La Metallurgia Italiana

International Journal of the Italian Association for Metallurgy

n. 2 Febbraio 2017

Organo ufficiale dell'Associazione Italiana di Metallurgia.
Rivista fondata nel 1909

ESSC & DUPLEX 2017

9th European Stainless Steel Conference Science & Market
&
5th European Duplex Stainless Steel Conference & Exhibition

Bergamo • Italy, 25-27 May 2017

http://www.aimnet.it/essc2017.htm

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ASSOCIAZIONE ITALIANA DI METALLURGIA

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Scope

After the successful experience of Graz 2015, once again, the 9th European Stainless Steel Conference Science & Market and the 5th European Duplex Stainless Steel Conference & Exhibition will be jointly organized, as a single event, by AIM, the Italian Association for Metallurgy.
The Conference will focus on all aspects of development, production technology (hot and cold rolling, heat treatment, etc.) and corrosion of stainless steels and duplex stainless steels and address delegates with both academic and industrial backgrounds.
The results shall contribute to the advancement of existing and potential applications and will help to guide future development.
The event will bring together developers, manufacturers and users of stainless steel from industry and academia and will compare the present and future needs to satisfy these demands now or in the future.
Short and medium term perspectives of European stainless steel flat and long products will be widely discussed during the Stainless Steel Market Outlook session. It is expected the presence of speakers representing the most important European stainless steel associations and reports coming from the big stainless steel companies.

Conference language

The Conference language will be English.

Exhibition & sponsorship opportunities

The Conference will be enhanced by an Exhibition of table-top units at which companies will have the opportunity to inform all delegates of their latest developments. The Exhibition area will be a focal point of the Conference. Companies will be able to reinforce their participation and enhance their corporate identification by taking advantage of benefits offered to them as Contributing Sponsors of the Conference.
The detailed sponsorship packages are available on the Conference website:
http://www.aimnet.it/essc2017.htm
Companies interested in taking part in the Exhibition or sponsoring the event may contact the Organising Secretariat (e-mail: aim@aimnet.it / fax: +39 0276020551).

Conference Venue

The Conference will be held in Bergamo at the Congress Center Giovanni XXIII, viale Papa Giovanni XXIII, 106 (www.congresscenter.bg.it).
Bergamo greets visitors with its Venetian Walls. Surrounded by rivers and lush, verdant valleys, crossed by paths that widen to Parco dei Colli, the area's largest park, the city looks like a lounge filled with art, culture and nature, with a fascinating and complex history just waiting to be shared with others. The "upper and lower" city reveals a mixture of pleasant surprises and unexpected encounters, such as those with Gaetano Donizetti, the great composer of international renown, Bartolomeo Colleoni, the Bergamo leader who served under the Republic of Venice and Lorenzo Lotto, among the most famous Italian Renaissance artists who lived and worked in Bergamo for over a decade.

Conference Organizing Secretariat

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We are looking forward to welcoming you in Italy!

La **Metallurgia** Italiana

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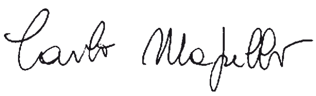
Forno elettrico ad arco/*Electric arc furnace*

l'editoriale

La Metallurgia Italiana

Prof. Carlo Mapelli - Presidente AIM



I forni elettrici troveranno nel contesto metallurgico una crescente applicazione: nonostante in Italia rappresentino da tempo il mezzo fusorio prevalente nell'industria siderurgica, tale tendenza si consoliderà anche su scala mondiale, in conseguenza dei significativi giacimenti di rottame ormai presenti anche nei paesi che sono sinora stati considerati in via di sviluppo (es. Cina, India ecc.). I forni elettrici ad arco rappresentano certamente un mezzo di produzione estremamente flessibile ed altamente produttivo, che ben si inserisce nel contesto dell'economia circolare, nella quale il recupero delle materie prime rappresenta il passo fondamentale per evitare lo sfruttamento ed il consumo delle risorse naturali. L'Italia nel contesto internazionale rappresenta un esempio guida, dato che nel 2016 la produzione siderurgica si è basata per il 75% sulla produzione da forno elettrico mentre il restante 25% è derivato dal ciclo integrato, basato sullo sfruttamento dei minerali mediante il combinato cokerie-altoforno-convertitori ad ossigeno; in tutte le altre siderurgie mondiali (fatta eccezione per la Spagna) la produzione siderurgica deriva per il 65% dai minerali trasformati nei cicli integrati e per il 35% dai rottami riciclati nei forni elettrici. Se da una parte l'Italia rappresenta il sistema di riferimento per l'utilizzo dei forni elettrici, in termini di automazione, diminuzione dell'impatto ambientale e risparmio energetico, dall'altra sperimenta sulla propria pelle le difficoltà derivanti dallo sfruttamento intensivo di questi sistemi fusori, a partire da un costo strutturalmente più elevato dei rottami rispetto ad altri mercati e dalla crescente necessità di diminuire la concentrazione di quegli elementi chimici che compromettono la qualità dei prodotti finali derivanti dal riciclo del rottame: il rame, lo stagno ed ultimamente anche lo zinco, a causa della crescente concentrazione di questo elemento nei lamierini zincati a caldo. Il problema dell'approvvigionamento di materie prime prive di tali elementi inquinanti dovrà portare ad un'attenta considerazione circa l'opportunità di dotarsi di impianti di preriduzione sul suolo italiano (alimentati con contratti a lungo termine attraverso l'eccellente rete di distribuzione nazionale del gas naturale), oppure mediante accordi ed installazioni presso paesi dotati di significativi giacimenti di gas naturale; si tratta di scelte ed opzioni che coinvolgeranno anche aspetti geopolitici non trascurabili.

Su un orizzonte più ampio si può notare come altri sistemi fusori ad alimentazione elettrica si stiano affacciando non solo in ambito siderurgico ma più in generale nell'ambito metallurgico. I forni elettrici a induzione, sino a poco tempo fa confinati nell'ambito delle fonderie, sono installati in misura crescente nei sistemi della siderurgia dell'acciaio inossidabile (al fine di limitare l'ossidazione di elementi chimici pregiati) e nelle metallurgie delle leghe di nickel, del rame e dell'alluminio, ma ancora più intrigante potrebbe divenire lo sviluppo di sistemi allo stadio sperimentale dotati di resistori ceramici o a base di grafene, che vengono alimentati mediante strategie in grado di aumentare sia la produttività che l'efficienza.

Ritengo che sia sufficiente questo breve quadro per indicare quante sfide e quali nuovi percorsi produttivi si potranno delineare in un prossimo futuro nell'utilizzo dei sistemi di fusione ad alimentazione elettrica, sia a livello di progettazione sia nell'attività di gestione dei processi metallurgici; questo futuro necessita dell'esperienza maturata dalla nostra industria nazionale e che costituisce un patrimonio di conoscenze che dobbiamo custodire e sviluppare.

Miglioramento della pulizia di acciai al carbonio mediante il controllo della scoria di processo

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Negli ultimi anni la necessità di produrre acciai di alta qualità e di ridurre i costi, ha portato l'industria siderurgica a rivalutare l'importanza delle scorie nei processi di fabbricazione dell'acciaio. Nonostante i numerosi articoli in letteratura che si sono resi disponibili negli ultimi anni sulle interazioni scoria-metallo-refrattario, i fondamenti dell'ottimizzazione delle scorie sono ancora poco conosciuti ed è ancora visto da molti come un'arte piuttosto che una scienza.
In questo lavoro è stato confrontato lo stato inclusionale in fase di affinazione di acciai al carbonio aventi due diverse desossidazioni (Al-killed, Si-killed) esaminato mediante analisi SEM-EDS, con i risultati ottenuti mediante simulazioni termodinamiche e modelli chimico-fisici. Ottimizzando le concentrazioni di CaO e CaF_2, si può ottenere un duplice vantaggio: un miglioramento della qualità dell'acciaio, tramite una scoria in grado di catturare le inclusioni senza che ne formi di nuove ed un beneficio ambientale, riducendo la fluorina.

PAROLE CHIAVE: METALLURGIA SECONDARIA - PULIZIA ACCIAIO - SCORIA - INCLUSIONI - MODELLI TERMODINAMICI

INTRODUZIONE

L'obiettivo dei produttori di acciaio è quello di ottenere acciaio pulito, cioè con basse quantità di inclusioni dannose per le prestazioni del prodotto finito.
La scoria assolve varie funzioni di considerevole importanza durante il processo di affinazione; le sue caratteristiche chimico-fisiche determinano il successo o meno delle operazioni metallurgiche fondamentali, come la desolforazione e la cattura delle inclusioni.
La formazione di inclusioni non metalliche è inevitabile e quando non vengono accuratamente controllate, possono causare problemi dal punto di vista della qualità e delle caratteristiche del prodotto. In siderurgia è noto che le inclusioni vengono assorbite dalla scoria. Per la buona riuscita di tale processo è richiesta tuttavia una adeguata flottazione delle inclusioni e delle altrettanto adeguate caratteristiche chimico/fisiche della scoria.
La genesi di inclusioni non metalliche è influenzata da vari parametri di processo durante la produzione di acciaio. Lo scopo dello studio in oggetto è una migliore comprensione del processo di affinazione in siviera relativamente all'interazione acciaio-scoria ed alle inclusioni.

PROCEDURA SPERIMENTALE

In Acciai Speciali Terni S.p.A, gli acciai al carbonio vengono spillati dal forno elettrico e trasferiti presso l'impianto ASEA-SKLB per essere affinati fino all'analisi voluta. Tra gli impianti di affinazione secondaria, l'ASEA-SKLB è uno dei più completi dal punto di vista delle funzioni metallurgiche che può assolvere. Caratteristica peculiare dell'ASEA-SKLB è la contemporanea presenza di due sistemi per l'agitazione del bagno: stirring ad induzione elettromagnetica e stirring con gas inerte (argon). Il bagno viene agitato principalmente per accelerare l'omogeneizzazione e favorire al massimo le reazioni tra le superfici

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(bagno-scoria) e per la rimozione di inclusioni non metalliche. In questo lavoro sono stati prelevati dei campioni in fase di affinazione per analizzare il panorama inclusionale in questa fase del processo. Si è, quindi, effettuata la verifica della capacità captante della scoria in riferimento alla tipologia di inclusioni riscontrata nei campioni stessi.
A tale scopo, l'utilizzo di modelli termodinamici è un metodo utile per effettuare una valutazione della capacità di una scoria di assorbire le inclusioni da un punto di vista chimico.
Per effettuare i calcoli termodinamici, si considera come dato di input la composizione della scoria in termini di concentrazione dei suoi principali ossidi costituenti, CaO, MgO, Al_2O_3, SiO_2, MnO, FeO, tralasciando invece gli ossidi in tracce (Cr_2O_3 e TiO_2) dato che la rilevanza di questi ultimi sulle proprietà della scoria è ritenuta trascurabile. In questo lavoro è stato utilizzato nello specifico Thermo-Calc [1].
Altro aspetto da considerare riguarda la capacità di cattura delle inclusioni da parte della scoria da un punto di vista fisico. Questo aspetto consiste (in modo semplificato) nel passaggio delle fasi ossido che costituiscono le inclusioni dalla fase metallica liquida ove sono disperse alla massa di scoria. In questo caso, si possono fare delle considerazioni tenendo conto di proprietà fisiche della scoria quali viscosità e tensione superficiale.
La temperatura di riferimento considerata è 1650°C, tipicamente quella raggiunta prima della fase di vuoto.
La valutazione è stata fatta per due differenti tipi di calmaggio, Al-killed e Si-killed. Per ciascuno di questi sistemi l'approccio è riassumibile come segue:

- approccio termodinamico: considerando le fasi solide e liquide presenti nel tipico range operativo, vengono valutate la capacità desolforante della scoria e la sua capacità di assorbimento delle inclusioni dal punto di vista dell'affinità chimica;
- approccio chimico-fisico: viene valutata la capacità di cattura delle inclusioni da parte della scoria sulla base delle sue proprietà fisiche di viscosità e tensione superficiale utilizzando un metodo messo a punto dal CSM che permette di calcolare un indice di cattura delle inclusioni.

ACCIAI Al-KILLED

In una prima fase, la composizione della scoria ASEA ottenuta dall'analisi chimica di campioni di scoria prelevati durante le operazioni di affinazione, viene utilizzata come input per i calcoli termodinamici. Un aspetto da considerare a tal proposito è la presenza di fluorina (CaF_2) che viene usata per aumentare la fluidità della scoria. Nei calcoli termodinamici, la fluorina non viene considerata e ciò comporta la necessità di una correzione della composizione scoria ottenuta dall'analisi chimica. Pertanto, nei calcoli si considera una composizione scoria in cui il CaO equivalente al quantitativo di fluorina presente viene sottratto al CaO totale, quest'ultimo ottenuto dall'analisi chimica del campione di scoria stessa. Il quantitativo di fluorina utilizzato è stimabile al 3.6% considerando un quantitativo di scoria di 2500 kg. Dai calcoli termodinamici fatti con la composizione scoria così ottenuta, risulta che un 10% circa della massa totale del sistema scoria si separa come fasi solide di CaO (Fig.1- A) e MgO (Fig.1- B).

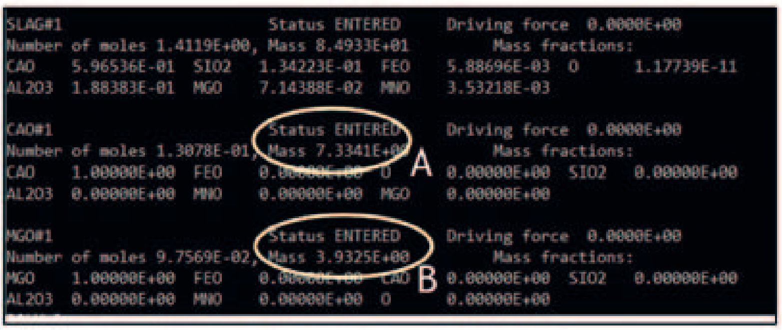
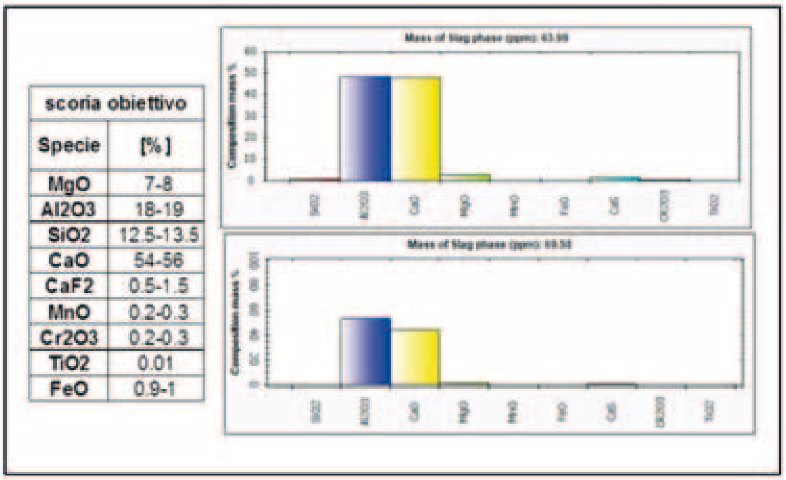


Fig. 1 - Output della simulazione al ThermoCalc per acciai calmati all'alluminio.
Masses of phases present at equilibrium calculated with Thermocalc (slag system in Al-killed steel case).

La separazione di CaO solido si spiega con l'utilizzo di un quantitativo eccessivo di tale specie nella formazione della scoria. La separazione di MgO solido si spiega con un arricchimento di tale specie nella scoria sino al raggiungimento della saturazione; tale arricchimento è dovuto all'usura dei refrattari base MgO. L'uso della fluorina permette di ovviare al problema dell'eccesso di CaO, mantenendo quindi la scoria con condizioni di fluidità accettabile. Esso costituisce tuttavia un problema perché contribuisce ad aumentare l'usura dei refrattari. In una seconda fase, i calcoli termodinamici vengono utilizzati per definire una composizione obiettivo ideale della scoria. Tale scoria ideale deve avere una elevata attività chimica della CaO (almeno superiore a 0.85), in modo da assicurare una buona capacità desolforante della scoria stessa senza arrivare alle condizioni di saturazione della CaO. Tale situazione porta al vantaggio di usare un quantitativo più limitato di fluorina con ovvi vantaggi sia dal punto di vista economico che ambientale. La Fig. 2 riporta il range di composizione ottenuto per la scoria obiettivo tramite calcoli effettuati tenendo conto di quanto detto sopra.Sul lato destro della figura sono anche riportati i risultati relativi alle inclusioni attese per il tipico acciaio Al-killed prodotto in ASEA-TR. Tali composizioni sono calcolate a partire dalla composizione acciaio e dal valore misurato di ossigeno alla temperatura operativa di riferimento.



scoria obiettivo	
Specie	[%]
MgO	7-8
Al2O3	18-19
SiO2	12.5-13.5
CaO	54-56
CaF2	0.5-1.5
MnO	0.2-0.3
Cr2O3	0.2-0.3
TiO2	0.01
FeO	0.9-1

Fig. 2 - Composizione scoria obiettivo (a sinistra) ottenuta da calcoli termodinamici (utilizzando Thermo-Calc). Composizione e massa inclusioni in acciaio Al-killed calcolate tramite software sviluppato da CSM utilizzante un "core termodinamico" basato su Thermo-Calc.

Composition aim slag (left) obtained from thermodynamic calculations (using ThermoCalc). Composition and mass inclusions in Al-killed steel computed using software developed by CSM utilizing a "thermodynamic core" based on Thermo-Calc.

La Fig. 3 mostra per confronto una tipica inclusione trovata tramite analisi microscopica, a conferma del buon accordo tra i valori calcolati ed i risultati reali.

Con la scoria obiettivo, ci si aspetta una diminuzione della necessità del quantitativo di fluorina da utilizzare, verso un dimezzamento rispetto al quantitativo attuale.

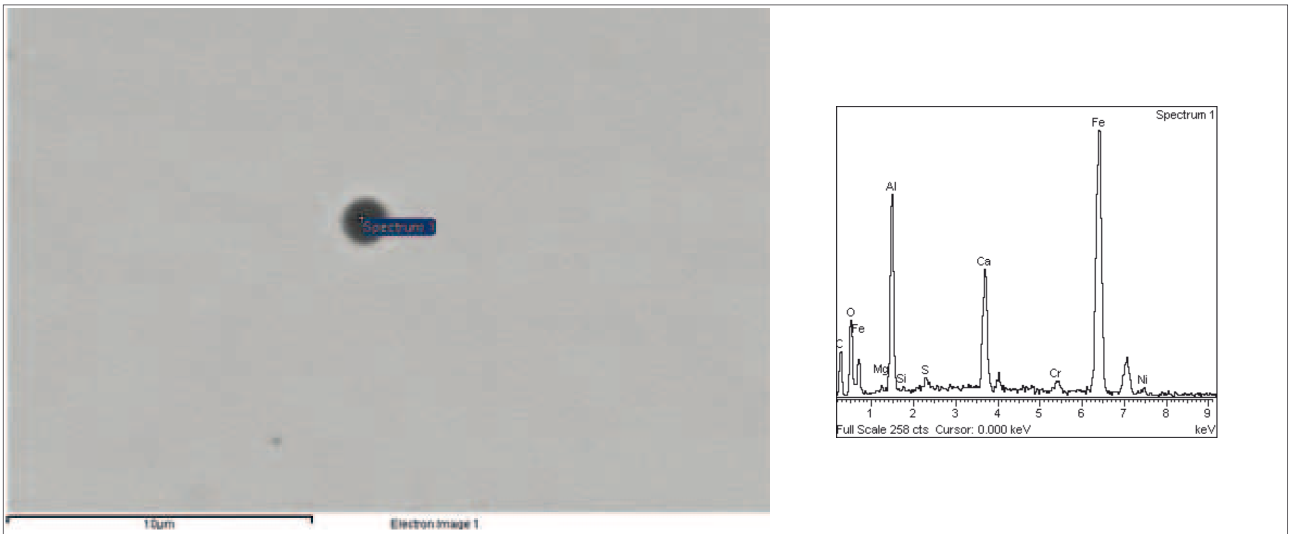


Fig. 3 - Inclusione tipica della fase di affinazione (calcio-alluminati).

Typical inclusion of refining phase (calcium aluminate).

Una volta stabilita la composizione chimica ideale per la scoria obiettivo, si è passati alla valutazione teorica della sua capacità captante per le inclusioni.

È noto da esperienze impiantistiche che una scoria con una buona capacità captante ha una consistenza che può essere definita come "cremosa" [2].

L'indice di basicità IB_5 può essere utilizzato per una valutazione a priori della cremosità di una scoria:

$$IB_5 = \frac{\%CaO + \%MgO}{\%SiO_2 + \%Al_2O_3 + \%CaF_2 + (\%FeO + \%MnO)} \quad (1)$$

È comune aggiungere anche FeO e MnO ai componenti acidi nel rapporto IB_5, a condizione che la loro somma (FeO + MnO) sia inferiore al 5%.

Quindi la scoria obiettivo ha un IB_5 di 1.8÷1.9; tale valore rientra nel range ottimale di cremosità per una scoria tipo allumino-calcica con basso quantitativo di fluorina.
Un ulteriore metodo è stato utilizzato per stimare la capacità captante della scoria. Tale metodo è stato messo a punto dal CSM nell'ambito di progetti per clienti industriali (confidenziali). In pratica, a partire da approcci descritti in letteratura [3-6]. il CSM ha costruito un sistema di calcolo per arrivare alla definizione di un indice che è poi stato verificato sperimentalmente. Tale indice (definito come "di cattura delle inclusioni") viene calcolato tenendo conto della viscosità e tensione superficiale della scoria e di opportuni coefficienti di correzione.
Confronti tra questo indice calcolato ed un corrispondente indice sperimentale (ottenuto con prove di laboratorio) hanno permesso di accertare un range ottimale (praticamente realizzabile) per l'indice calcolato tra 50-70% su di una scala di 100% ove quest'ultimo valore rappresenta la capacità captante assoluta.
Come si può notare dalla Fig.4, l'indice di cattura delle inclusioni per la scoria obiettivo si posiziona nella zona medio/alta (vedere punto rosso) del range ottimale.

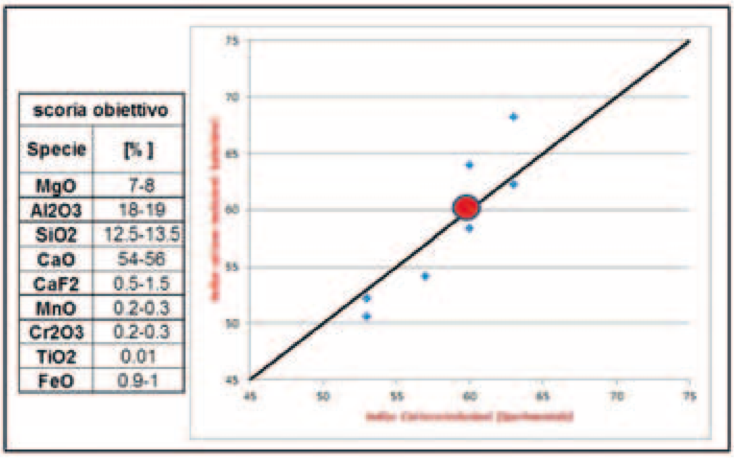


Fig. 4 - Rappresentazione dell'indice di cattura delle inclusioni per la scoria obiettivo (Al-killed).
Representation of inclusions capture index for the aim slag (Al-killed).

ACCIAI SI-KILLED

Un approccio analogo a quanto esposto sopra, è stato condotto per il caso degli acciai calmati al silicio. Alla temperatura tipica pre-vuoto (1650°C) la scoria presenta anche in questo caso un eccesso di fasi solide. La presenza di Ca-Silicato (Fig.5 - A), è spiegabile con un eccesso di CaO.

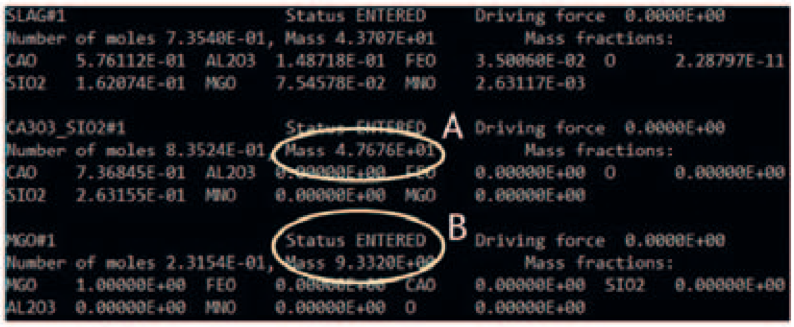


Fig. 5 - Output della simulazione al ThermoCalc per acciai calmati al silicio.
Output of ThermoCalc simulation for silicon killed steels.

Anche per gli acciai calmati al silicio viene impiegata fluorina per fluidificare la scoria.
Il quantitativo di CaF_2 utilizzato è stimabile al 6÷7% considerando un quantitativo di scoria di 2500 kg.
Analogamente agli acciai Al-killed, i calcoli sono stati fatti considerando una composizione della scoria in cui il CaO equivalente della fluorina presente è sottratto al CaO totale.
Svolgendo delle considerazioni sui risultati dei calcoli termodinamici, la situazione è analoga al caso degli acciai calmati all'alluminio: in fase di affinazione viene utilizzato un eccesso di CaO, che rende necessario l'utilizzo di maggiori quantità di CaF_2 per mantenere la scoria più liquida causando una maggiore usura dei refrattari (eccesso di MgO nella scoria). Pertanto il minor impiego di fluorina avrebbe un duplice vantaggio:

- economico (minor usura dei refrattari);
- ambientale (effetti fitotossici dei floruri).

I calcoli termodinamici sono stati fatti con l'obiettivo di mantenere l'attività di CaO sufficientemente alta ma tale da evitare la formazione della fase Ca-Silicato (la formazione di tale fase avviene a 1650°C per una attività chimica di CaO di circa 0.6). Quest'ultima situazione condurrebbe ad una scoria con tendenza alla formazione di fasi solide separate e ad una conseguente necessità di utilizzo di maggiori quantitativi di fluorina.
La scoria proposta è adeguata per l'assorbimento delle inclusioni tipiche da un punto di vista della affinità chimica (Fig.6,7).

scoria obiettivo	
Specie	**[%]**
MgO	6-7
Al2O3	6.5-8
SiO2	22-23
CaO	52-54
CaF2	3.5-4.5
MnO	0.1-0.2
Cr2O3	0.1-0.2
TiO2	0.01
FeO	0.9-1

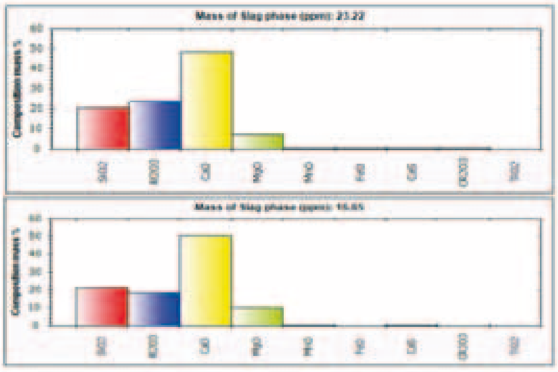


Fig. 6 - Composizione scoria obiettivo (a sinistra) ottenuta da calcoli termodinamici (utilizzando Thermo-Calc). Composizione e massa inclusioni in acciaio Si-killed calcolate tramite software sviluppato da CSM utilizzante un "core termodinamico" basato su Thermo-Calc.
Slag aim composition (left) obtained from thermodynamic calculations (using Thermo-Calc). Composition and mass inclusions in Al-killed steels calculated using software developed by CSM employing a "thermodynamic core" based on Thermo-Calc.

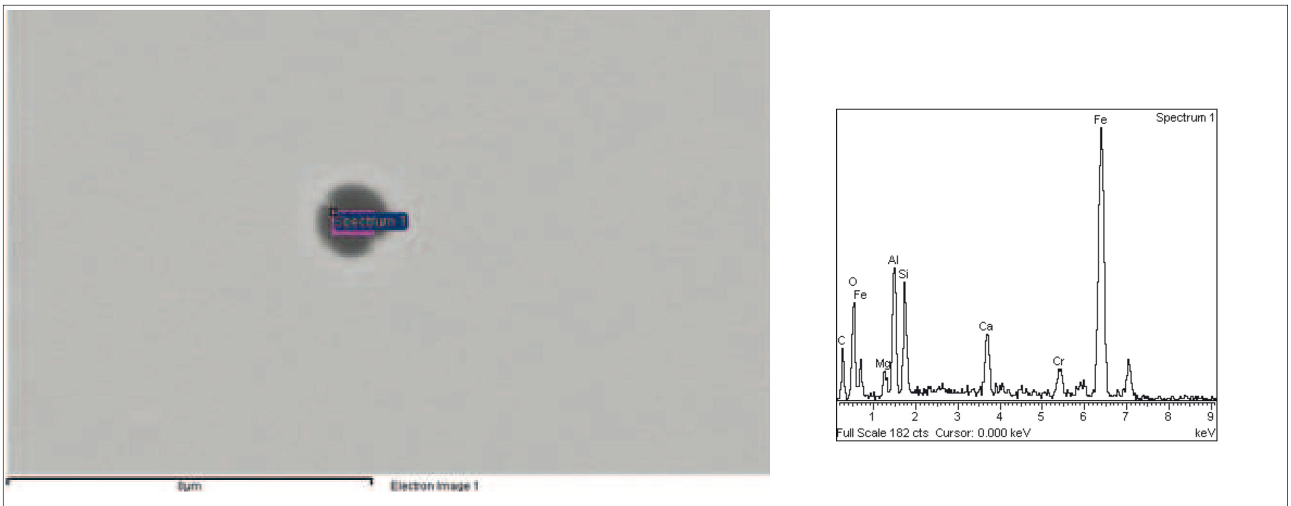


Fig. 7 - Inclusione tipica della fase di affinazione (calcio-silicati).
Typical inclusion on the refining phase (calcium-silicate).

Come si può vedere nella Fig.8, l'indice di cattura delle inclusioni della scoria obiettivo calcolato a 1650°C tenendo conto della viscosità e della tensione superficiale attese per la fase liquida si posiziona nella zona medio/bassa del range ottimale. Tuttavia, questa situazione è da ritenersi perfettamente normale per una scoria tipo silicato-calcica, per cui la scoria stessa può essere ritenuta come adeguata. Tale aspetto viene anche confermato dal valore di IB_5 di 1.6÷1.7 calcolato per la scoria obiettivo. In questo caso infatti, il valore minimo raccomandato è di 1.5.

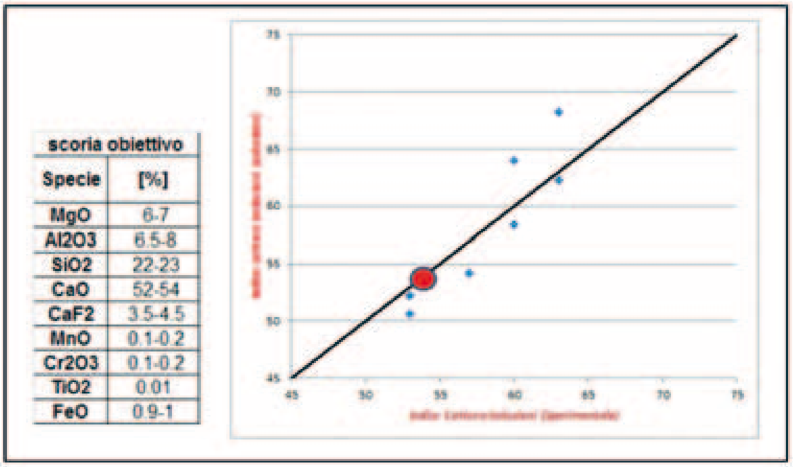


Fig. 8 - Rappresentazione dell'indice di cattura delle inclusioni per la scoria obiettivo (Si-killed).
Representation of inclusions capture index for the aim slag (Si-killed).

CONCLUSIONI

In questo lavoro, le caratteristiche della scoria di siviera di ASEA-TR sono state analizzate criticamente mediante un approccio sinergico di tipo teorico/sperimentale. La valutazione è stata condotta per due diversi tipi di calmaggio, Al-killed e Si-killed. Uno studio termodinamico ha permesso di valutare un possibile miglioramento della composizione scoria rispetto a quello attuale ai fini della riduzione del quantitativo di fluorina da utilizzare pur mantenendo adeguate caratteristiche della scoria stessa in termini di fluidità e capacità desolforante. Ciò ha consentito di definire una composizione obiettivo ideale per ciascun tipo di calmaggio.

L'applicazione di modelli teorico/sperimentali precedentemente messi a punto dal CSM per la valutazione della capacità della scoria di captare le inclusioni di processo, ha permesso la verifica della adeguatezza della composizione obiettivo anche per tale finalità. Sulla base delle considerazioni di cui sopra, si può assumere che la composizione obiettivo formulata per ciascun tipo di calmaggio consenta di ottenere dei benefici sia in termini economici che ambientali a causa del minore impiego di fluorina pur garantendo delle adeguate caratteristiche di processo.

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Steel cleanliness: process optimization by slag control

KEYWORDS: LADLE TREATMENT - CLEAN STEEL - SLAG - INCLUSIONS - COMPUTATIONAL THERMODYNAMICS - REFINING

Inclusions, when not properly controlled, are harmful to the mechanical properties of every kind of steel produced. Slag is one of the resources available to carry out this control.

In steelmaking, it is generally understood that inclusions are naturally absorbed by slag when flotation is sufficient. However, separation and dissolution may define the inclusion absorption capacity of slag.

In this study an evaluation of the slag optimization has been done by means of an integrated approach involving both experimental data and theoretical calculations.

The theoretical approach concerns both the use of thermodynamic calculations and of physical models. All the activities are aimed at the optimization of the slag composition. In particular, by means of a "tailoring" of CaO and CaF_2 concentrations in the slag it is possible to achieve good results in terms of inclusions capture and environmental benefits, too. These lasts, in particular, are directly related to the decrease of fluorine to be used.

EAF long term industrial trials of utilization of char from biomass as fossil coal substitute

F. Cirilli, G. Baracchini, L. Bianco

Biomass is a renewable resource having a steady and abundant supply, especially those biomass resources that are by-products of agricultural and industrial activity. Its use is carbon neutral, can displace fossil fuels, and helps reduce GHG emissions while closing the carbon cycle loop.
Steel produced starting from scrap, like in EAF route, already needs less energy if compared to BF-BOF route with beneficial effects on environment and economy that are greater as increases the share of fossil fuels in total energy feeding. The replacement, in EAF practice, of fossil fuels with char and syngas obtained from biomass can further improve the environmental performance and the attractiveness of the EAF based route, eventually increasing the amount of chemical energy respect electrical one, with beneficial effects on environment, economy and flexibility of the EAF process.
The feasibility of biochar as fossil coal substitute as charge material in EAF has already been proved in a previous RFCS project (SUSTAINABLE EAF STEEL PRODUCTION – GREENEAF - RFSR-CT-2009-00004). A test sequence of six consecutive heats were carried out replacing standard anthracite with biochar. The results of the industrial tests indicate that utilization of char as charge material can be done, but operating practice needs to be optimized with a long term experimentation.
In the ongoing RFCS project, (BIOCHAR FOR A SUSTAINABLE EAF STEEL PRODUCTION - GREENEAF2 - Grant Agreement Number RFSP-CT-2014-00003) an intensive industrial utilization of biochar is foreseen.
This paper describer the industrial long term trials with biochar in EAF, with the final target to replace fossil coal.
The results of industrial long term trials confirmed the feasibility of the use of biochar as charge material, without significant modification in steel and slag analysis.

KEYWORDS: EAF, ELECTRIC ARC FURNACE, COAL, CHAR, BIOACHAR, TORREFACTION, STEELMAKING

INTRODUCTION

Fossil sources are extensively used in the Electric Arc Furnaces (EAF), to provide energy (in addition to electricity) or in general for process needs (to provide carbon to steel bath and promote slag foaming which improves furnace energy efficiency). The substitution in EAF practice of fossil sources (natural gas and coal) with char coal obtained from biomass can improve the environmental and economic performance due to the fact that no new CO_2 emissions are introduced in the atmosphere (CO_2-neutral see Emission Trading European Directive).
Previous experience at pilot and industrial scale [1,2,3]confirmed that the char coal from biomass can replace coal. However the application at a specific EAF needs proper customization and long term trials.
The objective of this activity is the validation for the utilization of char from biomass as substitute of coal in the EAF.
Obtained results from preliminary experiences showed that char, due to the higher presence of volatile matter and specific area than fossil coal, is a highly reactive material. For this reason, in case of utilization as charge material, proper material pretreatment (briquetting) and optimization of operating practice is necessary. Due to the mentioned specific characteristics of char, flame formation during basket charge and a tendency to increase the thermal load of off gas is expected in case of EAF utilization as coal substitute.

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The carried out tests described in previous papers [1,2] revealed in any case that the EAF can work by replacing of fossil coal with char from biomass. In that tests, biochar from thermal pyrolysis was used. Thermal pyrolysis, is the most traditional and consolidated technology to transform biomass into charcoal, and the thermal treatment can be adjusted in order to increase as much as possible the fixed carbon content of biochar, in order to obtain a material having physic-chemical characteristics compared to fossil anthracite. On the other hand a more severe thermal treatment affects cost of material production, and material mechanical stability. Biochar from thermal pyrolysis, in fact, needs to be compressed into briquettes in order to obtain a material able to resist to handling operations inside the steel factory, avoiding the dispersion of very reactive powders during charging operation. Regarding the cost, a char market for steelmaking sector does not exist, even if costs analysis available in literature [4] reports a price still higher respect fossil coal (in the range 300-500 €/t).
In the ongoing RFCS project, (BIOCHAR FOR A SUSTAINABLE EAF STEEL PRODUCTION - GREENEAF2 - Grant Agreement Number RFSP-CT-2014-00003) an EAF utilization of biochar is foreseen for both injection (to promote slag foaming) and charging in the basket. In the project, three research centers are involved (Centro Sviluppo Materials, that is the coordinator, University of Aachen, and Imperial College, and three industrial partners, Ferriere Nord, Marhienutte and Georgemarienhutte). LCA study and economical evaluations are also included.
This paper is focused on the industrial activity carried out at Ferriere Nord, where utilization of charge material in the basket has been tested. In this new experimental activity, following aspects have been investigated:

- Long trials, in order to check the stability of the process
- Utilization of biochar with different characteristics (and lower production price), to check the sensitivity of the process to the different materials characteristics

The used material is produced by biomass torrefaction. Torrefaction is a relatively easy process, which differs from thermal pyrolysis for the process temperature, that is significantly lower (300-350 °C). Material produced from torrefaction has the following interesting characteristics:

- Market price is in general lower than already tested biochar (market price are in the range 200-300 €/t)
- Material densification is obtained very easily under the effect of pressure, without binding agent and obtained briquettes are very stable comparing to briquettes obtained with high temperature materials
- Torrefied biomass is hydrophobic

In what follows, description of materials characteristics and carried out industrial at Ferriere Nord tests are discussed.

EXPERIMENTAL ACTIVITY

The activity is focused on EAF utilization of biochar as charge material. The used material is a commercial biochar product delivered by TORR COAL company. Table 1 shows the characteristics of the used material; in the same table are also reported characteristics of:

- the standard anthracite currently used in the EAF
- the biochar already used successfully in the past industrial experimentation [1,2].

The char used in the current activity differs for many aspects respect to standard material and char from thermal pyrolysis:

- Higher amount of volatile matter (lower fixed carbon)
- Higher hydrogen content
- Higher density
- Higher mechanical stability of briquetted material
- Hydrophobic

These differences derive from the characteristics of the torrefaction production process. Torrefaction process is carried out at relatively low temperature (300-350°C), while thermal pyrolysis is carried out at higher temperatures (800°C). This fact determines for torrefied biomass a lower degree of carbonization of the material (higher content of volatile matter remains into the produce char). The residual presence of hydrocarbons of high molecular weight determines the hydrophobic characteristics of the material, while in general char from pyrolysed biomass is
Hydrophilic. For this reason storage of the torrefied material does not require special care.
Moreover, the mechanical stability of the obtained briquettes of biochar from torrefaction reduces the dispersion of powers during material handling into the steel factory.

Tab. 1 - Characteristics of standard charge material (anthracite), biochar used for industrial trials (torr coal) and material used for test carried out in past activity [1,2].

Component	Standard Anthracite	Biochar from TORR COAL	Biochar from thermal pyrolysis
C (%)	>80	55-75	70
H (%)	2	6	4
S (%)	<1,5	<0,14	0.05
Cl (%)	-	<0,05	<0,05
Ash (%)	<20	<4	10
Moisture (%)	<1	3-8	6
Volatile matter (%)	<10	50-70	25
Density kg/m^3	900	600	450

The scope of this activity is to carry out a long term experimentation, using a biomass derived material. In the first experimentation [1] the basic idea was to use a material as much as possible similar to the fossil coal. In this activity the main goal is to run the EAF process regularly, even in presence of a reduction and carburizing agent with different properties respect to the fossil.
Pittini steel factory is equipped with an EAF of 140 tons capacity, with three scrap buckets charging. Globally 1100 kg per heat of anthracite are used.
Being the selected char a new material, the experimentation has been divided into three steps:

1. A first sequence of six heats has been carried out just to check the first feasibility of material utilization; the goal was to have a qualitative evaluation of the suitability of the material in the EAF process
2. The second longer sequence has been carried out to optimize the EAF charging operation and to have e first check of process parameters (steel and slag analysis, productivity and consumption)
3. The third trial has been carried out to check the EAF operating parameters on one day production; supplementary stack analysis to check also the impact on environmental performances (mainly dust, dioxins and polycyclic aromatic compounds emissions at stack) have been also performed.

Table 2 reports the summary of performed industrial trials. In the test 1, 500 kg of char have been charged on the first basket. Char was charged on the bottom of the first basket. Flame emissions, larger than standard practice, were observed during charging operation. In spite of flame emission, the EAF process run quite regularly. The flame emission was attributed to the presence of high volatile matter fraction and also on the production and further dispersion of powders under the effect of pressure of scrap on char briquettes. The positioning of char on the top of the basket avoided the dispersion of dust during charging but caused the flame formation once the basket is opened on the top of the steel bath, due to the fact the char start reacting rapidly before getting in contact with steel bath.

Tab. 2 - Performed industrial trials with biochar

Test number (N)	Number of Heats (N)	Charged char per heat (kg)	Goal of the test
1	6	500	First feasibility
2	12	1000	Optimization of EAF charging practice
3	>20	1000	Long trial, collection of operating parameters and supplementary off gas analysis. Test to be performed

Position of the char briquettes into the scrap basket has been optimized through the test 2.
The charging practice optimized was:

- Positioning of 10-15 tons of scrap on the bottom of the basket (about 1 m)
- Positioning of a layer of fine scrap
- Positioning of char briquettes
- Positioning of a layer of fine scrap
- Filling the basket with scrap according to the regular basket management up to the capacity of 40-50 tons

With this optimization of basket management a significant reduction of flame emission during charging was observed.

RESULTS

The tests 1 and 2 had the main objective to check feasibility of utilization of biochar from torrefaction and to optimize the charging operation, which is a fundamental step in the EAF process. Some process parameters have been collected just to have a first rough idea of the furnace running conditions before the long term trial.
Table 3 reports the variation of four main process indicators (productivity, power-on time, electrical consumption and O_2 consumption) of the test heats respect five subsequent standard heats.

Tab. 3 - Plant indexes comparing standard heats with biochar

Test N.	Productivity	Power-on	Electric consumption	O_2 consumption
1	-1.27%	0.18%	-0.44%	-1.54%
2	1.02%	0.02%	-1.43%	-0.53%

Table 4 reports the average FeO content of the slag and the C content of the steel (at tapping) of three heats from test N. 1 and the subsequent standard heats. The oscillation of concentration values is in the range of what observed during regular EAF running.

Tab. 4 - FeO content of the slag and the C content of the steel (at tapping) of three heats from test 1 and three standard heats

Test 1	FeO (%)	C (%)
With biochar	29.1	0.170
standard	30.5	0.175

The carbon concentration in the steel at tapping is relatively constant (average C concentration calculated over eleven heats is 0.207% with standard deviation of 0.007%)
Trend of carbon concentration for the sequence of eleven heats is (test 2) reported in Figure 1.

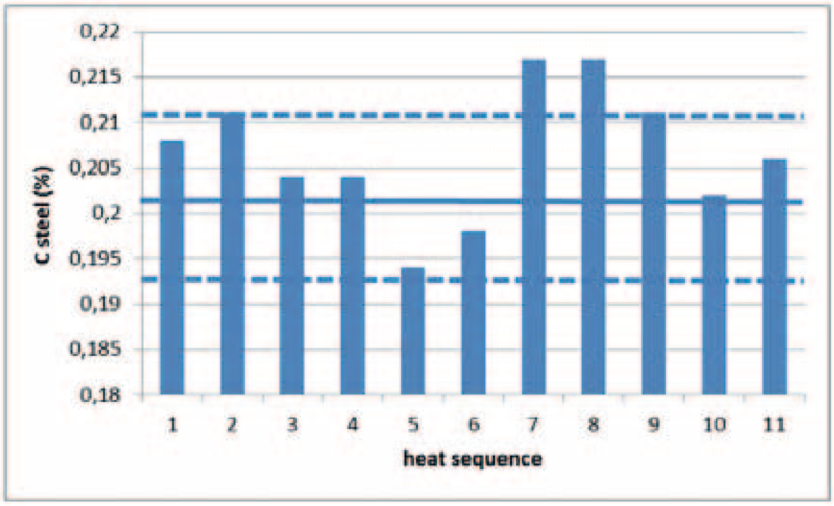

Fig. 1 - Trend of C concentration in the steel at tapping, test 2.

In the figure are reported also the average value of standard heats previous eleven standard heats and the standard deviation. The oscillation of the C concentration is in the range of standard operations.
The main process aspect outlined during the first two experimental campaign was the increase of fumes temperature. This fact is attributed to the high presence of hydrocarbons formed during devolatilization from charged biochar.
A better quantification of this phenomena will be given through planned longer test in table 1 (Test 3).
The best advantage in biochar utilization in EAF would be obtained with optimization of utilization of fumes energy, acting on:

- Improvement of EAF postcombustion and energy transfer to the bath
- Utilization of technologies of energy recovery from EAF off gass [7]

The environmental impacts of the usage of biochar during electric steelmaking in the EAF were investigated by a Life Cycle Assessment (LCA) study. The LCA study is currently at starting stage and will be presented in the Report of the Project.
In general a LCA study is divided into four phases:

- Goal and scope definition
- Life cycle inventory
- Life cycle impact assessment
- Interpretation

The LCA studies about the utilization of biochar in the EAF were carried out to compare the usage of fossil and biogenic carbon carriers. Therefore the modeling is focused on the melting process in the EAF without any upstream and downstream processes to calculate the CO_2 intensity of the electric steel production.
The Functional Unit (FU) was determined as 1 ton of liquid steel. The determination of the system boundary is based on the gate-to-gate approach.
The economical evaluations about biochar utilization are still onoing inside the RFCS project. The starting point is that an assessed market of biochar for steelmaking utilization (which means high volumes of production, low grade of input biomass) is not present. So the economical evaluation takes into account the purposely designed torrefation plant, for an hypothetical production of 10.000 ton of biochar per year
The torrefied material has following advantages:

- lower price respect to pyrolised materials (lower temperature process, and relatively easy plant configuration, see Figure 28)
- Hydrophobic
- Easily densified into briquettes without addition of bindings

On the other hand, the torrefied biomass has high volatile matter content, but industrial trials demonstrated that operating practice can be adjusted.
The torrefied biomass has a current market price in the range 250-350 €/t.

A first estimation carried out in the ongoing project report as first hypothesis of a tailored biochar production, the following cost figure (table 2). Table reports the simulated final price of torrefied biochar according to three different price of biomass.
On the basis of the costs figure of table 21, final char cost as a function of biomass costs have been simulated (Table 5).

Tab. 5 - Final price of biochar according to three different price of starting biomass

biomass cost €/t	torr char €/t
70	310
50	244
15	104

The complete economical evaluation of biochar utilization will be more precise after the longer trials, which would permit to better estimate the EAF energetic performance
First evaluation, in any case confirms that price can be competitive with col in case of utilization of low grade biomass. Size scale effect, and utilization of low grade biomass [6], which determines more than 60% of final cost of char production, would lead to a significant cost reduction, competitive with fossil coal.

CONCLUSIONS

Fossil sources are extensively used in the Electric Arc Furnaces (EAF), to provide energy (in addition to electricity) or in general for process needs (to provide carbon to steel bath and promote slag foaming which improves furnace energy efficiency.
This paper describer the industrial long term trials with biochar: series of industrial tests have been carried out using biochar as charge material, (about 1 ton per heat) replacing fossil coal.
The results of industrial long term trials confirmed the possibility to use the biochar as charge material, without significant modification in steel and slag analysis.
Better advantages will be obtained through the efficient utilization of the energy deriving from hydrocarbons emitted by biochar during EAF operation. The efficient utilization of such energetic potential require optimization of EAF postcombustion and energy recovery from offgas.
Market price of torrefied biomass is in the range 250-350 €/t. the price higher than fossil coal. Preliminary economical evaluation, considering a tailored production of biochar starting from low grade biomass showed that a price competitive with fossil coal can be obtained with torrefied material.

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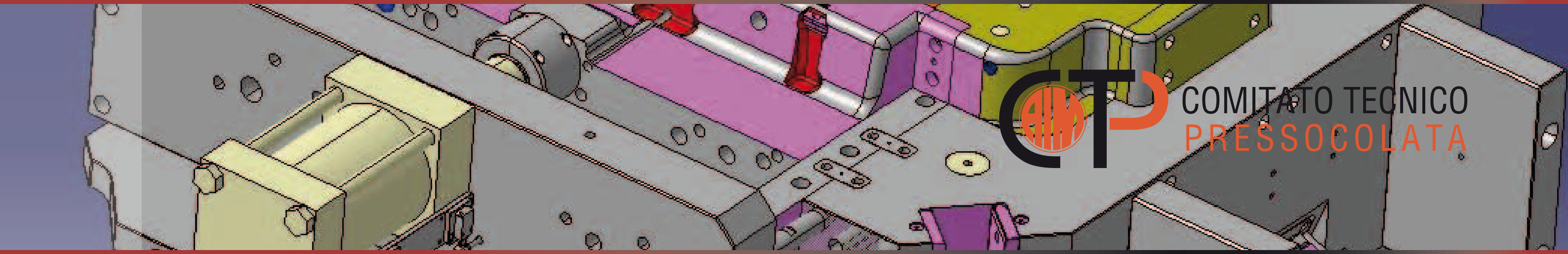

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The LM.3 - the new era of efficient energy input optimization in the EAF

A. Opfermann, F. Goekce, K. Libera, A. Grosse

The energy costs for the production of steel have a large influence on the final conversion costs. The optimization of the furnace operation aims for the usage of the highest amount of the cheapest energy source. But even the high powered furnaces run with the same burner powers as during the last 20 to 30 years, in most cases between 2-5 MW per burner. But this power limitation leads to a much smaller total power of the EAF during melting than during refining; this stage is characterized by an efficient flat bath operation with a high amount of multipoint-oxygen injection. Therefore the idea for the Tiltable-VLB was born and started with success. The mechanical movements as tried several times in history give the possibility of an increase in power without destroying the refractory or oxidizing the scrap.
Now the LM.3 offers the additional possibility of installing a powerful movable burner in the door tunnel. More than 6 MW are possible, even as a standalone tool the chemical energy input can be increased easily and without any pilot flame gas consumption.

KEYWORDS: EAF - ENERGY COST - CHEMICAL ENERGY - TILTABLE INJECTOR - BURNER OPERATION-LM 3

INTRODUCTION

The steelmaking process is one of the most energy intensive production processes. Therefore all steelmakers focus primarily on energy cost optimisation. As shown in Fig. 1 a large amount of the scrap-to-billet costs are energy costs in form of electricity, gas, and oxygen in the BSW steel plant.

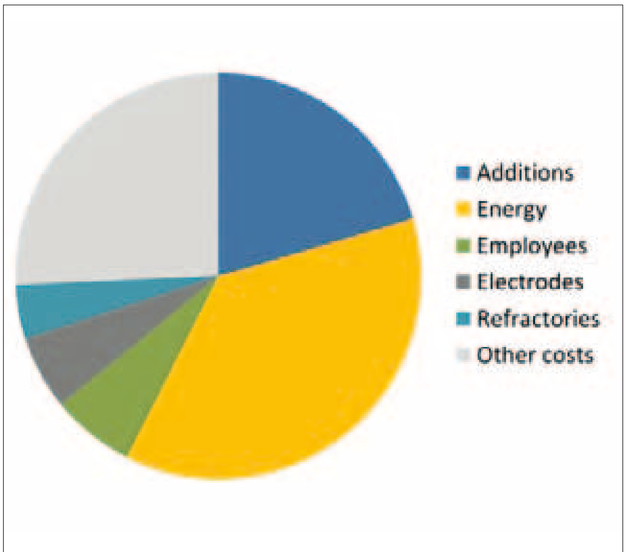

Fig. 1 - Conversion cost distribution at BSW for the steel plant

Electric steelmaking plants use primarily electrical energy followed by fossil energy in form of gas and oxygen. More than 70 % of the energy input of an electric steelmaking plant consists of electrical energy. Gas as a second source for energy is used not only in the EAF but also in the refractory bay, the ladle shop, and at the casting machines for preheating tundishes and torch cutting. Together with the optimization potential of new and modern drives, gas recuperation at burners and other possibilities for the auxiliary power input, currently cost optimization focuses on utilizing the cheapest energy mix for a steelmaking shop.

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Since the EAF is the most energy intensive equipment in an electrical steelmaking shop, the energy input mix optimisation plays a key role for the energy cost optimisation.
Nowadays modern EAFs are equipped with high specific installed transformer powers up to 1 $MW/t_{tap\ weight}$ with a remarkably high rated tap size of above 150 t/heat. The main energy input of modern EAFs is supplied through the electrical arc, which is additionally supported by sidewall and door oxygen injection, only 5-10% of the total energy is introduced by gas (see Tab. 1). On the other hand, small furnaces in foundries or at special steelmakers are not equipped with burners or other tools

		UHP-EAF	Low to medium powered EAF
Inputs	Electrical Energy	50-60%	75-85%
	Burners	5-10%	
	Chemical reactions	30-40%	15-25%

Tab. 1 - Energy input distribution in arc furnaces (modern furnace on the left, old style or foundry furnace on the right) [1]

During a heat the following energy inputs can be utilised:

1. Electrical energy by the electrodes in the furnace during melting and refining
2. Burner energy by gas or oil combined with oxygen during melting
3. Refining oxygen for exothermic reactions.

HOW TO FURTHER IMPROVE AND HOW TO RUN THE CHEAPEST ENERGY MIX?

During the last two to three decades the maximum applied burner rating (5 MW) has remained unchanged. The optimisation of the energy mix cost requires the increase of gas consumption obviously depending on the gas, electrical energy, but also heating oil prices.

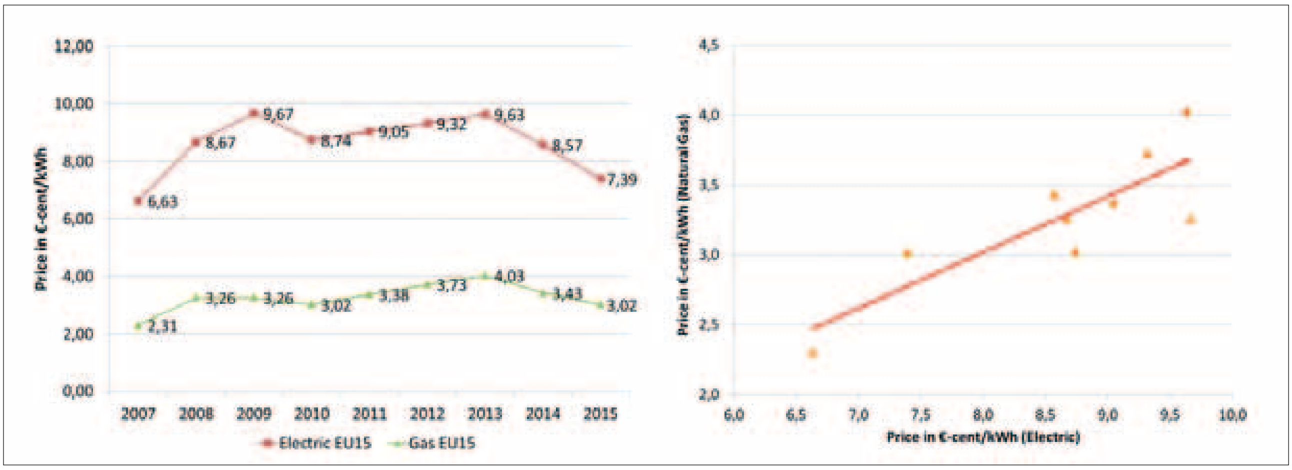

Fig. 2 - Electrical and natural gas prices from 2007 in EU15 and gas price as a function of electrical energy prices [2], [3]

During the last ten years the average difference between gas price and electrical energy price was in the range of 40% which is depicted in Fig. 2 from the annual costs of gas and electricity (left diagram). Similarly the light diesel oil can also be a cheaper alternative in some countries where gas is expensive. After the big discrepancies from 2009 to 2014, the oil price is back on its natural price as compared by the BTU-price. The future outlook should at least show that the low oil price will also have its influence on the gas price and the electrical energy costs. But the gas price and its traditional connection to the oil price are difficult to forecast, different effects can be expected for the different markets. [4], [5]

COST COMPARISON OF THE ENERGIES

In order to simplify the energy cost comparison, the prices are converted to €/kWh content. An example for the energy costs from different sources for three different countries namely Germany, USA, and Russia is shown in Errore. L'origine riferimento non è stata trovata.. In this diagram the specific cost per kWh is shown for the different energy sources as the gas input with oxygen as the base in comparison to the oxygen injection and reaction to carbon-monoxide, and the electrical energy.

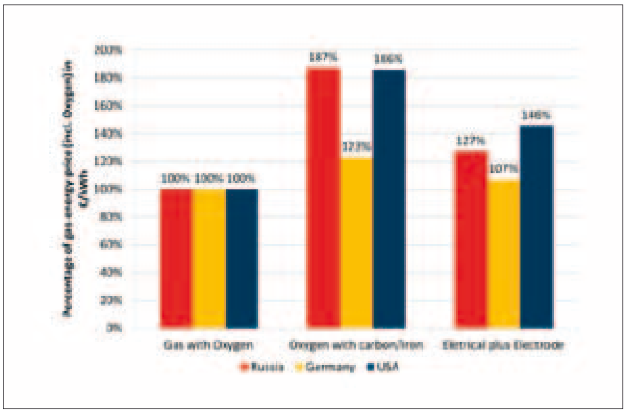

Fig. 3 - Comparison of energy prices of different sources for the EAF for three different countries as example

In this comparison the energy yield of the burners is reaching usually approx. 70%; 7 kWh/Nm³ are generated by the stoichiometric reaction of natural gas with oxygen; this is calculated as the base [6].The oxygen reaction reaches in lancing mode approx. 3,5 kWh/Nm³ which is taken into consideration for the price per kWh. This value is given by the combined reaction of oxygen with carbon and iron oxidation (6,6 kWh/Nm3 of oxygen). Iron losses caused by oxygen injection need to be compensated by carbon injection. The iron oxide is reduced back to iron with carbon which is an endothermic reaction. This reduction energy reduces of course the final energy supplied through oxygen injection. The electrical energy cost is considered along with the consumed electrode cost. As depicted in Fig. 3 the price for the gas energy is the lowest in these three cases. The oxygen itself has a low price, but it needs fuel. This fuel has to be added to the oxygen input; the resulting energy by the burning to CO is low as shown later on.

POWER INPUT DURING MELTING AND REFINING

An additional task for improving the chemical energy during melting is given by the energy input share of melting and refining: The limited burner capacity leads to a total power input which is far beyond the refining power, although the melting time needs approx. 60% of the total PON-time. The recommended burner powers are given with 0,133 $MW/t_{capacity}$, the range can be found from 30 kWh/t (for eliminating cold spots) to 55-90 kWh/t (for low powered furnaces).[6]

EAF side wall burners are usually operated with 3,5-4 MW each in the melting cycle. Depending on the furnace diameter and construction; the number of installed burners may vary from 3 - 5 pieces, i.e. 14-20 MW in total additional melting power only. On the other hand additional power through the oxygen injection by the side wall and door injection units can produce an additional power input of up to 30 MW which is equivalent to 10.000 Nm³/h oxygen flow rate during refining (3,5 kWh/Nm³ oxygen of chemical reactions). This total power increase by the burner in melting is by far lower than the power introduced by the lancing oxygen in refining: As a result an energy input gap between the melting and refining exists, which needs to be taken into account. Input shares of the power input for different phases are shown in Fig. 4 for BSW-EAFs. It can be clearly seen that the power input share during melting is approx. 30% lower than during refining. In this picture even the lance manipulator is counted by 12 MW. But, and this is obvious, this oxygen is reacting for post combustion but also burning iron of the scrap.

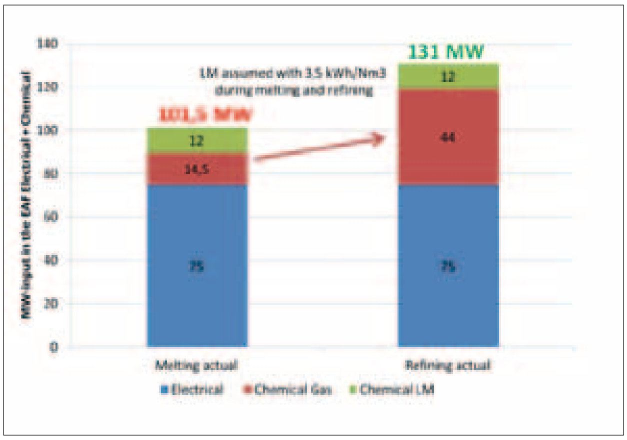

Fig. 4 - Melting and refining power input at BSW

INFLUENCES OF CARBON DURING REFINING

Electrical energy consumption can be improved by replacing the electrical energy with chemical energy. Replacement of electrical energy can be applied either by accelerating the melting with chemical energy input or adding additional energy in refining. The latter can be performed by carbon input because the increase in oxygen input only is leading to an over-oxidation of the steel melt, an increase in FeO in the slag, and decrease of the yield. Additionally refractory wear is increased by the FeO rich slag erosion. Carbon is an unavoidable metallurgical material which acts as a reducing agent, an alloying element, and also as an important energy carrier. It is the cheapest energy carrier used in steelmaking. Carbon oxidation to carbon monoxide gives 2,73 kWh/Nm^3_{oxygen}. This is a lower value than created by the simultaneous oxidation of alloys from scrap.[7]. If additional carbon is used to increase the energy input, additional 0,6 $kWh/t/kg_{carbon}$ is required for carbon dissolution in the bath [8]. Furthermore additional lime is required to neutralize the ash.

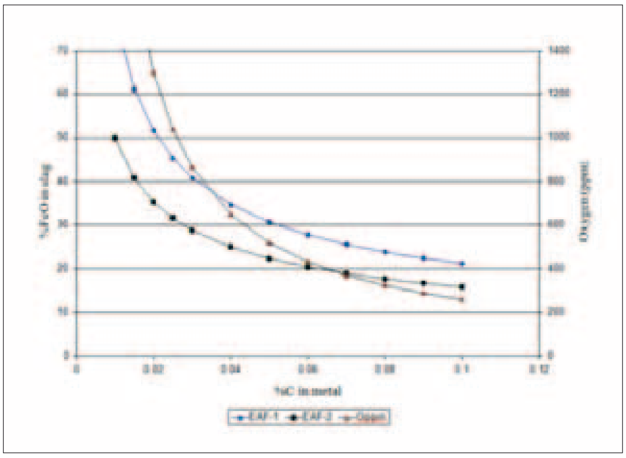

Fig. 5 - FeO-content of slag as function of the carbon content [1]

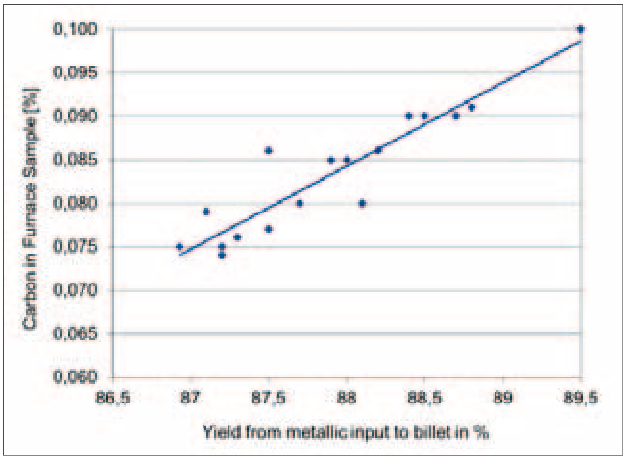

Fig. 6 - Yield from metallic input to billet as function of the carbon content

Tests have been performed for the influence of carbon with constant oxygen injection on other KPIs. Background was the fact that the over-oxidation leads to lower yield due to the oxidation of iron. This effect is shown in literature as example in Fig. 5. This effect can be clearly found in the annual and monthly data of BSW as shown in Fig. 6. The increase of losses by running to lower carbon contents is clearly visible.

The influence on the energy consumption at the BSW plant is shown in Fig. 7. It clearly shows that the kWh-consumption per ton of billet decreases if oxygen is reduced and carbon is increased. Other positive aspects on consumptions of alloys have been found additionally and have been published already [9].

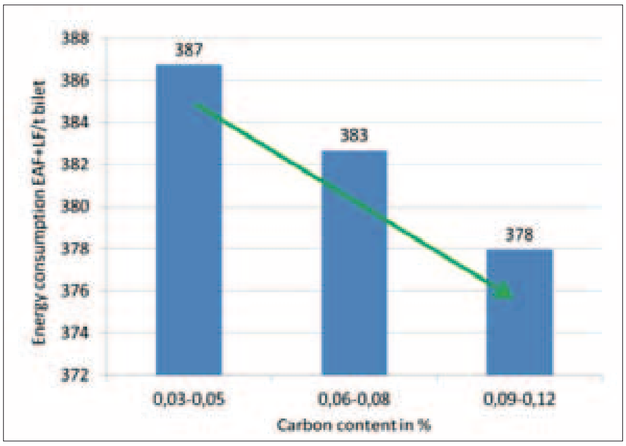

Fig. 7 - Energy consumption as function of the carbon content

The aim for increasing the oxygen for further decrease of the energy consumption would require a strict increase in carbon to generate heat on the one hand; on the other hand the yield loss by the oxidation of iron has to be avoided. But the result of the energy consumption of approx. 3,5 kWh/Nm3 is reached by the mixture of the reaction of iron and carbon:

$C + ½ O_2 = CO$ with a heat input of 2,73 kWh/Nm³ of oxygen (1)

$Fe + ½ O_2 = FeO$ with a heat input of 6,58 kWh/Nm³ of oxygen (2)

The value of an oxygen-carbon-reaction of 70-80% is found in several studies/references, i.e. 20-30% of oxygen is reacting with iron [1]. To avoid an iron loss by increasing the oxygen injection the carbon addition has to be increased; but this addition must be solved in the steel (charge carbon) or slag (injected carbon) to reduce the FeO. And this reaction is naturally taking energy again, as can be seen in Fig. 8. The total resulting energy of additional carbon with additional oxygen is therefore low, experiences of only 2 kWh/Nm³ of oxygen can be found.

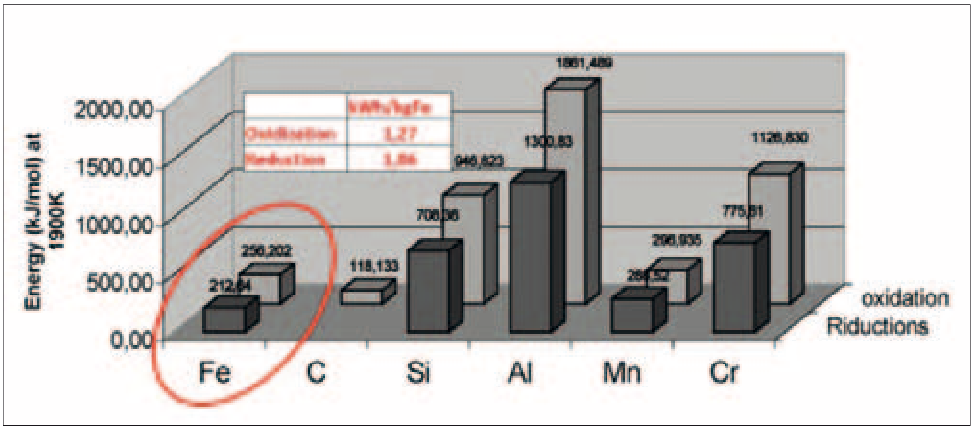

Fig. 8 - Energies for the reduction (with carbon) and oxidation with oxygen [10]

INFLUENCE OF INCREASING THE GAS CONSUMPTION IN THE FURNACE

Burner power increase targets to improve and accelerate melting down of charged scrap. Two customer experiences are shown in the following part within the typical limits of the fixed burner installations. In both cases the power of the existing VLB installation was increased by 33% and 43% (1,8 to 2,4 MW, 2,8 to 4 MW) during melting.

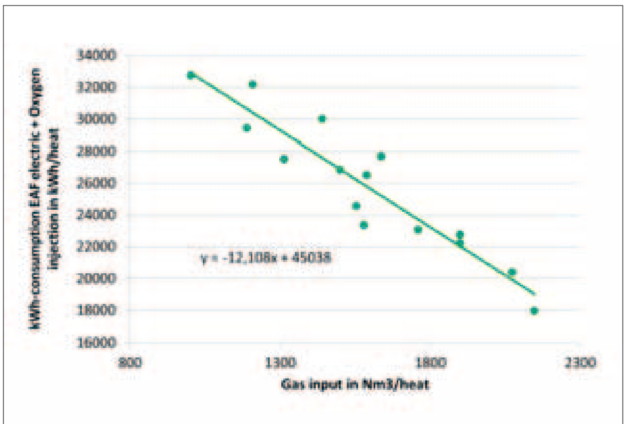

Fig. 9 - Improvement by increasing the gas input

The melting of scrap by burner and chemical energy only was performed in laboratory scale furnaces as example in England (FOS-process) in the 1960s or in Japan in NSR-process; but the control of the heating especially in the flat bath and also the yield loss have stopped these processes for industrial scale [11]. However, the aim for reducing the electrical energy consumption especially during melting is still given.

An example for higher gas consumption is shown in Fig. 9 for a BSE-system at a customer's furnace. In this case the scrap is pre-molten with burner only and therefore the gas consumption is higher than usual in the EAF. As to be seen the burners are working with an efficiency which is at the theoretical value. This is found because during this time the suction is reduced and losses are at a minimum. But as to be seen later on, also during melting a higher efficiency is reached, higher than in literature [12].The aim is the increase in the melting power; this long period of unstable arc and cold spots in the furnace is minimized by high power burner flames with variable directions to avoid the overheating and oxidation of scrap and fast melting till the centre of the furnace by the low burner inclination. Melting is the only phase where a higher burner power can be introduced during a heat cycle. Additional energy is given by the higher gas input but also extends the flame length, as shown for example in Errore. L'origine riferimento non è stata trovata.. It is clearly visible that a flame with a higher power and therefore a higher flowrate creates a longer flame. In these pictures the flame direction is shown for the Tiltable-VLB of BSE with a direction of 20° during melting.

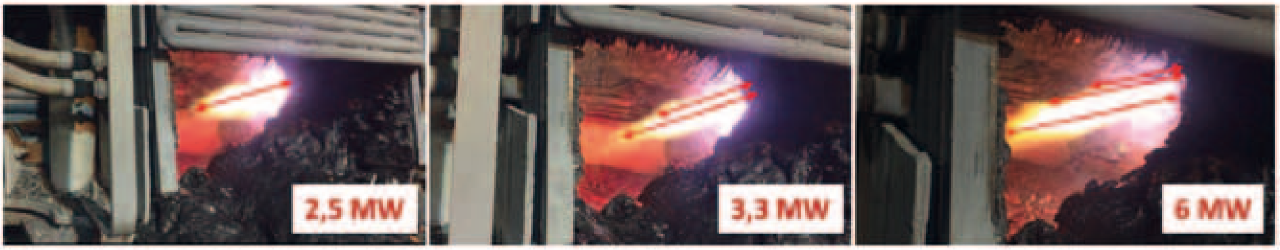

Fig. 10 - Change of the flame length as function of the flame-power and flame prolonging by increasing the power

Tests have been performed to see the effect of increasing the flame power. In the first test a 50 t furnace was operated with four VLBs with 1,8 MW first, then with 2,4 MW. The furnace was charged with three buckets. The result is shown in Fig. 11. Experienced was a large step forward in the direction of the energy consumption but also the flame shape and energy distribution changed.

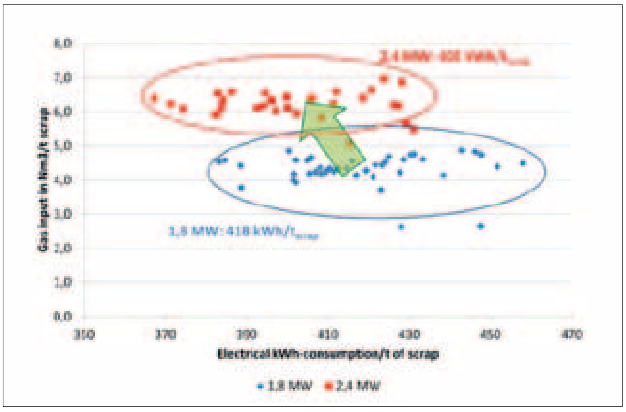

Fig. 11 - Improvement by increasing the chemical burner power from 1,8 to 2,4 MW

By increasing power the flame penetrated the scrap deeper and the heat was working more efficiently in the scrap. As to be seen in the graph the efficiency of the increase in power reached approx. 10 kWh/Nm³/t_{scrap} (1,6 Nm³/t gas increase for 16 kWh).

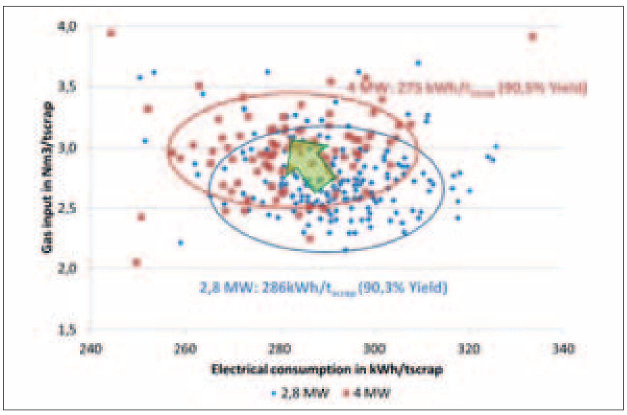

Fig. 12 - Improvement by increasing the chemical burner power from 2,8 to 4 MW

The yield remained unchanged; no further yield loss was reported. These results are close to the theoretical value of the natural gas energy content.

Nevertheless it has also been found in the next trials, that the burner power increment brought higher energy savings than the theoretical energy content of the natural gas: In this case the furnace (100 t with scrap preheating of the 1st bucket) was running with four VLBs with 2,8 MW each, i.e. a total chemical melting power of 11,2 MW. Burner power increased to 4 MW each VLB, i.e. a melting power of 16 MW. Also in this case the flame length was increased and the heat is penetrating deeper in the scrap; resulting in an energy decrease of even 11 kWh/tscrap with a gas consumption increase of only 0,5 Nm³/t, i.e. a decrease of electrical energy consumption by 16 kWh/Nm³ of gas. The yield was not influenced; the metallurgical oxygen was also in the same range, but 2 t more scrap have been charged, which has always an additional positive effect on the EAF-operation form BSW's experience. The total energy influence of the gas recalculated for different operational pattern leads to varying gas consumptions as to be seen in Fig. 13; in this case the metallurgical oxygen was added on the electrical consumption and the graph shows the pure gas variation and its influence.

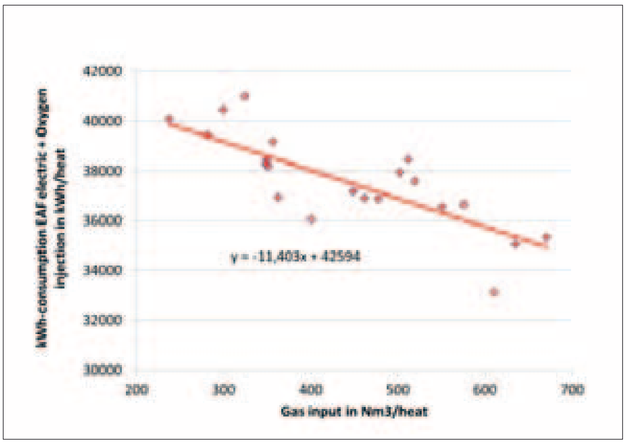

Fig. 13 - Decrease in electrical energy larger than theoretical gas-energy-input

Also here it can be seen that the gas has a large influence and the energy input is efficient. The high value reached is of course also influenced by factors which are following the fast melting:

- The more homogeneous and faster the melting, the earlier the flat bath phase is reached. The arc is covered and stable, the energy input high
- The liquid bath in the hearth of the furnace has lower losses than scrap in contact with off gas and water cooling equipment. Therefore the liquid bath formation should be accelerated.
- The longer the flame is, the deeper the flame can penetrate the scrap and work from outside while the arc is melting from centre. The longer the flame the more volume of scrap can be heated before the hot gas is leaving upwards to the 5th hole.
- The early back-charging leads to a decrease of energy consumption. Over-melting the bath because of solid scrap in the cold areas leads to overheating of the bath without covered arc (to melt the sidewalls). This leads to losses and refractory wear. At BSW a difference of 8-20 kWh/tbillet was found between earlier and late charged back-charging practices [13], also in the described furnace the 2nd bucket was charged earlier (10.500 kWh instead of 12.000 kWh, i.e. 166 kWh/tscrap instead 190 kWh/tscrap) on the preheated 1st bucket.
- Scrap cutting can start earlier without the danger of backfiring due to the high power input of the burners

The aim is given therefore: Increasing the melting power by burners leads to a total process improvement due to several causes:

1. The installation of burners with high power and flames reaching deeply inside the scrap leads to an increase in melting homogeneity and efficiency.
2. The increase in refining power by further oxygen injection is not helping the long and inhomogeneous melting process.

The problem with the increase in burner power is known [11]: Burners, or "multi-injection-tools" as used today, are mounted approx. 500 mm above the bath in the sidewall and work with an angle of 40°-50° towards the bath to be able to inject the lancing oxygen during refining also. The angle is kept and the burners work with low kinetic energy. The heat transfer of the burners with fuel and oxygen is made mainly by convection, due to the actual low power the speed of the flames is also reduced in the scrap pile. The heat transfer by convection is defined by Newton's law:

$$Q=\alpha \times F\times(t_W-t_{FL}) \qquad (3)$$

This means that the temperature difference between the flames and the scrap (tW-tFl) defines the efficiency by a high heat transfer. The hotter the scrap gets, the lower is the heat transfer. The burner flame has to get cold scrap to work efficiently; the fixed installation leads to a small reaction area and therefore a fast overheating of the scrap in the vicinity of the flame. Therefore the efficiency decreases.

But this is not the only cause for the lowering efficiency and the limit in power: If the scrap reaches 1400-1450°C, oxidation rate of the scrap rises sharply: The products of the fuel combustion are reduced to CO and H_2 and the scrap is oxidized.

$$CO_2\ (H_2O) + Fe = FeO + CO\ (H_2) \qquad (4)$$

Hence improved chemical energy input during melting must focus on preheating the scrap without excess heating in the area of the oxidation; the higher the power the faster with a fixed operational direction of the flame the scrap in this area gets too hot and oxidation occurs. The flame has therefore to move if the scrap is moving too slowly; the flame must look for fresh scrap to heat.

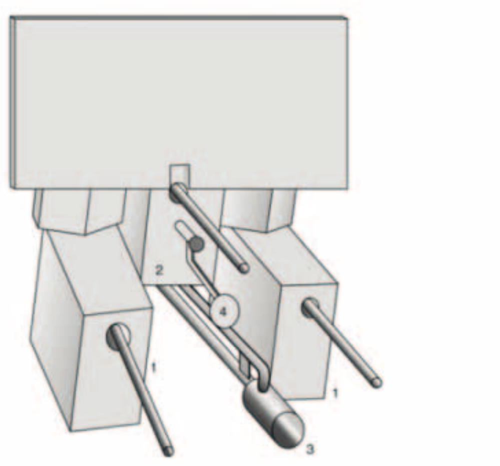

Fig. 14 - Burner (3) mounted on a lance manipulator [11]

Tests for moving with the scrap have been performed through the door and from the sidewall and roof. The first example is shown in Fig. 25 - Burner (3) mounted on a lance manipulator [11]; in this case a burner was mounted on a lance manipulator and it was used for melting the scrap in a 65t furnace with 35 MW electrical power input in Israel. And running with success: The burner was operated with liquid fuel and a power of 12-15 MW; by this operation during melting the electrical energy consumption was lowered by more than 5% [11]. In this case this manipulator was used instead of several side wall tools.

This is also to be seen in the BSE-customer's furnaces as described. From this knowledge the aim for the future chemical energy input can be defined:

1. The power increase of the burners only works, if the possibility of reaching "cold" scrap is given; a fixed burner installation does not work with high efficiency, especially if the flame is short, the melting is only performed close to the wall. The burner melts a hole and afterwards the efficiency can drop.
2. The power increase as tested by multi-purpose-sidewall-tools does show additional problems with increased refractory wear: The distance to the wall is too small, the flame burns the bricks; as to be found at installations a certain distance to the bricks is needed. Tests and measurements have been performed and the minimum distance can be kept by the tilting of the VLB during melting.

The T-VLBs are running with success, an example for a performance is shown in Fig. 15. The increase in gas by 0,9 Nm^3/t leads in combination with a further optimization of the chemical energy system also here to a remarkable decrease of electrical consumption by 17 kWh/t.

	Before	After
Elec. energy [kWh/t]	336	319
Oxygen [Nm^3/t]	32,0	34,6
Natural gas [Nm^3/t]	7,6	8,5
Power-on time [min]	28,3	26,8
Yield [%]	92,8	92,7

Fig. 15 - T-VLBs in a shaft furnace

The high power of the VLBs in combination with the optimization possibilities leads to the improvement of the melting process without harming the yield as example.
This high efficiency of the increase of melting power from the sidewall requires also improving the melting phase by additional non-oxidizing power input through the slag door.

THE NEW CONCEPT FOR THE SIDEWALL INSTALLATION AND THE OPTIMIZATION BY THE NEW LM.3

As to be seen an improved burner operation leads to a decrease of energy consumption; productivity can be improved and conversion costs can be reduced. So the aim should be a high power addition by chemical energy during melting. But since decades the power of the sidewall burners was not increased. But the burners are running till a limit as described. The aim was therefore for sidewall but also door burners to increase the heating volume in the scrap pile on the one hand by the power and velocity of the gases and on the other hand by changing the direction.

Fig. 16 - Flame volume increase by increasing the power of the burner form 3,5 to 6,5 MW

The sidewall solution is given by the T-VLB, the Tiltable-Virtual-Lance-Burner. The aim of the higher efficiency even with higher power is reached by the movement and the long flame. The simulation in Errore. L'origine riferimento non è stata trovata. shows the flame and the temperature distribution in the range of 1300-1600°C. As to be seen also in Fig. 10 the heat moves deeper inside the furnace; the velocity of the gases increases and the preheating range and volume is also increased. On top of this flame prolonging, the movement increases the working volume of the flame in the scrap as to be seen in Fig. 17; the variable positioning combined with the high velocity of the burner flame leads to a large volume of scrap to be heated. The movement on the other hand reduces the refractory wear by the larger distance to the bricks.

Fig. 17 - Schematically moving volume of the burner during meltdown

The new process would therefore lead to a varying angle during meltdown and a swinging of the burner tip as long as there is scrap. This leads on the one hand to a deeper penetration during the flat angles, but also to a preheating of scrap in the lower areas. By this the scrap can collapse faster. The high power of 6,5 MW would also distribute the heat for preheating far in the furnace as to be seen in Fig. 18.

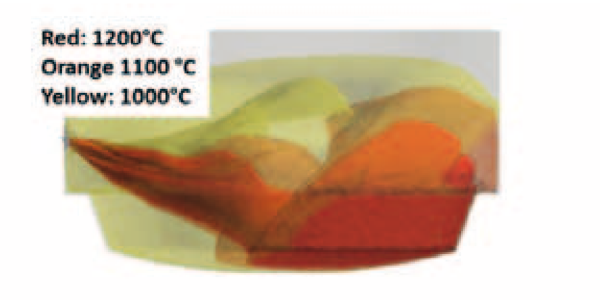

Fig. 18 - Temperature range between 1000°C and 1200° C in the empty furnace

THE LM.3

Knowing this history, but also looking for the further improvement of the EAF-process, BSE has developed for a customer a tool to melt the scrap on the bottom electrode in his cold furnace before starting the melting. The technology created is shown in Fig. 19. In this case the lance manipulator is beside the burner equipped with an oxygen lance, a carbon injection lance and a temperature and sampling manipulator. This tool is now used at the customer not only for the bottom electrode heating, but also for the melting of the scrap during operation instead of the existing fixed burner mounted in the door. The look back into the history was already showing the first ideas and the first installation in Israel having the same aim: Increase of chemical melting before oxygen injection (see Fig. 14). As done in the past this tool can on the one hand provide chemical energy to small furnaces without the sidewall installation or can give additional energy for larger and fast furnaces in an additional place except the sidewalls.

The main features are:

1. The LM.3 uses different tools for the melting and the refining. The aim is the additional energy without the danger of electrode burning and yield loss
2. The LM.3 uses a self-igniting burner to start the melting fully safely. As to be seen in Errore. L'origine riferimento non è stata trovata. a spark is electrically created to ignite the burner not depending on the furnace and scrap conditions
3. The LM.3 does not need a pilot flame; the burner is switched off after usage, the flows are set to zero. No additional gas or oxygen is used during the POFF of the furnace
4. The LM.3 can work automatically in the furnace door, the distance of the burner tip and the angle of the burner pipe is measured, the flows can be adjusted automatically for the optimized operation.

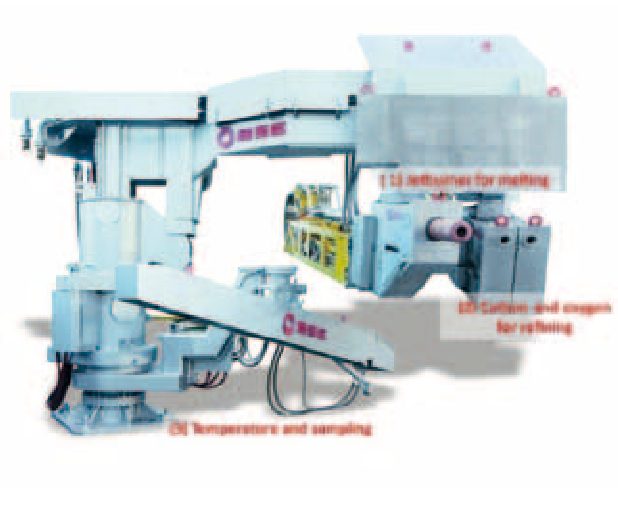

Fig. 19 - First LM.3 ready for installation at the customer

The tip for itself as to be seen in this picture is built like the BSE-VLB, i.e. a jet burner with a shrouding. This leads also for the melting to a high-speed-flame reaching deeply inside the scrap pile.

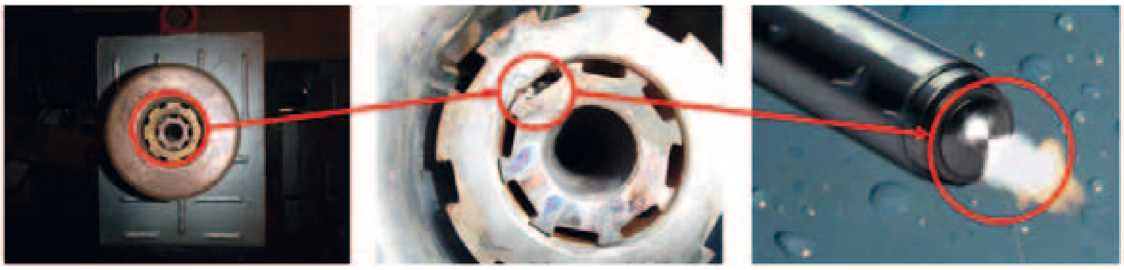

Fig. 20 - Electrical ignition of the gas by sparking

The LM.3 gives the possibility of adding easily more than 6 MW to the furnace without any changes in the refractory, panels, or any other parts. The melting is improved, the long flame melts the scrap, but gas and oxygen are just consumed when needed. The moving of the flame inside the door area avoids the overheating and the yield loss as described before.

In the example of the small furnace in Israel the burner was used to inject 4,1 Nm3/t of gas inside the furnace during melting only and led in addition with oxygen to a fast settling of the scrap. It reduced the energy consumption by 5% and the TTT by 6,4%, the same values as reached in larger furnaces by the sidewall installation[13]. Also at small furnaces the addition of chemical energy would improve the operation; in foundries or special steel shops the furnace is not the main aim; longer POFF-times and longer refining with adjustment of the bath are also followed. During all this times a wall mounted tool would require some flow, might it be gas and oxygen as a pilot flame, or pressurized air or nitrogen. But all the gases have in common that the consumption costs money. The LM.3 would have the advantage that it is removed after operation and just consumes, when needed. The ignition could take place even after long POFF; even the preheating is possible without an ignition source in the furnace.

As described the LM.3 will lead to a highly efficient melting by the movable high-speed burner, the melting operation is shown in Fig. 21 together with the view from top schematically. The burner is ignited directly after charging and the electronic ignition guarantees the flame under any conditions. The operation is performed by swinging the burner to reach the different scrap areas. The scrap heating is performed until
collapsing and then the burner is moved again. The heat input of more than 6 MW adds energy by the convection but also the hot gases are preheating the scrap. The melting period is started with low over-stoichiometric oxygen; this period will be finished by scrap cutting action. The movement leads to a large volume to heat up the scrap, no oxygen is needed for melting; scrap is less oxidized by free oxygen injection, so is the electrode.

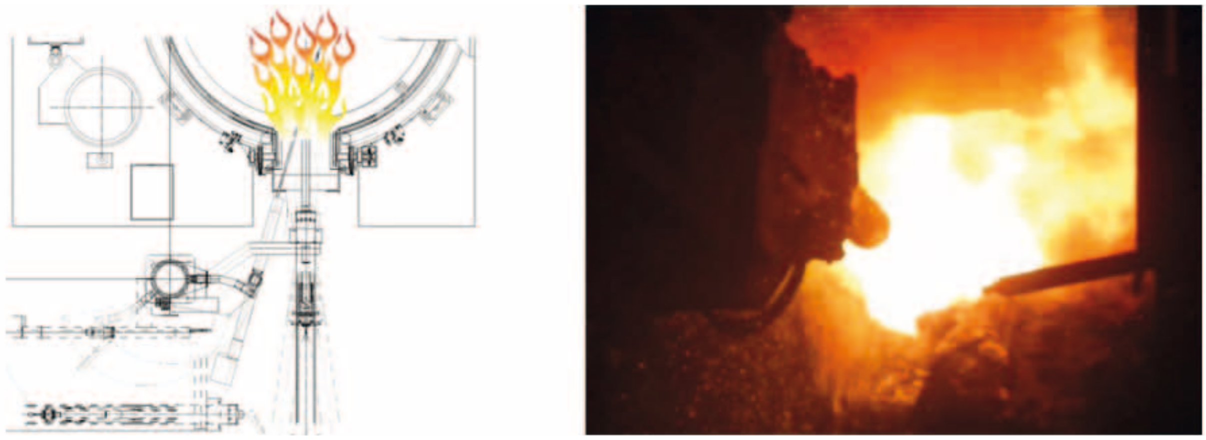

Fig. 21 - LM.3 working during melting and schematically in front of the furnace

The installed LM.3 has been operated for more than one year successfully during the whole melting period. The existing door burner was taken out of operation. This new tool improves the furnace process; the melting period as the longest of the PON-times is improved, the furnace reaches faster the homogeneous refining period.

CONCLUSION

During the last decades there has been almost no increase applied to chemical energy input during melting: The burner power was more or less constant. Higher burner power can now be introduced by the T-VLB of BSE from the sidewall based on gaseous or liquid fuels. Additionally a new tool was introduced to melt efficiently and automated through the door tunnel, the LM.3. It is a combined tool of the consumable lance and the installed lance and sampling manipulator. This tool is applicable not only for high productive furnaces but also small furnaces which usually cannot use the traditional sidewall tools efficiently. The BSE approach targets the cost and efficiency optimization of the EAF process which requires maximization of the cheapest energy portion to minimise the total energy cost.

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Le manifestazioni Aim
Aim meetings and events

MASTER IN PROGETTAZIONE STAMPI - I EDIZIONE
Centro P - *Vicenza,* **7-8-21-22 febbraio**

METALLURGIA PER NON METALLURGISTI
Corso - SEGR. - *Milano,* **15-16-22-23 febbraio/1-2 marzo**

LEGHE DI ALLUMNIO
Corso base - Centro ML - *Milano,* **2 marzo**

MASTER IN PROGETTAZIONE STAMPI - I EDIZIONE
Centro P - *Bergamo*, **8-9-21-22 marzo**

TRATTAMENTI TERMICI - XVII ED.
Corso modulare - Centro TTM - *Milano,* **21-22-28-29 marzo**

FOUNDRY 4.0 LA DIGITALIZZAZIONE IN FONDERIA
Controllo di processo e i costi della non qualità
GdS - Centro P - *Bergamo*, **23 marzo**

TRADIZIONE E INNOVAZIONE DEL RAME E DELLE SUE LEGHE
GdS - Centro MTA - *Milano,* **marzo**

MACCHINA FUSORIA
Corso itinerante - Centro A - **15-16-22-23-29-30 marzo**

MASTER IN PROGETTAZIONE STAMPI - I EDIZIONE
Centro P - *Sirone,* **5-6 aprile**

FORGIATORI - III EDIZIONE
Corso - Centro FOR - *Brescia,* **6-11-12 aprile**

TRATTAMENTI TERMICI - XVII EDIZIONE
Corso modulare - Centro TTM - *Milano,* **11-12-13 aprile**

ACCIAI INOSSIDABILI: TRATTAMENTI TERMICI E CONTROLLI NON DISTRUTTIVI
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Corso modulare - Centro TTM - *Milano,* **16-17 maggio**

9TH EUROPEAN STAINLESS STEEL CONGRESS - SCIENCE & MARKET & 5TH EUROPEAN CONFERENCE & EXPO DUPLEX
Convegno Internazionale - SEGR. - *Bergamo*, **25-26-27 maggio**

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Corso - Centro MFM - *Milano,* **6-7 giugno**

METALLI NELLE COSTRUZIONI ECOSOSTENIBILI
GdS - Centro MTA - *Milano,* **15 giugno**

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XII GIORNATE NAZIONALI SULLA CORROSIONE E PROTEZIONE
Convegno - SEGR. - *Milano,* **28-29-30 giugno**

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ORI MARTIN: the new environmentally friendly and energy efficient scenario. Operative results of the new CONSTEEL® evolution and iRECOVERY® system

a cura di: N. Monti, A. Grasselli, G. Di Zanni , U. De Miranda, N. Gaudenzi, M. Zanforlin

KEYWORDS: CONSTEEL® - EAF - IRECOVERY® - HEAT RECOVERY - WASTE HEAT BOILER - ORC - DISTRICT HEATING

INTRODUCTION

Ori Martin, confident with the engineering competence of Tenova, has successfully commissioned and started-up the revamping of the first European Consteel® with the aim of increase the flexibility and reduce the production cost. In addition to this, Ori Martin has also decided to install a heat recovery system on the primary off-gas line exiting the new Consteel®, to recover the remaining thermal energy in the off-gas for the production of steam. The paper describes the results that are achieved with the new Consteel® EAF and the new iRecovery® system that will deliver thermal energy to the city of Brescia district heating grid during winter time and that will feed an ORC turbo-generator to produce electric energy for Ori Martin's internal use.

The new installation lets Ori Martin have one of the most environmentally friendly and energy efficient steel melting plant in the World.

ORI MARTIN AND THE NEW CONSTEEL® PROJECT WITH iRECOVERY SYSTEM

Ori Martin group is specialized in the production of many specialty steel grades for automotive industry and demanding mechanical applications. The constant research effort allows the group to deliver now more than 200 steel grades to satisfy the needs of the European carmakers and to sustain profitability even in the most critical market conditions.

The growth of the group throughout the years was led by both increasing the productivity and increasing the added value by integrating downstream processes, sustained by a deeply rooted commercial presence on the European market. The group keeps on investing in both product quality improvement and technological modernization, keeping the brand on the forefront of the most advanced producers. In 1998, the group became the European pioneer in Consteel® EAFs, installing a new state-of-the art EAF fitted with the now widely spread Tenova continuous charging technology. The main goals of the project included the optimization the energetic efficiency utilization and the improvement of the environmental performance of the plant located near the very center of the city of Brescia, while keeping the production focused on the special steel grades and improving the product quality.

The operating results of recent times and the numerous tests carried out jointly by the Ori Martin team, backed by Tenova Engineering and Process departments, have highlighted the need to think about the design of a new Consteel®, which has as its objective the reduction of consumptions and improving the operational performances of the steel melting equipment in a scenario that requires a not common operational flexibility.

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The project of the new Consteel® is based on the following fundamental concepts:

- rebalance the two main components of the melting unit (Consteel® and EAF) to achieve efficiently and continuously the productivity goals;
- improve the thermal exchange between the EAF off-gas and the scrap in the different charging conditions (greater exposed surface and lower height of the scrap layer);
- improve the distribution of scrap entering the liquid steel bath (larger surface area where scrap falls in the steel bath) to speed up the melting with a lower interference with the steel bath stirring;
- keep the connecting car pan inserted inside the EAF for any furnace tilting angle, so as to have the metallic scrap charging and the electrical power-on to the EAF electrodes starting together at the soonest;
- reduce ambient air suction inside the Consteel® and the primary off-gas line by increasing the efficiency of the Consteel® seals between the EAF and the connecting car hood, along the connecting car hood and the conveyor in the preheating section and by better controlling ambient air intake through the dynamic seal;
- maintain high temperatures of the EAF off-gas;
- reduce off-gas flow rate in the primary off-gas line and consequently reducing the electric consumption to the fume treatment plant;
- improve the conditions of the off-gas at the inlet of the heat recovery system (iRecovery®) that will be installed on the primary off-gas line.

The correct conduction of the process is entrusted to a system for supervision and control completely new and innovative, able to interact consistently with management systems of the other production units. This type of system process control belongs to the global solution iSteel®, developed by Tenova for the continuous technological improvement of steel production cycle. The automation of the EAF with Consteel® is complete with management system and automatic control of spillage TAT® (Tenova-Auto Tapping-Technology), useful to control the EAF slag flow through the EBT during steel tapping into the ladle and to minimize human intervention during this operation. The design of the new Consteel® system has been updated in order to further improve its reliability and performances, considering the integration of the iRecovery® system. The new project was successfully started-up, right in line the contractual time schedule.

Fig. 1 - The new revamped Consteel®, connecting car side.

DEVELOPMENT OF THE INTEGRATED HEAT RECOVERY SYSTEM

The melting process in Ori Martin is rather atypical if compared with the other Consteel® EAFs as it employs limited oxygen and carbon injection, this leading to a modest quantity of energy in the off-gases. The main goal of the revamping is to maximize the recovery of the off-gas energy by improving the heat transfer to the scrap in the heating tunnel and by optimizing the conditions of the gases at the tunnel's exit to properly feed the downstream recovery system. The transfer of heat to the scrap has been improved by increasing the scrap exposed surface through the installation of the widest conveyor (2400 mm) compatible with the existing EAF geometry. At the same time the new Consteel® drive allows increasing the conveying speed by 2 m/min. The changes result in a reduction of the average scrap height from 800 mm to 500 mm that boosts the average scrap charging temperature at the EAF.

The hoods of the heating tunnel are being completely redesigned applying the results of a CFD analysis ran on the actual off-gases flow data. The aspect ratio of the hoods has been changed as they become wider and lower, while the overall section is reduced by about 20%.

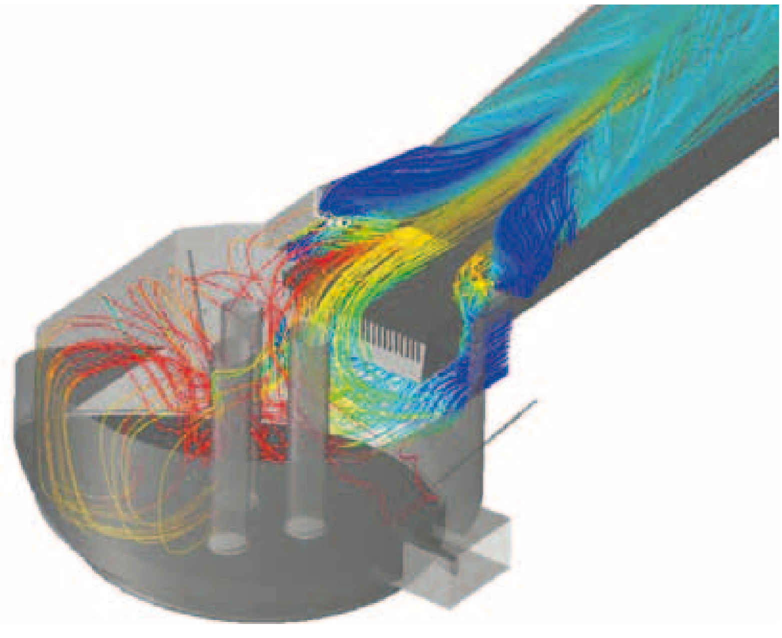

Fig. 2 - CFD analysis.

The efficiency of the energy recovery both in the Consteel® tunnel and in the downstream ECS improves dramatically with the increase of the temperature of the gases. Consistently, the new Consteel® implements a completely redesigned set of seals to reduce to a minimum the admission of bleed air. The sealing chamber at the open end of the conveyor (the Dynamic Seal) is reconfigured to achieve the result: the current seal features an axial fan to reduce the pressure in the seal's chamber and several rows of tubular fingers suspended to the chamber's roof on the scrap's inlet end to reduce the fresh air flow. To improve the dynamics of the chamber pressure control the new configuration utilizes a radial blower whose suction is regulated by pressure probes in the seal's chamber and in the end of the heating tunnel, while the tubular fingers are replaced by newly designed permanent leaf-shaped fingers, built in stainless steel on the hot side of the chamber and in polymers on the cold side. While the pressure in the current chamber is kept slightly higher than the one in the tunnel's end, in the new configuration the chamber is at a slightly lower pressure, and the outlet of the radial fan is connected to the secondary EAF suction line.

To seal the gap between the heating tunnel and the EAF shell a new circular flange, divided in two independent sectors, is installed. The position of the upper flange will be continuously regulated to adjust the quantity of post-combustion air to assure the complete combustion of CO and H_2 generated into the EAF. Both flange sections is completely retractable to give the needed clearance for the shell changeover between campaigns.

The improvement of the seals and the changes in the design of the Dynamic Seal allows fumes temperatures significantly higher than the ones observed today both inside the tunnel and at the tunnel's exit. To reduce the dust load in the fumes sent to the waste heat boiler and improve the deposition of the metallic dust particles on the scrap layer the offtake hood has also been redesigned, increasing both the horizontal section and the height to reduce the vertical speed of the fumes and increase the residence time of the fumes.

Fig. 3 - The new revamped Consteel®, offtake hood side.

The EAF platform cradles has been replaced to match the EAF tilting axis and the flange axis, and the Connecting Car has also been improved to allow leaving the connecting car inserted throughout the whole process, eliminating process delay. The design of the new Consteel® utilizes the existing original foundations reducing the shot down time required for the installation of the new equipment.

THE iRECOVERY® SYSTEM AT ORI MARTIN

The ECS (Evaporative Cooling System) heat recovery system, iRecovery®, was successfully started-up in the early 2016. This system, installed downstream of the new EAF Consteel® furnace, have the task to recover part of the energy contained in the fumes generated during the scrap melting and superheating process in the electrical furnace. The energy extracted from the fumes converts the recirculation water of the cooling circuit into steam. This phenomenon is made possible thanks to the use of cooling water at boiling conditions that, circulating and absorbing energy, will be subject to partial phase change generating steam. During winter time the steam produced is sent to a heat exchange unit dedicated to district heating for the town of Brescia managed by A2A Company. During summer time the steam produced is used to feed an ORC (Organic Rankine Cycle) turbogenerator supplied by Turboden for the production of electricity for internal use. This unit is also used to exploit any excess thermal power remaining after the absorption of heat for district heating. The heat exchanger, generally called waste heat boiler, consists of a single convective exchange unit, operating between fumes temperatures of approx. 500-550 °C down to a temperature of approx. 200 °C. However, since the EAF process generates heat loads which are not constant over time (scrap melting, liquid steel refining and superheating, tapping, EAF preparation), the fumes temperature has a significant variability over time. In any case, the system is designed to operate within a wide range of temperatures and flow rates. It is essential to consider that the new heat recovery system is fully integrated with the meltshop unit and has no influence on the steel production process of Ori Martin. It is installed in parallel to the existing primary off-gas cooling system with water cooled ducts and quenching tower and the commissioning of the plant was done without production stoppages of the process. It must be considered that the Ori Martin steel mill in Brescia can operate continuously. The steam generated by the recovery system will be available during this period of production, therefore excluding furnace stops and the periods in which stops are planned for ordinary and extraordinary maintenance. Since the recovered energy is used by the district heating network of A2A (the electric power and gas distribution company serving the district) and the ORC module, it is assumed that this energy will be fully utilized for such applications. The installation of an additional heat exchange unit with the purpose of dissipates the surplus of energy recovered by the heat recovery system compared to the energy absorbed by the two users is considered.

Fig. 4 - The new iRecovery system.

iRECOVERY SYSTEM DESCRIPTION

The system essentially subtracts the residual thermal energy of off-gas coming out from the new EAF Consteel® and produces saturated steam which will act as fluid media to transfer the energy recovered to the two main users: the first is the district heating network of A2A, the second is an ORC turbo-generator for the conversion of thermal energy into electrical energy. The recovery of heat and its transfer to the users is carried out according to a continuous cycle where water, coming from the degasser, evaporates into the Waste Heat Boiler, cools down in the heat exchangers of the users and then is sent back in the form of condensate to the degasser, thus closing the thermal cycle. With the aim to optimize the energy recovery process, the system has been designed also considering the possible contribution of energy from the billets preheating furnace.

The system is basically divided into five sections:

- **Heat recovery section**, starting from the new off-gas duct, in parallel to the existing off-gas duct to the Quenching Tower, which branching from the refractory lined underground tunnel (upstream of the Quenching Tower), conveys the hot fumes in the heat recuperator, Waste Heat Boiler, and then conveys them to the primary existing off-gas line downstream of the Quenching Tower.
  On this duct, the following equipment is foreseen:
- a Venturi meter for measuring the off-gas flow rate;
- two dampers, one cut-off damper installed upstream of the recuperator and the other for flow rate control installed downstream;
- a cut-off damper downstream of the quenching tower in addition to the existing flow rate control one.
  In case of recovery system blockage or in case of excess of energy recovered, the damper downstream of the recuperator is closed while the damper downstream of the quenching tower is opened so as to completely stop the flow of the off-gas through the recuperator and divert them to the quenching tower. The Waste Heat Boiler consists mainly of a steam generator with natural circulation water tube bundles fitted with:
- casing, namely the fumes flow chamber that contains the convective heat exchange units; it develops horizontally in the fumes flow direction;
- evaporators consisting of bundles of vertical tubes crossed by the off-gas inside which the water (liquid phase) coming from the steam drum undergoes a partial evaporation;

- steam drum which consists of a cylindrical pressure vessel installed above the recuperator in which the liquid water is in balance with the steam. From the bottom of the steam drum come out both down take pipes that go to the evaporators and the upwards pipes coming from the same evaporators;
- economizers consisting of bundles of vertical tubes crossed by the off-gas inside which water is coming from the degasser. In the economizers, water changes from the temperature of about 105°C, to a temperature close to the boiling point, at a defined pressure, in the steam drum; thanks to the economizers the temperature of the off-gas coming out from the evaporators can be further reduced;
- automatic cleaning system of the recuperator that allows the cyclical separation of dust deposited on the surfaces of the exchange units inside the heat machine;
- dust extraction system to collect and convey the dust separated in the recuperator up to a storage bin.

Fig. 5 - The new iRecovery system, heat recovery section.

- **Heat exchange section with A2A district heating system,** where the steam coming from the steam accumulation section is transferring, by condensing, its energy to the water of the district heating grid of A2A thanks to a heat exchange unit consisting of two condensing heat exchangers operating in parallel, a flash tank inside of which all the condensate is conveyed, and an additional condenser which condenses back the flash steam bringing it in exchange with the same district heating water. This system not only recovers the re-evaporation heat of condensate that would otherwise be lost into the atmosphere, but it also provides a pre-heating of the district heating water before being sent to the two heat exchangers. All the condensate in the tank is then subsequently sent to the degasser through a booster pump group.

Fig. 6 - The new iRecovery system, A2A exchange section.

- **ORC section** for converting the recovered thermal energy into electrical energy. Consists essentially in a turbo-generator with Organic Rankine Cycle that using the steam from the recovery section converts the recovered heat energy into electrical energy.

Fig. 7 - The ORC turbo-generator (by courtesy of Turboden).

- **Water supply section,** composed of a thermo-physical degasser with turret which carries out a dual role: the first is to ensure continuity of supply to the recuperator in case of non-supply of make-up water; the second is to degas the make-up water, i.e. to allow the elimination of gases dissolved in it.
  The degasser is composed of two elements:
  - a feed water tank consisting of a horizontal cylindrical tank in which water is stored, this, thanks to the direct injection of steam, is kept at a constant temperature of 105 °C. At the same time the tank collects the condensate from the drainage line and the condensate coming from the users;
  - a deaerator that heats the make-up water which is entering in the system at a temperature such as to allow the separation and elimination of the gases present, and in particular carbon dioxide and oxygen that are the most determining agents for the metallic corrosion phenomenon.

  The water in the degasser is drawn from a group of feed pumps and transferred to the steam drum of the recuperator; the pump group is provided with a level control valve that has the task to regulate the flow of water depending on the level of water in the steam drum.

- **Steam pressure accumulation and reduction section.** The steam produced by the recuperator is conveyed to a steam accumulator whose function is to accumulate the thermal energy. In its outlet, on the delivery lines to the users there are some thermal expansion valves whose purpose is to reduce and to ensure the steam pressure at a value below the pre-set value. Furthermore, between the steam drum and the accumulator there is a valve that prevents that the pressure in the steam drum falls below a predetermined value.
  The system allows meeting three basic requirements:
  1. accumulate the recovered thermal energy and release it to the users in the opposite case of no or insufficient energy from the recovery. In this way it is possible to keep the energy transferred to the users at a value roughly constant at around the average value of a complete casting cycle;
  2. ensure a reduction of the heat load transferred to the users in a smooth manner in accordance with a predetermined ramp in the event of a sudden stop or failure of the recovery system or of the electric furnace that would tend to reduce and stop in a very quick way the heat delivery to the users.
  3. make as much stable as possible the steam pressure in the steam drum when the thermal load of the fumes varies, which on the contrary is variable and fluctuating in time.

  The accumulation of steam exploits the well-known "flash steam" phenomenon: the lowering of the pressure on a liquid mass at the saturation temperature causes boiling and a rapid steam generation to the detriment of its internal energy.
  The capacity of the tank to accumulate steam and therefore to store the thermal energy thus depends on the quantity of the liquid contained in it and on the pressure difference that is established between the interior of the tank and the downstream user. It is possible to define two work phases for the steam accumulator:
  Accumulator charging phase
  Until the steam demand is less than the generated steam, the pressure inside the accumulator increases and consequently also the temperature. The tank is loaded until the entire system does not reach the maximum pressure and temperature design values.
  Accumulator discharging phase
  If the removal of the steam is greater than that generated, the internal pressure of the accumulator drops. This results in a flash evaporation of the liquid which results in steam available for the users.

PERFORMANCE AND RESULTS

Considering the first period of operation from the start-up of the new Consteel® EAF, followed by the commissioning and start-up of the iRecovery® system, the analysis of the operative data shows the good performances already reached by those two integrated systems.

Fig. 8 - The new revamped Consteel® in operation, tapping phase.

The performances of the new Consteel® EAF are measured calculating a cost index that considers energy and media consumptions: the expected reduction of more than 8% of this cost index compared with the previous average values is confirmed. As additional performance figure, the productivity of the furnace is increased by more than 13%, exceeding all the expectations and reaching outstanding reference value in the production of steel via electric arc furnace.
The performance figures mentioned above are the average of a long production period starting from the start-up of the furnace: further developments and continuous improvement are still ongoing to exploit the high potential demonstrated by the system to exceed the expected values. This kind of approach of considering the performance management in the long period proves the commitment of Tenova in this innovative project and the intention to give performance figures consistent with the real operating conditions of the plant and not relative to a short sequence of heats.
The operation achieved with the new Consteel® is the base to arrive at the expected performance of the iRecovery system to recover thermal energy from the primary off-gas in the order of 90 kWh/tgb and more that will be available for the district heating and, during summertime, for the ORC turbo-generator.

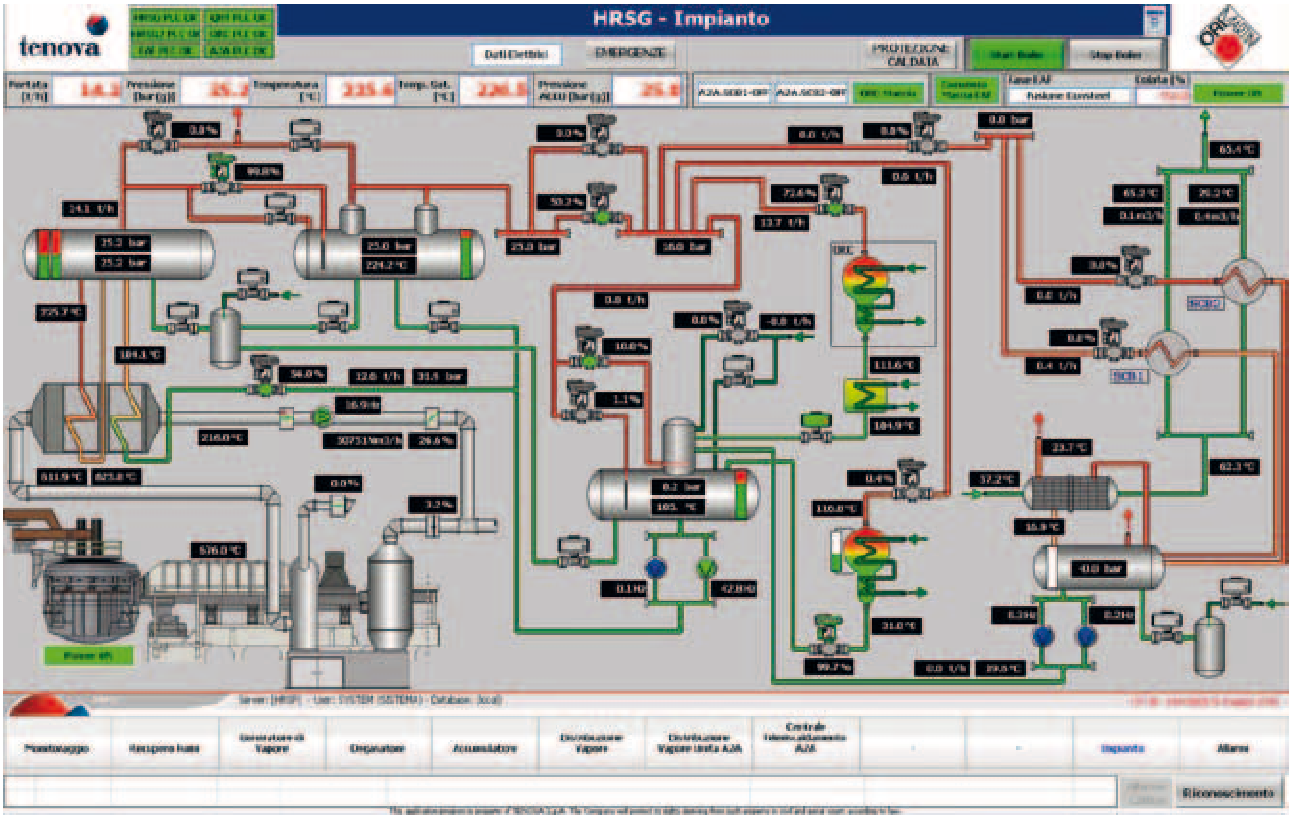

Fig. 9 - The new iRecovery® system in operation, HMI interface.

The thermal power exchanged with the district heating is flexible according to the thermal load generated by the off-gas exiting the Consteel® EAF. With an important and continuous commitment to reach the plant tuning during commissioning period, the steam flow rate can be controlled based on the average thermal load of the fumes and can be kept uniform over time due to the thermal buffer of the steam accumulator.

Fig. 10 - The new iRecovery system in operation, off-gas temperature cycle in a sequence of representative heats.

After the first period of operation, the average results of the iRecovery® system during several consecutive and representative sequence of heats show that the amount of energy recovered from the off-gas and transformed in thermal energy ready to be used is in line with the expected results. Considering the overall integrated system of Consteel® EAF and iRecovery®, comes out the outstanding performance in the steel production scenario.

The new Consteel® EAF and the new iRecovery® results now fully integrated and the operation of the whole system is steady and consistent and gives to ORI Martin the opportunity to exploit a new additional lever for a more flexible and efficient operation of the plant. The excellent potential demonstrated by the system drives for further development for the optimization of the performance and costs in any different scenarios.

In conclusion, the revamping and optimization lead Ori Martin to be one of the most flexible, efficient and environmentally friendly steel meltshop in the World.

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Modern electric arc furnaces: technologies to exceed the new market requirements

a cura di: Mauro Milocco, Alejandro Puppat - SMS group SpA

KEYWORDS: EAF - STEELMAKING - SUSTAINABILITY - EFFICIENCY - TECHNOLOGY

INTRODUCTION

As one of the largest OEM supplier for the steelmaking industry, German based SMS group, together with its worldwide subsidiary, including Italian company SMS group S.p.A., is driving the business into its new direction made of limited profit, unfair market trade and unstable environmental and regulation conditions which negatively affect the performances of the steelmakers globally.

Specifically for the EAF steelmaking route, in our position of supplier, we can help the market by:

- Designing equipment able to create profit regardless input material, being this any kind of steel scrap or DRI/HBI or HotMetal, also adapting to non-continuous operation;
- Designing equipment or part of it that optimize resources by reducing consumption or by using waste energy in a profitable manner, including reducing workforce, especially in dangerous areas;
- Designing equipment that have initial investment cost that allows fast ROI in an environment which does not allow for the 10-15years investment we have been used to;
- Understand the different needs of the different markets and adapt to it, applying anyhow what we learn in a field or market area to all of our Customers;
- Realize software that helps Customer optimizing their everyday job, being this production, maintenance or planning, everywhere in their plants moving towards a deep digitalization (aka industry 4.0).

As in next years steel scrap availability will grow at a rate just slightly higher than production (see table for EU27 respectively 0.9% vs 0.8%), and the EAF route becomes more profitable and flexible in an environment which requires production continuously adapt to the market demand, the EAF will have to adapt itself to different and flexible raw material inputs.

THE SMS GROUP APPROACH ON FURNACES

In the past 15 years, the SMS group, besides standard scrap EAFs, has supplied 24 furnaces with alternative input process raw material: 7 Cold/Hot DRI/HBI up to 100% of the charge, 7 Hot Metal up to 80% of the charge, 5 mixed Hot Metal and DRI/HBI, 4 Conarc® furnaces which combine the economy of a converter with the flexibility of the EAF working with HotMetal and scrap mix and 2 scrap pre-heating furnaces. The experience gained is helping the industry in setting new, more flexible, efficient routes to obtain crude steel products, pushing the technological envelope for modern EAFs. Below is a general approach when it comes to initial design of melting unit based on input material. This general approach is anyhow, as stated above, shifting in favour of EAFs with traditional design but optimized for different charges.

Fig. 1 - SMS EAF input material approach

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EFFICIENT USE OF CHEMICAL AND ELECTRIC ENERGY

Depending on the local cost of electric energy and natural gas, as well as on the required productivity of the EAF, amounts of electric energy are substituted by chemical energy via oxygen-gas burners and oxygen lances. For this purpose SMS group has, over the years, developed and continuously improved two different families of burner: the CONSO® and SIS® systems, which have been optimized respectively for scrap-based EAF and for flat bath operations as in continuously charged scrap, DRI/ HBI or in Hot Metal charged furnaces. The CONSO® design has been optimized for the distribution of natural gas and secondary oxygen with the latter surrounding the first in two concentric layers on a large surface. The flame, of up to 8 MW power, is therefore very efficient in flame generation, and thus in scrap preheating. Every burner can also be used, via a de Laval nozzle, for supersonic oxygen injection with shrouding effect from a lower power flame. Thanks to its unique design, the SIS® system ensures a fast decarburization during the flat bath phases. This thanks to a high-tech supersonic oxygen de Laval nozzle design. Its contour has been developed using the characteristic method, a special mathematical calculation which results in a unique bell-type. During the injector mode, the supersonic oxygen flow is supported by shroud gas for maximizing oxygen outlet velocity and efficiency. This special burner constitutes a highly economical integrated device: instead of using expensive industrial oxygen, natural gas is burned with conventional compressed-air, generating a hot air shrouding flow. This cuts costs for generating the shrouding gas by more than 70% with respect to conventional solutions.

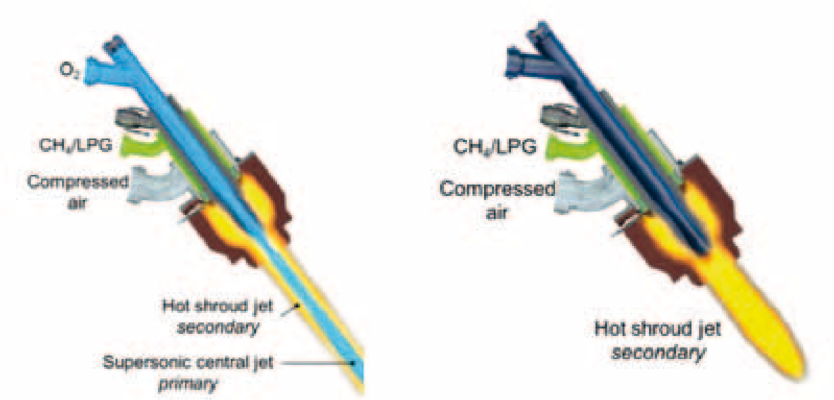
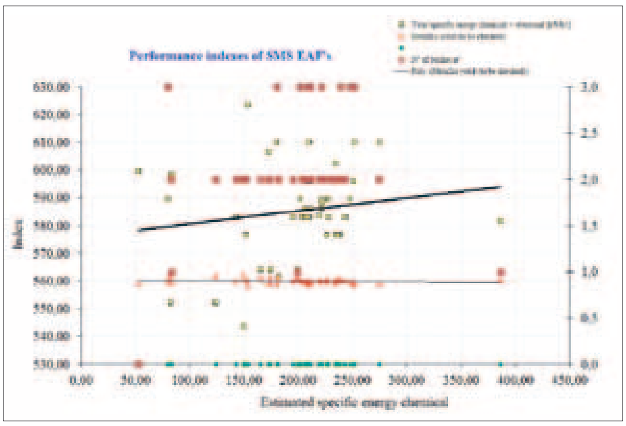
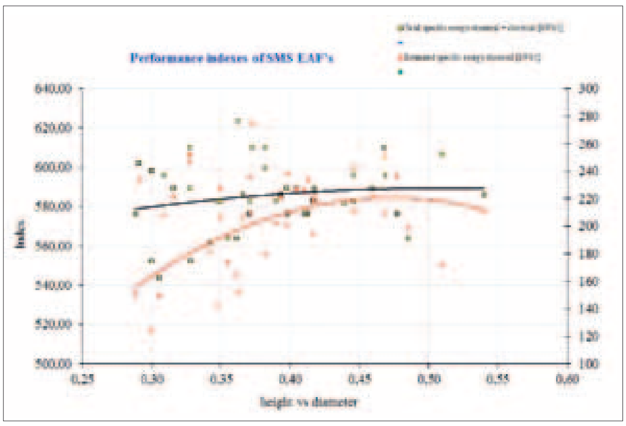


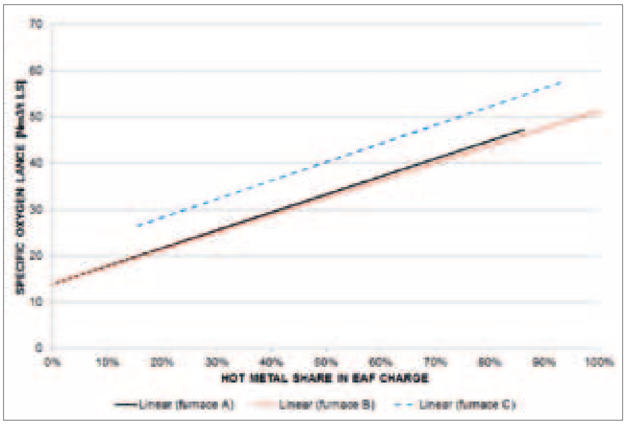
Fig. 2 - SMS SiS® Hot Gas shrouding technology

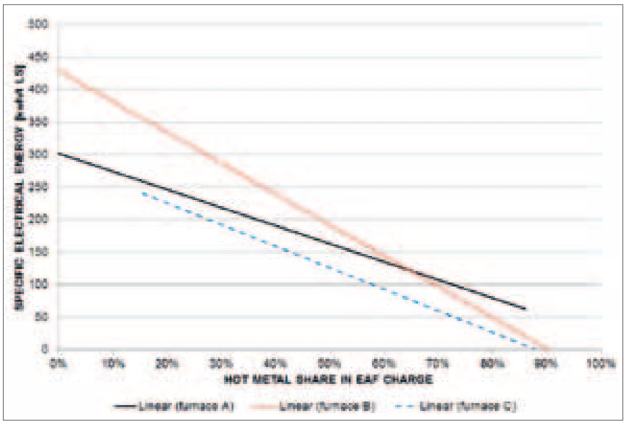
During design phase the technical solution to choose is evaluated on above mentioned factors. Regardless the conversion cost it is interesting to notice that, based on the analysis of the data for the last 20 years, there is quite a scattered graph for the total specific energy performance on specific energy chemical. This confirms that there is a tendency for the chemical energy to be lost in the fumes rather than being conveyed to the scrap/steel, and this is quite regardless the number of bucket as confirmed by graph below. Changes in this field are mainly in the ratio height/ diameter of the upper shell which, anyhow, shows that there is margin to reduce the chemical input on high furnaces (mostly single bucket ones).





Results of Electric Energy input and Chemical Energy input In hot metal furnaces recently supplied by SMS group are depicted in following graph.





INNOVATIVE EAF TECHNOLOGIES FOR THE FUTURE - AFERPI-Piombino future

As said each EAF has to be designed according the raw material input available or planned to be available in future for the specific plant. Beside optimizing the design of the "traditional EAF" based on the requirements, the SMS Group has always looked for innovative ideas to improve the furnace process based on raw material input and available energy. In the last few years examples of this vitality in R&D find its answers in the already briefly described and proven technology of the Conarc®, in the ShArc furnace and the Primary energy melter (PEM).

ShArc stands for Shaft Arc Furnace and is the latest patented shaft technology from the SMS Group for scrap preheating via exhaust fumes enthalpy. The ShArc is a DC furnace charged via two dedicated scrap buckets which discharge into dedicated preheating chambers which then discharge into the steel bath. It can also be charged with a mix of scrap and HBI, the latter through a dedicated port, up to 30%. The advantages are the lower electric energy consumption (down to 280 kWh/t) with a shorter tap to tap time thanks to the best known preheating technology for scrap. The pre-heated scrap can be isolated from the steel bath in order to allow homogenous superheating of the steel and decarburization. The downstream fumes practice meets the latest best available techniques to comply with regulations concerning dust and dioxin emissions.

It shall be mentioned that the ShArc is the technology choose for the new installation at AFERPI-Piombino plant thanks to its energy savings and green technology. In the specific case of AFERPI, the Italian government, trough EU Commission, has already authorized more than 90 Mio€ in 5 years of "White Certificates" for the utilization of the SMS Group technology.

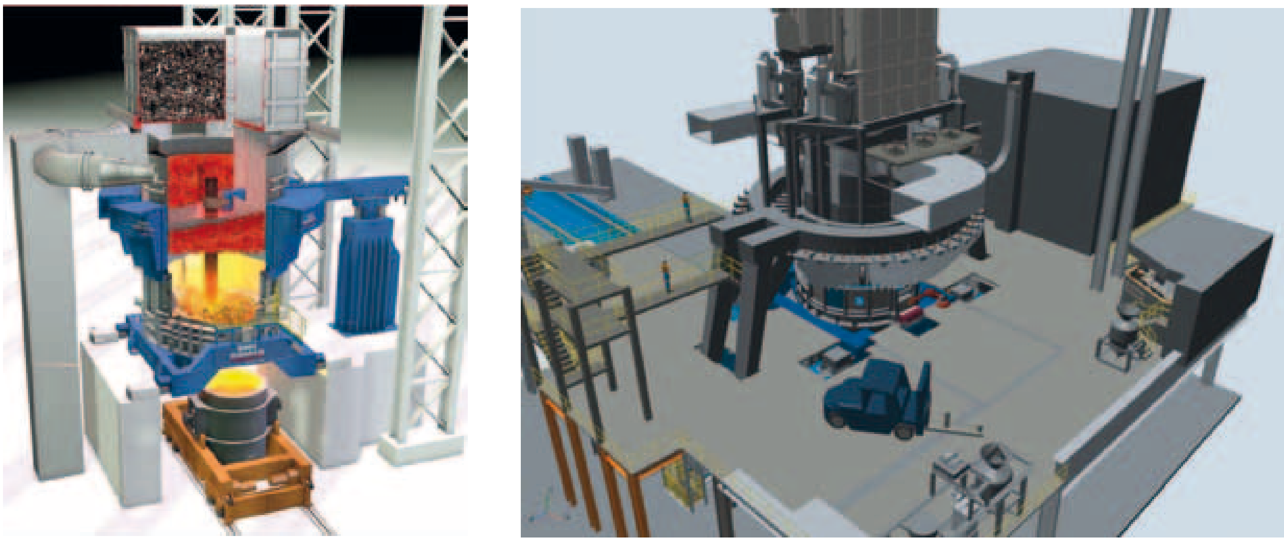


Fig. 3 - SMS Shaft Arc Furnace ShArc and AFERPI Basic layout

INNOVATIVE EAF TECHNOLOGIES FOR THE FUTURE - The PEM

The basic idea of the PEM process is to use directly primary energy instead of electricity to smelt the scrap. The target is to feed the required thermodynamic minimum energy value for preheating and melting (360 kWh/t) using primary energy and the energy for superheating (35 kWh/t) using electricity in EAF. Energy losses through the electric power generation and transmission

are minimized and the overall CO2 emissions are reduced by more than 30 %. Therefore the PEM process is predestined for areas with limited electrical power availability or limited electricity grid stability. The PEM is a shaft furnace charged with scrap continuously from the top via a sluice by a conveyor belt or a skip. The melting takes place in the lower parts of the shaft by burning natural gas injected all around the shaft axis. The scrap preheating uses the counter flow principle resulting in minimum overall energy consumption. The melted material is continuously transferred into the EAF via a short chute.
ArcelorMittal and SMS group have built a first pilot scale PEM located at the Gent steelworks to increase the hot metal offer for the BOF. Hot commissioning started at the end of 2014 and now both partners are ready to step to industrialization scale.

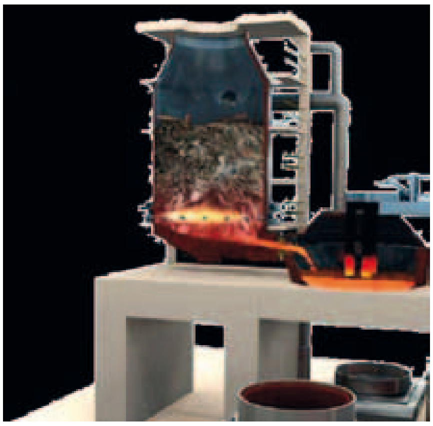


Fig. 4 - SMS group PEM, Primary Energy Melter

INNOVATIVE EAF TECHNOLOGIES FOR THE FUTURE - Fixed Roof EAFs

Furthermore, the SMS Group has worked to design a furnace specifically optimized for the upcoming demand of continuously charged HBI/DRI and hot metal. The outcomes are two concepts, results of the patented design for a fixed roof EAF, each with its peculiarity. The Arccess S/EAF, which stands for Steady EAF, is optimized for continuous DRI/HBI charge as well as hot metal charge. It aims to increase even further the advantages of the Conarc® furnace by having proper supersonic oxygen decarburization from the fixed roof, reducing the energy dissipation of the upper shell and furnace roof which typically accounts for >15% total energy input. It also has a patented design for the continuous slipping and elongation of the electrode under power-on that, combined with the lower shell design and tapping solution, results in a continuous operation under power-on with advantages in energy savings, electrical substation and especially productivity. A continuous power-on operation can increase productivity for an EAF by 30% or reduce the size of the furnace by 25% for the same productivity. Furthermore, continuous operation is the perfect match for the already described off-gas energy recovery system.

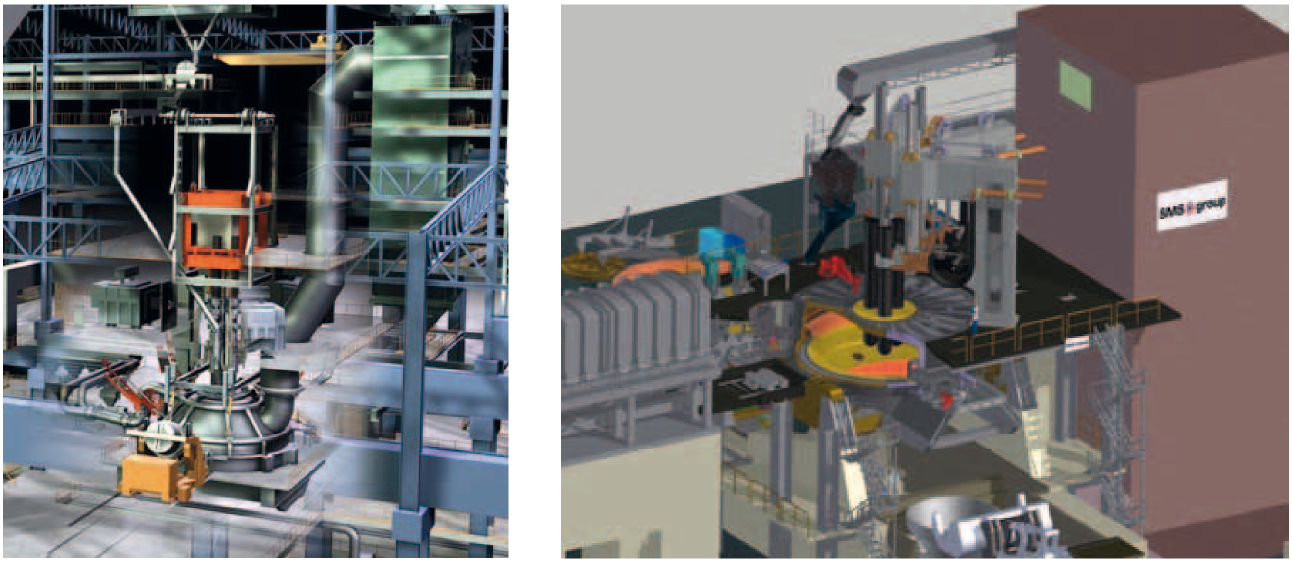


Fig. 5 - SMS S/EAF Furnace and SMS ConMelt Furnace

The second outcome of the fixed roof patent is the ConMelt EAF. This concept is optimized for brown field installations and continuous DRI/HBI or scrap feeding. Its compact layout fits in a standard EAF layout of same capacity, even if the general layout is different and makes it look and feel like a LF due to its fixed roof at the same level as the walking platform. The absence of an upper shell with big development of water-cooled panels, the reduced dimension of EAF roof and the precise energy input control, all help reduce total energy consumption by >15%. The layout is a step further towards the concept of a completely remotely-controlled furnace with no operators involved in dangerous operations. For the Conmelt EAF, SMS developed a concept of a hydraulic free EAF by replacing all hydraulic actuators by electric drives. Of course, the hydraulic free furnace operation can also be applied to a standard EAF, helping to cut the maintenance costs at investment costs comparable to actual hydraulic solutions.

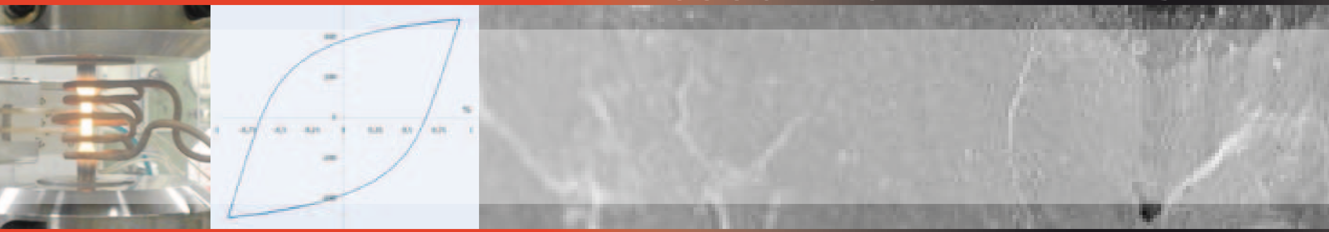
CONCLUSIONS

In the last two decades the EAF technology has been optimized to accept any kind of raw material available and has further adapted as new technologies had become available or sustainable. The EAF is quite a flexible machine in its simplicity but has to be designed taking into account the whole of the experiences gained so that the envelope is always pushed a bit forward.

Furthermore, for specific case, special designed furnaces may substitute the traditional scrap based EAF like in the case of the upcoming Aferpi-Piombino plant in Italy where one of this technology will be soon on stream.

By the continuous research of better solutions for electric steelmaking, a further optimization of the base concept of the EAF is taking place: the new designed EAF are helping the workhorse of steelmaking becoming better and better!

ASSOCIAZIONE ITALIANA DI METALLURGIA



Corso

Tenacità e resistenza a fatica dei materiali metallici

Milano, 6-7 giugno 2017

Centro Congressi Fast

Co-organizzato dal Centro di Studio
Metallurgia Fisica e Scienza dei Materiali
della

ASSOCIAZIONE ITALIANA DI METALLURGIA

e da

Ordine degli Ingegneri della Provincia di Milano

Le proprietà di tenacità e di resistenza a fatica dei materiali risultano fondamentali per l'integrità di componenti e strutture soggetti a carichi statici o dinamici, nei diversi ambienti in cui questi si trovano applicati. Le esperienze acquisite durante le più svariate condizioni di esercizio hanno messo in luce, nell'ambito della progettazione di organi meccanici, la necessità di una profonda conoscenza dei fenomeni annessi a queste due proprietà: dal punto di vista del materiale adottato o previsto, la microstruttura, la composizione chimica, il processo produttivo con cui il componente è ottenuto e la presenza di difetti sia superficiali sia interni, tipicamente collegati ai processi e alle lavorazioni che il materiale subisce, influiscono in maniera decisiva sulle prestazioni del componente, sia in condizioni normali che critiche di lavoro. Per questo motivo l'Associazione Italiana di Metallurgia propone un corso di base, volto ad illustrare i diversi aspetti della tenacità e del comportamento a fatica dei metalli. Il corso si articola in due giornate, la prima delle quali è dedicata ai principi di base, mentre la seconda all'influenza, sulle proprietà considerate, di ambienti e condizioni di carico particolari quali le alte temperature, gli ambienti corrosivi, le condizioni di fatica termica. A loro volta, ognuna delle due giornate viene strutturata in modo da affrontare gli aspetti più teorici durante la mattinata e quelli più sperimentali e applicativi nel pomeriggio, con interventi su casi particolari di materiali metallici di interesse industriale nella parte finale del corso. Il corso, alla sua quarta edizione, è rivolto a ricercatori, progettisti e tecnici operanti nel campo delle strutture metalliche e componenti funzionali in acciaio o leghe non ferrose, interessati ad approfondire gli aspetti legati alla corretta scelta del materiale, alle sue lavorazioni ed al trattamento superficiale per ottimizzarne il comportamento in esercizio e migliorare affidabilità e sicurezza delle strutture. Ai partecipanti al corso verrà distribuito il volume: "Tenacità e Resistenza a Fatica delle Leghe Metalliche" edito da AIM. I partecipanti potranno richiedere Crediti Formativi Professionali riconosciuti dall'Ordine degli Ingegneri della Provincia di Milano.

Coordinatore del Corso: Riccardo Donnini - ICMATE-CNR (Consiglio Nazionale delle Ricerche)

Per informazioni ed iscrizioni: Segreteria AIM · tel. 02 76021132 · met@aimnet.it

www.aimnet.it

#corso #formazione #tenacità #fatica #materiali #prove

Comunicato stampa SGL GROUP

a cura di: SGL Group - The Carbon Company

SGL lascia il business degli elettrodi di grafite per acciaieria e di conseguenza con l'acquisizione dello stesso, SDK punta ora a diventare un leader globale nell'industria degli elettrodi di grafite attraverso la definizione di una piattaforma competitiva di costi nelle tre regioni chiave, Europa, Stati Uniti, Asia, con la produzione a livello mondiale di elettrodi di grafite della più alta qualità.
Si riporta di seguito il comunicato stampa di SGL GROUP, sulla firma dell'accordo.

SGL Group signed agreement to sell its graphite electrode business to Showa Denko (SDK)
On October 20th, 2016 SGL Group signed the sale and purchase agreement to sell its graphite electrode (GE) business to Showa Denko (Japan). The two parties have agreed on an enterprise value (cash and debt free) of 350 million euros, which, after deduction of standard debt-like items (mainly pension and restructuring provisions) results in cash proceeds of at least 200 million euros. The final proceeds will be determined based on the balance sheets at closing. The transaction is subject to customary closing conditions, relating in particular to antitrust approvals. Closing is expected in the first half of 2017.
"Showa Denko is the ideal new owner for our graphite electrodes business. Both companies enjoy a high reputation in the market and assign great importance to the quality of their products. The combined business will be well positioned to serve customers on a global basis", said Dr. Jürgen Köhler, CEO of SGL Group. "The transaction is an important milestone for our strategic realignment. We will now be focusing our resources fully on our growth areas Composites - Fibers & Materials (CFM) and Graphite Materials & Systems (GMS) taking advantage of three megatrends mobility, energy supply, and digitization."

"Showa Denko and the graphite electrodes business of SGL are truly well-matched", says Hideo Ichikawa, President and CEO of Showa Denko. "Through this transaction, SDK aims to become a truly global leader in graphite electrode industry by establishing a cost competitive platform in all three key regions, Europe, the U.S., and Asia, and by producing the highest quality graphite electrode globally."

Showa Denko is one of Japan's leading chemical companies. In the fiscal year 2015, Showa Denko generated sales of 781 billion yen (6.8 billion euros) and an operating income of 34 billion yen (0.3 billion euros). The company employed a workforce of 10,561 at the end of 2015.

Following the closing of the transaction, approximately 900 employees and six production sites in Germany, Austria, Spain, USA, and Malaysia will be transferred from SGL Group to their new owner.

The sale will result in impairment charges of 40-50 million euros in the current fiscal year of SGL Group, which are related to transaction costs and the continuation of the GE business until the closing date. The cash proceeds equal the book value as of September 30, 2016. Thus, the transaction does not trigger any write-downs on the book value in the GE business. To maximize proceeds, the CFL/CE business, which is also part of the business unit PP, will be sold separately, with the sales process to be continued in early 2017. Given the outcome of the GE sale, SGL Group is now confident to achieve more than the book value of the former business unit PP in the aggregated transactions. SGL Group is convinced that the proceeds of the GE sale and the expected proceeds of the CFL/CE sale will contribute to a significant reduction of the Group's net debt position and thereby improve the balance sheet ratios. In addition, the company is currently evaluating the merits and viability of a potential near term rights issue utilising the existing authorized capital framework to further improve the capital structure and restore key financial metrics to create a solid foundation for our growth businesses CFM and GMS.

Against the backdrop of the disposal procedures for the GE and the CFL/CE businesses, the measures to adjust the administrative structures to a smaller SGL Group following the entire PP disposal, and the related other transitional matters in connection with the repositioning of the SGL Group to focus on its growth businesses CFM and GMS, the company decided to withdraw its guidance as provided in its report on the first half year 2016 with immediate effect, and to abstain for the time being from providing any short term profit guidance during this transformation phase. SGL Group plans to resume providing a new profit guidance around the time of the publication of its 2016 annual report in March 2017.

About SGL Group - The Carbon Company

SGL Group is one of the world's leading manufacturers of carbon-based products and materials. It has a comprehensive portfolio ranging from carbon and graphite products to carbon fibers and composites.

SGL Group's core competencies are its expertise in high-temperature technology as well as its applications and engineering know-how gained over many years.

These competencies enable the Company to make full use of its broad material base. SGL Group's carbon-based materials combine several unique properties such as very good electrical and thermal conductivity, heat and corrosion resistance as well as high mechanical strength combined with low weight. Due to industrialization in the growth regions of Asia and Latin America and increased substitution of traditional with innovative materials, there is a growing demand for SGL Group's high-performance materials and products. Products from SGL Group are used predominantly in the steel, aluminum, automotive and chemical industries as well as in the semiconductor, solar and LED sectors and in lithium-ion batteries. Carbon-based materials and products are also being used increasingly in the wind power, aerospace and defense industries.

With 40 production sites in Europe, North America and Asia as well as a service network covering more than 100 countries, SGL Group is a company with a global presence. In 2015, the Company's workforce of around 5,700 employees generated sales of €1,323 million. The Company's head office is located in Wiesbaden.

About Showa Denko

Showa Denko K.K. (SDK), which was established in 1939, is one of Japan's leading chemical companies.

The Showa Denko Group had annual consolidated sales of 781 billion yen in the year ending December 2015, and consists of 151 companies with more than 10,000 employees worldwide. SDK Group's business portfolio includes six segments; Petrochemicals, Chemicals, Electronics, Inorganics, Aluminum, and "Others" including materials for lithium-ion batteries. Based on its inorganic, metal and organic chemical technologies, the SDK Group provides individualized products in various areas including energy/environment, electronics, and basic materials for industrial use. Aiming to become a company contributing to the sound growth of society where affluence and sustainability are harmonized, SDK continues providing society with useful products and services.

ASSOCIAZIONE ITALIANA DI METALLURGIA

Giornata di Studio

Foundry 4.0

La digitalizzazione in fondería

Controllo di processo e i costi della non qualità

Bergamo, 23 marzo 2017

Parco Scientifico Tecnologico Kilometro Rosso

Organizzata da

COMITATO TECNICO
PRESSOCOLATA

Sull'onda del progetto Industry 4.0 in Germania, l'Italia ha sempre reagito negli anni trascorsi con entusiasmo e concretezza espressa dalle singole imprese sino alla recente emanazione del Piano Nazionale Industria 4.0 del Governo Italiano. Le tecnologie abilitanti sono ben note in molti ambiti industriali dove la digitalizzazione del processo è sempre stato un prerequisito fondamentale per l'elevata automazione e virtualizzazione.
La pressocolata, fra tutti processi di fonderia, rappresenta il processo più adatto, nonostante la complessità, ad un intenso monitoraggio dei parametri di processo. Molti parametri sono già oggi controllati ma i diversi "attori" che costituiscono l'isola di pressocolata sono spesso gestiti da pannelli di controllo diversi e la complessità del processo impone una gestione intelligente di tutte le variabili che concorrono alla definizione della Qualità del getto, al consumo Energetico e al Costo finale del prodotto.
Se da un lato i dati di produzione e le sue performance vengono monitorati tramite dei sistemi gestionali per stimare i valori di riferimento dell'OEE, molte di queste informazioni provengono dai meccanismi al cuore della cella produttiva - oggi è possibile sensorizzare e Monitorare ogni singola fase del processo. La grande mole di dati non costituisce una conoscenza e un vantaggio se le correlazioni di riferimento non sono estratte e processate in tempo reale - oggi esistono sistemi Cognitivi in grado di prevedere la Qualità per ogni getto. La maturità e applicabilità di queste nuove tecnologie dell'era della digitalizzazione saranno discusse da rappresentanti di diverse entità imprenditoriali per comprendere assieme come trasformare la fonderia in una Fabbrica del Futuro che possiamo chiamare Foundry 4.0.
La giornata è stata suddivisa in due sessioni per consentire un approccio più tecnico e metodologico alla mattina e un dibattito manageriale al pomeriggio con l'intento di rispondere alle domande su quali siano le risorse necessarie e i passi per implementare un percorso di digitalizzazione, quale la formazione richiesta, quali gli obiettivi concretizzabili a breve e lungo termine, e come sfruttare gli incentivi fiscali e/o co-finanziamenti disponibili.

Per informazioni ed iscrizioni: **Segreteria AIM · tel. 02 76021132 · info@aimnet.it**

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#formazione #progettazione
#pressocolata #fonderia

Interview with Milocco Mauro, SMS group

Mauro Milocco graduated from Technical High School "A.Malignani" (Udine) in mechanical engineering in 1997. Enrolled first in the Air Force then served in the aerospace industry as pilot. Joined SMS group in 2006 as mechanical engineer and served also as site manager and R&D coordinator. He is now Head of Development & Product Design for Steelmaking Business Unit of Tarcento based SMS group S.p.A. He published 16 technical papers in the last years as author or co-author as well as patents.

As a boy scout, I made Sir Robert Baden-Powell's, founder of the movement, quote: "leave this world a little better than you found it" mine. I have always tried to apply this motto to my personal life as well as to my professional life and, fortunately, for the last 11 years, I have had the chance to work for SMS group in the steelmaking Business Unit, a Company where profit and eco-awareness are equal driving forces together with operative conditions for our Customers id est sustainability.

Why do you feel your present job can help steelmaking to become a better industry?

The steelmaking business has changed a lot in the last 40 years, mostly in the technologies used, and yet we will face more changes in the near future, now mainly in the concept of steelmaking industry itself, driven by a series of factors which are new to this business and the industry in general. European steelmaking is the one I personally feel has been adapting more (although not enough) to the new environment and is setting the standards for the future forced by internal (i.e. company size , location, business type, R&D approach) and external (i.e. regulations, availability and cost of raw materials and media) factors. This is why I feel so lucky to serve in the R&D department for steelmaking of the German company SMS group. With over 13000 employees worldwide, of which almost 70% located in Europe, the SMS group is one of the largest equipment suppliers worldwide for the steel industry, and being mainly European based it is in a position to take an active part in the changes the world is imposing and the market requiring to this industry.
The SMS group is today able to supply goods for the ferrous and non-ferrous metals industry and, as far as steelmaking is concerned, it supplies equipment for the whole of the production routes: Integrated, Smelting reduction, Direct Reduction and Scrap-based, from small revamps to brand new large turnkey installations. Each of the steelmaking production routes are developed at a specific Center of Competence and, while the experiences and general market approach are clearly shared between the CoC, in Tarcento (Udine, Italy), SMS group has its Electric Arc Furnace Business Unit with competences "from the gate of the plant to the CCM turret". In our aim to exceed our Customer and market expectations we tend not to act in a strict Customer/Supplier relationship but rather in a Partnership relationship, trying to understand the specific needs of each Customer and to guide the project towards the best technology available, delivering the most profitable, safe and environmentally friendly products both for actual and future needs.

You mention changes for the future of steelmaking: may you define the most representative ones in your opinion?

The future of steelmaking must be set in the light of its remote and near past. There is no need to detail the shift in technology over the last 40 years: from Thomas/Siemens furnaces, to Open Hearth, from primary Blast Furnaces to EAF with use of merely Scrap or other primary materials, the method for producing steel has changed and today Blast Furnaces and Electric Arc Furnaces remain the sole main contenders. Continuous Casting is now the standard solidification technology whilst in 1970 its share was only 8%.

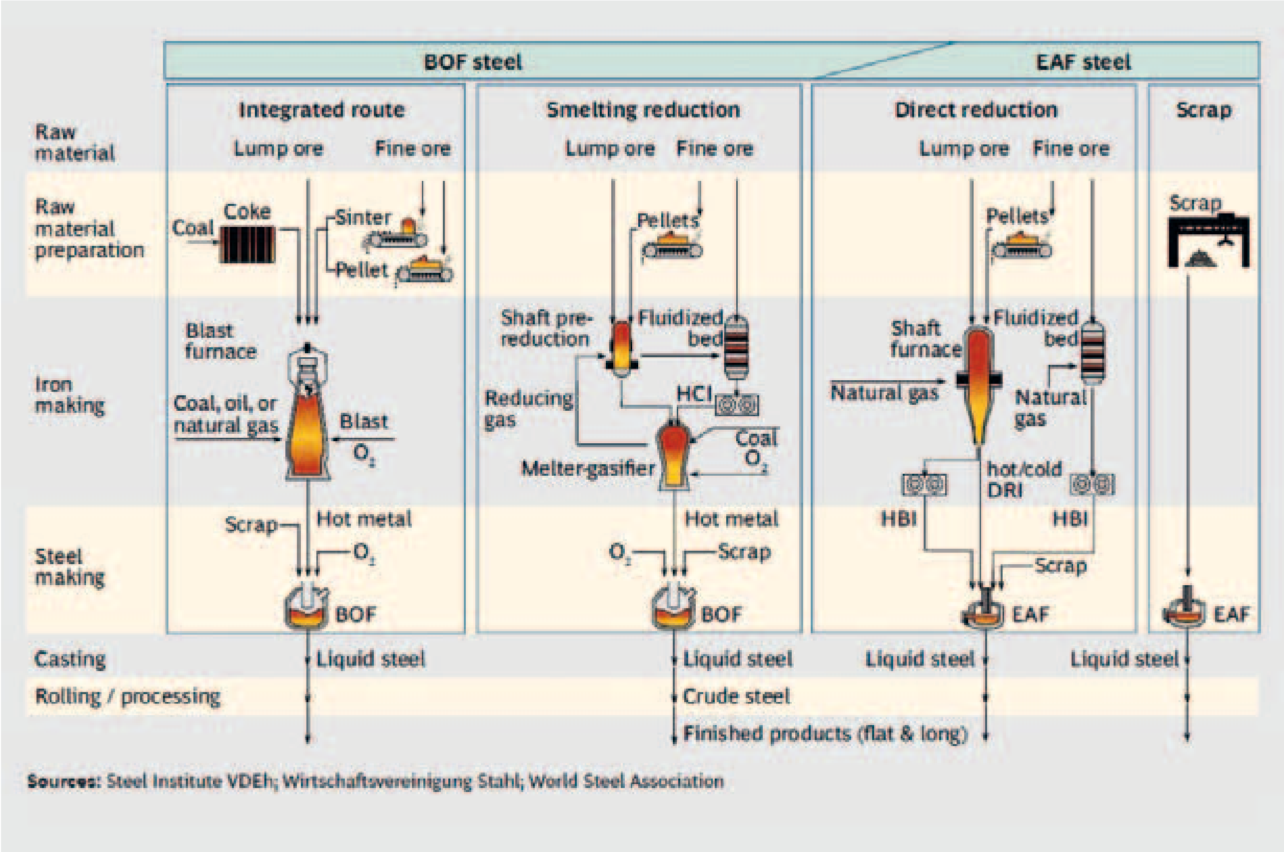


Fig. 1 - Steelmaking Routes

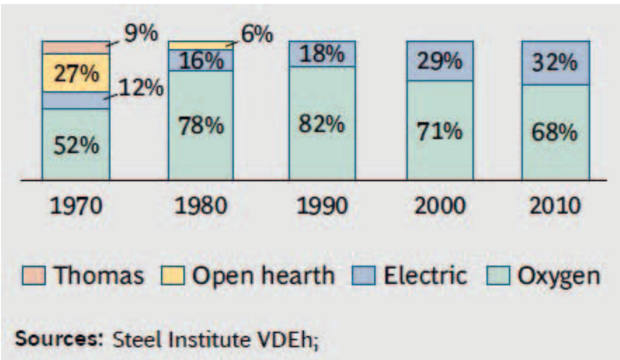


Fig. 2 - Production Method in Germany

Steel production has continuously increased up to the beginning of this decade and so has the capacity installed. During the last crisis, production was reduced as was demand. C capacity has clearly remained stable or has even increased as on-going projects were put into stream creating an overcapacity which is negatively influencing the global market (with local regulation) creating less value for the steelmakers which are more unlikely to invest in those radical changes which regulations impose to happen right now, regardless of the negative conditions. The reason for overcapacity having influenced the market so much and being the sole subject of discussion over the last few years is that, even though the industry has changed, one thing has never changed over time: this industry measures its performance solely in production ton/year. This unit of measurement has always been adopted by the industry itself and has been the number often presented to the world to demonstrate the steelmaking's impact on GDPs and employment. In my opinion, but an opinion which is fortunately spreading and which I hope every stakeholder will start sharing, the industry will begin to be measured by the value it creates with a product that comes out of the facilities. If we began considering the value, then it would be easier to present this business in a different way to public opinion too. My personal experience before starting my job in the steel industry, is that I considered this

as a polluting, old-fashioned business; a primary sector business that clearly had to exist but could not be improved so it was simply something to live with. This was only 11 years ago and since then I realized the industry was far better than I thought, with a strong preoccupation for ecological and sustainability aspects and that much had already been achieved and moreover there was more in the pipeline with skilled engineers and good local and global organizations trying to work in the same direction. Unfortunately these aspects and results are not reaching public opinion. Even worse, basically we are still aiming solely for the highest level of production every year, focusing on the production numbers of a new plant and not on increased sustainability which is possible.

About steel value already available and how to get it to the market?

Modern steelmaking already has a certain value and this is known to most of the stakeholders, but newer aspects should be considered and understood too. Not only are we by far the largest recycling industry globally in absolute terms, with 500Mt/year of recycled scrap, representing about 83% of the steel which ends its working life, but we are also looking to optimize our output of by-products to render them valuable and not dangerous, so as to become an industry of zero waste. Not only have we reduced CO_2 emissions by 25% in 25 years but we are continuously investing in R&D to reduce them to the (unfair) targets set by lawmakers. Not only are we constantly reducing accidents (-70% in the last 10 years), but we are constantly investing in training and in accident-prevention equipment. Not only are we investing in R&D to reduce raw material consumption per ton of steel produced, but we are also creating stronger and lighter steel to allow car manufacturers to deliver stronger and lighter cars which means safer and more eco-friendly…and yet recyclable at $1/6^{th}$ of the energy other materials allow.

The inherent value is there and we need to present it to the "outside world". Information and knowledge nowadays pass through the media: television and internet, with the latter being somehow more democratic but more imprecise than the former . Other industries have done a good job in presenting their value: exempli gratia commercials for new cars are always showing a green world and happy environments even though the transportation industry accounts for the largest CO_2 emissions globally. The car is a necessary commodity to the end user and one which, in my opinion, meet (almost always) the regulations set in a more realistic way than those for steelmaking. In general when buying a new car everybody thinks he has done his bit towards creating a better world thanks to the car producer alone. Even after recent scandals concerning emissions, public opinion has not changed its general mood towards the automotive industry, blaming it not for absolute "damage" but mainly for lying to the world. On the other hand, , as soon as something goes wrong at one of our plants, the media does not hesitate to depict us (again) as dangerous, polluting and out of date. Trying to fight against the media which is supported and supports public opinion at those moments is useless and we should all act continuously and well in advance on such powerful instruments, to make the world aware. Changing the general opinion the world has of the industry would help in having more precise regulations and this would allow steelmakers to have a market price recognizing the value, gaining more profit , which, as they have always done, will be re-invested in technology that will allow greater sustainability creating a Virtuous circle of sustainability.

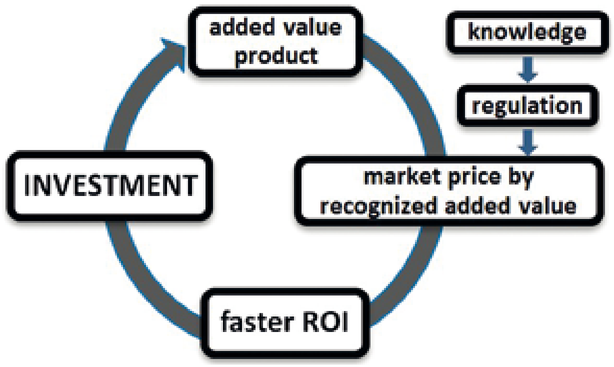


Fig. 3 - Virtuous Circle of sustainability: to begin we need a change of mindset which recognizes the value of steel

In Europe we have very good, precise studies which have reached the European Commission and have led to two important documents in the last few years centered on our industry. Unfortunately those documents did not materialize into real facts/regulations perhaps because the EU is still an agglomerate of Sovereign States, each with its own interests, rather than a Union. Furthermore, in none of those documents was the real added value of steel vs. other materials emphasized enough. The law is asking this industry to reduce Green House Emissions (GHG) by 90% by the year 2050 without looking at the support and value this industry is delivering to reduce GHG from other industries. It may be possible, by applying the best technologies available, to reach a reduction target of 15% of CO_2 by that date, as many of our processes are already very close to their physical limits. A study by VDEh and BCG shows that steel has a high emission reduction potential due to steel use in other sectors. In practice, steel would allow the manufacture of equipment that will then reduce CO_2 emissions. Considering eight of those cases, the savings realized by that equipment would account for more of the sum of the actual CO_2 and the extra one produced to realize such equipment: in practice steel would become a zero impact item in a circular economy.

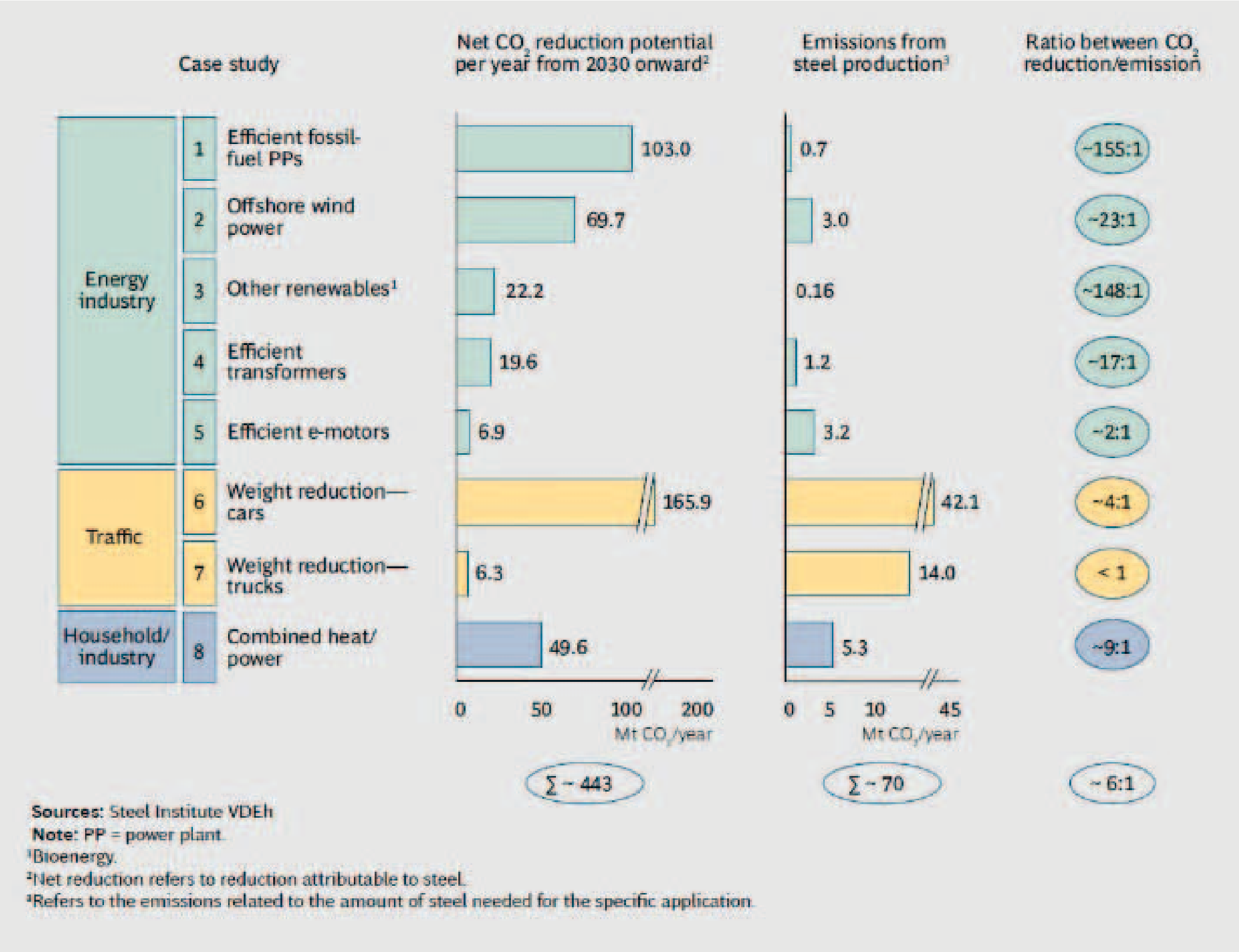


Fig. 4 - EU27 savings from 8 technologies. Net CO2 reduction 370Mt with actual emissions at 230Mt

So we are green, we are efficient and we are safe: do we only need to work on our image through media then?

No, not only. The perception of the industry must change but we have to continue implementing the best available technologies that allow this perception to be confirmed by results, developing new solutions to push the envelope even further allowing steelmakers to increase quality and reduce operational costs adapting to a changing market of raw materials.

As OEM supplier for SMS group this means, in the EAF route:

- Designing equipment able to create a profit regardless of the input material, whether a kind of steel scrap or DRI/HBI or Hot-Metal, also adapting to non-continuous operation. At SMS group we have a wide range of furnaces from 100% to 90% DRI or Hot-Metal. We also have specially-designed furnaces for DRI or HBI only (named Conmelt and S/EAF) or for scrap melted using only chemical power (called PEM, Primary Energy Melter). About this we need to make sure we spread a correct approach about savings: lower kWh/t is not always the solution that creates profit as it may hide other costs;
- Designing equipment or part of it that optimizes resources by reducing consumption or by using waste energy in a profitable manner, including reducing workforce, especially in dangerous areas. For example at SMS group we have high efficiency burners (Conso R6 and SiS4.0 families), the automatic Slag Door Condoor, anthropomorphic robot solutions in various area of the shop, tools for EBT automation, state-of-the-art Electrode regulation and water optimization solutions, Off-Gas heat recovery solutions;
- Designing equipment that has an initial investment cost that allows fast ROI in an environment which does not allow for the 10-15years investment we have been used to;
- Understanding the different needs of the different markets and adapting to them, applying anyhow what we learn in one field or market area to all of our Customers;
- Developing software that helps Customer optimize their

everyday job, whether production, maintenance or planning, everywhere in their plants moving towards a deep digitalization (aka industry 4.0).

Fig. 5 - SMS automatic slag door Condoor and robot for samplig and measuring inside dog-house at Riva Acciai Caronno

As stakeholders this means:

- pushing for regulations that reduce CO_2 leakages in a global market where not all the players have the same rules;
- pushing for further recycling of consumer steel at end of life from the present level of 83% to possibly 90-95% by designing the parts in different ways, maybe even using Additive Manufacturing technologies;
- making the steel industry attractive again for our youngest generations: this business must be welcomed as a pleasant business environment to work in as it is. At the same time we have to realize that we will need to relocate or re-instruct some of the workforce which is no longer up to the business model. In general we need to invest in training;
- acting together towards changing "the marketing" of our product: steel is far more green than many other everyday-use goods and the world has to realize this.

Together we will be able to change ourselves and deliver a better industry to future generations creating a value again in what we make, after years in which tertiary business had become, unfortunately, the model to follow.

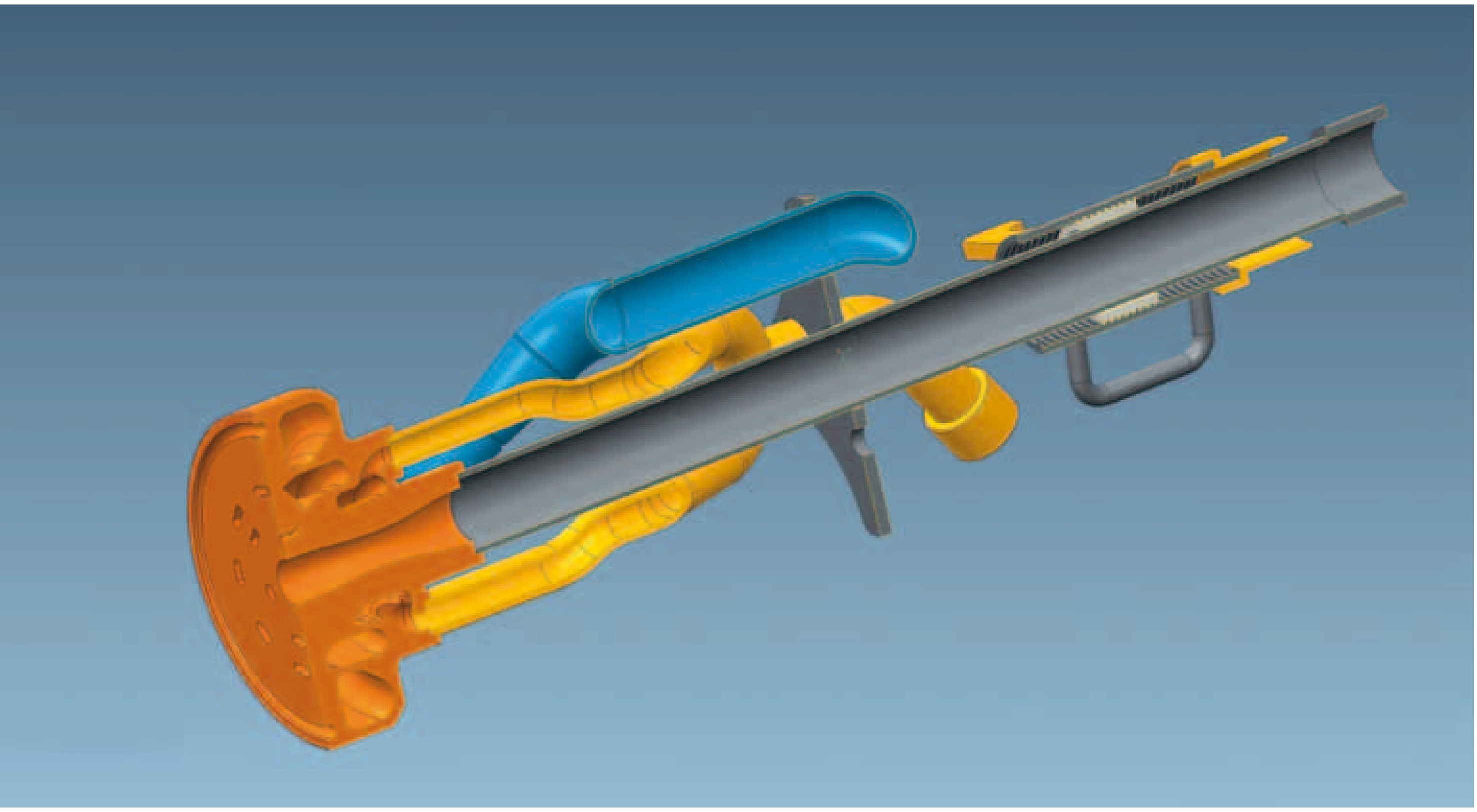
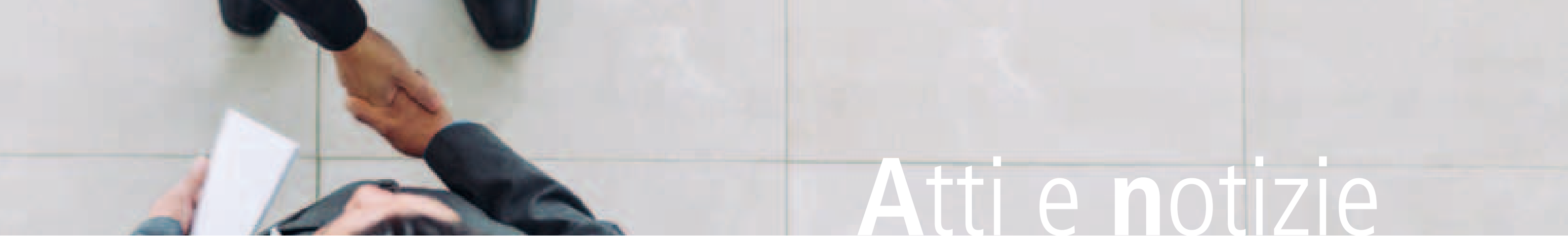


Fig. 6 - SMS latest Conso burner design with head printed with 3D additive manfacturing technology



Calendario degli eventi internazionali
International events calendar

February 26 - March 2 *San Diego, California*
TMS 2017- 146th Annual Meeting & Exhibition

March 30 - 31 *Madrid, Spain*
14th Global Experts Meeting on Nanomaterials and Nanotechnology

April 5 - 7 *Barcelona, Spain*
4th World Congress and Expo on Nanotechnology and Materials Science

May 1 - 4 *Houston, Texas*
Offshore Technology Conference (OTC) 2017

May 21 - 25 *Ypsilanti, Michigan*
4th World Congress on Integrated Computational Materials Engineering (ICME 2017)

May 25 *Bergamo*
9th European Stainless Steel Conference - Science & Market and 5th European Duplex Stainless Steel Conference & Exhibition.
Info: http://www.aimnet.it/essc2017.htm

May 29 - June 2 *Reutte, Austria*
19th Plansee Seminar 2017 on Refractory Metals and Hard Materials

June 1 - 3 *Osaka, Japan*
2nd World Congress on Petroleum and Refinery

June 13 - 14 *Falmouth, United Kingdom*
Computational Modelling '17

June 25 - 28 *Leipzig, Germany*
European Metallurgical Conference (EMC) 2017

June 26 - 29 *Nice, France*
24th IFHTSE Congress 2017, European Conference on Heat Treatment and Surface Engineering, A3TS Congress

July 3 - 5 *Dresden, Germany*
Seventh International Conference on Very High Cycle Fatigue (VHCF7)

July 24 - 26 *Chicago, Illinois*
International Conference on Graphene and Semiconductors

August 13 - 17 *Portland, Oregon*
18th International Conference on Environmental Degradation of Materials in Nuclear Power Systems - Water Reactors

September 3 - 7 *Praga, Repubblica Ceca*
Eurocorr 2017 - 20th International Corrosion Congress

September 10 - 13 *Philapdelphia, Pennsylvania*
Liquid Metal Processing & Casting Conference (LPMC 2017)

September 17 - 22 *Thessaloniki, Greece*
Euromat 2017

November *Osaka, Japan*
11th International Conference on Zinc and Zinc Alloy Coated Steel Sheet (GALVATECH)

SOMMARIO

Atti e notizie/*Aim news*

QUOTE SOCIALI AIM 2017 (ANNO SOLARE)

Benemeriti (quota minima)	1.750,00 €
Sostenitori (quota minima)	750,00 €
Ordinari (solo persona)	70,00 €
Seniores	25,00 €
Juniores	15,00 €

La quota dà diritto di ricevere la rivista dell'Associazione, La Metallurgia Italiana (distribuita in formato digitale). Ai Soci viene riservato un prezzo speciale per la partecipazione alle manifestazioni AIM e per l'acquisto delle pubblicazioni edite da AIM.

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Attività dei Comitati Tecnici

CENTRO AMBIENTE E SICUREZZA (AS)
(riunione del C.T. - 9 settembre 2016)

Consuntivo di attività svolte

- La GdS " Analisi infortuni e near miss nell'industria metallurgica" (Vicenza, 14 dicembre 2016) vedrà anche una rappresentanza INAIL e Spisal. Verranno presentati sei casi di infortunio e sei di near misses, con analisi della cause.
- Guarnieri introduce il tema di approfondimento "Gestione conformità macchine ed attrezzature di lavoro" da lui coordinato. Avvalendosi della disposizione di Accredia "Valutazione della conformità delle macchine e attrezzature di lavoro, ai fini del rilascio di certificati BS OHSAS 18001:2007" del luglio 2014, segnala le criticità legate all'utilizzo delle macchine ed attrezzature nei luoghi di lavoro, sia dal punto di vista normativo che della loro gestione sistemica.

Iniziative future

- In linea generale, per il futuro, Bassani (Segreteria AIM) propone che le attività siano impostate in combinazione con workshop internazionali, per dare loro un respiro sovranazionale . Inoltre tale soluzione comporterebbe un "call for papers" che potrebbe riuscire ad agganciare anche relatori stranieri interessati ad esporre loro esperienze/punti di vista sulle tematiche proposte. A livello di proceedings si richiederebbe una presentazione in Power Point al posto di una memoria scritta, e pertanto un carico inferiore di lavoro per relatori.
- Dopo approfondita discussione, si arriva a definire un possibile calendario delle iniziative 2017: GdS "Sicurezza appalti" a marzo 2017, con gruppo di lavoro costituito da Gelmi (Coordinatore), Aquino, Filippini, Forti, Sorella; Corso itinerante "Ambiente&Energia", di 3 giorni verso maggio/giugno 2017, inserendo gli interventi/tematiche emersi dalla discussione (es. recupero materiali, economia circolare, ecc.), con gruppo di lavoro costituito da Galimberti, Aghion (Coordinatore), Sacchetto, Praolini, Zanforlini, Filippini; Workshop Internazionale su "Industria 4.0", legato a temi di salute e sicurezza, da tenersi ad ottobre 2017, con "call for papers" pianificato per gennaio/febbraio 2017 e gruppo di lavoro formato da Malfa (Coordinatore), De Santis, Cerlesi, Isacchi, Forti, Filippini, Zanforlini; Pillole per preposti "Strumenti concreti per la vigilanza", previsto per fine novembre/dicembre 2017, con gruppo di lavoro: Bordon, Gelmi, Filippini, Forti, Aquino.
- Il Presidente Fusato ricorda che era stata anche proposta in passato una GdS sul rischio chimico. Viene supportata quest'ultima proposta segnalando che in tal senso vi è esigenza soprattutto per le aziende che eseguono lavorazioni a freddo.
- Viene riproposta la tematica concernente gli interventi in "spazi confinati" e relativa qualifica degli appaltatori.

Stato dell'arte e notizie

- AIM ha avviato la procedura per poter essere riconosciuta come punto di formazione AIAS, da cui deriverebbe una facilitazione nel rilascio dei crediti formativi per RSPP a seguito della presenza ad iniziative di formazione organizzate dall'AIM.

CENTRO PRESSOCOLATA (P)
(riunione del C.T. c/o Università di Brescia - 26 ottobre 2016)

Manifestazioni in corso di organizzazione

- Timelli, Coordinatore del Master "Progettazione Stampi" insieme a Garlet, presenta il programma ed evidenzia come il Master si svilupperà su dieci giornate che si terranno a Vicenza presso l'Università (7-8-21-22 febbraio 2017), a Bergamo presso il Parco Scientifico Tecnologico Kilometro Rosso (8-9 marzo e 5-6 aprile 2017), a Sirone presso Co.Stamp (21-22 marzo 2017). In particolare nella sede di Bergamo saranno svolte le due giornate di esercitazioni previste. Il programma è costruito tenendo conto dei tre precedenti Corsi sulla progettazione stampi organizzati dal Centro Pressocolata, (Progettazione stampi - Corso di base; Progettazione stampi - Corso avanzato, Termica degli stampi), che venivano svolti in 12 giornate formative complessive; da parte dei Coordinatori è stato quindi condotto un lavoro di sintesi per evitare ridondanze e sovrapposizione degli argomenti. Il Presidente Parona, sottolineando l'importanza di questo Master, propone di coinvolgere ASSOFOND, AMAFOND e UCISAP per il patrocinio.
- Gramegna, Coordinatore della GdS "Foundry 4.0" insieme a Furlati, espone il programma da svolgere il 23 marzo 2017 a Bergamo, presso il Parco Scientifico Tecnologico Kilometro Rosso. In particolare, il programma è suddiviso in modo da coinvolgere maggiormente il personale tecnico la mattina e l'area manageriale nel pomeriggio. La Giornata si concluderà con una Tavola Rotonda per il ruolo di Chairman della quale vengono avanzati diversi nominativi. Si suggerisce di riproporre una parte di questa Giornata (al massimo in 2 ore) durante il Metef (Verona, 21-24 giugno 2017).

Iniziative future

- Il Presidente Parona suggerisce di discutere, durante la prossima riunione del CT, l'argomento "Raddrizzatura dei getti pressocolati", da proporre come Giornata di studio nella seconda meta del 2017.

Stato dell'arte e notizie

- Per le attività del Gruppo di lavoro "Azioni pratiche per la soluzione dei difetti nei getti pressocolati", Vanalli e Timelli informano che, per completare l'individuazione delle azioni pratiche per la soluzione dei difetti

superficiali, manca solo quanto concerne cinque tipi di difetti. È stata altresì completata la parte relativa alle azioni pratiche per i difetti interni e geometrici. Il lavoro dovrebbe concludersi entro febbraio 2017. Sarà da concordare con AIM la definizione della grafica e dell'impaginazione di questo nuovo manuale.
- Riguardo al Gruppo di lavoro "Capitolato acciai", viene riportato come nelle ultime riunioni siano state illustrate le correzioni da apportare al Capitolato. A fine 2016 dovrebbe essere pronta una prima bozza nella quale saranno presentati acciai definiti e non da normativa; in particolare per gli acciai non presenti in normativa, il Gruppo di lavoro ritiene utile aggiungere dei dati tecnici specifici.
- Parona informa che è in fase di organizzazione il Metef e Conserva conferma i buoni presupposti per tale attività, in particolare per quello che riguarda il mondo della fonderia.
- Si segnala che l'Open House di IDRA si terrà per il 7 novembre 2016.

CENTRO METALLI LEGGERI (ML)
(riunione del C.T. - 4 novembre 2016)

Consuntivo di attività svolte
- Si discute sull'esito del recente Convegno Nazionale AIM, apprezzando il buon livello della manifestazione; in particolare, per quanto riguarda la sessione sulle leghe leggere, la partecipazione è stata buona e gli argomenti trattati di interesse per i presenti.
- Il Corso "Metallografia delle leghe leggere" (27-29 settembre), si è tenuto presso la sede AIM nella prima giornata e presso il Politecnico di Milano, sede Bovisa per le rimanenti due giornate, includendo le attività di laboratorio. Il riscontro di presenze è positivo (circa 35); dai commenti dei questionari compilati dai partecipanti saranno tratti spunti per le prossime manifestazioni.

Manifestazioni in corso di organizzazione
- Il Corso "Il disegno dei getti in leghe di alluminio" (9 febbraio 2017) assume come sottotitolo "Codesign e definizione dei sistemi di colata", per dare una maggiore risonanza agli argomenti trattati. Il programma, la cui impostazione generale era già stata discussa in precedenti riunioni, viene definito nei dettagli. Il Corso si terrà a Stezzano (BG) il 9 febbraio 2017.
- Il focus del Corso base "Leghe di alluminio" dovrà essere in particolare indirizzato al mondo dei progettisti, evidenziando tra l'altro le differenze tra la progettazione con l'acciaio e quella con le leghe di alluminio. In generale gli argomenti su cui organizzare le lezioni dovranno essere: applicazioni nei trasporti (anche navale e ferroviario); finiture superficiali; tecnologie; processi; prestazione leghe commerciali; trattamenti superficiali. La data prevista della manifestazione è il 2 marzo 2017, presso il Centro Congressi FAST.

Iniziative future
- In abbinamento al Corso base, si prevede un secondo evento, di approfondimento per il settore dei trasporti, dedicato in particolare al mondo automotive, ospitato presso la sede CRF.
- Il Prof. Monetta ha contattato il Presidente Vedani per ribadire interesse e disponibilità ad ospitare un incontro del CT Metalli Leggeri a Napoli presso la sede dell'Università degli Studi "Federico II", orientativamente nella primavera del 2017. L'iniziativa raccoglie il favore dei presenti; si propone di organizzare la riunione del CT nella tarda mattinata, aperta ad eventuali interessati, anche se non membri del CT, nella quale illustrare le linee di azione di AIM in generale e le iniziative del Centro ML in particolare. Nel pomeriggio si potrebbe poi tenere un breve Seminario di Studio per le aziende operanti in Campania, o in genere nel Sud dell'Italia, su un tema ancora da definire. Con la Segreteria AIM è stato impostato un primo elenco di aziende del Sud che in anni recenti hanno mostrato interesse per le attività AIM, in modo da poter generare una prima mailing list, alla quale andranno aggiunti contatti personali dei membri del CT ML.

Stato dell'arte e notizie
- Il Convegno INALCO di Napoli, tenutosi dal 21 al 23 settembre, ha registrato una partecipazione di circa 100 delegati per una sessione unica. In particolare si segnala l'interessante parte relativa alle leghe e ai processi, alla quale hanno contribuito anche membri del CT Metalli Leggeri.

CENTRO TRATTAMENTI TERMICI E METALLOGRAFIA (TTM)
(riunione del C.T. - 24 novembre 2016)

Consuntivo di attività svolte
- Il Corso "Metallografia" (ultimo modulo, 27-28-29 settembre e 4 ottobre 2016) ha raccolto valutazioni concentrate tra buono e ottimo; il commento più frequente è relativo alla richiesta di più casi pratici/applicativi. Dai questionari risulta una forte frammentazione dei partecipanti sui diversi moduli; secondo il Coordinatore Bavaro la riduzione del numero totale degli iscritti è imputabile al Corso di metallurgia di base, effettuato a inizio 2016, e pertanto caldeggia l'accorpamento delle lezioni per ridurre i moduli (es. da 5 a 3, mantenendo le giornate propedeutiche). Il Presidente Petta propone un'integrazione con approfondimenti specifici (es. mezza giornata dedicata a materiali e applicazioni automotive).
- Si relaziona sugli esiti della GdS "Trattamenti criogenici e tecniche di tempra innovative" (10 novembre 2016) che ha avuto circa 50 iscritti, con riscontri molto positivi dai partecipanti e dai membri del CT, che confermano l'elevato livello degli interventi e l'ottima organizzazione tecnica e logistica da parte del Coordinatore Pellizzari.

Manifestazioni in corso di organizzazione
- Bavaro, Coordinatore del Corso "Trattamenti termici" (previsto suddiviso in diversi moduli) presenterà una prima bozza durante la prossima riunione, se possibile anticipandola ai potenziali docenti, tenendo conto dell'introduzione di argomenti innovativi (trattamenti criogenici, pallinatura, applicazioni automotive). I moduli si svolgeranno da marzo a giugno 2017.
- Rolli e Morgano, Coordinatori della GdS "Acciai inossidabili: trattamenti termici e prove non distruttive" (Bologna, sede di Magneti Marelli, 11 maggio 2017), si impegnano ad abbozzarne un programma. Anche la Segreteria AIM ha contattato AIPnD (Associazione Italiana Prove non Distruttive) per condividere contenuti e organizzazione logistica. La GdS prevedrá quattro presentazioni a cura di AIM (relative ai trattamenti termici) e altrettante a cura di AIPnD (relativi ai controlli non distruttivi), completate da una visita ai laboratori Magneti Marelli e dalla Tavola Rotonda finale.

La Giornata verrà dedicata alla memoria di Marco Farinet. Nella prossima riunione verrà esaminato uno storico degli eventi pregressi AIM che potrebbero essere attinenti, per evitare sovrapposizioni. La GdS includerà anche una visita ai laboratori del CRF.

- Per il Convegno Nazionale Trattamenti Termici (primavera 2018) proseguono le attività di organizzazione congiunta tra segreteria AIM e MAV (Materiali Innovativi per il settore Automotive e Vehicles). La sede ipotizzata è Verona, alla luce del buon risultato del Convegno 2011.

Iniziative future

- Si propone di modificare la cadenza dei corsi "tradizionali" come segue: Metallurgia di Base (2018), Metallografia (2019), Trattamenti Termici (2020) e così via con ciclo triennale, per ridurre il rischio di perdita di iscritti a causa di parziali sovrapposizioni di tematiche.
- Si individuano i possibili interventi per una GdS su materiali per lo stampaggio (fine 2017 – inizio 2018). Il Coordinatore Rivolta si impegna ad abbozzare un programma per la prossima riunione.

Stato dell'arte e notizie

- Si procede al rinnovo delle cariche del Centro TTM; viene riconfermato Petta come Presidente e Marina La Vecchia come Vicepresidente. Tenendo conto della parziale indisponibilità dell'attuale Segretario Valentina Vicario, il ruolo di Segretario viene affidato a Stefano Schiavo.
- Si decide di ricontattare i membri del CT che da diverse riunioni non partecipano, per verificarne l'effettivo interesse e richiedere l'eventuale nomina di sostituti, soprattutto in ambito universitario.
- La prossima Conferenza Europea assegnata all'Italia è prevista per il 2019; da chiarire il ruolo previsto dall'organizzazione europea, alla luce del sovraffollamento di eventi nei prossimi due anni, che porterebbe l'Italia a dover organizzare un convegno a breve distanza dal Nazionale 2018.
- Viene presentata quale nuovo membro del CT, responsabile del laboratorio di microscopia ottica ed elettronica del Centro Ricerche FIAT.
- Dalla prossima riunione verrà ripresa la prassi del "giro di tavolo" dedicando 10 minuti alla presentazione delle attività di 1-2 membri per ogni incontro (primo appuntamento dedicato a Schiavo e a Morgano).

CENTRO CONTROLLO E CARATTERIZZAZIONE PRODOTTI (CCP)

(riunione del C.T. - 30 novembre 2016)

Consuntivo di attività svolte

- Il Coordinatore del Corso "Analisi Chimiche", Stella, riferisce sui 40 iscritti, in prevalenza provenienti da università (13) e acciaierie, e sul gradimento (buono 71%, ottimo 13%). La documentazione è risultata adeguata, come il dialogo con i docenti. In sede di Consiglio Direttivo AIM, il suggerimento di indire un Corso internazionale sull' argomento ha raccolto l'approvazione del Presidente AIM; il Presidente del Centro CCP, Calliari, pensa che si potrebbe organizzare con tedeschi e austriaci, con docenti non solo italiani. Si discute a lungo su eventuali costi e reciprocità. Per maggior facilità nell'organizzazione viene suggerito di puntare su una Giornata di Studio piuttosto che a un Corso, con la partecipazione di qualche relatore straniero; in un secondo momento si può pensare ad un Corso.

Iniziative future

- L'ultimo Corso "Prove meccaniche" si è tenuto nel 2015 e potrebbe essere ripetuto nel 2017. Calliari ha contattato l'Università di Trento, sede utilizzata nel 2008, ricevendo disponibilità, fatto salvo l'accavallamento con le lezioni. Il periodo migliore potrebbe essere attorno al 10 settembre o nella seconda metà di giugno. Risulta anche la possibilità di visita ad un laboratorio prove (a Pergine Valsugana, oppure a Trento - Latif). Si decide di indire un Corso di 3 giorni (come l'ultimo) e Trentini viene indicato come Coordinatore.
- L'ultimo Corso "PnD" è stato organizzato nel 2013, coordinato da Trentini e Mario Cusolito. Per poter scendere nel dettaglio occorre chiarire lo scopo del Corso e il target. Preliminarmente si guarda alla GdS dal titolo: "Acciai inossidabili: trattamenti termici e controlli non distruttivi", schedulata dal Centro TTM per l'11 maggio, nella quale è prevista la partecipazione di AI PnD.

Si avanza l'ipotesi di abbinare al Corso questa Giornata; si prenderà contatto con il CT TTM per definire le possibilità di collaborazione.

CENTRO MATERIALI PER L'ENERGIA (ME)

(riunione del C.T. - 10 gennaio 2017)

Consuntivo di attività svolte

- Il Presidente Gavelli riferisce sulla GdS "Energia: Materiali metallici ed Accumulo" (Milano, 16 dicembre 2016). Nonostante l'esiguità della partecipazione (5 partecipanti, esclusi i relatori), la discussione è stata vivace e creativa. Come evidenziato dai questionari di valutazione raccolti, la Giornata ha ottenuto giudizi tra il buono e l'ottimo ed è stata ritenuta utile, adeguata, stimolante. Tra i suggerimenti, vi è l'invito ad approfondire ulteriormente le problematiche riguardante i materiali metallici per l'accumulo e per lo stoccaggio dell'idrogeno.

Manifestazioni in corso di organizzazione

- Merckling, Coordinatore della GdS sul Life Assessment, riferisce di avere ancora recentemente incontrato difficoltà a stabilire contatti con ENEL, a causa degli avvicendamenti che si sono succeduti negli ultimi mesi nella struttura dell'azienda; auspica però di riuscire a creare nuovamente il contatto a breve. Nessun problema invece per quanto riguarda i contributi da ALSTOM. In ragione di queste ed alcune altre verifiche ancora da effettuare, Merckling ribadisce l'opportunità di posticipare l'iniziativa a giugno 2017.

Iniziative future

- Si conferma l'interesse per il tema relativo ai materiali per il Settore Petrolchimico e l'organizzazione di una GdS che affronti i problemi relativi, dovuti principalmente alla alte temperature, all'ambiente chimico, alla durata della vita di tali impianti, alla presenza di grandi saldature. Si ritiene opportuno chiedere il contributo dell'IIS, data la competenza in questo campo, e coinvolgere il CT Corrosione; Gavelli e Cristiani porteranno la proposta di collaborare all'organizzazione della GdS alla prossima riunione di tale CT.
- Per quanto riguarda l'Italia e l'Europa,

l'attenzione va rivolta alle fonti di energia rinnovabile. Si propone, come spunto per l'organizzazione di nuovi eventi, il tema dell'eolico nei suoi diversi aspetti (meccanico, alto numero di cicli di vita, problemi di tipo elettrico, materiali metallici ma anche compositi), senza dimenticare i problemi legati all'ambiente (usura, erosione, corrosione). Si considera l'opportunità di una Giornata più di carattere informativo che non dedicata ad aspetti innovativi. Si chiederanno ai docenti del Politecnico, presenti nei corsi che si occupano di rinnovabili, contributi che presentino in generale la tematica e diano un quadro anche storico della tecnologia; inoltre verranno loro chiesti contatti con altre parti interessate. Si ipotizza quindi una Giornata che comprenda un inquadramento della tematica nella parte introduttiva, mentre a seguire ci potranno essere presentazioni relative all'individuazione delle problematiche inerenti i materiali, i relativi controlli e le verifiche nelle varie casistiche.

Stato dell'arte e notizie

- Su invito della Segreteria AIM, si decide di inserire all'ordine del giorno della prossima riunione l'elezione del Vice Presidente di Centro, carica rimasta vacante all'ultimo rinnovo.
- Di Gianfrancesco è stato nominato nuovo Chairman dell'ECCC e prende il posto di D. Allen. È sua intenzione prestare il suo contributo, del tutto volontario, in modo da tenere vivo lo spirito con cui era stato fondato in Network, nonostante il periodo critico che sta attraversando per gli avvicendamenti di persone, per dismissione o fusione di alcune aziende e per la diversa complessità delle tematiche dei vari Working Group . Nel corso del 2016 sono state riviste le raccolte per i materiali Grado 91, 92 e 23, con dati che superano le 200.000 ore. La presenza italiana in ECCC è sempre più importante, anche superiore alla componente tedeschi. Comunque fuori d'Europa (USA Cina e Giappone), sono in corso progetti volti alla qualifica di materiali (leghe speciali) per impianti a vapore operanti a temperature più elevate (> 700°C). Per quanto riguarda l'Italia, anche se le rinnovabili siano presenti, si dovranno sempre tenere attivi impianti termici per il carico di base. I problemi quindi saranno quelli relativi all'esercizio flessibile, la manutenzione, la sostituzione ecc.
- La prossima riunione dell'ECCC è prevista ad aprile e sarà ospitata da FRANCHINI ACCIAI (BS).
- A Düsseldorf si terrà la IV Conferenza ECCC, dal 10 al 13 settembre 2017: sono già state raccolte 135 proposte di contributi; si pensa dunque che almeno 100 di quelle presentate rimarranno anche dopo la selezione. Circa il 10% dei paper è stata presentato da italiani.
- Il Presidente Gavelli introduce un nuovo membro del CT, appartenente a RSE, che ha manifestato la richiesta di partecipare alle attività del Comitato Tecnico.

CENTRO CORROSIONE (C)

(riunione del C.T. - 13 gennaio 2017)

Manifestazioni in corso di organizzazione

- I Coordinatori, Ormellese e Pedeferri, illustrano lo stato di avanzamento dell'organizzazione delle Giornate Nazionali sulla Corrosione e Protezione (Milano, 28-30 giugno 2017). Sono pervenute un totale di 108 memorie, di cui 90 destinate alle sessioni scientifiche, 6 per il workshop APCE, 5 per il workshop del Centro Inox e 7 per il workshop NACE; di queste memorie, 65 provengono dalle università e 43 dall'industria e sono state distribuite in 10 sessioni che saranno programmate nei tre giorni del Convegno. La plenary lecture sarà tenuta dal prof. Fratesi sulla zincatura come metodo di protezione dalla corrosione, La sede del Convegno sarà l'aula Rogers del Politecnico di Milano. Alla fine di questo lavoro, 32 memorie, di 4 pagine, saranno selezionate per la pubblicazione sulla versione digitale de La Metallurgia Italiana. Tutte le memorie accettate, preparate secondo le linee guida fornite dalla Segreteria AIM, saranno comunque pubblicate nella raccolta degli atti del Convegno, alla quale sarà associato un codice ISBN.
- Relativamente al Corso "Corrosione e Protezione dei Materiali Metallici", interviene la Coordinatrice Cabrini, che si è occupata anche delle precedenti edizioni e che compilerà una bozza per un nuovo programma, tenendo conto di temi più o meno attuali che potrebbero essere affrontati. Si prevede che il Corso si effettuerà a Milano nel periodo collocato tra fine ottobre e il mese di novembre 2017. Sono previsti 4 moduli come nell'edizione precedente, che ha visto la partecipazione di 70 persone. Contrariamente alle aspettative, un buon numero di questi partecipanti è stato registrato nelle lezioni introduttive sulla corrosione, indice del fatto che in certi corsi universitari probabilmente stanno sparendo alcuni insegnamenti della corrosione. Si evidenzia la criticità di poter programmare delle esercitazioni di laboratorio nell'ambito di questo evento.

Iniziative future

- L'AIM sta riflettendo sulla possibilità di proporre la sua candidatura per l'organizzazione di EuroCorr 2020. Per questo motivo sono stati chiesti diversi preventivi a centri congressi in grado di ospitare fino a 1000 partecipanti.

Stato dell'arte e notizie

- Il Presidente Proverbio dà il benvenuto ad un nuovo membro del CT della ditta Anton Paar Italia, filiale della multinazionale austriaca, che produce attrezzature scientifiche per la caratterizzazione delle superfici, viscosimetri, ecc.

In memoria di Luca Bertolini (1966-2017)

Nato a Sondrio nel 1966, dopo la Laurea in Ingegneria delle Tecnologie Industriali nel 1990 ha conseguito il Dottorato di Ricerca in Ingegneria Elettrochimica nel 1995, con una tesi dal titolo "Controllo della corrosione delle armature nel calcestruzzo mediante circolazione di corrente: aspetti elettrochimici", relatori Prof. Pietro Pedeferri e Prof. Tommaso Pastore.

Ricercatore universitario nel 1995, professore associato nel 1998 e professore ordinario dal 2005 in Scienza e tecnologia dei materiali presso il Dipartimento di Chimica, Materiali e Ingegneria Chimica "G. Natta" (in precedenza di Chimica Fisica Applicata) del Politecnico di Milano.

La sua attività didattica è stata dedicata principalmente alla scienza e tecnologia dei materiali e alla durabilità delle costruzioni e si è svolta presso le Scuole (Facoltà) di Ingegneria Civile, Ambientale e Territoriale e di Ingegneria Edile-Architettura del Politecnico di Milano. Ha insegnato anche nei corsi di Formazione Permanente, di formazione professionale e nei Master di specializzazione. La sua attività didattica ha portato alla pubblicazione, a partire dalla seconda metà degli anni '90, di diversi libri, in particolare il testo in due volumi "Materiali da costruzione" (2006). È stato relatore di numerose tesi di Laurea e di Dottorato di Ricerca.

La sua attività di ricerca si è svolta nel Dipartimento di Chimica, Materiali e Ingegneria Chimica del Politecnico di Milano e per alcuni periodi presso la Aston University, Birmingham, Regno Unito dove ha

collaborato con il Prof. C.L. Page e il Dr. G. Sergi e presso il TNO di Delft, Paesi Bassi, dove ha collaborato con il Dr. R. Polder.

Ha conseguito risultati di significativa rilevanza scientifica in diversi campi di ricerca: materiali cementizi innovativi, armature in acciaio inossidabile, tecniche elettrochimiche, conservazione dei beni culturali, progetto della durabilità, monitoraggio e ripristino delle strutture in calcestruzzo armato.

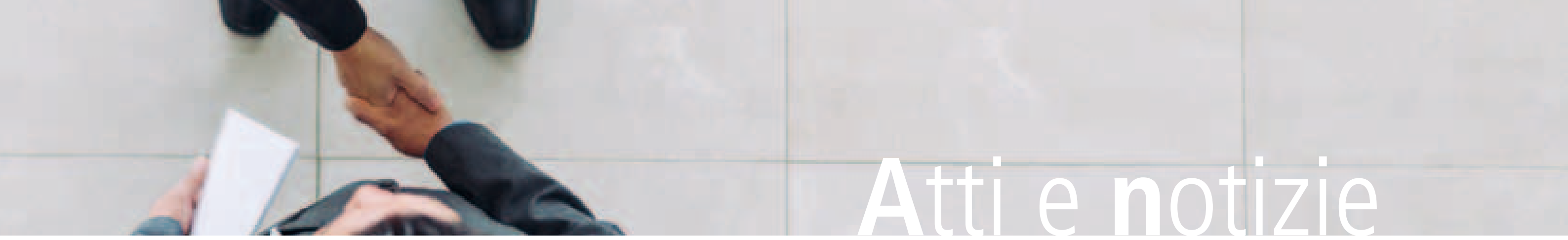
La sua attività scientifica è testimoniata dai numerosi progetti, che hanno portato a un numero elevato di pubblicazioni, oltre 300 articoli scientifici. Tra i libri scientifici, sono da ricordare "La corrosione nel calcestruzzo e negli ambienti naturali" (1996), "La durabilità del calcestruzzo armato" (2000), entrambi con Pietro Pedeferri e "Corrosion of steel in concrete" con Pietro Pedeferri, Bernhard Elsener e Rob Polder; questi testi sono un riferimento per gli studenti, i ricercatori, i professionisti interessati alla durabilità delle costruzioni in calcestruzzo armato.

È stato membro del RILEM (International Union of Laboratories and experts in construction materials, systems and structures), dell'American Concrete Institute e del Working Party "Corrosion of steel in concrete" della European Federation of Corrosion. Ha partecipato a vari comitati tecnici e alle attività di cooperazione nel campo della ricerca scientifica e tecnologica dell'Unione Europea (azioni COST 521 e 534).

Luca è stato uno scienziato e un docente di altissimo livello, ma soprattutto una persona gentile. Sarà ricordato da migliaia di studenti che hanno conosciuto le sue capacità didattiche e la sua devozione all'insegnamento. Lascia un vuoto incolmabile nei colleghi che hanno potuto apprezzare la sua passione per il lavoro e la sua gentilezza nei rapporti umani. Rimarrà nei cuori della sua famiglia e dei suoi amici, che non dimenticheranno mai il suo coraggio nell'affrontare la malattia e il suo inesauribile ottimismo.

"Se si escludono istanti prodigiosi e singoli che il destino ci può donare, l'amare il proprio lavoro (che purtroppo è privilegio di pochi) costituisce la migliore approssimazione alla felicità sulla terra", Primo Levi, La chiave a stella, 1978.

Fabio Bolzoni, Matteo Gastaldi, Federica Lollini, Elena Redaelli



Notizie da UNSIDER Norme pubblicate e progetti in inchiesta EN e ISO

(aggiornamento 2 febbraio2017)

NORME UNSIDER PUBBLICATE DA UNI NEI MESI DI DICEMBRE 2016 E GENNAIO 2017

EC 1-2017 UNI EN ISO 14224:2016
Industrie del petrolio, della petrolchimica e del gas naturale - Raccolta e scambio dei dati sull'affidabilità e sulla manutenzione delle attrezzature

EC 1-2017 UNI EN ISO 8062-3:2009
Specifiche geometriche dei prodotti (GPS) - Tolleranze dimensionali e geometriche dei pezzi ottenuti da fusione - Parte 3: Tolleranze dimensionali e geometriche generali e sovrametalli di lavorazione dei getti

EC 1-2017 UNI EN 13480-8:2015
Tubazioni industriali metalliche - Parte 8: Requisiti addizionali per tubazioni di alluminio e leghe di alluminio

EC 2-2017 UNI EN 13480-5:2013
Tubazioni industriali metalliche - Parte 5: Collaudo e prove

EC 3-2017 UNI EN 13480-1:2012
Tubazioni industriali metalliche - Parte 1: Generalità

EC 3-2017 UNI EN 13480-3:2012
Tubazioni industriali metalliche - Parte 3: Progettazione e calcolo

UNI EN 10205:2017
Banda nera laminata a freddo per la produzione di acciaio per imballaggi

UNI EN ISO 14577-4:2017
Materiali metallici - Prova di penetrazione strumentata per la determinazione della durezza e dei parametri dei materiali - Parte 4: Metodo di prova per rivestimenti metallici e non metallici

UNI EN ISO 148-1:2016
Materiali metallici - Prova di resilienza Charpy - Parte 1: Metodo di prova

UNI EN ISO 148-2:2016
Materiali metallici - Prova di resilienza Charpy - Parte 2: Verifica delle macchine di prova

UNI EN ISO 148-3:2016
Materiali metallici - Prova di resilienza Charpy - Parte 3: Preparazione e caratterizzazione delle provette Charpy con intaglio a V per la verifica indiretta delle macchine di prova di resilienza

UNI EN ISO 16440:2016
Industrie del petrolio e del gas naturale - Sistemi di trasporto tubazioni - Progettazione, costruzione e manutenzione di condotte rivestite in acciaio

NORME UNSIDER RITIRATE DA UNI NEI MESI DI DICEMBRE 2016 E GENNAIO 2017

UNI EN ISO 148-1:2011
Materiali metallici - Prova di resilienza su provetta Charpy - Parte 1: Metodo di prova

UNI EN ISO 148-2:2009
Materiali metallici - Prova di resilienza Charpy mediante pendolo - Parte 2: Verifica delle macchine di prova

UNI EN ISO 148-3:2009
Materiali metallici - Prova di resilienza Charpy mediante pendolo - Parte 3: Preparazione e caratterizzazione delle provette Charpy ad intaglio a V per la verifica indiretta delle macchine di prova di resilienza

UNI EN ISO 14577-4:2007
Materiali metallici - Prova di penetrazione strumentata per la determinazione della durezza e dei parametri dei materiali - Parte 4: Metodo di prova per rivestimenti metallici e non metallici

UNI EN 10205:1993
Banda nera in rotoli laminata a freddo, per la produzione di banda stagnata o di banda cromata elettrolitica.

NORME UNSIDER PUBBLICATE DA CEN E ISO NEI MESI DI DICEMBRE 2016 E GENNAIO 2017

EN ISO 17776:2016
Petroleum and natural gas industries - Offshore production installations - Major Accident hazard management during the design of new installations (ISO 17776:2016)

EN 10056-1:2017
Structural steel equal and unequal leg angles - Part 1: Dimensions

EN 10365:2017
Hot rolled steel channels, I and H sections - Dimensions and masses

EN 10152:2017
Electrolytically zinc coated cold rolled steel flat products for cold forming - Technical delivery conditions

ISO 18203:2016
Steel -- Determination of the thickness of surface-hardened layers

ISO 16112:2017
Compacted (vermicular) graphite cast irons -- Classification

PROGETTI UNSIDER IN INCHIESTA PREN E ISO/DIS – FEBBRAIO 2017

prEN – PROGETTI DI NORMA EUROPEI

EN 13480-2:2012/prA8
Metallic industrial piping - Part 2: Materials

prEN ISO 377
Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO/FDIS 377:2017)

prEN ISO 15630-1
Steel for the reinforcement and prestressing of concrete - Test methods - Part 1: Reinforcing bars, wire rod and wire (ISO/DIS 15630-1:2017)

prEN ISO 15630-2
Steel for the reinforcement and prestressing of concrete - Test methods - Part 2: Welded fabric and lattice girder (ISO/DIS 15630-2:2017)

prEN ISO 15630-3
Steel for the reinforcement and prestressing of concrete - Test methods - Part 3: Prestressing steel (ISO/DIS 15630-3:2017)

ISO/DIS – PROGETTI DI NORMA INTERNAZIONALI

ISO/DIS 22682
Iron ores -- Determination of trace elements -- Plasma spectrometric method

ISO/DIS 17832
Non-parallel steel wire and cords for tyre reinforcement

ISO/DIS 35104
Petroleum and natural gas industries -- Arctic operations -- Ice management

ISO/DIS 9328-3
Steel flat products for pressure purposes -- Technical delivery conditions -- Part 3: Weldable fine grain steels, normalized

ISO/DIS 9328-5
Steel flat products for pressure purposes -- Technical delivery conditions -- Part 5: Weldable fine grain steels, thermomechanically rolled

ISO/DIS 9328-1
Steel flat products for pressure purposes -- Technical delivery conditions -- Part 1: General requirements

ISO/DIS 9328-7
Steel flat products for pressure purposes -- Technical delivery conditions -- Part 7: Stainless steels

ISO/DIS 9328-6
Steel flat products for pressure purposes -- Technical delivery conditions -- Part 6: Weldable fine grain steels, quenched and tempered

ISO/DIS 9328-4
Steel flat products for pressure purposes -- Technical delivery conditions -- Part 4: Nickel-alloy steels with specified low temperature properties

ISO/DIS 9328-2
Steel flat products for pressure purposes -- Technical delivery conditions -- Part 2: Non-alloy and alloy steels with specified elevated temperature properties

ISO/DIS 10144
Steels for the reinforcement and prestressing of concrete -- Certification scheme for steel bars and wires

ISO/DIS 16169
Preparation of silicon carbide and similar materials for analysis by ISO 12677 X-ray fluorescence (XRF) -- Fused cast-bead method

ISO/DIS 15835-1
Steels for the reinforcement of concrete -- Reinforcement couplers for mechanical splices of bars -- Part 1: Requirements

ISO/DIS 15835-3
Steels for the reinforcement of concrete -- Reinforcement couplers for mechanical splices of bars -- Part 3: Conformity assessment scheme

ISO/DIS 15630-1
Steel for the reinforcement and prestressing of concrete -- Test methods -- Part 1: Reinforcing bars, wire rod and wire

ISO/DIS 15835-2
Steels for the reinforcement of concrete -- Reinforcement couplers for mechanical splices of bars -- Part 2: Test methods

ISO/DIS 15630-3
Steel for the reinforcement and prestressing of concrete -- Test methods -- Part 3: Prestressing steel

ISO/DIS 15461
Steel forgings -- Testing frequency, sampling conditions and test methods for mechanical tests

ISO/DIS 15630-2
Steel for the reinforcement and prestressing of concrete -- Test methods -- Part 2: Welded fabric and lattice girder

PROGETTI UNSIDER AL VOTO FPREN E ISO/FDIS – FEBBRAIO 2017

FprEN – PROGETTI DI NORMA EUROPEI

FprEN ISO 16120-1
Non-alloy steel wire rod for conversion to wire - Part 1: General requirements (ISO/FDIS 16120-1:2017)

FprEN ISO 16120-4
Non-alloy steel wire rod for conversion to wire - Part 4: Specific requirements for wire rod for special applications (ISO/FDIS 16120-4:2017)

ISO/FDIS – PROGETTI DI NORMA INTERNAZIONALI

ISO/FDIS 16120-1
Non-alloy steel wire rod for conversion to wire -- Part 1: General requirements

ISO/FDIS 16120-4
Non-alloy steel wire rod for conversion to wire -- Part 4: Specific requirements for wire rod for special applications

ISO/FDIS 3082
Iron ores -- Sampling and sample preparation procedures

ISO/FDIS 377
Steel and steel products -- Location and preparation of samples and test pieces for mechanical testing