MPI Materials Processing Institute

Excellence in Materials & Process Innovation

1944 - 2014 70 YEARS OF INNOVATION

RFCS Project Disstec

Optimisation of Secondary Metallurgy Practices - models, measurement and control technologies (focus on clean steel)

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27th September, 2017

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Objectives of the Disstec Dissemination Project

The main objective of Disstec is to revisit the most important European projects related to Secondary Metallurgy technologies carried out under ECSC and RFCS research programmes over the last 25 years and to assess, distribute, promote and exploit the results

- *Identify the merits and limitations of the various technological developments and the extent of their implementation in European steel plants*
- *Evaluate the impact of the results on a technological level*
- *Promote dissemination of technological developments and knowledge gained in selected Secondary Metallurgy projects*
- *Identify future developments and trends in Secondary Metallurgy technology*
- *Provide guidelines for future developments in Secondary Metallurgy technologies and indicate priorities for research subjects and activities*
- *Prepare a road map for technological developments in Secondary Metallurgy technologies*

Planned Dissemination Activities
(July 2016 – December, 2017)

- *Establish a Website that locates the results of project analysis, presentations from seminars, webinars, workshop and a road map for future Secondary Steelmaking technology developments*
- *A series of Seminars on Secondary Steelmaking technology topics*
- *Webinars including demonstrations of successful technological applications*
- *Workshop to provide a platform for exchange of information and open discussion, especially in identifying future developments and progression of the road map*

Project Partners

Project partners are the major steel research institutes in Europe:

- *VDEH-Betriebsforschungsinstitut (BFI), Dusseldorf, Germany*
- *RINA Consulting – Centro Sviluppo Materiali (CSM), Rome, Italy*
- *Centre de Recherches Metallurgiques (CRM), Liege, Belgium*
- *Swerea MEFOS, Lulea, Sweden*
- *Materials Processing Institute (MPI), Teesside, UK*

Selection and Assessment of Research Projects

Selection of ECSC and RFCS projects that deal with Secondary Metallurgy technology for evaluation and dissemination in Disstec:

- *Time period: 1990 – present*
- *60 projects in total*
- *35 ECSC projects (1990 – 2005)*
- *25 RFCS projects (2006 – present)*
- *Project table with key data are provided on the project website:*

Nr	Number of contract	Title	Acronym	Report number	Participants	Start date	End date	Abstract
26	7210/PR/206	The Determination and elimination of the effect of Anti-Oxidants in Magnesia-Carbon bricks on steel composition and inclusion formation	/	EUR 21446 EN	Corus UK, CSM, DIFK, Saarstahl	2000-07-01	2003-12-31	This project investigated the effects of anti-oxidant materials in MgO-C bricks on steel clearness and ladle life. A rapid analysis technique, using Laser Induced Breakdown Spectroscopy (LIBS), to detect trace elements and inclusions was also developed. LIBS was successful in mapping element distributions in refractory, slag and metal. Inclusion detection is compared with SEM methods and advantages of LIBS in speed of analysis are defined.
27	7210-RP-204	Innovative continuous on-line determination of the steel melt temperature by direct optical measurement in the melt	/	EUR 21428 EN	ACERALIA, CRM, BFI	2000-07-01	2003-12-31	In this project a new method for a continuous temperature measurement of liquid steel by pyrometer with optical fibre measurement technology was developed. The new system was tested and optimised on several steel plants including EAF furnaces, BOF converters, ladles and tundishes.

Identification and Categorisation of Project Results

Dissemination of the research results is limited to technologies that allow for relatively easy transfer to the European steel industry

Investigations that are focussed purely on fundamental research or metallurgical quality issues have been excluded from the dissemination activities, because the direct transferability of such results to industrial application is limited

Main Topics of Project Results with Sub-Topics

1. Measurement technologies for liquid steel operating parameters related to steel quality

1.1. Temperature
1.2. Composition of steel and ladle slag
1.3. Numbers and composition of non-metallic inclusions
1.4. Ratio of steel and slag at melt bath surface

2. Process models

2.1. Analytical and thermodynamic models
2.2. Statistical models
2.3. CFD and physical modelling
2.4. Off-line simulation
2.5. On-line dynamic models for monitoring and control

3. Approach to on-line control

3.1. Manufacturing execution systems
3.2. Set-point and alloy calculations
3.3. Regulation and control
3.4. Through process control for the whole chain of secondary steelmaking operations
3.5. On-line monitoring of process conditions

Main Topics of Project Results with Sub-Topics

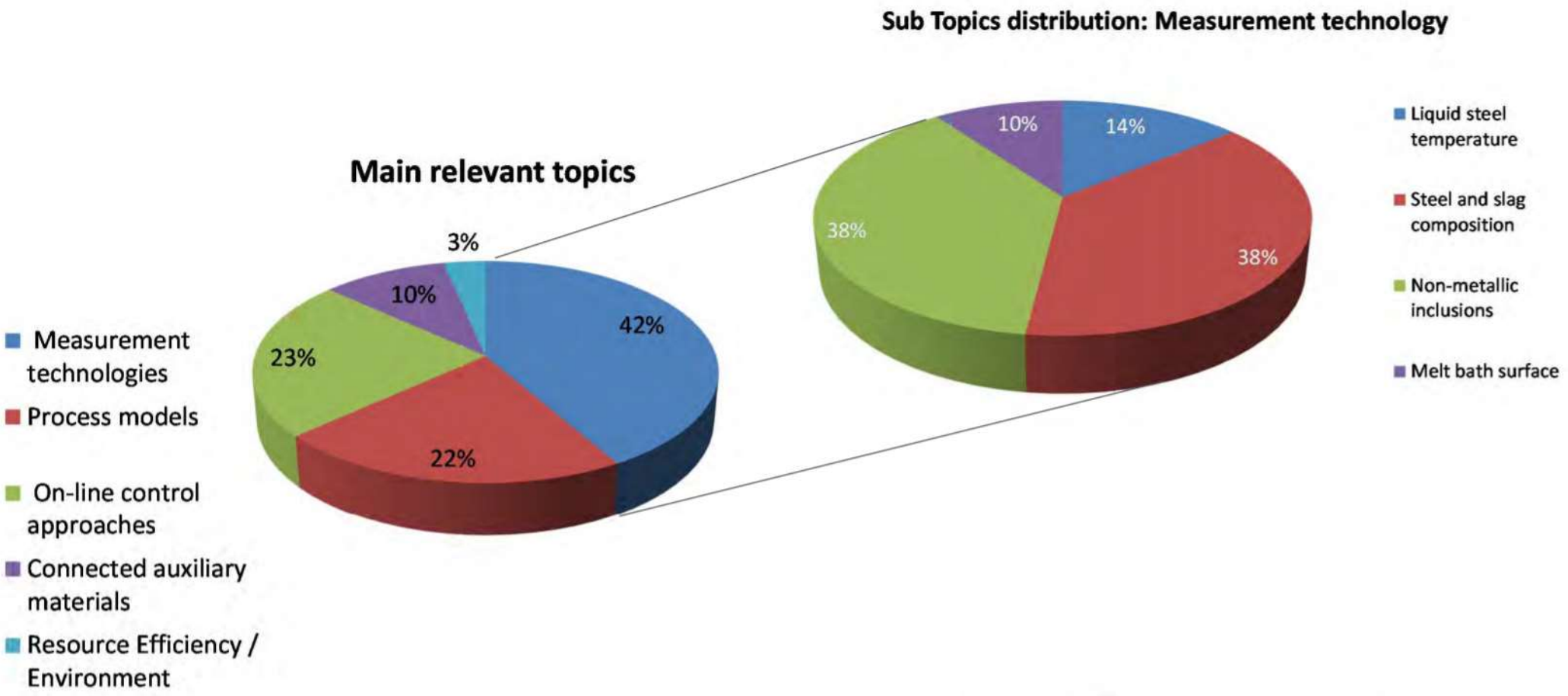
4. Connected auxiliary materials

4.1. Refractories
4.2. Stirring plugs
4.3. Slag formers and slag control

5. Resource efficiency and environmental aspects

5.1. Reduction of emissions
5.2. Energy efficiency
5.3. Resource efficiency and alloy yield improvement
5.4. Re-use of by-products

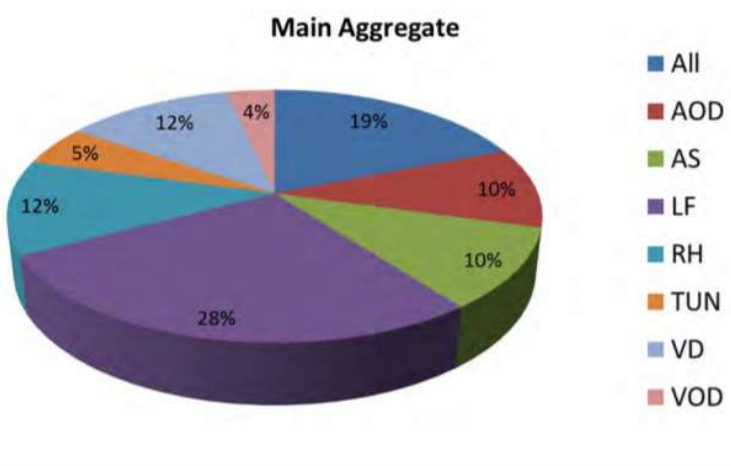
Distribution of Projects to Main topics and Sub-topics

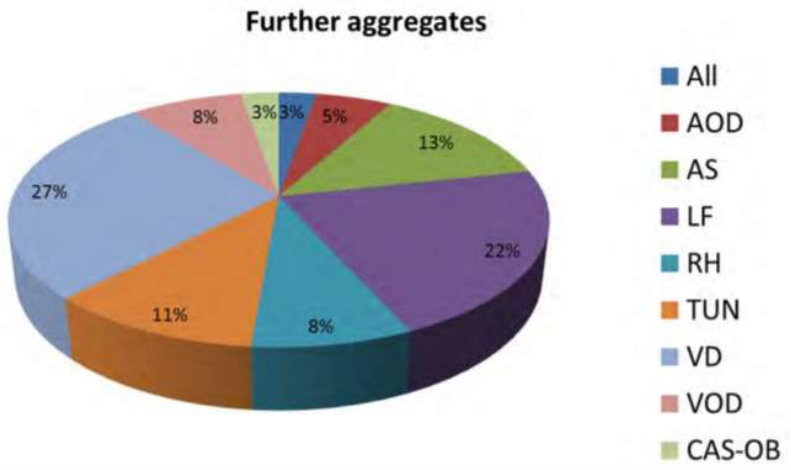


Categorisation According to Secondary Steelmaking Operations

Projects were also classified according to aggregated Secondary Steelmaking operations:

- Ladle Furnace (LF)
- Ladle Stirring Station (AS)
- Vacuum Tank Degassing Plant (VD)
- RH Degassing Plant (RH)
- CAS(-OB) Plant (CAS)
- AOD Converter (AOD)
- Tundish (TUN)
- VOD

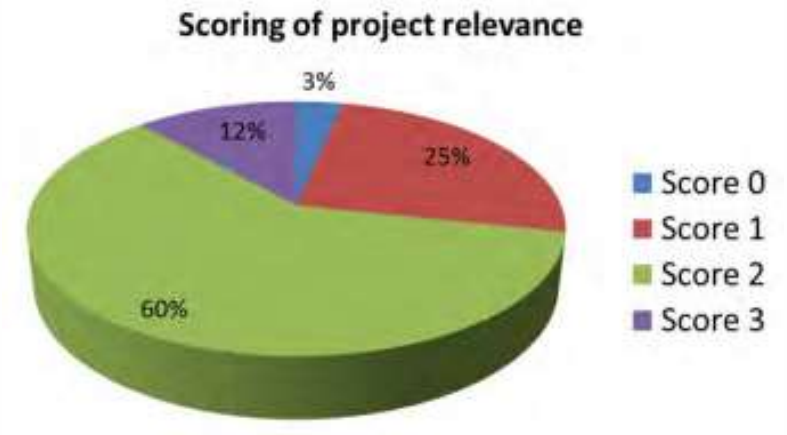




Analysis and Evaluation of Project Results

Four criteria were used to define a projects' success for industrial application:

- *Score "zero": the project idea did not work at all*
- *Score "one": the project idea was good in principle but industrial implementation was not possible at the time*
- *Score "two": the project idea is applied in at least one industrial plant*
- *Score "three": the project idea is state of the art and is applied in many plants*



Documentation of Project Analysis Results

Extension of the project table with:

- Main project results
- Level of industrial and practical application
- Categorisation of relevant topics and aggregates

Database table with search functions for topics and aggregates accessible via the website

1) Searching only "Main relevant topic" : Use Pulldown menu and push button above
2) Searching only "Main aggregate" : Use Pulldown menu and push button above
3) Searching both "Main relevant topic" and "Main relevant topic : Use both Pulldown menus and push button "Activate both Filters"
2) See the whole table : Push button "Delete Filter"

Activate Filter Main relevant topic

3_Online control

Activate Filter Main Aggregate

ALL

Activate both Filters

Delete Filter

Nr	Number of contract	Title	Acronym	Abstract	Main relevant topic	Further relevant topics	Relevant Sub-Topics	Main Aggregate	Further Aggregates	Main project results	Level of industrial / practical application	Report nu
1	7210-CB/107	Development of process technology and metallurgy for extremely low and strictly limited nitrogen contents	/	To satisfy requirements for steel with low nitrogen contents and steels with very precise nitrogen contents, fundamental data on denitrogenation in liquid steelmaking were applied to develop a thermodynamic and kinetic model.	2		2.1, 2.4	AOD		General process indications were given on hot metal, plain carbon steel, high-alloy steels, vacuum treatment and a thermodynamic and kinetic model was developed to characterize the elimination or fixing of nitrogen.	Findings applied on benficiary plant.	EUR 14483
2	7215-CA/107	On-line analysis of molten steel for automated steel production (1st phase)	AMSAS	The objective of this pilot project was to build and test an on-line analysis system for monitoring and measuring the change in concentration of various elements in liquid steel by laser-induced spectroscopy. The measurement system was tested for monitoring the carbon content in an AOD converter.	1		1.2, 3.5	AOD		The carbon content of liquid melt was measured online at an AOD converter using LIBS, but freezing of metal at the gas purged measurement tuyere in the converter bottom limited availability	After testes at laboratory furnaces the measurement system was successfully applied for 6 month at an industrial AOD converter	EUR 15184
3	7210-CC/104	Development of a model for the vacuum circulating process	/	The objective of this project was to develop a detailed dynamic model for decarburisation in the RH process, which can be used for on-line monitoring of the process behaviour.	2	3	2.1, 2.5	RH		Dynamic process model for description of decarburisation behaviour during RH process	Process model was provided as simulation model with validation by industrial process data. On-line application was possible, but not foressen within the project.	EUR 16186

DissTec Website

The Website gives access to:

- Results of the project analysis
- Schedule for seminars, webinars and workshop plus event programmes/ flyers
- Presentation downloads for seminars, webinars and workshop and for the roadmap for future developments

English and German versions of the website are hosted by BFI under:

www.bfi.de.en/projects/disstec www.bfi.de/de/projekte/disstec

Dissemination Activities

Five Seminars held at different sites and in different countries with a focus on various topics:

1. Models for secondary metallurgy processes
2. Connected auxiliary materials (refractories, stirring plugs, slag control, (…)
3. Measurement technologies for the quality relevant parameters of liquid steel (temperature, composition, cleanness, (…)
4. Optimisation of operating practices with focus on clean steel production
5. Approaches for on-line monitoring and control

Two Webinars:

1. Level 2/ Level 3 control systems
2. Measurement technologies

One Workshop:

1. Establish a road map for future Secondary Metallurgy technologies

Schedule for Seminars, Webinars and Workshops

Event	When	Who	Where	Context	Topic
Seminar 1	27. April 2017	CSM	Brescia, Italy		Process Models for Secondary Metallurgy
Seminar 2	22. / 23. May 2017	MEFOS	Stockholm, Sweden		Connected auxiliary materials, gas stirring
Seminar 3	29. June 2017	BFI & CRM	Vienna, Austria	ESTAD 2017	Measurement technologies
Seminar 4	27. Sept. 2017	MPI	London, UK IOM3 Premises	IOM Seminar	Optimisation of Secondary Metallurgy practices - models, measurement and control technologies (focus on clean steel)
Seminar 5	15. Nov. 2017	BFI	Duisburg, Germany FEhS Institute	VDEh expert group meeting "Electric Steelmaking"	On-line process control of Secondary Metallurgy plants (focus on EAF steelmaking)
Webinar 1	18. Oct. 2017	BFI	WebEx platform		On-line Process Control in SecMet Level 2/ 3 Control Systems
Webinar 2	November 2017	CSM & BFI	WebEx platform		Measurement Systems
Workshop	10. Nov 2017	BFI	Düsseldorf, Germany	Steel 2017, Annual conference	Road map for future Secondary Metallurgy technology

Acknowledgements

This project receives funding from the European Union's Research Fund for Coal and Steel under grant agreement no. 709740 (Disstec)

Thank you for your attention