSR-CT-2009-00031 KNOWDEC

Knowledge management and decision support with special focus to process and quality optimization at flat steel production

Info

Type of Project	Research	Duration (months)	42
Total Budget	1198145 €	Start Date	1/07/2009
EU Contribution	718887 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26210:EN

Final Abstract

The European steel industry is exposed to a very competitive market. Manufacturing high quality flat steel products demands highly skilled personnel, excellent plant technology, suitable plant maintenance, good quality of raw material, suitable automation systems, proper set points for control systems, etc. In all these areas the knowledge and experience of the technical staff, gathered during many years in operation and tuning their processes plays a big role. Problems in common usage of this knowledge and experience arise from its heterogeneous distribution over the individual staff members, human obliviousness, and knowledge erosion by leaving staff members. The goal of this project is to investigate and implement methods to collect this knowledge, to represent and store it, to embed it in a process structure framework, to make it accessible in a sharable way, and to apply it to quality improvement

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Alexander EBEL (Pr. Coord.)
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Diego DÍAZ FIGALDO
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Francesca MARCHIORI
LUCCHINI S.p.A.	ITALIA	Gabriele LONZI

RFSR-CT-2009-00032 ENCOP

Development of tools for reduction of energy demand and CO2-emissions within the iron and steel industry based on energy register, CO2-monitoring and waste heat power generation

Info

Type of Project	Research	Duration (months)	54
Total Budget	1449341 €	Start Date	1/07/2009
EU Contribution	869604 €	End Date	31/12/2013

State Project completed, final report not published yet

Provisional Abstract

The reduction of energy demand in the iron and steel industry is a highly investigated issue. However, evaluation of the reduction potential on a systematically level is still missing. Therefore the project aims at analysing the energy flows, energy demand and CO2-emissions in typical production processes in selected steel plants. Energy saving potentials will be identified by means of holistic energy register, CO2-monitoring system and decision guidance matrix for
power generation using low to mid temperature waste heat. These tools provide a sophisticated basis for the iron and steel industry to evaluate and energetically optimise its processes and plants.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Holger ROSEMANN (Pr. Coord.)
ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Olaf HEINEMANN
ÖSTERREICHISCHES FORSCHUNGS- UND PRÜFZENTRUM ARSENAL GmbH	OESTERREICH	Richard KITZBERGER
LUCCHINI S.p.A.	ITALIA	Lisa CHIAPPELLI
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

Selected Publications

G.F. Porzio, A. Amato, V. Colla, T. A. Branca: Holistic Modelling Development to Reduce Energy Demand and CO2 Emissions within the Iron and Steel Industry, in Proceedings of the 2nd International Conference and Exhibition on Clean Technologies in the Steel Industry, Budapest (Hungary), 2011.

G.F. Porzio, B. Fornai, A. Amato, N. Matarese, M. Vannucci, L. Chiappelli, V. Colla: Reducing the energy consumption and CO2 emissions of energy intensive industries through decision support systems - An example of application to the steel industry, in Applied Energy Journal, in press , DOI 10.1016/j.apenergy.2013.05.005

G.F. Porzio, G. Nastasi, V. Colla, M. Vannucci, T. A. Branca: Comparison of Multi-Objective Optimization Techniques in Industrial Systems: an Example of Application to the Steel Industry, in International Conference on Applied Energy, ICAE 2013, Pretoria (South Africa), 2013

A. Amato, V. Colla, G.F. Porzio, N. Matarese, L. Chiappelli: A CO2-Management Tool for Integrated Steelworks, in Proceedings of UKSim 15th International Conference on Computer Modelling and Simulation, UKSim2013, Cambridge (UK), 2013, p. 501-506, DOI 10.1109/UKSim.2013.36

G. F. Porzio, V. Colla, N. Matarese, G. Nastasi, T.A. Branca, A. Amato, B. Fornai, M. Vannucci: Process Integration in Energy and carbon Intensive Industries through Exploitation of Optimization Techniques and Decision Support, in Chemical Engineering Transactions Journal, Vol. 35, 2013.

RFSR-CT-2009-00033 SUPSYSCC

Development of an integrative plant, process and quality supervisory system at continuous casting by the intelligent combination of sensors, data analysis & decision support tech.

Info

Type of Project	Research	Duration (months)	42
Total Budget	1965692 €	Start Date	1/07/2009
EU Contribution	1179415 €	End Date	31/12/2012

State Project completed

Final Report http://bookshop.europa.eu/uri?target=EUB:NOTICE:KINA26398:EN

Final Abstract

SUPSYSCC project has been focused on the development of concepts and methods for an integrated plant, process and quality supervisory system for continuous casting by means of the intelligent analysis of results from process and quality measurement devices combined with higher level supervisory tools like decision support systems. The consortium used several innovative approaches to measure and model the process and quality parameters of different casting products. BFI applied methods for checking the plausibility of data, the analysis of relationships between process and plant parameters and product quality features, and the estimation of product features by data-based models. Results were implemented into online applicable tools and validated under operational conditions. ArcelorMittal developed a system for the on-line monitoring of the continuous caster motors paying special attention to the mould oscillators and the line drive system. Lucchini and CSM developed a supervisory system for square billet production of microalloyed resulphurised steels. The system was useful to improve product quality by giving the production staff prompt reporting about process deviations which helped improve plant and process set-up. Aalto developed soft-sensors for predicting the billet surface quality which were integrated into an on-line supervisory system able to control the secondary cooling performance. Tools for secondary cooling status control systems based on PQ curves and solidification process characterisation based on imageprocessing methods were developed by Gerdau. Riva developed new tools for the quality control of the production of blooms and for the calculation of the Jominy profile and the steel hardenability

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL ESPAÑA SA	ESPAÑA	Jose DÍAZ ÁLVAREZ (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Ricardo TONELLI
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Juan Luis MUÑOZ
LUCCHINI S.p.A.	ITALIA	Luca TRILLINI
RIVA ACCIAIO SPA	ITALIA	Stefano BARAGIOLA
AALTO-KORKEAKOULUSAATIO (AALTO UNIVERSITY FOUNDATION	FINLAND	Jukka LAINE
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert LINK

Patents Procedimiento de control de un sistema de refrigeración secundaria en el proceso de colada continua (Control procedure of the secondary cooling in continuous casting process). Status of the patent: PENDING

RFSR-CT-2009-00034 SISCON

Improved monitoring and control of flat steel surface quality and production performance by utilisation of results from automatic surface inspection systems

Info

Type of Project	Research	Duration (months)	36
Total Budget	2214945 €	Start Date	1/07/2009
EU Contribution	1328968 €	End Date	30/06/2012

State Project completed

Provisional Abstract

Aim of this project is the development of an advanced supervisory system for surface quality and production performance of flat steel production based on the results from automatic surface inspection systems (ASIS). Therefore first of all a performance monitoring system for ASIS will be realised to ensure the required
reliability of the provided data even during long-term operation. Based on this trusted data key performance indices (KPI) related to surface quality and line performance will be defined. Complemented with a suitable KPI combination of multiple lines new solutions supporting and monitoring the whole flat steel production process will be developed.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Jens BRANDENBURGER (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Roberto PIANCALDINI
DUFERCO LA LOUVIERE SA	BELGIQUE	Benoit VANDEROOST
ILVA S.P.A.	ITALIA	Floriano FERRO
ISRA PARSYTEC GMBH	DEUTSCHLAND	Jan ERXLEBEN
THYSSENKRUPP RASSELSTEIN GMBH	DEUTSCHLAND	Michael NÖRTERSHEUSER
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Mathias STOLZENBERG
SIEMENS VAI METALS TECHNOLOGIES SAS	FRANCE	Olivier DESCHAMPS

Selected Publications

J. Brandenburger, R. Piancaldini, D. Talamini F. Ferro, C.Schirm, M. Nörtersheuser V. Colla, N. Matarese, M. Stolzenberg, O. Deschamps, M. Luxen: List of Key Performance Indices for ASIS and surface quality. SISCON project deliverable 4.1 and 5.1

"V. Colla, N. Matarese and F. Cervigni, ""Quality Improvement in Hot Dip Galvanizing Line through hybrid Case-Based Reasoning System"", UKSim 15th International Conference on Mathematical/Analytical Modelling and Computer Simulation, Cambridge University (UK), April 2013"

J.Brandenburger: “Improved monitoring and control of flat steel surface quality and production performance by utilisation of results from automatic surface inspection systems (SISCON)”, proceedings of the “Workshop Integrated Intelligent Maniufacturing (I2M) in Steel Industry” in Maizieres-les-Metz in April 2012, pp. 172- 179

O. Deschamps, M. Luxen: Definition of ASIS performance indicators. SISCON project deliverable 2.2

M. Luxen: ASIS Maintenance Guidelines. SISCON final report Annex 7

Software

BFIDataStudio BFIDataStudio is a flexible framework designed to support any kind of data processing activity. Within the SISCON project modules for the calculation, normalisation and combination of key performance index and the automatic global root cause analysis were integrated. www.bfi.de

SIROLL SIAS Post Processing SIAS PostProcessing analyses and updates all the inspection data after the coil has been completely inspected. Within the SISCON project, the KPI calculations have been implemented inside the module. http://www.industry.siemens.com/datapool/industry/industrysolutions/metals/siroll/en/SIROLL-SIAS-en.pdf

RFCR-CT-2010-00010 ECOWATER

Enhanced treatment of coke oven plant wastewater

Info

Type of Project	Research	Duration (months)	42
Total Budget	1054116 €	Start Date	1/07/2010
EU Contribution	632470 €	End Date	31/12/2013

State Running project

Provisional Abstract

The main objectives of ECOWATER are:
- to reduce discharges of priority substances and priority hazardous substances (PS and PHS) in coke oven fluents in order to meet the objectives of the EU Water Framework Directive.
- to characterise the behaviour of PS and PHS in the coke oven wastewater treatment proces
- to study the chemical and ecological impact of coke oven effluents upon the quality of local river basins
- to enhance the efficiency of biological effluent treatment plants through better understanding of the sludge treatment characteristics using novel molecular biology approaches
- to investigate the use of advanced photo-oxidation, filtration and adsoption techniques for the abatment of PS and PHS in coke oven effluents.

Partners

	Country	*Scientific person in charge*
TATA STEEL UK LIMITED	UNITED KINGDOM	Eric ARIES (Pr. Coord.)
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Daphne MIRABILE
THE UNIVERSITY OF SHEFFIELD	UNITED KINGDOM	Wei HUANG

Selected Publications

Chen, J., Aries, E., Collins, P, Hodges, 2012. Emissions inventory of Priority Hazardous Substances and Priority Substances from the Water Framework Directive in effluents from UK integrated steelworks. In Proceedings of the 30th International Steel Industry Conference, December 19th, Paris, France

Zhang, D., Huang, W. (2012). Characterisation and modelling of transcriptional cross-regulation in Acinetobacter baylyi ADP1, ACS Synthetic Biology, 1(7), 274-283.

Pistelli, M.I., Mirabile, D., Beone, T., Serra, M., Zanlucchi, S., 2012. Approccio DOE per acque di cokeria", ICP - Rivista Dell Industria Chimica, N.11, 2012, 68-73.

• Aries, E., Chen, J., Collins, P, Hodges, J., Pearson, S., 2011. Characterisation of Priority Hazardous Substances and Priority Substances in cokemaking and steelmaking effluents from UK integrated steelworks. In proceedings of the 2nd International Conference and Exhibition on Clean Technologies in the Steel Industry, 26-28 September, Budapest

Webster, S., Aries, E., Huang, W., 2011. Molecular biology approaches to assess PAH degradation in coke oven biological effluent treatment plants. Paper presented at the 5th European Bioremediation Conference, July 4-7, Chania, Crete

RFSR-CT-2010-00033 MU-STEEL

Muons scanner to detect radioactive sources hidden in scrap metal containers

Info	Type of Project	Research	Duration (months)	30
	Total Budget	1100478 €	Start Date	1/07/2010
	EU Contribution	660288 €	End Date	31/12/2012
State	Project completed			

Provisional Abstract Accidental melting of radioactive material creates large economical losses in the steel industry and problems in the environment. Orphan sources are not detectable with radiation portals when shielded. The Mu-steel project will design an inspection gate using the scattering of a radiation naturally falling on earth, the cosmic ray muons, therefore without any radiation hazard. This technique has been developed recently, and is able of detecting and classifying materials inside a container. Relevant hardware and software components of the system will be designed to be cost-effective and ready for industrial production. Prototypes of components will be delivered and tested.

		Country	*Scientific person in charge*
Partners	**TECNOGAMMA SPA**	ITALIA	Eleonora MARTON (Pr. Coord.)
	AFV ACCIAIERIE BELTRAME SPA	ITALIA	Giovanni BORINELLI
	ISTITUTO NAZIONALE DI FISICA NUCLEARE	ITALIA	Paolo CHECCHIA
	S.R.B. COSTRUZIONI SRL	ITALIA	Massimo RIVOLI
	UNIVERSITA DEGLI STUDI DI BRESCIA	ITALIA	Germano BONOMI
	UNIVERSITA DEGLI STUDI DI PADOVA	ITALIA	Gianni ZUMERLE

RFSR-CT-2010-00034 RELOTEMP

Reuse of low-temperature heat (<350°) for the reduction of CO^2-impact of the steel industry

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1679311 €	Start Date	1/07/2010
	EU Contribution	1007587 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract The aim of the project is to reduce energy consumption and CO2-emissions of the steel industry by the reuse of waste low temperature heat (LTH) with T<350°C in typical production processes (coke plant, sintering plant, BF, steelmaking, rolling mill and coating). To reach it, LTH sources and possible users (e.g. production of vapour, electricity and cold) will be identified, LTH reuse pathways and decision matrixes for integration of LTH recovery techniques will be developed.
Concepts for the reuse of excess LTH in the steel industry will be elaborated and evaluated on basis of economical study and carbon footprint calculation.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Pavel IVASHECHKIN (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Gérard GRIFFAY
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Juan José ARRIBAS RAMIREZ
	INSTITUTO DE SOLDADURA E QUALIDADE	PORTUGAL	Marco ESTRELA
	SWEREA MEFOS AB	SVERIGE	Chuan WANG
	SSAB TUNNPLÅT AB	SVERIGE	Jonny KARLSSON
	SALZGITTER FLACHSTAHL GmbH	DEUTSCHLAND	Ralph SCHAPER

RFSR-CT-2010-00035 SELSA

Selective salt elimination and valorisation for sustainable water and facility management in the steel industry

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1497768 €	Start Date	1/07/2010
	EU Contribution	898661 €	End Date	31/12/2013
State	Project completed, final report not published yet			

Provisional Abstract

The project aims at the development of innovative concepts for sustainable water and facility management in the European Steel Industry on basis of selective salt elimination techniques with integrated salt valorisation. The novel desalination processes will be automated and monitored by means of online ion analyser to minimise maintenance costs. Influence of the salt elimination on the pipe service life, product quality and process water reuse will be evaluated.
Following results are expected: better product quality, prolonged pipe service life, reduced impact on the aquatic environment, saving of natural resources, reduced fresh water costs and waste water discharge costs.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Pavel IVASHECHKIN (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Beatriz PADILLA VIVAS
	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	ESPAÑA	Manuel MORCILLO LINARES
	ILVA S.P.A.	ITALIA	Carmelo LUCCA
	OUTOKUMPU NIROSTA GmbH	DEUTSCHLAND	Alexander RASSOW
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

Selected Publications

D. de la Fuente, J. Simancas, A. Baz, M. Morcillo (2012): A laboratory study on the influence of saline streams on pipeline corrosion in the steel industry. Poster presentation at EUROCORR 2012 – Istanbul 9-13 September 2012

RFSR-CT-2010-00036 IPRO

Inline elemental characterisation of scrap charging for improved EAF charging control and internal scrap recycling

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1690008 €	Start Date	1/07/2010
	EU Contribution	1014004 €	End Date	30/06/2013
State	Running project			

Provisional Abstract

The overall objective of this project is to develop an improved guidance of scrap charging operation for electrical arc furnace (EAF, both for carbon and stainless steel production) in order to stabilize process conditions and optimise internal scrap recycling. Steel scrap will be characterised in-line with compact tailored laser analysers, monitoring the content of key elements in real time.
In particular systems will be developed and set up to allow:
- monitoring of Si (and also Ni and Mo) in a continuous scrap charging system with the objective to improve EAF charging procedure control for process stabilization;
- monitoring of Mo in high-alloy steel internal scrap for stainless steel production with the objective to improve internal scrap recycling.

		Country	*Scientific person in charge*
Partners	**FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG e.V.**	DEUTSCHLAND	Reinhard NOLL (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Ugo CHIAROTTI
	SWEREA KIMAB AB	SVERIGE	Jonas GURELL
	O.R.I. MARTIN - ACCIAIERIA E FERRIERA DI BRESCIA SpA	ITALIA	Uggero DE MIRANDA
	OUTOKUMPU STAINLESS AB	SVERIGE	Appell ANDERS
	RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN	DEUTSCHLAND	Nadine STRAUSS

Selected Publications

J. Gurella, A. Bengtsona, M. Falkenströma, B.A.M. Hanssonb, Laser induced breakdown spectroscopy for fast elemental analysis and sorting of metallic scrap pieces using certified reference materials, Spectrochimica Acta Part B: Atomic Spectroscopy , Vol 74–75, August–September 2012, Pages 46–50. DOI: http://dx.doi.org/10.1016/j.sab.2012.06.013

Jonas Gurell, PhD: Spectroscopy: the future of steel?. International Innovation. Hrsg. Research Media Ltd. Bristol, United Kingdom, 2012:49:117-119.

RFSR-CT-2010-00037 Cognitive Control

Cognitive control systems in steel processing lines for minimised energy consumption and higher product quality

Info

Type of Project	Research	Duration (months)	42
Total Budget	1585478 €	Start Date	1/07/2010
EU Contribution	951287 €	End Date	31/12/2013

State Running project

Provisional Abstract

Much attention has been paid to the development of energy-saving technologies in terms of new/modified equipment and processes to reduce energy costs and reduce CO2 emissions. However, the efficiency of quality assurance as well as energy-savings can only be fully achieved for production lines with an optimally-
tuned control performance. This project aims to create cognitive automation systems by integrating the features: self-monitoring; self-detection; self-testing; and self-adaptation. New strategies, methods and software will be developed for on-line performance assessment and diagnosis to determine origins of poor
performance due to abnormal conditions in sensors, actuators, or controllers. The performance diagnosis and tuning information is to be derived using only operating data through innovative calculation techniques.
This will provide self-adaptation of setup systems and automatic retuning of controllers or verify and eliminate given fault causes, keeping the control performance at optimum values. The techniques and systems to be developed will be demonstrated on different industrial processing lines (cold rolling, annealing,
galvanising), aiming to improve product quality and to minimise energy consumption.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Andreas WOLFF (Pr. Coord.)
ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Jürgen BATHELT
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UNIVERSITY OF STRATHCLYDE* ROYAL COLLEGE OF SCIENCE & TECHNOLOGY	UNITED KINGDOM	Reza KATEBI

RFSR-CT-2010-00038 COATHYDRO

New approaches to quantitative hydrogen analysis of coated steel products

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1571121 €	Start Date	1/07/2010
	EU Contribution	942672 €	End Date	31/12/2013
State	Running project			

Provisional Abstract

Basic objective is to improve production control and R&D capabilities for coated steel products with high strength and sensitive microstructure. To continue the development of such products clear and rigorous methodologies of hydrogen measurements are necessary. Particular effort will be dedicated to implement:
- SIMS and new laser-based methods to measure hydrogen local concentration;
- GD-OES methodologies to measure bulk concentration and identify possible interface enrichment of hydrogen;
- new TDA MS-based instrumentation for improved distinction of traps and origin of hydrogen;
- new, possible Certified Reference Materials.

New methodologies will be evaluated on the basis of standard extraction procedures.

		Country	*Scientific person in charge*
Partners	**LEIBNIZ-INSTITUT FÜR ANALYTISCHE WISSENSCHAFTEN - ISAS e.V.**	DEUTSCHLAND	Roland HERGENRÖDER (Pr. Coord.)
	JOHANNES KEPLER UNIVERSITY, LINZ	OESTERREICH	Achim Walter HASSEL
	SWEREA KIMAB AB	SVERIGE	Arne BENGTSON
	MAX-PLANCK-INSTITUT FÜR EISENFORSCHUNG GmbH	DEUTSCHLAND	Michael ROHWERDER
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Karin BERGERS
	VOESTALPINE STAHL GMBH	OESTERREICH	Hubert DUCHACZEK

RFSR-CT-2011-00036 MULTISAVE

Multichannel spectroscopy and hyperspectral imaging for improved steel surface states monitoring and cost savings

Info

Type of Project	Research	Duration (months)	36
Total Budget	1428502 €	Start Date	1/07/2011
EU Contribution	857101 €	End Date	30/06/2014

State Running project

Provisional Abstract

With the development of new steel grades and coatings presenting specific surface chemistries, the control of the surface states has become a need for a better product surface quality in downstream applications. Having access to a punctual measurement for surface characterization only brings local information but not a global chemical understanding. Recent developments in hyperspectral technology offer the possibility to couple it with multiple optical fibres. This research project aims at leading to a pre-industrial multipoint spectroscopic
analyzer to monitor the online chemistry of surface states at critical processing points and then quantifying the resulting economic benefits.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	David GLIJER (Pr. Coord.)
SPECIM, SPECTRAL IMAGING OY	FINLAND	Timo HYVÄRINEN
UNIVERSITÄT PADERBORN	DEUTSCHLAND	Guido GRUNDMEIER
TEKNOLOGIAN TUTKIMUSKESKUS VTT*TECHNIC. RESEARCH CENTRE OF FINLAND	FINLAND	Mikko JUUTI

Selected Publications

Key dekliverable : Industrial sample data base (around 40 industrial samples collected within the project)

Key deliveralble : Model sample data base (around 30 industrial samples collected within the project)

Key deliverable: Characterization by reference techniques of both samples data base

Key deliverable: Characterization by spectroscopic techniques (FTIR, Raman, UV-visible) of both samples data base

Key deliverable: Instrumental requirements and optical geometries definition

RFSR-CT-2011-00037 SLAGFERTILISER

Impact of long-term application of blast furnace and steel slags as liming materials on soil fertility, crop yields and plant health

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1904134 €	Start Date	1/07/2011
	EU Contribution	1142480 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

Based on the results from the research project 7210-PR-267 finished in 2005, additional questions on the effects of Cr and V from iron and steel slags on soils and plants will be investigated as a basis for further environmental discussions on liming agents in the EU.
The use of the fine grained steel slag as fertiliser in agriculture is advantageous for both the steel industry and the farmers in Europe and world wide. Steel industry cannot sell the fines into building industry, farmer have always positive yield. Therefore it is necessary to investigate, if there will be no harmful effects on the food chain soil-plant-animal-humans.

Partners	*Country*	*Scientific person in charge*
FEhS - INSTITUT FÜR BAUSTOFF-FORSCHUNG e.V.	DEUTSCHLAND	Dirk MUDERSBACH (Pr. Coord.)
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ÖSTERREICHISCHE AGENTUR FÜR GESUNDHEIT UND ERNÄHRUNGSSICHERHEIT GmbH	OESTERREICH	Heide SPIEGEL
ARBEITSGEMEINSCHAFT HÜTTENKALK E.V. - ARGE	DEUTSCHLAND	Martin REX
ILVA S.P.A.	ITALIA	Renzo TOMASSINI
RUUKKI METALS OY	FINLAND	Sakari TUOMIKOSKI
SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
VOESTALPINE STAHL GMBH	OESTERREICH	Mario MAUHART

RFSR-CT-2011-00038 CORSA

Cost effective, reliable and safe acid management at European pickling plants

Info

Type of Project	Research	Duration (months)	42
Total Budget	1316464 €	Start Date	1/07/2011
EU Contribution	789878 €	End Date	31/12/2014

State Running project

Project web page www.rfcscorsa.com

Provisional Abstract

Plastic materials are frequently used in process equipment for pickling and acid regeneration to cope with the aggressive conditions (50-90 °C, pH<1). Thus safety, service reliability and an effective acid regeneration depends on these materials. Still very little is known about the longterm performance of plastics in equipment for pickling lines. Claims from the society for industrial safety in terms of both, occupational health and safety and environmental welfare have become stronger and stronger. Thus, this project aims at improving the knowledge of plastic corrosion in European Steel plants to achieve a safe, reliable and effective acid
management.

Partners

	Country	*Scientific person in charge*
SWEREA KIMAB AB	SVERIGE	Daniel EJDEHOLM (Pr. Coord.)
ANDRITZ AG	OESTERREICH	Thomas HOFBAUER
GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	José Manuel LLANOS RUIZ
OUTOKUMPU NIROSTA GmbH	DEUTSCHLAND	Karl-Heinz KIRCHHOFF
OUTOKUMPU STAINLESS AB	SVERIGE	Thorsten SCHNEIKER
SCANACON AB	SVERIGE	Lars-Ake FREDRIKSSON
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Frank RÖGENER

Selected Publications

F. Rögener, K. Jacobson, P. Bergsjö, G. Hartmann, M. Sartor, T. Reichardt: Steel pickling, acid regeneration and plastic corrosion in steel rolling mills. 30. Journées Siderurgiques Internationales, Abstracts, pp. 184-185, Paris, 18.-19.12.2012

K. Jacobson: Thermoplastic materials in contact with strong acids used in pickling applications. Plastic-Materials in Plant Engineering, March 7-8, 2012, Munich.

RFSR-CT-2011-00039 RECONI

Recovery of nickel from waste in stainless steel industry

Info

Type of Project	Research	Duration (months)	42
Total Budget	1843952 €	Start Date	1/07/2011
EU Contribution	1106372 €	End Date	31/12/2014

State Running project

Provisional Abstract

Pickling processes in stainless steel industry produce large amounts of waste acid and neutralisation sludge which contains a lot of valuable nickel. In Europe more than 2500 t/a of nickel with a current value of 40 million €/a are deposited.
The objective of the project is to recover this nickel from waste acid and neutralisation sludge, respectively. Therefore, two processing routes with several well coordinated unit operations will be investigated. The recovered nickel will be re-used in the steelmaking process. The recovery processes can be used for both main pickling systems, HF/HNO3-pickling and HNO3-free pickling.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Andreas BAN (Pr. Coord.)
ACCIAI SPECIALI TERNI SpA	ITALIA	Alessandro SEGALA
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Luca LATTANZI
HENKEL ITALIA SPA	ITALIA	Yean DEMERTZIS
MEAB METALLEXTRAKTION AB	SVERIGE	Hans REINHARDT
OUTOKUMPU NIROSTA GmbH	DEUTSCHLAND	Hans-Günther HARTMANN

Selected Publications

F. Rögener, D. Buchloh, A. Bán, T. Reichardt: Metal recovery from liquid and solid waste streams generated in stainless steel cold rolling mills. 30th International Steel Industry Conference, Paris, France, 18.-19. December 2012.

C. Dittrich, F. Rögener: Recovery of nickel from stainless steel waste streams. 1st Metallurgical & Materials Engineering Congress of South-East Europe, Belgrade, Serbia, 23.-25. May 2013

RFSR-CT-2011-00040 TECPLAN

Technology-based assistance system for production planning in stainless mills

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1572839 €	Start Date	1/07/2011
	EU Contribution	943704 €	End Date	31/12/2014
State	Running project			

Provisional Abstract

Production planning systems are essential for minimising costs and maximising productivity in steel processing plants. This project aims at introducing and developing a new assistance system that determines the optimal production route for stainless steel, depending on the value of an applicability index as function of the desired strip quality, mill capabilities (i.e. actuators and control equipment) and customer requirements. This will be based on (1) the installation and measurement of strip flatness at different locations in the processing chain and (2) the development of prediction (transfer) models for flatness, crossbow, thickness tolerance, other quality parameters and plant throughput for the different processing routes (hot strip mill, four 20-high rolling mills, three annealing plants, three temper mills and one finishing line).

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Jan POLZER (Pr. Coord.)
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	OUTOKUMPU NIROSTA GmbH	DEUTSCHLAND	Hans-Günther HARTMANN
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

RFSR-CT-2012-00037 ICONSYS

Intelligent control station for improved quality management in flat steel production by a next generation decision support system

Info

Type of Project	Research	Duration (months)	42
Total Budget	1243745 €	Start Date	1/07/2012
EU Contribution	746248 €	End Date	31/12/2015

State Running project

Provisional Abstract

Based on four years of very successful operation of a Decision Support System regarding quality of steel strips (developed in a RFCS project), now the next significant step has to be done to support people at the control stations of rolling and finishing mills: the Intelligent Control Station.
Therefore the following new developments will be integrated in existing decision support solutions: automatic monitoring of used manufacturing specifications and their continuous improvement, evaluation procedures to detect products which exceed the customer requirements significantly and methods to optimise between environmental and technical aspects during the decision about further treatment of coils.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert HOLZKNECHT (Pr. Coord.)
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UNIVERSIDAD DE OVIEDO	ESPAÑA	Francisco ORTEGA FERNANDEZ

RFSR-CT-2012-00038 I2MSTEEL

Development of a new automation and information paradigm for integrated intelligent manufacturing in steel industry based on holonic agent technology

Info	Type of Project	Research	Duration (months)	42
	Total Budget	3545543 €	Start Date	1/07/2012
	EU Contribution	2127326 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

Most of the European steel production relies on information systems with limitations which are typically due to the unrelated historic development of their respective elements (typically over several decades). Actual production environments are inflexible and have many roadblocks for a seamless and agile cooperation and exchange of information along the whole supply chain.
In this context, I²MSteel will develop and demonstrate a new paradigm for a factory- and company-wide automation and information technology for Intelligent and Integrated Manufacturing at steel production.
A description of the steel making supply using semantic technologies in such a way, that higher-level automation and information systems have the basis for orientation, communication and high-level information exchange across the complete supply chain.
A platform of agents and holons will be developed for its capacity to perform all the high level tasks of steel production: product tracking, process control, process planning, through-process quality control, information storage, logistics, etc.
This platform will operate on Service Oriented Architecture which offers the necessary basic routines for the agent level regarding communication, product tracking, negotiation protocols, data storage, event handling, etc.
A demonstration will be installed in a hot facility from continuous casting to hot rolling. The platform will operate in real time with on line data coming from the production site. Decisions done by the platform will be compared with day to day production in order to evaluate the added-value for the main objectives: cost, quality and leadtime.
Finally the transferability of the new paradigm to all possible kinds of processes and process chains in the steelindustry will be demonstrated.

		Country	*Scientific person in charge*
Partners	**ARCELORMITTAL MAIZIERES RESEARCH S.A.**	FRANCE	Gael MATHIS (Pr. Coord.)
	CENTRE D'EXCELLENCE EN TECHNOLOGIES DE L'INFORMATION ET DE LA COMMUNIC	BELGIQUE	Philippe MASSONET
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Francesca MARCHIORI
	SIEMENS AG	DEUTSCHLAND	Norbert GOLDENBERG
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Alexander EBEL

RFSR-CT-2012-00039 REFFIPLANT

Efficient use of resources in steel plants through process integration

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2351879 €	Start Date	1/07/2012
	EU Contribution	1411127 €	End Date	31/12/2015
State	Running project			

Project web page http://www.reffiplant.com/

Provisional Abstract The project aims to improve the efficiency of resource use (materials, water, energy) in integrated steelworks.
This aim will be achieved by developing alternative design solutions for the use of materials at source and improved recycling, reuse, treatment of wastewater, sludge and dust by considering the site-wide interactions between the processes and related factors. When optimisation of the different criteria leads to contradictory answers, the project will demonstrate how to utilize Process Integration methods and techniques in combination with multi-criteria optimisation to identify overall solutions that minimise the ecological footprint of steelmaking

		Country	*Scientific person in charge*
Partners	**SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA**	ITALIA	Valentina COLLA (Pr. Coord.)
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	SSAB EMEA AB	SVERIGE	Katarina KYLEFORS
	TATA STEEL UK LIMITED	UNITED KINGDOM	Mansour SAIEPOUR

RFSR-CT-2012-00040 EvalHD

Refinement of flat steel quality assessment by evaluation of high-resolution process and product data

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1452752 €	Start Date	1/07/2012
	EU Contribution	871651 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

Product quality is the main driver for European steel producers competing against other steel companies on the global market. Therefore continuous quality improvement and zero-defect-manufacturing are major targets of European steel makers which is why the production of high quality steel is supported by modern measuring systems gathering an increasing amount of high resolution (HR) quality and process data along the complete flat steel production chain. Whereas this kind of data is already used for online process control applications where possible, this is not the case for the assessment of product quality.
The aim of this project is to develop an advanced product quality supervisory system for flat steel production based on HR measuring data. To achieve this ambitious target new methods have to be developed, employing innovative software technologies and modern computation capabilities, tailored to handle the massive amount of data accumulating during the steel production process.
A dedicated HR data storage system capable of handling high-performance HR data access not achievable using standard data-warehouse technology will be designed and built. Based on this new quality of data access a modular software system for product quality supervision will be developed supporting standardised network access to product data by definition of a unified web-service.
This web-service will be implemented at the industrial sites, providing intuitive visualisations of the current production state and through-process synchronization of data coming from different production steps. By cause and effect analysis based on HR data increased knowledge about origin and evolution of quality deficiencies shall be gained to improve quality decisions already at early stage. Conditions for high quality production will be quantified to increase process understanding and optimize the whole production chain towards zero-defect production

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Jens BRANDENBURGER (Pr. Coord.)
	ILVA S.P.A.	ITALIA	Floriano FERRO
	SWEREA MEFOS AB	SVERIGE	Thorbjörn HANSEN
	THYSSENKRUPP RASSELSTEIN GMBH	DEUTSCHLAND	Christoph SCHIRM
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

RFSR-CT-2012-00041 MONWIRE

Quality and process monitoring system based on surface and internal defect detection for hot and cold wire

Info

Type of Project	Research	Duration (months)	42
Total Budget	2273046 €	Start Date	1/07/2012
EU Contribution	1363827 €	End Date	31/12/2015

State Running project

Provisional Abstract

The aim of this research proposal is to develop a new advanced on-line monitoring for wire production by means of integration of the main quality product parameters (as surface and internal defects presence, defect classification) and process variables in order to aid the application of grading rules, product allocation,
optimisation of feedback actions.
This goal will be reached with the development and upgrading of innovative inspection techniques (EC, EMAT and Optical). Only the combination of multiple solution and the integration of process measures linked with an efficient product tracking assure the complete monitoring/control of product quality.

Partners

	Country	*Scientific person in charge*
CENTRO SVILUPPO MATERIALI SPA	ITALIA	Roberto PIANCALDINI (Pr. Coord.)
ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Philip MEILLAND
DANIELI AUTOMATION SPA	ITALIA	Riccardo FERRARI
O.R.I. MARTIN - ACCIAIERIA E FERRIERA DI BRESCIA SpA	ITALIA	Uggero DE MIRANDA
ROHMANN GMBH	DEUTSCHLAND	Gerald SCHNEIBEL
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Dietmar OBERHOFF

Selected Publications

R.Piancaldini, D. Oberhoff, R.Ferrari, P. Meilland, G. Schneibel, S. Betti : Quality Policy of Hot Rolling Mill. MONWIRE project deliverable 1.1

P. Meilland, G. Schneibel: Specifications-ADFEC driver. MONWIRE project deliverable 1.2

RFSR-CT-2012-00042 MAGSEP

Strong field magnetic separation of fine particles from cooling water and gas wash water circuits of the steel industry

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1024100 €	Start Date	1/07/2012
	EU Contribution	614460 €	End Date	31/12/2015
State	Running project			

Provisional Abstract

The project aims at the filter aid free separation of fine iron containing particles, especially between 0,5 µm and 10 µm, from cooling water (strip casting, descaling, hot rolling) and gas wash water (e.g. blast furnace) by using permanent strong-field magnets. This proposed technology focuses on a small ratio plant design with significantly low back flush water flows below 1% of the treated flow. Efficient separation of the iron containing particles is required to ensure a high and homogenous product quality (surface, strength). Nozzle wear by abrasive particles leads to differing spray patterns and cooling rates and hence inhomogeneous microstructures. Furthermore, the concentration of fine scale/particles causes an increased maintenance effort due to blocking. Considering increasing raw material prices (iron, alloys), metallurgical reuse of the separated particles after conditioning in the steel industry (sinter plant, basic oxygen furnace) is mandatory to decrease the loss of resources by disposal of filter aid contaminated particles.

The proposed research project is a joint project involving partners with different tasks according to their respective areas of expertise. AME, TATA and DEW are representative users of the research results, supplying products with different microstructures and compositions like carbon steel (AME), medium alloyed carbon steels (TATA) and stainless steels (DEW). Furthermore, these steel producing companies focus on operational tests and application. The emphasis of the research companies (BFI, AME) is on laboratory tests to describe the magnetic separation (BFI), CFD simulations to evaluate the suitable plant geometry (AME) as well as conditioning of separated particles and evaluation of the research results in field tests (BFI). The project results in development of rules of construction and a concept including the particle separation, conditioning and metallurgical reuse done by the research institutes and users like DEW and AME

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Martin HUBRICH (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Beatriz PADILLA VIVAS
	DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Peter KÜHN
	TATA STEEL UK LIMITED	UNITED KINGDOM	Mansour SAIEPOUR

RFSR-CT-2013-00027 EnergyDB

Application of a factory wide and product related energy database for energy reduction

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1794734 €	Start Date	1/07/2013
	EU Contribution	1076840 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

Being an energy intensive industry, the reduction of energy consumption is today of extremely large interest at steel production. To identify possibilities of energy reduction, suitable energy consumption data related to single products and / or to product groups like e.g. one material class are essential. This collection of energy consumption data is today only time related for billing purposes, without relation to products or process conditions. The proposals idea is to create an energy information database in which the energy consumption is directly assigned to the different intermediate or final products and to connect it with the production conditions, which are stored in existing Quality- and Process databases. These connections have to take into account special conditions like e.g. number of pieces in an oven or energy consumption during downtimes. Manual and automatic procedures for different evaluation purposes will be developed and implemented, taking environmental and technical aspects into account. These will be the cause&effect analysis of energy consumption deviations, improvement of the process route by means of environmental aspects, the benchmarking of comparable plants and the improvement of the control of the process schedule in terms of energy consumption efficiency. The latter application will be realised by the connection to a Manufacturing Execution System (MES) and tested by means of a simulation environment provided by Danieli Automation. The developed system will be installed at three industrial sites (ArcelorMittal Espana, ThyssenKrupp Nirosta, Riva Acciaio) covering stainless, carbon steel and tinplate flat products as well as long products. This guarantees a large amount of different exemplarily cases and therefore a good transferability of the developed system to the whole European steel industry.

Partners		*Country*	*Scientific person in charge*
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Norbert LINK (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	María Luisa Teresa RODRIGUEZ MONTEQIN
	ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Jens GELLERT
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Francesca MARCHIORI
	DANIELI AUTOMATION SPA	ITALIA	Andrea MERLUZZI
	RIVA ACCIAIO SPA	ITALIA	Paolo ROSSI
	UNIVERSIDAD DE OVIEDO	ESPAÑA	Vicente RODRIGUEZ MONTEQUIN

RFSR-CT-2013-00028 DynCyanide

Cyanide Monitoring and Treatment under dynamic Process Conditions

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1882555 €	Start Date	1/07/2013
	EU Contribution	1129534 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

During iron production in the blast furnace, formation of cyanide occurs. A part of the cyanide leaves the blast furnace with the furnace gas. The correlations between blast furnace operation and cycanide concentration in the top gas are mainly unknown. During gas cleaning, cyanide is transferred into the gas washing water. The transfer rates are not known. Cyanide concentrations in the water cycles can be measured off-line, but no reliable on-line measurement method exists. Stricter limit values for water discharge demand an exact cyanide online-measurement and an efficient cyanide treatment process operated depending on blast furnace operation and gas washing water conditions. The fact that nowadays blast furnace operation includes use of alternative input material increases the necessity of research on this topic. The project aims are: determination of the dynamic correlation between cyanide concentration in the top gas and blast furnace operation, determination of cyanide transfer rates from top gas into the gas washing water, determination of cyanide concentrations in gas washing water circuits and cyanide treatment rates. The prior condition to gain this knowledge is the development of a reliable and reproducible cyanide online-measurement including determination of interfering components in the gas washing water. An additional aim is the development of a cyanide treatment process for water reuse, using the online concentration data for adapted dosage of treatment chemicals. In the project, analysis of cyanide concentrations at three industrial sites will be combined with development and on-site testing of cyanide online-measurement and modelling of cyanide concentrations in gas washing water circuits. Different cyanide treatment methods will be tested in laboratory and in bypass of the industrial gas washing water circuits. The results will be combined to provide guidelines and exemplary concepts for cyanide measurement and treatment.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Martin HUBRICH (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Beatriz PADILLA VIVAS
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	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	TATA STEEL UK LIMITED	UNITED KINGDOM	David R. ANDERSON
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Eckhard PAPPERT

RFSR-CT-2013-00029 THERELEXPRO

Thermoelectric Heat Recovery from Low Temperature Exhausts of Steel Processes

Info	Type of Project	Research	Duration (months)	36
	Total Budget	1503358 €	Start Date	1/07/2013
	EU Contribution	902015 €	End Date	30/06/2016
State	Running project			

Provisional Abstract The project develops and improves a fluidless technology based on thermoelectricity to recover the heat from low temperature (T< 350°C) exhaust fluids of steel processes and convert it into electricity. The thermoelectricity, now improved through nanotechnology, allows to obtain higher heat-to-electricity conversion efficiency than the previous generation, made through "casting" process, that is, with current technologies, about 10% at 350°C. The technology will be tested to identify more reliable and high-performance configurations and ultimately assessed on selected steel plants sections by an “ad hoc” developed monitoring system.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Ugo CHIAROTTI (Pr. Coord.)
	ARCELORMITTAL ESPAÑA SA	ESPAÑA	Juan José ARRIBAS RAMIREZ
	CARDIFF UNIVERSITY	UNITED KINGDOM	Min GAO
	FERRIERE NORD S.P.A.	ITALIA	Loris BIANCO
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Jacques Joannes SOONS

RFSR-CT-2013-00030 EIRES

Environmental impact evaluation and effective management of resources in the EAF steelmaking

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2844251 €	Start Date	1/07/2013
	EU Contribution	1706551 €	End Date	31/12/2016
State	Running project			

Provisional Abstract

The present proposal aims at defining a methodology for the assessment of the environmental impact of EAF steelmaking plants, being widely recognized and accepted, consistent and transferable. Impacts of emissions into air, water and soil, as well as energy, water and wastes management, properly measured and weighted, will contribute to the definition of a global index. Moreover, simulation models for the plants of the EAF steelmaking route will be developed and linked with LCA tool to predict the environmental impact of process alterations/modifications and to recognize potential improvements of the production cycle.

		Country	*Scientific person in charge*
Partners	**SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA**	ITALIA	Valentina COLLA (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Enrico MALFA
	DALMINE SPA	ITALIA	Fabio PRAOLINI
	DEUTSCHE EDELSTAHLWERKE GMBH	DEUTSCHLAND	Christof BEILER
	GERDAU INVESTIGACION Y DESARROLLO EUROPA S.A.	ESPAÑA	Iñigo UNAMUNO
	O.R.I. MARTIN - ACCIAIERIA E FERRIERA DI BRESCIA SpA	ITALIA	Uggero DE MIRANDA
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	FUNDACION TECNALIA RESEARCH & INNOVATION	ESPAÑA	Borja PENA QUINTERO
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernhart STRANZINGER

RFSR-CT-2013-00031 PUC

Product Uniformity Control

Info	Type of Project	Research	Duration (months)	54
	Total Budget	4337151 €	Start Date	1/07/2013
	EU Contribution	2602290 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

The uniformity of the microstructure of steel strip over the entire coil length (“intra-coil uniformity”) and between different coils of the same grade (“inter-coil uniformity”) is key to consistent material behaviour at steel manufacturers’ proprietary processes like rolling and customers’ processes like pressing and deep-drawing. Evidently, stable and consistent processes yield optimal product quality and maximize efficiency, giving minimal loss of material and energy over the entire production chain. The steel manufacturers already control the quality of their products by tensile testing and microstructure analysis of samples taken at the coil head or tail. Whereas this procedure yields data on the “inter-coil uniformity”, the “intra-coil uniformity” can be monitored and improved only using continuous product measurements over the full length of the strip. Since the microstructure of steel governs the electromagnetic and ultrasonic properties, practically all measurement techniques to monitor the microstructure online are based on sensing these properties. Despite many efforts however, the steel research community has not established unique and universal relationships between the online measured parameters and microstructure. In this perspective, the present proposal Product Uniformity Control (PUC) is not aiming for absolute prediction of microstructure parameters, but seeks for relative relationships in order to improve both “inter-coil” and “intra-coil” uniformity of steel strip. The PUC proposal follows an integrated research path of modelling, laboratory tests and dedicated plant trials to enhance the understanding of the relation between microstructure and online measured parameters. It also aims to understand and reduce cross-sensitivities of the sensor systems to measurement conditions like speed and lift-off. Finally, it investigates the quality and monetary benefits from application of continuous product uniformity monitoring in the steel industry.

		Country	*Scientific person in charge*
Partners	**TATA STEEL NEDERLAND TECHNOLOGY B.V.**	NEDERLAND	Frenk VAN DEN BERG (Pr. Coord.)
	ARCELORMITTAL MAIZIERES RESEARCH S.A.	FRANCE	Philip MEILLAND
	ARCELORMITTAL EISENHÜTTENSTADT GmbH	DEUTSCHLAND	Rene SCHMIDT
	COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	FRANCE	Christophe REBOUD
	CEDRAT SA	FRANCE	Vincent LECONTE
	ASOCIACION CENTRO DE ESTUDIOS E INVESTIGACIONES TECNICAS	ESPAÑA	Ane MARTINEZ DE GUEREÑU
	CHALMERS TEKNISKA HÖGSKOLA AB	SVERIGE	Hakan WIRDELIUS
	SWEREA KIMAB AB	SVERIGE	Martin ENGMAN
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	SALZGITTER MANNESMANN FORSCHUNG GmbH	DEUTSCHLAND	Mathias STOLZENBERG
	THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Thomas KEBE
	TNO, NED ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	NEDERLAND	Gerrit BLACQUIERE
	UNIVERSITE JOSEPH FOURIER GRENOBLE 1	FRANCE	Stéphane LABBÉ
	THE UNIVERSITY OF BIRMINGHAM	UNITED KINGDOM	Claire DAVIS
	THE UNIVERSITY OF MANCHESTER	UNITED KINGDOM	Anthony PEYTON

RFSR-CT-2013-00032 PSP-BOF

Removal of Phosphorus from BOF-slag

Info	Type of Project	Research	Duration (months)	36
	Total Budget	2413955 €	Start Date	1/07/2013
	EU Contribution	1448372 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

This project seeks to separate useable substances from BOF-slag for utilisation in different application. Different separation techniques will be investigated based on either liquid slag (partial) or on solidified slag, where treatment of liquid slag with phosphorus- and iron containing residues is an important part. Fractions rich in phosphorus and calcium can be used as fertiliser or in cement and V-rich fraction as raw material for vanadium production. Remaining slag is low in phosphorous and hence no restrictions exist for internal recycling via sinter plant or blast furnace. Advantages will be significant savings of iron ore, limestone, CO2 and energy. The goal of the PSP-BOF project is to add knowledge and value by investigating the entire chain by innovative methods and carry out operational tests by: • treatment of liquid slag with P- and Fe-containing residues to reach the target of successful separation and optimised recycling, • investigation of two different phosphorus separation methods, one based on separation of liquid (partial) state and one based on separation in solid state by mineral processing, by investigation of different techniques and selection of optimised process routes for these two methods and • investigations of potential applications of all fractions, partly not investigated in the past, aiming at a zero-waste process.

		Country	*Scientific person in charge*
Partners	**SWEREA MEFOS AB**	SVERIGE	Marcel MAGNUSSON (Pr. Coord.)
	FEhS - INSTITUT FÜR BAUSTOFF-FORSCHUNG e.V.	DEUTSCHLAND	Dirk MUDERSBACH
	ILVA S.P.A.	ITALIA	Renzo TOMASSINI
	SSAB MEROX AB	SVERIGE	Diana ORRLING
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA
	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Roland PIETRUCK
	VOESTALPINE STAHL GMBH	OESTERREICH	Herbert SCHMID

RFSR-CT-2013-00033 MODELCOR

Modular simulation tool for in-service behaviour prediction of the cooling water systems of the steelmaking industry

Info

Type of Project	Research	Duration (months)	42
Total Budget	1163178 €	Start Date	1/07/2013
EU Contribution	697907 €	End Date	31/12/2016

State Running project

Provisional Abstract

The objective of this proposal is to develop a tool/software for predicting the in-service behaviour of cooling water circuits. Experimental data from laboratories and data-mining analyses will be used to create a data base of circuit elements (pipes, elbows, pumps, venturis, etc.), operation parameters (temperature, flow, pressure, etc.) and control parameters (corrosion rate, scaling risk, bio-fouling and heat efficiency). The results of this data base will be specific circuit units with defined characteristics and parameters associated. These units will be used for developing software based on Finite Element Method to simulate the behaviour of the cooling water circuit under operation conditions.

Partners

	Country	*Scientific person in charge*
ARCELORMITTAL ESPAÑA SA	ESPAÑA	María Luisa Teresa RODRIGUEZ MONTEQIN (Pr. Coord.)
EURO CFD SARL INDUSTRIAL SIMULATIONS	FRANCE	Alvaro HERNANDEZ-GOMEZ
FUNDACION ITMA*INSTITUTO TECNOLOGICO DE MATERIALES	ESPAÑA	Olga CONEJERO
METALOGIC AI TECHNOLOGIES & ENGINEERING NV	BELGIQUE	Erik THOMAS
UNIVERSIDAD DE OVIEDO	ESPAÑA	Francisco ORTEGA FERNANDEZ

RFSR-CT-2013-00034 LACOMORE

Laser-based continuous monitoring and resolution of steel grades in sequence casting machines

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1629420 €	Start Date	1/07/2013
	EU Contribution	977652 €	End Date	31/12/2016
State	Running project			

Provisional Abstract On-line elemental analysis of hot, transition slabs/billets from a distance, without any interference or delay in the production line, will be performed with a new sensing system based on laser induced breakdown spectroscopy (LIBS). Intermediate chemical composition in transition materials resulting from successive heats will be then readily identified. A number of laboratory tests and industrial trials will be carried out to validate the LIBS technology. The sensor is aimed at working in plant environment in absence of human intervention. A mathematical model based on LIBS measurements to predict the mixing process will be also developed.

		Country	*Scientific person in charge*
Partners	**UNIVERSIDAD DE MALAGA**	ESPAÑA	Javier LASERNA (Pr. Coord.)
	ACERINOX EUROPA SA	ESPAÑA	David PEREZ
	CONSIGLIO NAZIONALE DELLE RICERCHE	ITALIA	Vincenzo PALLESCHI
	CENTRE DE RECHERCHES METALLURGIQUES ASBL	BELGIQUE	Guy MONFORT
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	SWEREA KIMAB AB	SVERIGE	Arne BENGTSON

RFSR-CT-2014-00027 Mu-Blast

Study of the capability of muon tomography to map the material composition inside a blast furnace

Info	Type of Project	Research	Duration (months)	24
	Total Budget	896123 €	Start Date	1/07/2014
	EU Contribution	537672 €	End Date	30/06/2016
State	Running project			

Provisional Abstract

The aim of present proposal is to explore the application of muon scattering tomography to obtain a three-dimensional map of the distribution of different components present in the blast furnace burden (coke, ore and reduced metal) in the various positions (heights) in the inner zone of the stack. Muon tomography uses muons naturally falling on earth. Measuring the change of direction that muons undergo when crossing matter, muon tomography can measure the “scattering density” of the crossed material. The “scattering density” depends both on mass density and on the atomic number composition. The proposal foresees two steps. First, samples of burden material in the different states present in a furnace will be measured in a muon tomography prototype. This will allow to relate the material “scattering density” with chemical composition and status of the material. The raw material will be procured or from cores drilled in a furnace or from material reduced in laboratory. In the second step, using a software simulating the passage of muons in matter and a software model of the material distribution inside a blast furnace, the existing software for tomographic image reconstruction will be modified to cope with the large total thickness of a BF. The three-dimensional tomographic images will be use to assess the capability of muon tomography to produce information useful to monitor the BF operation.

Partners		*Country*	*Scientific person in charge*
	UNIVERSITA DEGLI STUDI DI PADOVA	ITALIA	Gianni ZUMERLE (Pr. Coord.)
	CENTRO SVILUPPO MATERIALI SPA	ITALIA	Eros Luciano FARACI
	ISTITUTO NAZIONALE DI FISICA NUCLEARE	ITALIA	Paolo CHECCHIA
	LUOSSAVAARA-KIIRUNAVAARA AB (LKAB)	SVERIGE	Fredrik FORSBERG
	SWEREA MEFOS AB	SVERIGE	Lena SUNDQVIST ÖQVIST
	UNIVERSITA DEGLI STUDI DI BRESCIA	ITALIA	Aldo ZENONI

RFSR-CT-2014-00028 SOProd

Economic and flexible decentral self-optimising production

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1574576 €	Start Date	1/07/2014
	EU Contribution	944744 €	End Date	31/12/2017
State	Running project			

Provisional Abstract Aim of this project is increasing flexibility, resource efficiency and productivity as well as decreasing energy consumption of the production. To meet this aim a new approach will be developed and implemented at HHO/ILVA and uses a combination of real-time and de-centralised optimisations for scheduling, an automatic process self-optimisation and autonomous communication between the processes. This concept allows to decentrally optimise the scheduling considering detailed product and process knowledge. It facilitates a process self-optimisation by using individual product properties and processing information of neighbouring processes. Furthermore, a fast dynamically reaction on process disturbances will be enabled.

		Country	*Scientific person in charge*
Partners	**VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH**	DEUTSCHLAND	Dirk ZANDER (Pr. Coord.)
	HOESCH HOHENLIMBURG GmbH	DEUTSCHLAND	Andreas HESSLER
	ILVA S.P.A.	ITALIA	Alessandro OSTA
	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO SANT'ANNA	ITALIA	Valentina COLLA

RFSR-CT-2014-00029 DYNERGYSteel

Integrated dynamic energy management for steel production

Info	Type of Project	Research	Duration (months)	42
	Total Budget	2924333 €	Start Date	1/07/2014
	EU Contribution	1754598 €	End Date	31/12/2017
State	Running project			

Provisional Abstract Steel Industry is an important energy consumer facing with problems of electrical grid instability due to the increasing of renewable energy sources. Power fluctuations have important influences on production costs (fares) and continuity (grid disconnections); a closer cooperation between grid operators and steel industry is needed to improve the power engagement forecast. DYNERGYsteel will develop dynamic approaches for electricity demand monitoring and timely reactions to grid situation to avoid non flexible equipment disconnection and financial fines when deviating from energy contingent. Simulation, decision support procedures, control tools will be implemented at several steelmaking plants to improve power management capability.

		Country	*Scientific person in charge*
Partners	**CENTRO SVILUPPO MATERIALI SPA**	ITALIA	Francesca MARCHIORI (Pr. Coord.)
	ACCIAI SPECIALI TERNI SpA	ITALIA	Massimo PENNESI
	HOESCH HOHENLIMBURG GmbH	DEUTSCHLAND	Ralf STERNITZKE
	LECH-STAHLWERKE GmbH	DEUTSCHLAND	Hans-Peter MARKUS
	O.R.I. MARTIN - ACCIAIERIA E FERRIERA DI BRESCIA SpA	ITALIA	Uggero DE MIRANDA
	RICERCA SUL SISTEMA ENERGETICO - RSE SPA	ITALIA	Michele BENINI
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	VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Bernd KLEIMT

RFSR-CT-2014-00030 CHECKSIS

Independent performance assessment of automatic surface inspection systems through integration of computer-aided external supervision procedures

Info

Type of Project	Research	Duration (months)	42
Total Budget	1392414 €	Start Date	1/07/2014
EU Contribution	835447 €	End Date	31/12/2017

State Running project

Provisional Abstract

Continuous quality improvement and zero-defect manufacturing are major targets of European steel makers. For the flat steel production the surface quality and the knowledge of surface defects is crucial to deliver a high quality product to the customer, as it offers the essential information for the optimization of production processes, the traceability of quality decisions and the determination of quality trends. Automatic surface inspection systems (ASIS) have been established as tightly integrated tool for surface quality supervision, but even today no one in the world can precisely quantify ASIS performance for the whole running production and ASIS results always inhere in a certain kind of vagueness regarding data reliability. Aim of this project is the development of methods enabling the automatic verification of ASIS results as a first step towards real measurement of surface quality. Two approaches of external ASIS supervision will be followed: 1. artificial defects For the calibration of optical measuring devices usually measurement standards with precisely predefined structures are applied. This is not possible for ASIS calibration since the re-coiling process would affect the reference coil during each testing procedure. Within this project a prototypical system for the online calibration of ASIS by means of artificial defects directly applied to the coil surface will be developed. 2. online synchronization Aim is to determine how far it is possible to “measure” line-specific surface defects by means of double inspection. Therefore the verification of ASIS results by redundant inspection of two subsequent ASIS installed at the entry and exit section of the same line will be investigated. Afterwards the findings of this research will be summarized and it is foreseen to define a first official standard for calibration and supervision procedures of ASIS adopted by the German Iron and Steel Institute VDEh.

Partners

	Country	*Scientific person in charge*
VDEh-BETRIEBSFORSCHUNGSINSTITUT GmbH	DEUTSCHLAND	Jens BRANDENBURGER (Pr. Coord.)
THYSSENKRUPP RASSELSTEIN GMBH	DEUTSCHLAND	Michael NÖRTERSHEUSER
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THYSSENKRUPP STEEL EUROPE AG	DEUTSCHLAND	Harald HENKEMEYER
VOESTALPINE STAHL GMBH	OESTERREICH	Andreas KOGLER

RFSR-CT-2014-00031 PRESED

Predictive Sensor Data mining for Product Quality Improvement

Info	Type of Project	Research	Duration (months)	42
	Total Budget	1748698 €	Start Date	1/07/2014
	EU Contribution	1049217 €	End Date	31/12/2017
State	Running project			

Provisional Abstract

The goal of our project is to develop new methodologies and tools to help plants to improve the quality of their products and reduce their manufacturing costs by focusing primarily on three quality criteria: appearance surface, internal health and mechanical properties. These tools should allow: 1. Optimize the manufacturing process by identifying the main causes of bad quality 2. Predict the quality of the product as soon as possible to better characterize it and reduce the cost To achieve this goal and to make a major breakthrough in the application of data mining approach in the steel industry, we propose to contribute to new research areas recently developed in the field of data mining. These new approaches are designed to extract knowledge from huge amount of complex data: sensorial time series of very large number of parameters (several hundred) registered for a substantial period of time (2-3 years) and a high frequency (1-10Hz). Indeed, only summary information (e.g.; casting speed average) was used for statistical analysis. To analyse automatically and massively these sensorial time series data, we propose a comprehensive solution built around five main axes: 1. Big data : design and manage new database type suitable for data analysis of very large amounts of data 2. Feature Extraction from time series : develop algorithms for constructing advanced indicators to better represent process phenomena that may affect the quality 3. Machine Learning : descriptive and predictive analysis for the identification of the causes of non-quality and a better prediction 4. Analytics Server : develop an analytical server to speed up models construction, optimize their managements and improve exchanges between process experts and data mining experts 5. Knowledge Management for expertise capitalisation and valuable statistics: formalize and optimize exchange between process knowledge and statistical knowledge

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