

ISSUE 01 | MAY 2015

METALS MAGAZINE

INNOVATION AND TECHNOLOGY FOR THE METALS INDUSTRY

CREATING THE FUTURE OF METALS AS ONE

End-to-end Excellence
Across the Metals Value Chain

Primetals Technologies
At METEC 2015



A vintage steam locomotive is shown in silhouette, pulling a train through a snowy landscape. The locomotive is emitting a large, thick plume of white smoke that rises into the sky. The sun is bright and positioned in the upper center of the frame, creating a starburst effect. The sky is a clear, deep blue. The foreground is covered in snow with some low-lying, dark vegetation.

To create
the future,
you must build
upon the past.

The steam engine, as applied here in a vintage locomotive, was one of the groundbreaking inventions that ushered in the Industrial Age and created a brighter future for mankind.

EDITOR'S COLUMN



LAWRENCE GOULD

DEAR READER,

The business slogan of the newly formed joint-venture company Primetals Technologies is: “Creating the future of metals as one.” What does it mean to create the future?

People, things and circumstances can, of course, have an impact on future events. It happens all the time. The result may be long- or short-term, limited or extensive in scope, and may affect many or just a few. For example, the construction of a new bridge over a river or other infrastructural improvements can significantly reduce traveling time and save fuel costs for thousands of people over decades. Or the decision to start a business may provide a source of income for a number of individuals for many generations. The skilled political leader may be in a position to enact decisions that lead to increased prosperity for millions of human beings, nationally and even globally.

The Industrial Revolution that began around 1760 marked a major turning point in history that benefited the general population on a large scale. Thanks to a series of groundbreaking inventions and developments at that time – such as major improvements to the design of the steam engine by the Scottish inventor James Watt – manual production methods began to be increasingly replaced by machines. This was particularly true for the manufacture of iron and other metals. Tools, agricultural implements, wheels and vehicles could be made using metals that were far cheaper to produce than ever before. Almost every aspect of daily life was changed in some way, and the standard of living began to gradually improve for the first time ever.

Pioneering developments in metallurgical processes dramatically reduced the cost of making steel. These included the use of coal for smelting ores (instead of charcoal) that

began in the 1700s, the introduction of the Bessemer, Thomas and Siemens-Martin steelmaking processes in the 19th century, all the way to the worldwide application of LD (BOF) technology that commenced in the 1950s. The annual world average per capita consumption of steel went from virtually zero in 1760 to 225 kg today. According to the World Steel Association (worldsteel), the global steel industry today directly employs some 2 million people. This highly versatile material is and will remain the predominant metal used in the automotive, construction, transportation, power and machine-manufacturing industries. Assuming a multiplication factor of 25 for the number of persons involved in selling, processing, working or servicing steel or steel products, worldsteel estimates that this industrial segment directly or indirectly employs more than 50 million people. When one adds in the number of workers occupied with the mining and processing of other types of metals, it is obvious that major developments in this field have the potential to dramatically affect society as a whole – as they did in the Industrial Revolution.

Despite the rapid technological advances and the progress that has been achieved, the metals market is currently faced with an unprecedented crisis. World production of crude steel reached 1.662 billion metric tons in 2014. However, with a total installed capacity in the range of 2.1 billion tons per annum, there is a current worldwide overcapacity of nearly 440 million tons. Increasing competition, fluctuating prices and reduced growth have made life tougher for producers and suppliers alike. »

“ The joint venture unites the singular strengths and proven competencies of both Siemens VAI and MHMM in a way that is unique in the industry.”

At the same time, billions of tons of steel are now in use in buildings, vehicles, ships, machines, bridges and other structures, more than 80% of which will one day be recycled. With consideration to the continually increasing quantities of scrap that are becoming available, are we witnessing the beginning of a dramatic decline in primary steelmaking via the traditional blast furnace route? This is one of the many areas where considerable rethinking of the status quo is required. New solution approaches are called for, especially in regard to recycling and processing

scrap more efficiently in electric furnaces and converters*, improving refining techniques of scrap-based steel, as well as supporting producers in developing special steel grades for new market applications.

In response to these and other challenges confronting the metals industry, Siemens VAI Metals Technologies (Siemens VAI) and Mitsubishi-Hitachi Metals Machinery (MHMM) joined forces in January 2015 to form Primetals Technologies. This enterprise represents a powerhouse of



well-established brands, combining the experience and technological legacies of companies such as VAI, Davy, Fuchs, Morgan, Pomini, Clecim, Cosim, Mitsubishi, Hitachi, IHI, Concast India, GFG, vatron and others.

The joint venture unites the singular strengths and proven competencies of both Siemens VAI and MHMM in a way that is unique in the industry. Siemens VAI particularly excels in upstream processes where the highest cost burden in steelmaking arises, especially in regard to raw materials, energy consumption and emission control. With its long history in plant engineering and construction, production steps are fully integrated and automated in such a way that the entire production process is optimized from the raw materials to finishing lines. MHMM is distinguished by its superb downstream rolling and processing expertise where the quality of the steel products is decisive. All of this is backed by the extensive service, workshop and manufacturing capabilities of both partners to support producers in maintaining their metallurgical facilities at peak performance levels throughout their entire lifecycle.

To create the future, you must build upon the past. Through the merger of two strong partners into a single entity, the foundation has been laid to find the solutions to meet tomorrow's challenges. And together with our customers, suppliers and stakeholders, our goal is to create the future of metals as one. ●

Yours sincerely,



Dr. Lawrence Gould

Managing Editor

Primetals Technologies Limited

*See a brief description of the EAF Quantum furnace and the Jet Steelmaking process on pages 13 and 63 respectively.



Pioneering developments in the iron and steel industry have contributed to an improved standard of living for many millions of people and have created the basis for a long-term, prosperous future. Various technological, market and environmental matters, however, need to be addressed, and Primetals Technologies is committed to finding answers to meet the challenges facing the industry.
Photo: Tata Steel Europe, IJmuiden steelworks, the Netherlands



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What does it mean to create the future?

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Examples of Recent Primetals Technologies Project Activities

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Interview with Yasukuni Yamasaki, CEO & Chairman of Primetals Technologies

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Primetals Technologies creates long-term value for metals producers with advanced technology and innovation: 65 papers from Primetals Technologies will be presented at the ESTAD Congress, concurrent with METEC 2015.

42 Agglomeration

Five agglomeration papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of sintering and pelletizing.

48 Ironmaking

Eight ironmaking papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of blast furnace ironmaking, Corex and Finex smelting-reduction technology, and solutions for processing direct-reduced iron (DRI) and by-products.

56 Steelmaking

Sixteen steelmaking papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of electric steelmaking, converter steelmaking, stainless steelmaking and secondary metallurgy.

68 Continuous Casting

Nine continuous casting papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of slab, billet and bloom casting in addition to automation, logistics and modernization solutions.

76 Linked Casting and Rolling

Five linked casting and rolling papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the continuous production of both flat and long products.

16 COVER STORY

On the basis of the combined technological Power of Mitsubishi-Hitachi Metals Machinery and Siemens VAI Metals Technologies (now Primetals Technologies), producers can count on a strong and experienced partner to provide end-to-end excellence across the metals value chain.

82 Rolling

Thirteen rolling papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of plate rolling, hot-strip rolling, cold rolling and long rolling.

92 Energy & Environmental Care

Two energy & environmental care papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of energy recovery and the recycling of carbon emissions from steelworks.

96 Mechatronics

Three mechatronics papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of improved strip-steering control using an optical measurement device, inline determination of the mechanical properties of steel strip on the basis of electromagnetic parameters, and improved strip side trimming applying optical inspection devices.

100 Automation

Four automation papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of process optimization, condition monitoring, the Process Expert system and intelligent warehouse logistics.

PANORAMA

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Primetals Technologies at METEC 2015

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METALS MAGAZINE IS ALSO AVAILABLE FOR TABLET COMPUTERS

For selected magazine topics readers can access additional content with the new magazine app for tablet computers. This offers an interactive alternative to the print version of Metals Magazine and can be downloaded at the Primetals magazine newsstand.

For iOS



For Android



PROJECT REVIEW

EXAMPLES OF RECENT PRIMETALS TECHNOLOGIES **PROJECT ACTIVITIES**



1. Ranshofen, Austria
2. Rizhao, China
3. Tangshan, China
4. Changzhou, China
5. Hospet, India
6. Pohang, Korea
7. Shuaiba, Kuwait
8. Ixtaczoquitlan, Mexico
9. Baytown, Texas, U.S.A.



Aluminum strip production at AMAG rolling GmbH, Ranshofen, Austria (photo: courtesy of AMAG rolling GmbH)

ROLLING MILL DRIVES TO BE MODERNIZED AT AMAG ROLLING

1. AUSTRIA: Primetals Technologies received an order from the aluminum producer AMAG rolling GmbH (part of the Austrian AMAG Group), located in Ranshofen, Austria, to modernize the complete drive technology of its 4-high hot-rolling stand. The purpose of the project is to increase overall plant availability. The project includes the supply of the motors, converters and converter transformers, as well as couplings, disc brakes, mechanical adaptations and spare parts. Primetals Technologies is responsible for the layout, engineering, project management and training of operator personnel, and will also handle the dismantling, installation and commissioning of components and equipment. The new drive technology will replace the existing Siemens DC infeeds and third-party DC motors. The equipment conversion and commissioning is scheduled to take place during a brief plant shutdown at the end of 2015.

FIRST COIL PRODUCED ON NEW ARVEDI ESP LINE AT RIZHAO

2. CHINA: In February 2015, Chinese steel producer Rizhao Steel Group Co., Ltd. (Rizhao) rolled the first coil on its Arvedi ESP (Endless Strip Production) plant No. 1 supplied by Primetals Technologies. The plant is designed for an annual production of 2.55 million tons of high-quality, ultra-thin hot strip in widths up to 1,600 mm and thicknesses down to 0.8 mm. The plant is one of five endless casting-rolling plants that Rizhao ordered from Primetals Technologies in 2013 and 2014. The other plants are either under construction or are currently being delivered. Primetals Technologies is responsible for engineering and the supply of mechanical equipment, media systems, technology packages and automation. All of the rolling stands will be equipped with Morgoil KLX oil film bearings that are specifically designed for Arvedi ESP applications. The project also includes a comprehensive training and support package.

In an Arvedi ESP line hot strip is continuously produced without interruption in a directly linked continuous caster and rolling mill. Energy consumption is reduced by up to 45% compared to conventional plant configurations. With an overall length of just 180 meters, Arvedi ESP is also the most compact mill of its type in the world.



Primetals Technologies-supplied cold-rolling mill at Tangsteel, China

FIRST COIL PRODUCED ON NEW COLD-ROLLING MILL AT TANGSHAN

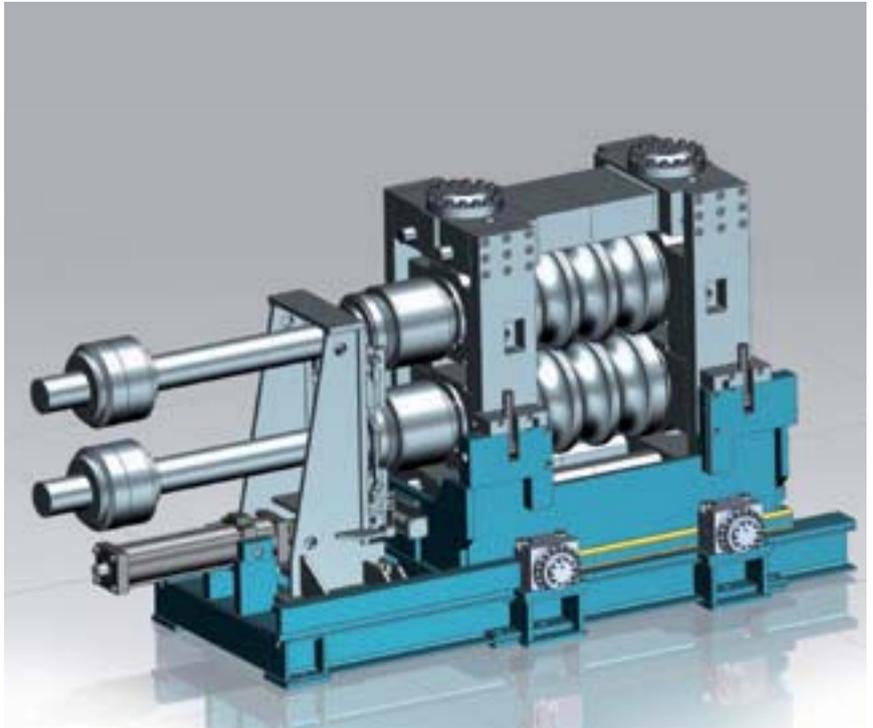
3. CHINA: The new cold-rolling mill that a Primetals Technologies-led consortium supplied to Tangshan Iron and Steel Group Co. Ltd. (Tangsteel) entered service with the production of the first coil in January 2015. The mill consists of a coupled pickling line and tandem cold mill (PLTCM), a continuous annealing line and a galvanizing line. The rolling complex is capable of producing 1.8 million t/a of high-strength, cold-rolled strip for use in the Chinese automotive industry. The PLTCM consists of five 6-high rolling stands that are equipped with SmartCrown rolls and special actuators and control systems to ensure that the required flatness demands of the finished products are met. The entry thickness of the strip ranges from 1.5 mm to 6 mm, which is rolled to a final thickness of between 0.2 mm and 2.5 mm. Strip widths vary between 700 mm and 1,600 mm. The PLTCM, annealing and galvanizing lines feature a common, integrated automation system that comprises basic (Level 1) and process-optimization (Level 2) systems and models. This enables all of the plant sections to be coordinated precisely with each other, which contributes to maximum plant availability and output while ensuring consistently high product quality.

The Tangsteel rolling complex is capable of producing 1.8 million t/a of high-strength, cold-rolled strip for use in the Chinese automotive industry.

THREE WIRE ROD MILLS TO BE MODERNIZED AT ZENITH STEEL

4. CHINA: Zenith Steel (Changzhou Zhongtian Iron & Steel), located in Changzhou, Jiangsu province, China, placed an order with Primetals Technologies for the upgrading of two of its wire rod outlets to improve the quality and range of its products. The project scope includes the supply of mini-finishing blocks, a Morgan Intelligent Pinch Roll and new laying heads. The revamped mills will be capable of rolling rebars with diameters ranging from 6.0 mm to 16 mm, and rods in sizes from 5.5 mm to 20 mm. The new equipment will enable thermomechanical rolling to produce fine-grain rebars at low cost. The wire-rod mills will operate at a speed of 105 m/s. Commissioning is planned for early 2016.

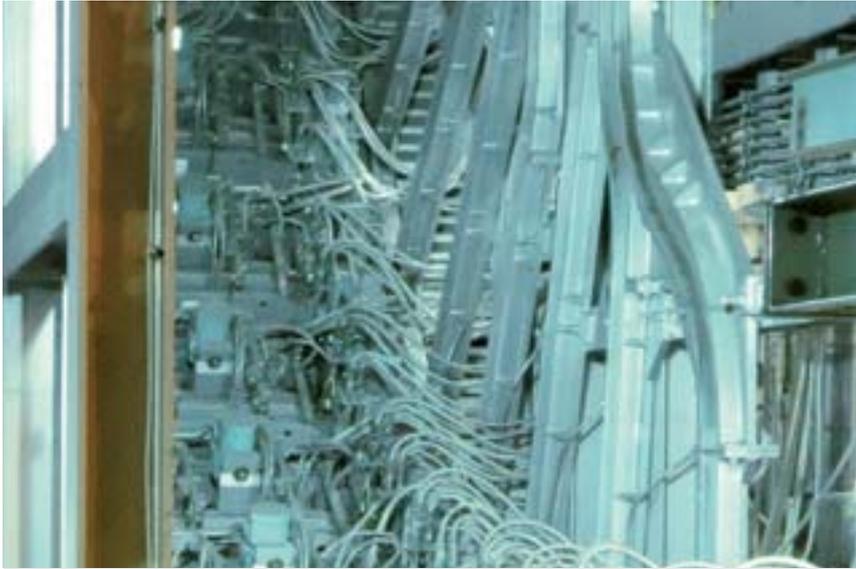
In a subsequent order received from Zenith Steel, Primetals Technologies was commissioned to revamp the complete rod outlet section of an additional wire rod mill. The existing Morgan Stelmor conveyor will be equipped with the first Optimesh system installed in China. This solution increases the rod-cooling capacity and ensures fast and uniform air cooling of high-carbon products across the width of a Stelmor conveyor. The mechanical properties and metallurgical structure of the rods are thereby improved. The contract scope includes the supply of a prefinishing mill, shear, a Morgan Vee No-Twist Mill, a Morgan Intelligent Pinch Roll, laying head and water boxes. The upgraded mill will run at a speed up to 110 m/s, and start-up is scheduled for early 2016. This most recent project is the fifth wire rod mill contract signed with Zenith Steel.



CGA sizing stand

NEW BAR-ROLLING LINE TO BE INSTALLED IN MINIMILL OF INDIAN STEEL PRODUCER SLR METALIKS

5. INDIA: A state-of-the-art bar-rolling mill will be installed in the new steel plant of SLR Metaliks Ltd. near Hospet in the Indian state of Karnataka. The mill is designed for an annual production of 320,000 tons of rebars (diameters: 8–32 mm) and special bar quality (SBQ) rounds (diameters: 16–63 mm) that will be primarily used in the automotive industry. Primetals Technologies will supply the complete process equipment for the new bar-rolling mill that includes the billet infeed with a hot-charging option, descaling equipment, shears, bundling, wire-tying and weighing machines, and finished-bar handling systems. The supply scope also comprises transformers, motors, drives, mechatronic packages and measuring instruments, as well as the basic Level 1 automation system, operator consoles and the HMI system. The actual rolling line consists of a roughing mill, intermediate mill and a finishing mill, followed by a three-stand sizing mill equipped with CGA stands. An inline system will be used for thermomechanical rolling of the SBQ bars, and also for rebar quenching and tempering. The quality of the rolled bars will be monitored online by non-contact, laser-based Orbis measuring systems. The plant is scheduled for start-up in the first half of 2016.



Modernized stainless steel slab caster at Posco, Pohang Works, Korea

MODERNIZED STAINLESS STEEL SLAB CASTER RESTARTS PRODUCTION AT POSCO

6. KOREA: The single-strand stainless steel slab caster (SSC 2) that was modernized by Primetals Technologies restarted operations at Pohang Iron and Steel Co. Ltd. (Posco) in Pohang, Korea. The project covered the replacement of the entire casting plant beginning with the tundish car up to the slab-discharge area. The caster was outfitted with a number of technology packages that enables Posco to produce a wide range of different and advanced stainless steel grades. Internal slab quality, especially for martensitic stainless steel grades, could be considerably improved. The installed technology packages include DynaWidth for the online adjustment of the slab width, the DynaFlex mold oscillator and the LevCon mold-level control system equipped with anti-bulging compensation. Internal strand quality is enhanced applying DynaGap Soft Reduction in combination with the Dynacs 3D cooling model. The latter allows the final strand solidification point to be accurately determined. Optimized secondary cooling is made possible using DynaJet spray nozzles. Project execution and implementation were carried out within schedule through the application of the well-proven Connect and Cast revamping concept from VAI. From day one, the caster produced high-quality slabs in the fully automatic mode. Slab thicknesses range from 140 mm to 200 mm at widths between 1,000 mm and 1,850 mm. The Final Acceptance Certificate was issued by Posco in October 2014.

REBAR ROLLING LINE MODERNIZATION AT KWTSTEEL

7. KUWAIT: The Kuwaiti steel producer United Steel Industrial Company (KWTSteel) awarded Primetals Technologies with a contract to upgrade its rebar rolling mill, which currently has a annual capacity of 650,000 tons of rebars. The mill will be equipped with the inline Pomini Quenching System (PQS), a new higher-capacity hot-dividing shear and a new entry table. The quenching system will enable bars to be produced with the required mechanical properties, largely without the need for expensive alloying agents. Bars treated in this way will feature a fine-grain perlitic core and a hard martensitic surface. Primetals Technologies will also supply the lubrication system, a water-treatment plant, medium- and low-voltage transformers, the low-voltage distribution system, and motors and drives. Basic automation (Level 1) for the new plant equipment and the integration into the existing process-optimization system (Level 2) will also be provided. The modernized rolling mill is scheduled to start up in late 2015.



The Pomini Quenching System (PQS) is capable of imparting the required mechanical properties to rolled bars, largely without the need for alloying agents

The caster was outfitted with a number of technology packages that enables Posco to produce a wide range of different and advanced stainless steel grades.



JUST IN!

EAF Quantum furnace order from Acciaieria Arvedi, site of world's first Arvedi ESP plant. More information at METEC 2015.

TYASA ISSUES FAC FOR MINIMILL MELT-SHOP SUPPLIED BY PRIMETALS TECHNOLOGIES

8. MEXICO: In late 2014, Mexican steel producer Talleres y Aceros S.A. de C.V. (Tyasa) issued Primetals Technologies the final acceptance certificate (FAC) for a new minimill meltshop installed at Ixtaczoquitlan in the Mexican state of Veracruz. The plant has an annual capacity of 1.2 million tons of steel. An EAF Quantum electric arc furnace (EAF) with a steel tapping weight of 100 tons was deployed worldwide for the first time. This new generation of electric furnaces efficiently preheats scrap in an integrated shaft and incorporates a new tilting concept for the lower shell and an optimized tapping system. Tap-to-tap times of 36 minutes are achieved. Electrical energy requirements of only 280 kWh per ton of tapped steel, coupled with the lower consumption of electrodes and oxygen, results in a reduction of specific conversion costs by around 20%. The project also covered the supply of the secondary metallurgical facilities that comprised a 100-ton twin-stand ladle furnace and a 100-ton twin-stand vacuum-degassing plant for the production of killed, low-, medium- and high-carbon steel grades. The combined 6-strand continuous caster is capable of casting billets as well as preliminary sections, beam blanks and rounds on two lines. Furthermore, equipment and systems were provided for primary and secondary dedusting; power distribution and electrics; Level 1 and Level 2 automation; and water cooling and water treatment.

The shaft-type EAF Quantum furnace installed at Tyasa, Mexico



Heat-treatment plant for a new tube and pipe mill at Borusan, Texas, U.S.A.

RECEIPT OF FAC FOR HEAT-TREATMENT PLANT INSTALLED AT BORUSAN MANNESMANN IN TEXAS

9. U.S.A.: Following the successful start-up and operation of a Primetals Technologies-installed heat-treatment plant for a new ERW (Electric Resistance Welded) pipe mill in Baytown, Texas, the final acceptance certificate (FAC) was issued by the Turkish-owned company Borusan Mannesmann Pipe U.S. The special furnace is used to quench and temper oil country tubular grades (OCTG), which enables Borusan Mannesmann to produce a wide range of high-quality products for the demanding OCTG market. FCE - F&D Furnace Technologies equipment - part of the product portfolio of Primetals Technologies - was supplied that included quenching and tempering systems; a direct-fired, walking beam, austenitizing furnace; a high-pressure water-spray quench system; a convective walking-beam tempering furnace; the related material-handling equipment; all necessary instrumentation; and a PLC control system. Services included engineering, supply, installation and commissioning of the heat-treatment plant.

NEWS FLASHES

Altos Hornos de México S.A.B. de C.V.

Mexico

In December 2014, the contract commenced for the provision of maintenance, training and supervision services for the Steckel/plate mill and roll shop. The contract involves full-time on-site technical supervision and support that is being managed by Primetals Technologies USA in Worcester, Massachusetts, and Primetals Technologies Mexico.

Aperam Genk NV

Belgium

Primetals Technologies received an order to implement the first phase of an upgrading project for the Continuous Annealing and Pickling Line 2.

ArcelorMittal Ghent NV

Belgium

Industrial commissioning was completed for the first re-vamping phase of a Level 1 automation system for a continuous galvanizing line where the Primetals Technologies system interacts with the former Alstom 80 MT automation system. The start-up to full production and fulfillment of the required quality parameters was achieved within less than one day.

ArcelorMittal Kessales SA

Belgium

The PAC* was received for the upgrading of the Level 1 automation system of a skin-pass mill. The project included supervision of installation and commissioning.

Çemtaş Çelik Makina Sanayi ve Ticaret A.Ş.

Turkey

Hot commissioning is now underway at the new high-quality round and flat bar mill in Bursa. The mill has an annual rolling capacity of 210,000 tons. Phase I has been completed and production started at the new fully automated breakdown mill, which features a sliding reversing roughing stand with a maximum working roll centerline distance of 1,800 mm and a roll barrel length 1,800 mm. Phase II is ongoing for the installation of a new intermediate train.

Companhia Siderúrgica Nacional (CSN)

Brazil

Two orders were received for the modernization of the Level 2 automation systems of Blast Furnace No. 3 and Slab Caster No. 4.

Ereğli Demir ve Çelik T.A.Ş. (Erdemir)

Turkey

Primetals Technologies will upgrade the Level 2 automation system of Blast Furnace No. 2 and install a Level 2 automation system in Blast Furnace No. 1.

Ess Dee Aluminium Ltd.

India

The commissioning certificate was received for the revamping and upgrade of a 4-high foil mill that included supervision of installation and commissioning. This is the first ALU TCS project carried out in India.

Georgsmarienhütte GmbH**Germany**

The Level 2 process-optimization system will be extended to cover the entire steelmaking plant.

Hadeed Saudi Iron & Steel Company (Hadeed)**Saudi Arabia**

The Level 2 process-optimization system was started up for the electric arc furnace, ladle furnace and continuous caster in early December 2014.

Höganäs AB**Sweden**

The FAC* was received in March 2015 for the installation of a Level 2 process-optimization system for the ladle furnace and the alloying calculation system for the electric arc furnace.

Indian Iron & Steel Company Ltd. (IISCO)**India**

The 6-strand Billet Caster No. 1 was started up in December 2013, and the 6-strand Billet Caster No. 2 entered service in October 2014. Both casters have a combined casting capacity of approximately 1.7 million tons of steel per year. Construction of the Bloom/Beam-blank Caster No. 3 is now underway, which has an annual casting capacity of 460,000 tons of blooms or 475,000 tons of beam blanks. Cold trials have already commenced at this caster.

İskenderun Demir ve Çelik A.Ş., (İSDEMİR)**Turkey**

The Level 2 automation system was extended for Blast Furnace No. 3 following the successful installation of a Level 2 system in Blast Furnace No. 4. Both upgraded blast furnaces now operate on the same level of functionality.

JSW Steel Ltd.**India**

Primetals Technologies received the PAC* for the supply and installation of automation systems in Steel Making Shop I and in Steel Making Shop II in November 2014 and December 2014, respectively. The Level 2 automation system upgrade includes not only hardware, system software, network equipment and application software, but also metallurgical process models for the optimization of the production process and the necessary Level 1 modifications on the existing system.

JSW Steel Ltd.**India**

The oxygen-blowing lances of one converter were equipped with a quick-coupling system to automatically connect the media supply of the lances during their insertion into the converter. The system has been in operation since December 2014.

Kalika Steel Alloys Pvt. Ltd.**India**

The hot-commissioning phase is now taking place at the new rebar rolling mill in Jalna (Maharashtra state). The installed capacity is 250,000 t/a. The supplied equipment includes a new rolling train with 18 Red Ring stands, a Pomini Quenching System (PQS) and a 54-meter-long

cooling bed. This is the first so-called M3 rolling mill reference in India, which represents a highly streamlined and economical solution to ideally address local market needs.

OJSC Byelorussian Steel Works**Belarus**

On February 13, 2015, the FAC* was received for the Continuous Casting Machine No. 2, which is installed in Zhlobin, Belarus.

SAIL, Bokaro Steel Plant**India**

In September 2014, the Performance Guarantee Certificate was received from SAIL's (Steel Authority of India Limited) state-owned Bokaro steelworks for the installation of two 300-ton-capacity ladle refining furnaces installed in its Continuous Casting Shop & Steel Making Shop II.

Shaoguan Iron & Steel Group Songshan Co. Ltd. (Baosteel Group)**China**

The FAC* was received for the modernization of the rolling mill for alloyed bars in Guang Dong. The main equipment supplied includes new pre-finishing and finishing trains, a precision sizing mill and two abrasive saws for cold cutting. The mill has an annual production capacity of 460,000 tons.

Tata Steel Ltd.**India**

In February 2015, Tata Steel Ltd. placed a work order with Primetals Technologies to carry out a detailed onsite study of plant conditions and operating practices of their existing secondary emission-control system in the LD 1 steelworks in Jamshedpur. On the basis of the study report, Tata Steel will implement the future steps to upgrade the secondary dedusting system to meet the required emission levels.

Tata Steel Europe Ltd.**The Netherlands**

The first Transformation Monitor Sensor that utilizes EMspec technology in each sensor of a full three-sensor system will be installed in the hot-strip mill of the IJmuiden steelworks of Tata Steel Europe in early April 2015. The EMspec sensor is the world's only system that allows real-time measurements of the transformed phase fraction during the cooling of hot-rolled long or flat steel products.

voestalpine Stahl GmbH**Austria**

An order was received for the installation of new process models for Blast Furnace No. 5. In close cooperation with voestalpine automation specialists, the complete Level 2 process-optimization system of this blast furnace will be upgraded to the latest software generation.

*FAC = Final Acceptance Certificate

*PAC = Preliminary Acceptance Certificate

COVER STORY

**Primetals Technologies:
Birth of a new company
with a heritage of
technology and innovation**

CREATING THE FUTURE OF METALS AS ONE

**MITSUBISHI-HITACHI METALS MACHINERY
AND SIEMENS VAI METALS TECHNOLOGIES
HAVE FORMALLY MERGED TO FORM
A NEW PLANT-BUILDING COMPANY:
PRIMETALS TECHNOLOGIES LIMITED**

On January 7, 2015, Mitsubishi-Hitachi Metals Machinery, Inc. (MHMM) and Siemens VAI Metals Technologies GmbH (Siemens VAI) joined forces to form a new plant-building company: Primetals Technologies Limited. On the basis of the combined technological legacies of the predecessor companies, producers can count on a strong and experienced partner to provide end-to-end excellence across the metals value chain.



1.



2.

1. BLAST FURNACE TAPHOLE DRILLING

Dragon Steel Corporation, Taiwan

2. LD (BOF) STEELMAKING

with bottom stirring

3. SCRAP CHARGING

Ultimate EAF, Colakoğlu Metalurji A.S., Turkey



The intention to establish a new joint-venture company (JV) in steel and metal production machinery was announced in May 2014 by parent companies Mitsubishi Heavy Industries, Ltd. (MHI) and Siemens AG. Equity ownership in the new venture is 51% for MHMM (an MHI-consolidated group company with equity participation by Hitachi, Ltd. and IHI Corporation) and 49% for Siemens. MHMM and Siemens VAI ideally complement one another with regard to their product portfolios, manufacturing know-how and geographical spread. The technology strengths of the former Siemens VAI lie in particular in iron and steel production, continuous casting, electrics and automation, process know-how, plant integration, environmental technologies and lifecycle services. MHMM's competence is primarily focused on hot and cold rolling, processing and manufacturing expertise. With the combined portfolio of the JV partners, Primetals Technologies offers solutions for the entire value chain in iron and steel production that extend from the treatment of raw materials up to processing



3.

and finishing of the steel products, in addition to rolling mills and equipment for nonferrous metals.

GLOBAL NETWORK

A key reason behind the merger was to establish a truly global presence. The new company has six main regional bases: Japan, Austria, Germany, the United States, China and India. MHMM and Siemens VAI are a good match with respect to geographic coverage, a factor that will enable acceleration of worldwide business expansion into Asia, Europe, Russia, the Americas and Africa. The headquarters of the new company is located in the U.K., which will manage the regional bases and maintain cross-business functions in charge of sales and marketing, customer management, procurement, manufacturing and R&D planning to support each business. Currently, close to 9,000 employees of Primetals Technologies are based in more than 40 company offices and engineering, workshop and service centers to provide immediate support to customers whenever required. In addition, the

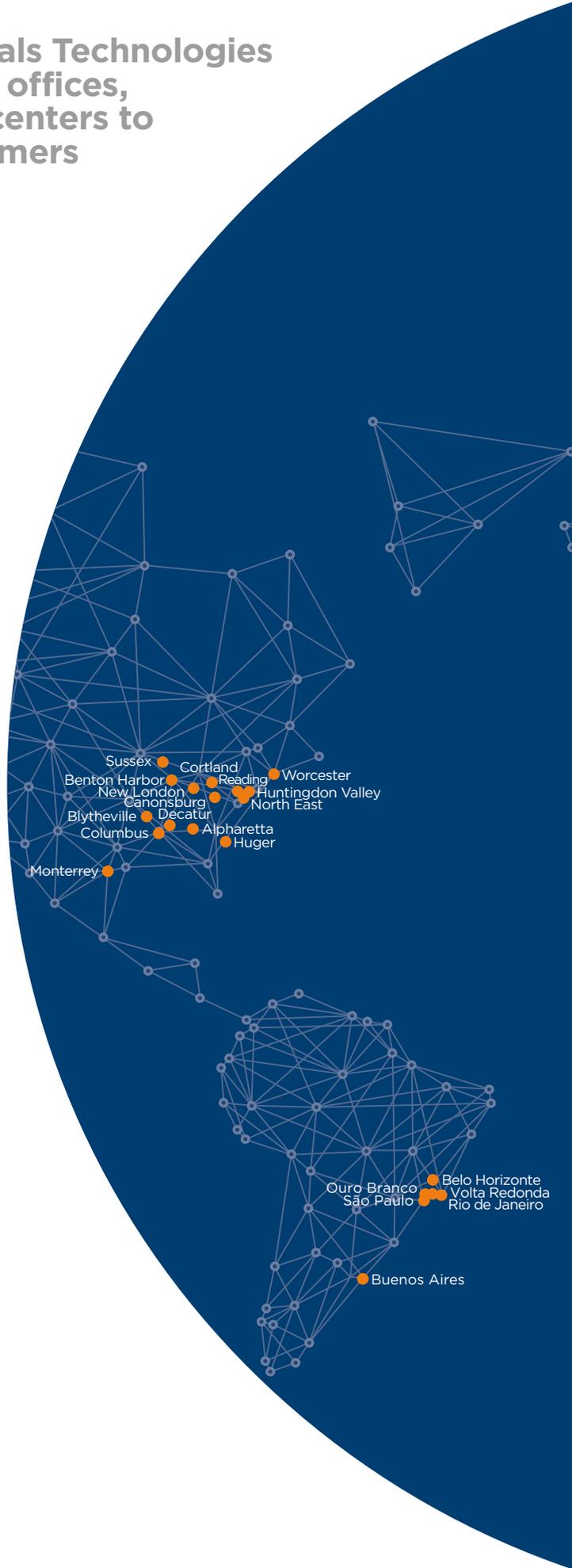
backing of the international office network of the parent companies MHI and Siemens provides more than 300 group sites located in 190 countries.

SIEMENS VAI HERITAGE IN PLANT-BUILDING COMPETENCE

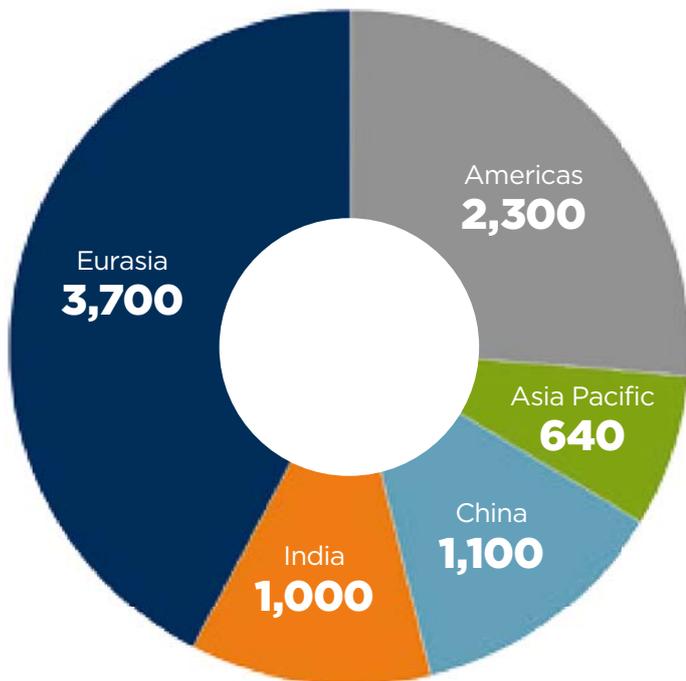
Siemens VAI has 60 years of experience in metallurgical engineering and plant building. With its strong R&D focus, Siemens VAI has introduced a number of innovations that today form the backbone of global steelmaking. These can be traced to the company's origin within the VÖEST steelworks – today voestalpine – in Linz, Austria, where in 1952 the first commercial oxygen steelmaking converter process was developed. The new technology was called LD steelmaking – named after the cities Linz and Donawitz where it was first applied at company steelworks. Today, the process is generally known as basic oxygen steelmaking (BOS) or basic oxygen furnace (BOF).

»

Close to 9,000 employees of Primetals Technologies are based in more than 40 company offices, engineering, workshop and service centers to provide immediate support to customers whenever required.



EMPLOYEES WORLDWIDE*



* Approximate values

GLOBAL NETWORK

Company offices and engineering, manufacturing and service centers



London is the headquarters of Primetals Technologies



In 1956, Voest-Alpine Industrieanlagenbau (VAI) was established to further develop and market this steelmaking technology on a global basis. The first order came from the Indian steel producer Rourkela. Continuous slab casting followed with the first straight mold caster introduced in 1968. After the acquisition of the Korf Engineering technology for smelting reduction, the first Corex unit was commissioned in 1989 in South Africa. In 1996, VAI acquired Fuchs of Germany, which significantly expanded the company's electric steelmaking portfolio. In 1999, it added the metals division of the Norwegian Kvaerner group, which itself had acquired the U.K. Davy McKee company and Clecim of France, providing blast furnace and rolling mill expertise. Italian bar mill manufacturer Pomini was acquired in 2001. Four years later in 2005, Siemens of Germany took over the VA Tech Group, which included VAI. Under Siemens, the first Finex plant commenced operation in 2007 as a modification of a Corex plant by South Korean steelmaker Posco. Long products

mill builder Morgan of the United States was acquired in 2008. In 2009, Siemens VAI jointly built the first endless strip production (ESP) plant for Arvedi of Italy as a further development of the Mannesmann Demag In-line Strip Production (ISP) plant originally installed at Arvedi's Cremona steelworks. The year 2011 saw the integration of vatron, a mechatronics competence center in Linz, and in 2012 the U.S.-based furnace-product lines company FCE Drever was acquired. The latest acquisition was of the U.S. company Service Guide Inc. in 2013.

MHMM HERITAGE IN PLANT-BUILDING COMPETENCE

MHMM also has a long pedigree of serving the metals industries. The company was launched in October 2000 as a JV between MHI and Hitachi Metals Machinery, Inc. It was originally named MHI-Hitachi Metals Machinery, Inc., and was changed to Mitsubishi-Hitachi Metals Machinery, Inc. (MHMM) in 2002. In 2004, a subsidiary of this com-

With the combined portfolio of the JV partners, Primetals Technologies offers solutions for the entire value chain in iron and steel production in addition to rolling mills for nonferrous metals.



1.

1. MONTBRISON, FRANCE

An example of one of the many worldwide workshops and manufacturing centers of Primetals Technologies

2. JIANGSU SHAGANG GROUP CO. LTD., CHINA

State-of-the-art hot rolling thanks to the installed technological packages and process models

3. HIGH-QUALITY COLD-ROLLED COILS

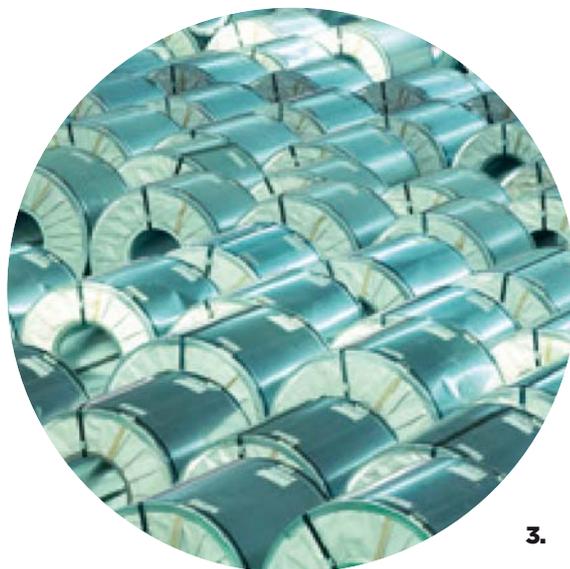
suitable for the most demanding downstream applications



2.

pany was founded in the United States, and the following year the U.S. company New Genecoat Inc. was acquired. In 2006, MHMM supplied a pickling line - tandem cold mill to Shougang Jingtang in China. One year later, a subsidiary company was established in Shanghai; and in 2010, Mitsubishi-Hitachi Metals Machinery South Asia Private Ltd. was set up in New Delhi. In 2013, the Ishikawajima Harima Jūkōgyō (IHI) Metaltech rolling mill business joined the group as well as Concast India. Also that year, a 100% holding in the Hasegawa Gear Works in Japan was obtained.

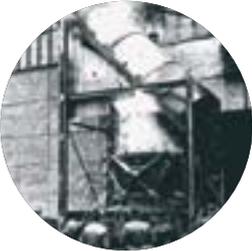
MHMM thereby acquired capabilities in product areas from continuous casting, hot and cold rolling, steel bar rolling up to downstream continuous annealing and galvanizing - all backed by in-house manufacturing and a strong sales network with engineering competence, particularly in Asia. As of April 2015, the company can refer to more than 2,200 plant references worldwide. »



3.

TECHNOLOGY LEGACY

PEDIGREE OF SIEMENS VAI METALS TECHNOLOGIES

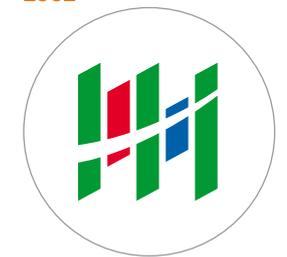
| | | | | |
|---|---|---|---|---|
| <p>1952</p>  <p>First LD steelmaking plant at the VOEST steelworks in Linz, Austria</p> | <p>1956</p>  <p>Founding of VAI; LD steelmaking plant sold to Rourkela, India</p> | <p>1968</p>  <p>Start-up of world's first continuous slab caster with straight mold</p> | <p>1989</p>  <p>Start-up of world's first commercial Corex plant</p> | <p>1996</p>  <p>Acquisition of Fuchs Group, Germany</p> |
|---|---|---|---|---|

| | | | | |
|---|---|--|--|---|
| <p>1999</p>  <p>Major increase in blast furnace competence through acquisition of Kvaerner Metals, U.K. (comprising former Davy and Clecim companies)</p> | <p>2001</p>  <p>Founding of VAI Pomini, Italy</p> | <p>2005</p>  <p>Power Coiler for coiling of thick strip; Siemens acquires VA TECH Group, including VAI</p> | <p>2007</p>  <p>World's first Meros plant - maximized emission reduction of sintering. Start-up of world's first Finex commercial plant</p> | <p>2008</p>  <p>Acquisition of Morgan, U.S.A.</p> |
|---|---|--|--|---|

| | | | |
|--|--|--|---|
| <p>2009</p>  <p>Start-up of the first Arvedi ESP (endless strip production) line in Cremona, Italy</p> | <p>2011</p>  <p>Integration of vatron (Mechatronic Competence Center), Linz, Austria</p> | <p>2012</p>  <p>Acquisition of FCE, U.S.A.</p> | <p>2013</p>  <p>Acquisition of Service Guide, U.S.A.</p> |
|--|--|--|---|

Primetals Technologies offers a complete technology, product and service portfolio that ultimately comes to the benefit of producers. The company is dedicated to continuing its tradition of technological innovation and to creating the future of metals – as one.

PEDIGREE OF MITSUBISHI-HITACHI METALS MACHINERY

| | | | | |
|---|---|--|---|--|
| <p>1984</p>  | <p>1990</p>  | <p>2000</p>  | <p>2002</p>  | <p>2004</p>  |
| <p>Start-up of first hot-strip mill equipped with Pair Cross mill stands at Nippon Steel, Hirohata Works, Japan</p> | <p>Three hot-strip mills (investment phase 1) supplied to Posco Gwangyang Works, South Korea</p> | <p>Founding of MHI-Hitachi Metals Machinery, Inc. joint-venture company</p> | <p>Corporate name changed to Mitsubishi-Hitachi Metals Machinery, Inc.</p> | <p>Founding of Mitsubishi-Hitachi Metals Machinery, Inc., U.S.A.</p> |
| <p>2005</p>  | <p>2006</p>  | <p>2007</p>  | <p>2010</p>  | <p>2010</p>  |
| <p>Acquisition of New Gencoat, Inc., U.S.A.</p> | <p>MHMM receives contract for supply of pickling line and tandem cold mill from Shougang Jingtang Inc., China</p> | <p>Mitsubishi-Hitachi Metals Machinery, Inc. established in Shanghai, China</p> | <p>Start-up of joining machine for hot-rolling mill (joint development of Posco, South Korea, and Hitachi, Japan)</p> | <p>Founding of Mitsubishi-Hitachi Metals Machinery South Asia Private Ltd.</p> |
| <p>2012</p>  | <p>2013</p>  | <p>2013</p>  | <p>2013</p>  | |
| <p>Start-up of No. 2 Hot-Rolling Mill at Usiminas in Cubatão, Brazil</p> | <p>Integration of IHI Metaltech rolling mill business</p> | <p>Concast Ltd, India joins Mitsubishi-Hitachi Group</p> | <p>Acquisition of 100% shares of Hasegawa Gear Works, Ltd.</p> | |

THE COMBINED PORTFOLIO OF THE JV COMPANIES

- Integrated mills
- Minimills
- Beneficiation plants
- Coking plants
- Sinter and pellet plants
- Blast furnaces
- Corex and Finex ironmaking plants
- Direct-reduction plants
- Converter steelmaking plants
- Electric steelmaking plants
- Stainless steelmaking plants
- Secondary metallurgical facilities
- Continuous casting plants
- Arvedi ESP plants (endless strip production)
- Strip-casting plants
- Plate and Steckel mills
- Hot-strip rolling mills
- Pickling plants
- Cold-rolling mills
- Nonferrous rolling mills
- Bar, wire rod, section, rail, tube and pipe mills
- Strip-processing and finishing lines
- Environmental plants
- Electrics and automation
- Metallurgical, consulting and financial services
- Modernization packages

GOVERNANCE

The shareholders have appointed five directors to manage the new company as follows:

Yasukuni Yamasaki
Chief Executive Officer (CEO) and Chairman of the Board

Peter Schraut
Chief Financial Officer (CFO)

Heiner Röhl
Chief Operating Officer (COO) - Upstream

Ryoichi Nishi
Chief Operating Officer (COO) - Downstream

Etsuro Hirai
Chief Technology Officer (CTO)

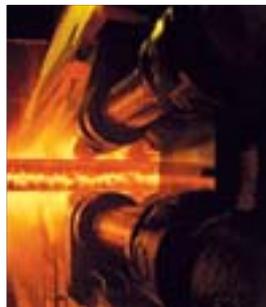
BUSINESS AREAS OF PRIMETALS TECHNOLOGIES



IRONMAKING



STEELMAKING AND LONG ROLLING



CASTING & ENDLESS ROLLING



STRIP CASTING



HOT ROLLING



COLD ROLLING



PROCESSING, TUBE AND PIPE MILLS



ECO SOLUTIONS

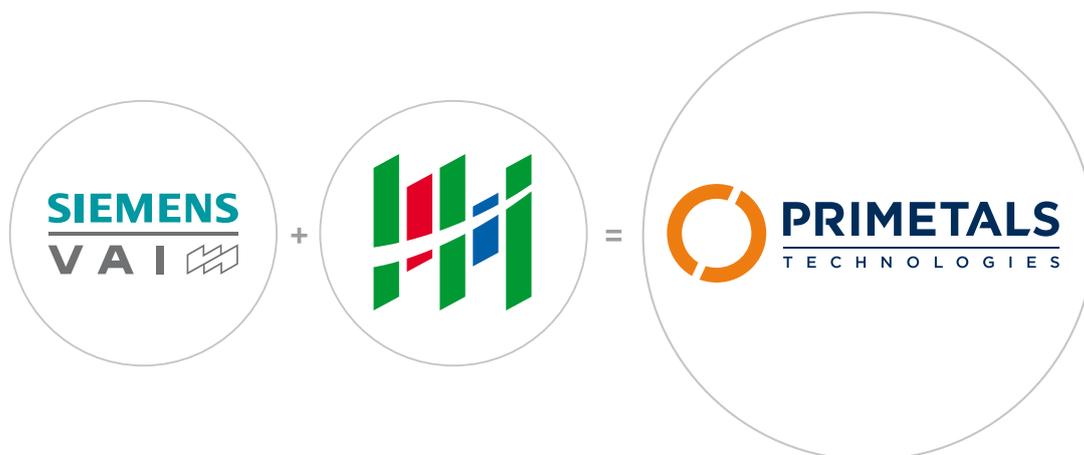


ELECTRICS AND AUTOMATION



METALLURGICAL SERVICES

A NEW LOGO FOR A NEW COMPANY



THE NEW NAME

Following a lengthy and detailed name-selection process, it was decided to create a completely new brand name: Primetals Technologies. This would underline the opening of a new chapter in the joint company history. Primetals Technologies is a combination of the words prime, metals and technologies. It reflects a commitment to deliver the best (prime) and the most advanced technologies to produce the highest-quality metal products. The name prime also echoes the impressive technology legacies that all of the previously merged companies of the JV partners have brought to the new organization.

THE LOGO

The logo of the new company consists of two separate arcs that symbolize the forging of two strong partners into a single, unified whole, but which reflects the differing intrinsic values, cultures and characteristics of the JV partners. The split circle indicates forward motion focused on the future. The orange color signifies the temperature of the steel transition from the liquid phase to the solid phase - the point at which the outstanding technological strengths of Siemens VAI in the liquid phase meet the rolling and processing excellence of MHMM in the solid phase. The company name stands to the right of the circle.

PORTFOLIO OF PRODUCTS AND SERVICES

On the basis of the experience and expertise acquired from the successful implementation of thousands of projects for the global metals industry, Primetals Technologies provides advanced and optimized solutions for integrated steelworks and minimills, for new and existing plants, and for all auxiliary facilities. The vertically integrated supply portfolio comprises mechanical equipment and mechatronic systems; drives, motors, automation, electrics and electronics; and utility supply and energy technologies. Primetals Technologies manufactures much of the core components used in its plant machinery at its own state-of-the-art factories and workshops. This underlines the company commitment to

ensure that the machines and systems supplied meet the highest standards with respect to workmanship, reliability and durability. A key focus is placed on continuous improvement of products and processes, achieved in both incremental steps and by fostering a culture of innovation within the company. The results are seen in groundbreaking and pioneering product developments and solutions that enable customers to meet the increasingly stringent requirements for environmental standards and energy efficiency while reducing energy consumption and production costs. Primetals Technologies also has unrivaled experience in the modernization of metallurgical facilities. The objective is to ensure that machines and equipment operate at peak performance and in a cost-efficient manner throughout their entire lifetime. Through the installation of innovative technology packages and the integration of process-optimization systems, long-term value is created for customers. The results can be seen in significant improvements in productivity, product quality, plant flexibility and safety.

Primetals Technologies thus offers a complete technology, product and service portfolio that ultimately comes to the benefit of producers. The company is dedicated to continuing its tradition of technological innovation and to creating the future of metals - as one. ●

Dr. Tim Smith, Independent Consulting Editor

Dr. Lawrence Gould, Managing Editor, Metals Magazine



To download the Primetals Technologies image brochure, visit primetals.com or scan the QR code.

To see a film about the merging of the two companies to form Primetals Technologies, visit <http://youtu.be/f98TxbfDlak> or scan the QR code.



A MAN WITH **A PASSION FOR METALS**

**INTERVIEW WITH YASUKUNI YAMASAKI,
CEO AND CHAIRMAN OF PRIMETALS TECHNOLOGIES**

On January 7, 2015, a joint venture between Mitsubishi Heavy Industries (MHI) and Siemens was formally inaugurated to create a new plant-building company for the metals industries. The company name: Primetals Technologies.

YASUKUNI YAMASAKI

discusses the product portfolio of Primetals Technologies and his visions for meeting the challenges facing the metals industries





“ Combining the operation of a Japanese company with that of a European one can lead to a concerted effort to the benefit of our customers.”

“The two cultures will complement one another in the global network in which we work with customers who themselves have a range of cultures.”

With its headquarters based in Chiswick, London, Primetals Technologies brings together the global expertise of the metals divisions of the parent companies Mitsubishi Heavy Industries and Siemens. With around 9,000 employees across the world, the task of welding the two entities into one has fallen on one of MHI's most experienced engineers, Yasukuni Yamasaki, who has been appointed CEO and Chairman of the Board. In the following interview, Yamasaki explains the aims and scope of the joint venture. The interview was conducted by Dr. Tim Smith, a metallurgist by training and now an independent consulting editor for the steel and aluminum industries.

ABOUT THE COMPANY

Tim Smith: Primetals Technologies was officially launched in January. What are your first priorities as CEO of this joint venture?

Yasukuni Yamasaki: Post-merger integration following the joint venture is a priority. Synergies will be targeted so that by working together we can improve operating efficiency. Transparency in operation is an important factor. Combining the operation of a Japanese company with that of a European one can lead to a concerted effort to the benefit of our customers. The two cultures will complement one another in the global network in which we work with customers who themselves have a range of cultures.

What has been the general response of customers so far regarding the new company?

Yamasaki: I have already visited a number of customers in Europe, the United States, Japan, and other parts of Asia. So far, all have responded positively to the joint venture. They see the different cultures between the two organizations as a benefit to meeting their specific needs at their individual locations.

MARKETS

Worldwide demand for steel is expected to grow 2.5% this year and installed capacity will reach 2.1 billion tons. However, global overcapacity has doubled since 2001 to around 440 million tons. Of this total, China accounts for 58%, North America 10%, Europe 9%, CIS 7%, Latin America 6%, Japan 5% and India 5%. With these statistics in mind, which regions of the world have the greatest potential for new plants or upgrades?

Yamasaki: India has considerable potential for growth with a population close to that of China, but with a steel output of only about one-tenth of China's. The economic model of India is very different from the Chinese system, but the growth rate is comparable. The Indian government has plans to make major improvements in infrastructure, a fundamental requirement of which is steel. Other regions of importance are the Middle East and North Africa. Greenfield plants in Europe, the United States and Japan are unlikely, but the growing demand for high-grade steels from these three regions will require revamping of existing equipment.

Steel demand in Europe has fallen 32% since 2007. Likewise, there have been significant drops in demand in Japan and the United States. Do you see this destroying the market for new plants and upgrades in these regions? Or do you view this as an opportunity for upgrades to make steel producers more competitive?

Yamasaki: In these regions there is growing demand to save energy and meet increasingly stringent environmental limitations, which requires upgrading and renewing plant equipment. There is also a need to improve plants for downstream processing as more high-quality and high-strength steels are demanded. New technologies are required to meet some of these demands both upstream and downstream of steel production. »



“ Primetals Technologies has the technology to deliver complete solution packages.”





“The Quantum EAF with a scrap preheater shaft can provide a 30% reduction in CO₂ emissions. Such a furnace is being paired with the Arvedi ESP inline casting and rolling plant, which itself can lower energy consumption by 40%.”

Which minimill solutions offered by Primetals Technologies would be of potential interest for smaller-sized producers?

Yamasaki: Primetals Technologies has the technology to deliver complete solution packages. For the minimill, we can provide everything from the electric arc furnace, casting and rolling technologies all the way to finishing for both long and flat products. Innovative technologies are also available such as nonstop rolling to rod in which hot billets are welded tail to head for continuous entry into the mill. This is more cost-effective than traditional interrupted processes. However, for small tonnages or frequent changes in grade and size, sometimes a batch process is more feasible. For minimills rolling flat products, direct linking of the caster to the strip mill is commercially viable. Primetals Technologies already has such technologies in its portfolio that includes the Arvedi ESP process as well as the Mitsubishi endless and semi-endless inline rolling of thin slab. These technologies provide smaller physical footprints than conventional casters and mills, and they can save as much as 40% in energy. A twin-drum strip caster is also part of the product portfolio of Primetals Technologies.

Turkey is now the 8th largest producer of steel in the world (34 million tons in 2014) with Germany ranking 7th (42.9 million tons in 2014). Which of these two countries has the greatest potential for new and upgraded plants?

Yamasaki: We see a growing market for new equipment to increase the output of flat products in Turkey, and we have received inquiries for this. In Germany, the demand is for upgrading existing plants to improve product quality, reduce energy requirements and increase automation.

TECHNOLOGY

Reducing CO₂ emissions is a driving force, in particular in Europe and Japan where legislation is penalizing steelmakers who emit over a set threshold. Do you see a change in steelmaking technology to reduce emissions, such as through more electric arc furnace (EAF) steelmaking and more direct-reduced iron (DRI) feed, or do you expect fundamental changes such as those aimed at halving emissions as being explored by ULCOS [Ultra-Low CO₂ Steelmaking] in Europe and the COURSE 50 [CO₂ Ultimate Reduction in Steelmaking Process by Innovative Technology for Cool Earth 50] program in Japan?

Yamasaki: Electric arc furnaces and the use of DRI can reduce the carbon footprint. The Quantum EAF with a scrap preheater shaft, for example, can provide a 30% reduction in CO₂ emissions. Such a furnace is being paired with the Arvedi ESP inline casting and rolling plant, which itself can lower energy consumption by 40%. These technologies are aimed at the minimill steelmaker rather than integrated mills where the high investment costs of installed plants make replacements difficult. »

“The plant now being built by Primetals Technologies in Texas makes use of the low-cost shale gas presently exploited in the U.S. and will produce hot-briquetted DRI (HBI) suitable for shipment to Europe or elsewhere as a blast furnace feed.”

Two of Siemens VAI's lower-energy technologies, Finex and Arvedi ESP, were developed closely with steel companies. Do you envisage similar collaborations with other steelmakers?

Yamasaki: Yes, if a steelmaker requests joint development of a technology, we are willing to embark on joint-venture projects. Finex and Arvedi ESP are examples where this has already happened successfully with both technologies now being sold to other steelmakers.

The exploitation of shale gas in the United States has resulted in a renaissance of DRI plants in the country. An example is the plant equipment supply for a 2-million-ton-per-year hot-briquetted DRI (HBI) plant by Primetals Technologies in Texas for the export of merchant HBI as a blast furnace feed. Do you see potential for more such projects that do not require the more stringent DRI qualities required for the EAF?

Yamasaki: I do not expect shale gas to have a major influence on steelmaking technologies in Europe. For the integrated mill, productivity can be increased by charging pre-reduced iron, which lowers CO₂ emissions per ton of iron output. The DRI for this application does not require the low gangue ores needed for an EAF, as there are fewer regulations limiting the amount of slag formed. The plant now being supplied by Primetals Technologies in Texas makes use of the low-cost shale gas presently exploited in the U.S. and will produce hot-briquetted DRI (HBI) suitable for shipment to Europe or elsewhere as a blast furnace feed.

A number of thin-slab inline rolling processes are available to customers today. Is there a particular advantage in the Arvedi ESP process supplied by Primetals Technologies that will win new customers?

Yamasaki: The Arvedi ESP process can readily produce thin hot band rolled to as little as 0.8 mm gauge and even thinner. This can replace cold-rolled and annealed material for these gauges at much lower processing costs.

Will metallurgical services continue to play a key role in the business activities of Primetals Technologies?

Yamasaki: Customers increasingly want a complete life-cycle service, which we can provide. Outsourcing of such functions is now common in the United States and in Europe. On top of routine maintenance, Primetals Technologies can upgrade plant automation to maintain the plant working at optimum efficiency. This service is also offered for third-party equipment.

Where there are overlapping technologies between MHMM and Siemens VAI, such as in hot-strip mills and flue-gas cleaning, will new customers be given the choice of either technology?

Yamasaki: There is little overlap in the portfolios of the two joint-venture companies. MHMM had, for example, no caster technology comparable to that of Siemens VAI. MHMM brings particular expertise in the hot-strip mill, such as the Pair Cross Mill stand for strip crown and flatness control, and the sizing press to minimize caster mold changes. The joint venture has enlarged the portfolio that can now be offered to customers.

The construction market accounts for 40% of all finished steel. Do you therefore see a need to increase development of plants to produce long products and plate?

Yamasaki: We do offer many technologies for long products, including head-hardened rails for railways, endless bar rolling mills as previously mentioned, beam mills and plate mills.

The company slogan is “Creating the future of metals as one.” Does this also mean increasing Primetals Technologies' portfolio for nonferrous metals – aluminum in particular?

Yamasaki: Yes. Rolling mills for aluminum and copper foil are already part of the technologies offered and forecasts indicate an increasing demand for aluminum sheet for the automotive sector.

I note that you have been in the metals business for more than 35 years. Do you feel that experience in industry is more beneficial than the drive of youth?

Yamasaki: The metals business is very complicated and draws on a mixture of technologies. A young graduate engineer may take ten years working in a company to fully learn the trade, and a further ten years to gain the mechanical, electrical and automation experience. After that, the person is ready to negotiate with customers. Managerial skills must also be fully developed before senior positions of responsibility can be undertaken. Every employee should have a passion to work in this field. I definitely have passion for the metals business and would like to work as long as possible. ●

“Every employee should have a passion to work in this field. I definitely have passion for the metals business and would like to work as long as possible.”



YASUKUNI YAMASAKI
CHIEF EXECUTIVE OFFICER AND
CHAIRMAN OF THE BOARD OF
PRIMETALS TECHNOLOGIES

1973: Graduated from Keio University in Tokyo with a bachelor's degree in electrical and automation engineering

Joined Mitsubishi Heavy Industries, Ltd, Hiroshima Shipyard & Engine Works as an engineer where he worked his way up through various appointments to become the General Manager of the Machinery Designing Department

2000: General Manager of Machinery Designing Department, Steel Manufacturing of Mitsubishi Heavy Industries, Ltd, Hiroshima Works

2002: General Works Manager of Mitsubishi-Hitachi Metals Machinery, Inc., Hiroshima Works

January–April 2006: President of Mitsubishi-Hitachi Metals Machinery USA, Inc. He was recalled to become president of Mitsubishi-Hitachi Metals Machinery, Inc. when the former president, Shunichi Miyanaga, was appointed president of the parent company, Mitsubishi Heavy Industries, Ltd.

April 2006 onwards: President of Mitsubishi-Hitachi Metals Machinery, Inc.

2010: President of Mitsubishi-Hitachi Metals Machinery, Inc. and Senior Vice President of Mitsubishi Heavy Industries, Ltd.

2014: Executive Officer of Mitsubishi Heavy Industries, Ltd, Machinery, Equipment & Infrastructure

2015: Chief Executive Officer and Chairman of Primetals Technologies.

TECHNOLOGY

END-TO-END EXCELLENCE

ACROSS
THE METALS
VALUE CHAIN

**PRIMETALS TECHNOLOGIES CREATES LONG-TERM
VALUE FOR METALS PRODUCERS WITH
ADVANCED TECHNOLOGY AND INNOVATION**



65

TECHNICAL PAPERS FROM PRIMETALS TECHNOLOGIES AT THE ESTAD CONGRESS

As a worldwide leading engineering, plant-building and lifecycle partner for the metals industry, Primetals Technologies offers an unparalleled world-class technology, product and service portfolio for every step of the iron and steel production route, in addition to nonferrous rolling. This also includes the integrated electrical, automation and environmental systems. This comprehensive capability will be demonstrated at the METEC trade fair & 2nd European Steel Technology and Application Days (ESTAD) 2015 (June 15-19) where Primetals Technologies will hold 65 technical lectures – approximately 10% of the total number to be presented. These impressive figures eclipse by far the number of papers submitted by any other company. Abstracts of the Primetals Technologies ESTAD papers are grouped according to their respective technological areas and presented in the following sections.



DRAGON STEEL CORPORATION, TAIWAN

A DEMONSTRATION OF THE COMBINED
TECHNOLOGICAL POWER OF
SIEMENS VAI AND MHMM,
NOW PRIMETALS TECHNOLOGIES



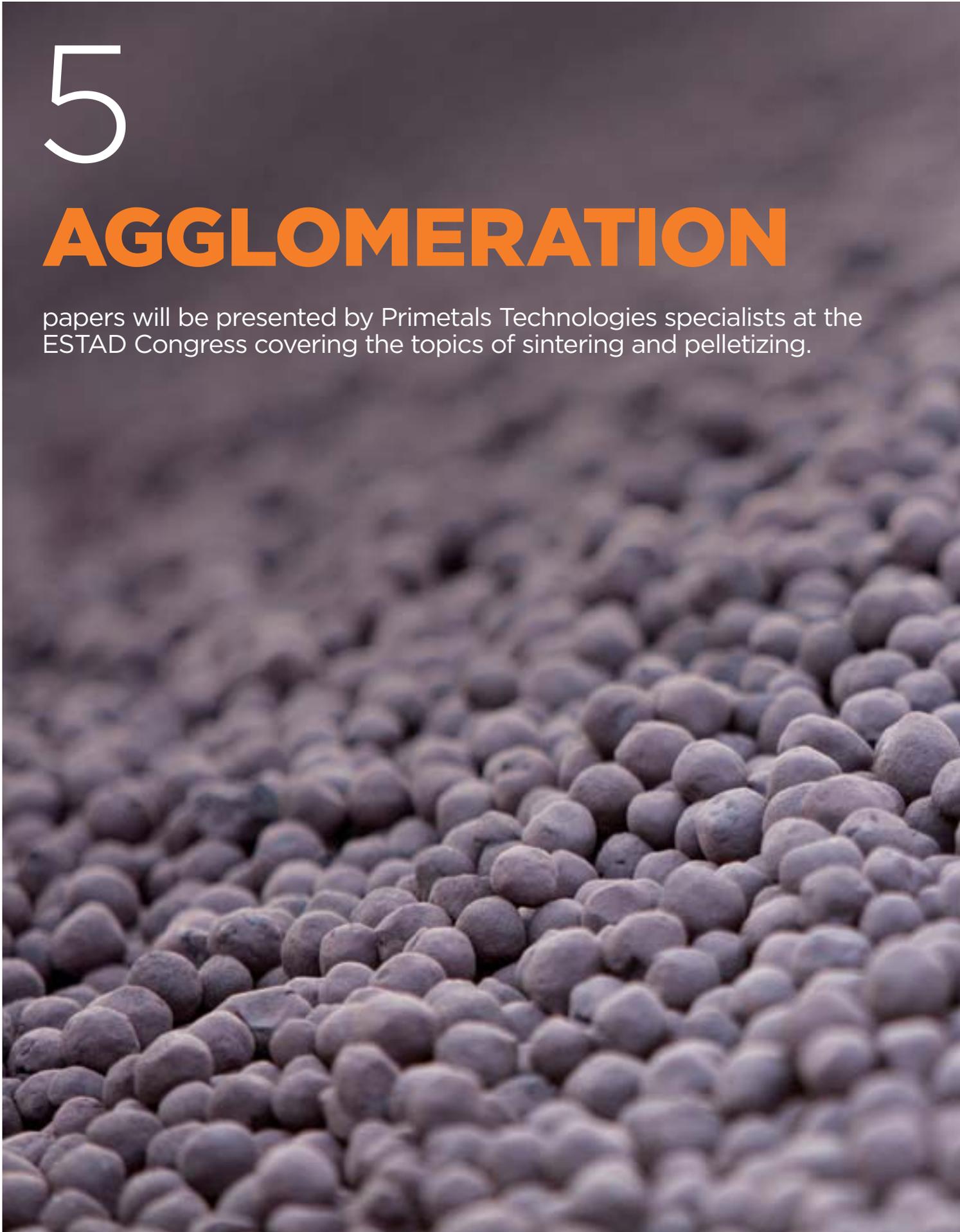


Supplied plants: two sinter plants (rated total capacity of 6 million t/a of sinter); two 12-meter-diameter blast furnaces (rated hot metal output of 2.5 million t/a each); three 2-strand slab casters (rated total annual capacity of more than 5 million tons of slabs); a 7-stand, 4-high hot-strip rolling mill capable of producing nearly 4 million t/a of strip with widths up to 1,880 mm; and the related electrical, automation and environmental systems.

5

AGGLOMERATION

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of sintering and pelletizing.





The simulations provide valuable information for the design of greenfield plants and allow simulations for different plant configurations to be made.



Temperature development across the sinter machine

NUMERICAL SIMULATION OF THE SINTERING AND THE PELLETIZING PROCESSES

Principal author: Dr. Johann Reidetschläger
Paper number: 237

Changing the raw materials in an operating plant can significantly influence the sintering or pelletizing process. Adjusting all process parameters to regain stable and high productive operations takes considerable time and incurs production losses. Furthermore, changes in raw materials lead to variations in process gas flows and emission concentrations. Therefore, Primetals Technologies has developed two models for the numerical simulation of the sintering process and the pelletizing process. Among others, the models are based on the Ergun equation and include chemical reactions of the related processes. For plants already under operation, the simulations predict changes in the process parameters when raw materials are exchanged or when operational parameters are varied. In addition, the simulations provide valuable information for the design of greenfield plants and allow simulations for different plant configurations to be made. This paper describes the latest developments in the field of numerical simulations and shows how these sophisticated calculation tools can help producers master future challenges in agglomeration.



Selective Waste Gas Recirculation system installed at Dragon Steel Corporation, Taiwan

With the next generation of SWGR, Primetals Technologies can provide an energy-optimized, emission-optimized and environmentally friendly solution.



THE NEXT GENERATION OF SELECTIVE WASTE GAS RECIRCULATION SYSTEMS FOR SINTER PLANTS

Principal author: Marlene Mühlböck; Paper number: 242

Increasingly stringent global environmental regulations are forcing steel producers to continually improve the efficiency of sinter waste gas treatment. With the Selective Waste Gas Recirculation (SWGR) system from Primetals Technologies, lower production costs can be achieved and the size of downstream waste-gas-cleaning units can be reduced for investment savings. SWGR features the extraction and reuse of hot sinter offgas from selected wind boxes along the sinter strand, which contributes to improved energy efficiency and offgas treatment in the sintering process. The main emission components in sinter offgas are CO, CO₂, SO_x, NO_x and dioxins. The level of gaseous emissions depends on the physical and chemical properties of the sinter raw mix. Additionally, there are

typical distribution profiles of the waste gas components emitted along the sinter strand. Therefore, the portion of sinter waste gas used for recirculation has a major impact on the final offgas treatment prior to the release to the environment through the stack. Different offgas-extraction and -recirculation strategies have therefore been developed. With the next generation of SWGR, Primetals Technologies can provide an energy-optimized, emission-optimized and environmentally friendly solution that meets customer requirements and local regulations. This paper demonstrates the latest developments in selective waste-gas recirculation, particularly the adjustable configuration of waste-gas recirculation schemes aligned to specific requirements.

Recovery of the sensible heat of sinter during cooling noticeably improves the energy efficiency of a sinter plant (photo: Dragon Steel Corporation, Taiwan)



ECONOMIC WASTE-HEAT RECOVERY FOR DIFFERENT SINTER COOLER TYPES

Principal author: Gerald Strasser; Paper number: 262

In the energy-intensive sintering process, fine iron ore, recycled process materials, additives and fossil fuels are agglomerated to fulfill the requirements for high-performance blast furnace operations. The sintered material is discharged from the sinter strand in a temperature range between 500°C and 700°C and cooled down to less than 100°C on the sinter cooler. The sensible heat of the produced sinter, which amounts to about half of the total energy input, is normally lost to the environment at the sinter cooler. For a typical sinter plant with a capacity of 4.5 million t/a, more than 800,000 MWh/a of thermal energy – equivalent to the average annual heating energy requirements of some 40,000 central European households – is wasted as a result of cooling. To reduce energy costs, plant operators are increasingly looking at solutions

to utilize this heat in an economic way. Waste-heat recovery systems have therefore been developed to meet the specific requirements of different sinter cooler types and on-site conditions. By means of specially designed cooler hoods, the bulk of the thermal energy in hot sinter can be extracted and efficiently used in a waste-heat boiler for steam generation. The steam can then be fed either to the local steam network for various local applications, or applied to produce electricity in a dedicated modular power block. By additional firing of low-calorific blast furnace gas in an external superheating system, the steam temperature and pressure can be further increased to meet local requirements. Technologies to improve the efficiency of heat-recovery during sinter cooling are discussed in this paper.

The shaft cooler design allows the total heat capacity of the hot sinter to be utilized for heating the cooling air that moves in counterflow to the sinter during its descent through the shaft.

THE SINTER SHAFT COOLER: A HIGHLY ENERGY-EFFICIENT SOLUTION FOR SINTER COOLING

Principal author: Dr. Michaela Böberl
Paper number: 239

Primetals Technologies has developed a new sinter shaft cooler that is not only highly energy-efficient but is also much more environmentally friendly than conventional sinter coolers. The shaft cooler design allows the total heat capacity of the hot sinter to be utilized for heating the cooling air that moves in counterflow to the sinter during its descent through the shaft. With this solution, the temperature of the cooling air exiting the shaft can be maximized and more efficiently applied for the generation of steam and electricity in downstream process steps, or used for preheating and drying of materials or media used in a steelworks.

Compared to conventional sinter coolers, the sinter shaft cooler features lower specific investment and production costs, a reduced energy consumption for sinter cooling, a higher throughput, and reduced dust and other emissions due to a closed cooler shaft system. In this paper the features, benefits and challenges of the sinter shaft cooler are presented.

CIRCULAR PELLETIZING TECHNOLOGY: A REVOLUTIONARY SOLUTION

Primary author: Reinhard Redl
Paper number: 245

As the quality of raw materials worldwide is constantly decreasing, ultra-fine ore grades will dominate the future of iron- and steelmaking. The share of pellets in total iron production has increased steadily over the last ten years, and this trend is expected to intensify in the mid- and long term. In order to become independent of the steadily rising prices for pellets in the world market, steel producers are increasingly looking into the possibility to produce pellets directly at the steel plant site. By doing so, they can additionally achieve the exact chemical properties that are required for optimized production and improved product quality. Mine operators are also seeking an efficient, compact and feasible pelletizing technology to produce pellets within a smaller output range when this is required. Circular Pelletizing Technology (CPT) from Primetals Technologies is the next step in the evolution of highly efficient, ultra-compact pelletizing plants. Its footprint is significantly smaller than conventional plants and it offers a completely new level of flexibility in plant integration and pellet production. Iron and steel producers are thereby protected from the rising costs for pellet supply.



Construction of the world's first CPT plant at Pro Minerals Pvt. Ltd., Keonjhar, Orissa, India (February 2015)

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IRONMAKING

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of blast furnace ironmaking, Corex and Finex smelting-reduction technology, and solutions for processing direct-reduced iron (DRI) and by-products.

Blast Furnace A,
voestalpine Stahl GmbH,
Austria



Primetals Technologies is able to provide a customer-focused and reliably engineered hot blast system to the ironmaking industry.

IMPROVEMENTS TO THE HOT BLAST SYSTEM FOR BLAST FURNACES

Principal author: Mark Geach

Paper number: 252

Since the mid-2000s, Primetals Technologies has made a number of important contributions to improve the engineering, design, supply and installation of the hot blast system to meet producer requirements. This paper addresses numerous developments related to the external stove crossover, refractory arrangement of the hot blast system, refractory material supply and quality control, combustion (heating) cycle control, modified combustion cycle (flue-gas recycling) for increased efficiency, and refractory chequer design. In the course of developing the hot blast system during the past ten years, Primetals Technologies has consulted with its global network of ironmaking customers to learn more about their requirements. The result is innovative and tailored engineering solutions that have subsequently been applied throughout the company's design portfolio for blast furnaces. Primetals Technologies is therefore able to provide a customer-focused and reliably engineered hot blast system to the ironmaking industry.



External stove crossover of the hot-blast system from Primetals Technologies



Cooling-stave arrangement in the blast furnace

BLAST FURNACE COOLING STAVE DESIGN

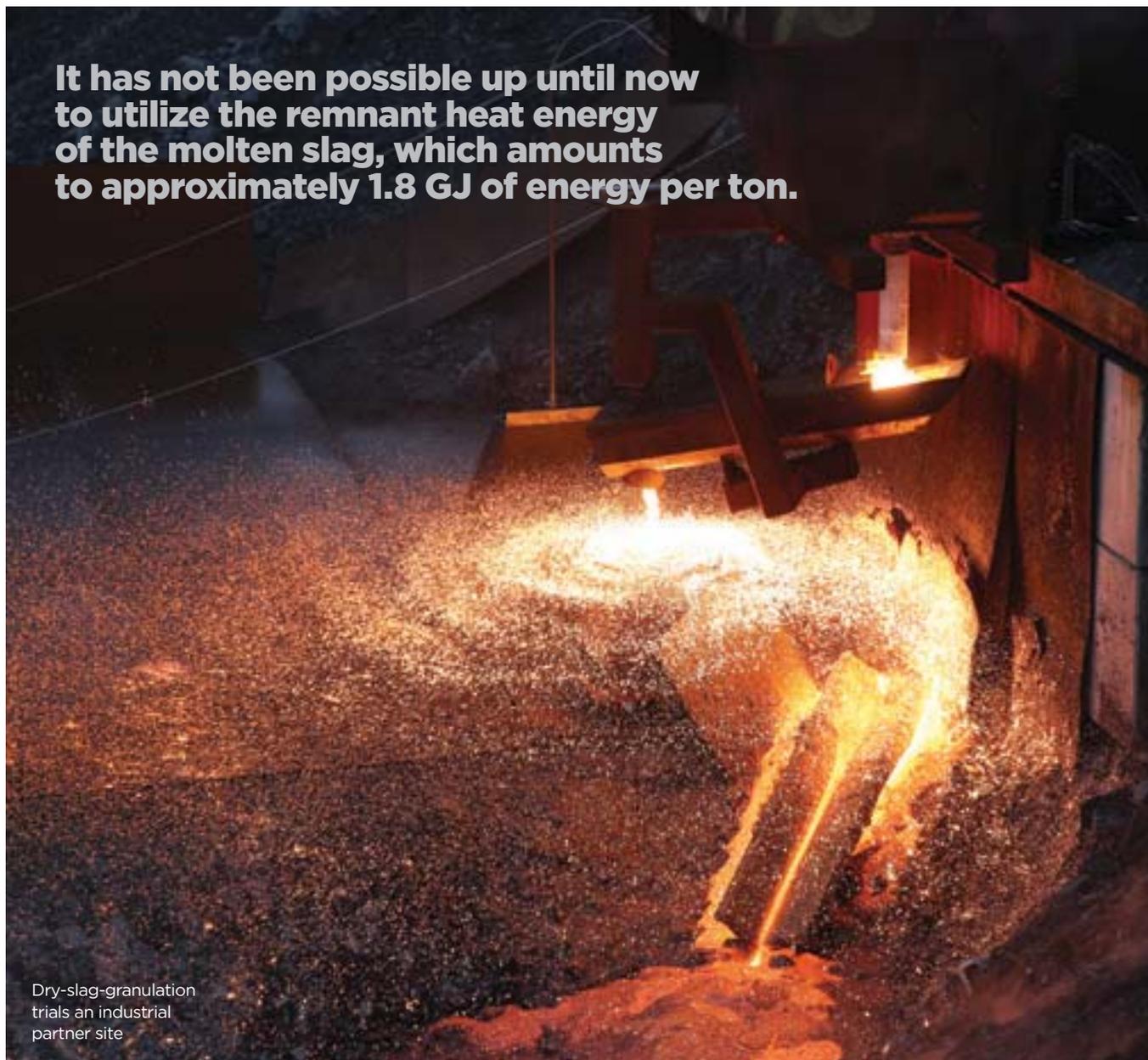
Principal author: Martin Smith

Paper number: 250

The quality of the cooling system design is critical for any blast furnace campaign. Over the many years of blast furnace history, cooling systems have evolved and changed to give an optimum design today that provides a long campaign life balanced against future costs. In recent years, the latest evolution of the cooling system design has been related to the shape of the copper stave, which is now considered state of the art and has become an established feature on a large number of furnaces around the world. When first introduced, the copper stave was marketed as the ultimate cooling element, since it not only provided a cooling function but also featured self-protection through the formation of an accretion layer. Lately, however, furnaces equipped with a copper stave design have been affected by significant problems that have arisen during operation. This has led to premature failure of the staves and reduced campaign life. This paper reviews the evolution of the copper stave design and illustrates the latest techniques applied by Primetals Technologies in this critical area.

The quality of the cooling system design is critical for any blast furnace campaign.

It has not been possible up until now to utilize the remnant heat energy of the molten slag, which amounts to approximately 1.8 GJ of energy per ton.



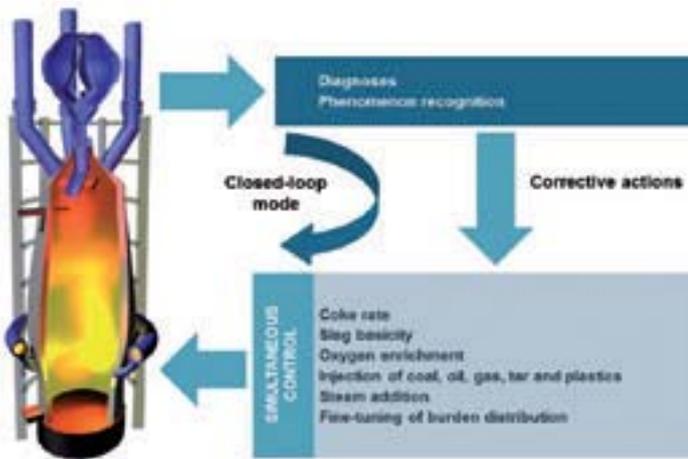
Dry-slag-granulation trials an industrial partner site

DRY SLAG GRANULATION WITH HEAT RECOVERY

Principal author: Ian McDonald; Paper number: 251

Each year, approximately 400 million tons of blast furnace slag are produced worldwide with a tapping temperature of around 1,500°C. The slag is normally used as a substitute for cement clinker or as an aggregate material in road construction. Currently, the slag is granulated in wet-granulation plants using large volumes of water. It has not been possible up until now to utilize the remnant heat energy of the molten slag, which amounts to approximately 1.8 GJ of energy per ton. In an R&D project now underway by a consortium of companies comprised of Primetals Technologies, voestalpine Stahl, the FEhS - Building Materials Institute, and the University of Leoben (Austria), a new dry-type technology is being investigated to use air to cool molten slag and recover the lost heat energy. The resultant pelletized slag fulfills the same criteria as wet-granulated slag for use in the cement industry. Phase

1 of the project, which has been completed, involved setting up a technical plant at the University of Leoben in 2012. This was followed by a series of dry-slag granulation campaigns using remelted blast furnace slag. The elevated offgas temperatures and the quality of the slag product have shown that the process is suitable as an industrial application. The decision was then made to escalate the project from a large laboratory scale to a full-size pilot plant. Phase 2 development of this plant is now underway, and starting in mid-2016 the full slag flow from Blast Furnace A at voestalpine Stahl in Linz will be fed directly to the plant. This paper describes the development path taken to date, and outlines the next steps toward achieving the goal in late 2016 of industrializing this game-changing process of dry slag granulation with heat recovery from the slag.



Blast Furnace A expert system with closed-loop control at voestalpine Stahl, Linz, Austria

INTEGRATED BURDEN CONTROL OPERATION FOR BLAST FURNACES

Principal author: Dr. Martin Schaler

Paper number: 257

Primetals Technologies, in close cooperation with the ironmaking division of voestalpine Stahl, developed the BF Optimization System to ensure high-performance and cost-effective blast furnace operation. A key issue for low-cost, hot-metal production is effective control of the composition and distribution of the raw materials in the blast furnace.

The first part of the paper describes the individual process models for exact burden proportioning and for burden distribution control, as well as the model toolbox for checking the plausibility of mass and energy balances.

The second part outlines the integration of these individual models into the BF Expert System, which is implemented as a rule-based decision aid. Practical examples of suggested corrective actions are shown. A detailed explanation of the applicability and limitations of the closed-loop burden control concept is also presented. Closed-loop burden control made possible by the expert system has been used by voestalpine Stahl in Linz, Austria, for all blast furnaces during the last campaigns.

The final section of the paper presents the 2014 operational data for the burden composition, including the fuel rates in addition to details on hot metal production and quality. For Blast Furnace A, the total coke-equivalent fuel rate is below 455 kg/t of hot metal and the productivity rate is above 2.8 t of hot metal per m³ of working volume. This shows the potential of the presented integrated burden control philosophy for low-cost, highly efficient ironmaking.

RECYCLING OF FERROUS BY-PRODUCTS IN DRI PLANTS

Principal author: Christian Brunner

Paper number: 273

In DRI-based plants, a large amount of oxide fines, DRI sludge and DRI fines are generated either as a result of the process itself, or during material and product handling. In many cases, these by-products may be used in sinter plants without further processing. However, in most DRI-based plants there is no sinter plant available for recycling, and the most effective way to process this material is in the direct-reduction plant as a partial substitute for pellets or lump ore. However, the reuse of such by-products in direct-reduction plants is currently uncommon.

Primetals Technologies has therefore performed comprehensive studies and tests on briquetting iron-containing by-products. To verify the physical stability and chemical reducibility of the briquetted material, extensive laboratory tests (for example, static reduction tests) as well as field tests – so-called basket tests – have been performed and proved to be successful. The very promising results of these tests and the concept for briquetting iron-containing materials are presented in this paper.



Example of a basket test on briquetted residuals from the direct-reduction process. The tests were performed in the direct-reduction shaft of the DR plant at ArcelorMittal Hamburg, Germany (briquette size: ca. 5 cm³)

COREX – AN ANSWER FOR HOT METAL PRODUCTION IN A CHALLENGING ENVIRONMENT

Principal author: Wolfgang Sterrer; Paper number: 274

Corex and Finex are the only industrially implemented technologies to the blast furnace route for the production of hot metal. With consideration to the current challenges in the raw material sector – deteriorating raw material quality, ever-stricter environmental regulations, etc. – it is worth reevaluating the Corex process and comparing it with traditional blast furnace technology. Current trends in the iron and steel industry are making it increasingly attractive to utilize the Corex export gas for the production of direct-reduced iron (DRI). Integrated plant concepts based on a Corex/Midrex DR plant combination offer highly feasible solutions to meet

future challenges in the iron and steel industry. The benefits include:

- Economical production of hot metal and DRI based on the use of coal
- No need for coking or sinter plants
- Integrated energy and waste-processing solutions
- Environmentally friendly production of high-quality hot metal

An economic evaluation of different Corex gas-based integrated plant concepts is presented and compared with the traditional blast furnace route.



Corex Plant C-3000 installed at Shanghai Baosteel Group Corporation (Baosteel), Pudong, Shanghai, China



Aerial view of Posco's Pohang steelworks with three Finex plants; right: Finex F-2000 Demonstration Plant (approx. 800,000 t/a), left: Finex 1.5M (1.5 million t/a), center background: Finex 2.0M Plant (2 million t/a)

FINEX – AN IRONMAKING DREAM COME TRUE

Principal author: Shibu Kondoor John; Paper number: 302

Today's dominating technology for the production of hot metal is the conventional blast furnace route. Beside the blast furnace itself, coking and sintering plants are also required. With the innovative Finex process, however, ironmaking is possible without the need for the coking and sintering steps – a metallurgist's dream comes true. This technology is based on a smelting-reduction solution that features the direct use of non-coking coal as a reducing agent and energy source, and a non-agglomerating fine ore as the iron carrier. Finex allows steel plant opera-

tors to reduce the costs of ironmaking in an environmentally manner. Considering future possible optimizations of the process, Finex has the potential to revolutionize the iron and steel industry, similar to the successful development and industrial application of LD (BOF) converter steelmaking or continuous casting. The main topics covered in this paper are the status and outlook of Finex plants now under operation as well as the latest technological developments.

DRI PROCESSING IN THE BLAST FURNACE, EAF OR WITH THE JET PROCESS – A COMPREHENSIVE OVERVIEW

Principal author: Dr. Gerald Wimmer; Paper number: 367

Several new direct-reduced iron (DRI) production facilities have been put into operation in recent years. This trend is mainly driven by new raw material sources that are well suited for DRI production and in view of decreasing gas prices. This led to an increased availability of DRI for downstream steelmaking facilities. Several technical solutions exist to process the DRI: melting with electrical energy in an EAF, substituting part of the iron ore in a blast furnace, or melting in a converter equipped with

coal injection such as in the Jet Process that is designed to handle increased hot-briquetted iron (HBI) and scrap rates. A detailed description of these methods and the necessary core equipment is presented in this paper. Figures from reference plants and process calculations are used to compare the different procedures of DRI processing and highlight their advantages, disadvantages, limitations and potential areas of application. Finally, figures and results from real operation are discussed.

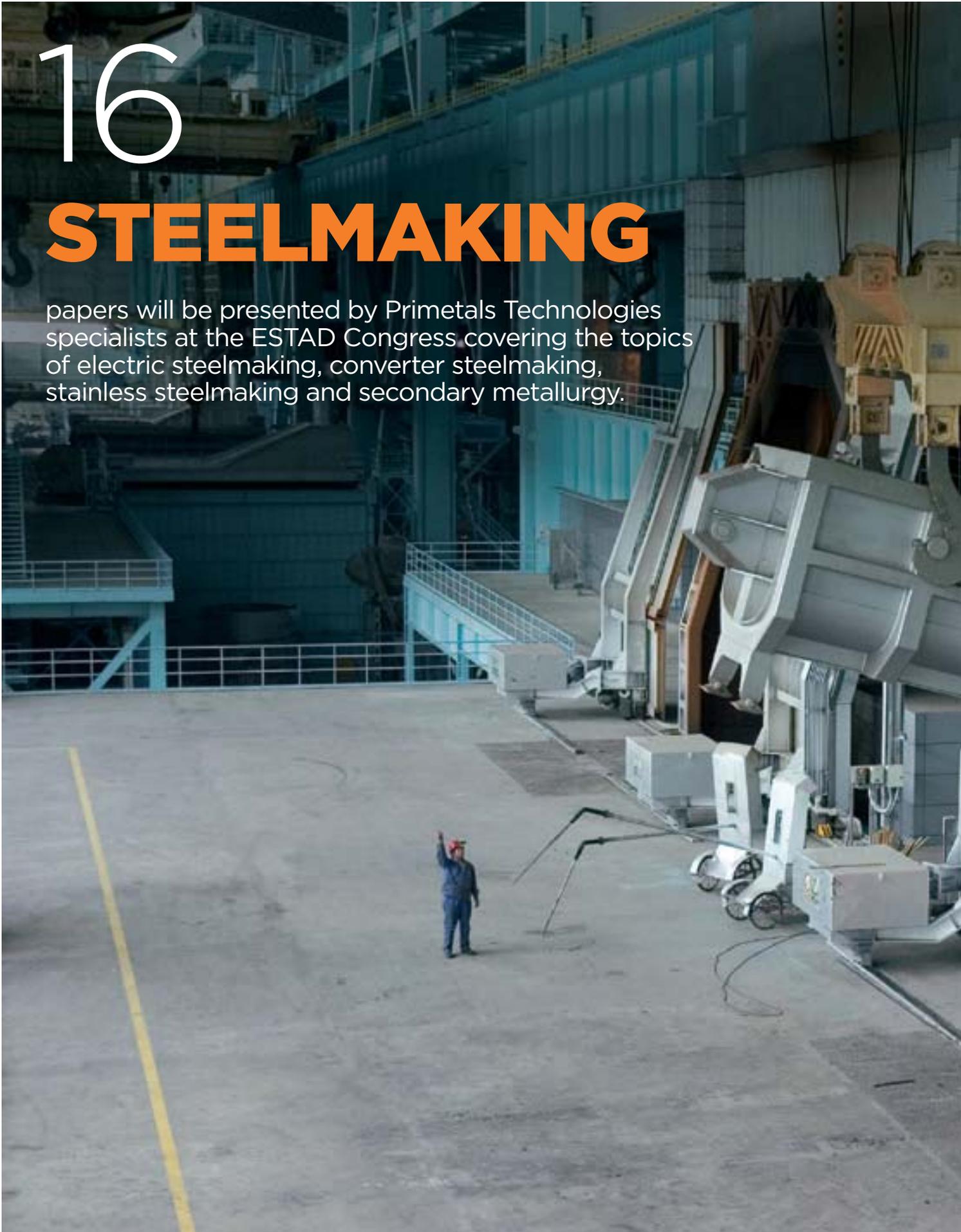


HOT-BRIQUETTED IRON
(Photo: voestalpine)

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STEELMAKING

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of electric steelmaking, converter steelmaking, stainless steelmaking and secondary metallurgy.





“ Production and metallurgical expectations were fully met, and even partially exceeded.”

Company manager,
voestalpine Stahl GmbH,
Austria



100-ton EAF Quantum Furnace, Tyasa, Mexico

START-UP AND OPERATIONAL RESULTS OF THE EAF QUANTUM FURNACE AT TYASA

Principal author: Dr. Jens Apfel; Paper number: 213

This paper describes the operational results of the world's first minimill equipped with an EAF Quantum furnace that was started up at Tyasa in Mexico on May 7, 2014. Several design concepts of this new technology are also presented.

With the new shaft-type electric arc furnace, Primetals Technologies has demonstrated the competence to support steelmakers with respect to overall process efficiency, improved productivity and low operational costs.

**EAF Heatopt
serves as the
kernel of a holistic
approach in EAF
steelmaking.**

INTELLIGENT AND HOLISTIC ELECTRIC STEELMAKING

Principal author: Dr. Martin Fleischer
Paper number: 210

In order to remain competitive in a challenging business environment and to increase operational safety, steelmakers have to consider all factors, including raw materials and consumables, in a holistic process-control system. EAF transparency can be increased through a high level of automated functions and processes, as well as with the use of the latest measurement and analyzing technologies. EAF Heatopt serves as the kernel of a holistic approach in EAF steelmaking. This dynamic process-control system for all material flows has been designed to fulfill the need for reproducible efficiency, and it takes into consideration all relevant factors for profitable steelmaking. Scrapopt and Chargeopt – further automation solutions for scrap and material handling and charging, respectively – complete the holistic approach. All of this, combined with intelligent and closed-loop control algorithms and Level 2 process guiding at an extraordinary high level of automation, gives the operator the possibility of handling, modifying and optimizing the entire process.



EAF Heatopt contributes to improved and optimized electric steelmaking operations

EAF MODERNIZATION TO MAXIMIZE POWER INPUT

Principal author: Patrick Zipp
Paper number: 209

In electric arc furnaces (EAF), high performance and improved productivity can be achieved by fully utilizing existing transformer capacity in combination with a rigid electrode lifting system. Applying the right process know-how also leads to a generally uniform heat-load operation. The furnace must be designed in such a way that the electric transmission path to the arc results in a maximum power input. The installation of a more powerful transformer with a suitable high-current system up to the electrodes is another possibility to increase melting capacity. Cycle times during power-off and power-on times may be reduced with faster, single movements made possible with new hydraulic settings.

The latest EAF modernization developments to increase plant performance result in higher productivity, lower conversion costs, operation with a symmetrical power input, decreased refractory wear, improved plant availability and a longer plant lifetime. This paper reviews the results of the latest EAF modernizations performed by Primetals Technologies to attain maximum electrical power input.



Current-conducting electrode arms installed in the 100-ton EAF Quantum Furnace at Tyasa, Mexico

INFLUENCE OF POLYATOMIC GASES ON THE PHYSICAL PROPERTIES OF THE ARC PLASMA IN AN EAF

Principal author: Dr. Thomas Matschullat

Paper number: 230

Process conditions and consumption figures in electric arc furnaces (EAF) can be considerably improved through the introduction of additional gases into the plasma environment of a furnace. With an annual electrical energy consumption on the order of 600 GWh for a typical EAF, there is substantial potential for enhancing overall performance and reducing costs. The size and power requirements of conducting the related experiments, however, necessitates the substantiation of theoretical considerations through detailed simulation models before testing. Hence, a transient, 3-D physical model has been implemented, which is suitable for arc simulation of AC and DC arcs at currents up to 70 kA and even more. Developed using COMSOL, the model incorporates a radiation transport solver based on net radiation coefficients as well as on temperature-dependent material properties (electrical, heat conductivity and heat capacity). These are calculated in an additional simulation module for the relevant parameter ranges. Different gas compositions have been modeled, taking into account a standard furnace atmosphere typically consisting of 30% CO, 10% CO₂, 5% H₂, and 55% N₂. Different monatomic and molecular gases have been modeled (Ar, CO₂, N₂, and CH₄) at concentrations of between 0% and 80%. Also, Fe vapor at concentrations of between 0% and 4% have been considered in these simulations.

The simulations offer spatially and temporally resolved insight into the relevant arc plasma parameters. Of particular interest are macroscopic process parameters such as arc voltage and electric field inside the arc, because these parameters can be easily related to experimental results. However, other parameters such as temperature and current density distributions for different arc currents and gas compositions are also of particular interest. The simulations show that EAF arcs can be influenced substantially using additional gases, which can lead to an increase in the arc length at fixed arc voltages on the order of 25%.

The technique of gas injection into an EAF may also offer significant advantages for other electric steel producers.



Electric arc furnace at Dörrenberg Edelmetall GmbH, Germany

CONTROLLING THE ELECTRIC ARC PROPERTIES IN AN INDUSTRIAL AC EAF USING ADDITIONAL GAS FLOWS: RESULTS AND NEXT STEPS

Principal author: Dr. Thomas Matschullat

Paper number: 229

Electric arc furnaces (EAF) represent an important plasma application in which the process requirements can be better fulfilled by introducing additional gas species. The usual furnace atmosphere, which is mainly composed of nitrogen and carbon monoxide, allows for acceptable arc operation. Nevertheless, there are considerable tuning opportunities to decrease energy consumption and flicker, while at the same time increasing productivity as a result of reduced process time.

A detailed simulation of arc plasma properties using different working gases was carried out. Initial verification trials were performed at an 4 MVA AC EAF at Dörrenberg Edelmetall GmbH in Engelskirchen, Germany. The furnace has a tapping weight of approximately 12 tons, and it is used for re-melts and the production of special steels for tools. The addition of argon and nitrogen resulted in arc length extensions. With argon, a much smoother melt-down procedure with the reduction of flicker, especially in the case of pressed scrap packages, was observed. Using natural gas, a shortening of the arc length by up to 20% is possible during flat-bath operation. Different campaigns related to the needs of the Dörrenberg process show significant potential for process optimization. The technique of gas injection into an EAF may also offer significant advantages for other electric steel producers.

SUPERIOR FLICKER REDUCTION WITH SVC PLUS – OPERATIONAL EXPERIENCE

Principal author: Björn Dittmer

Paper number: 235

The SVC PLUS is a static synchronous compensator – commonly known as STATCOM – which is based on a voltage source converter (VSC). It forms a source or sink of reactive power, that is, it generates inductive or capacitive reactive power. The SVC PLUS uses three delta-connected series connections of individual modules (a multi-level converter), each comprising an IGBT bridge with its individual capacitor as the power source. The number of series-connected modules is determined by the voltage level to which the VSC is connected. The SVC PLUS is a FACTS device (Flexible AC Transmission System), commonly used for power-factor improvement and voltage stabilization. Its fast response time as a result of fast switching of the IGBTs and the possibility to connect directly to a medium-voltage bus bar led to the idea to apply it also for flicker reduction, especially for electric arc furnaces (EAF). The need for better flicker performance than provided by classic SVCs is increasing worldwide due to the wish to operate larger arc furnaces on weaker networks, along with increasingly stricter power-quality regulations. Around two years ago, the first SVC PLUS system for flicker reduction and reactive power compensation of an EAF went into operation. The original challenging expectations were met: much better flicker reduction than classic SVC systems, lower losses than conventional STATCOM solutions, excellent wave shape of the current output and real redundancy of the VSC power modules. Meanwhile, eight installations are in commercial service, two of them as TWIN SVC PLUS (two VSCs connected in parallel). One advantage of the modular multilevel converter design of the SVC PLUS technology is the very fast dynamic reaction in combination with low switching frequency of the individual semiconductors. This property enables excellent flicker mitigation performance and low converter losses. These and other results from operation of the SVC PLUS systems are described in this paper.



SVC PLUS control cubicle based on Simatic TDC

The aim is to offer the most modern electrode control system available on the market.

NEXT-GENERATION ELECTRODE CONTROL SYSTEMS – FIRST OPERATIONAL RESULTS

Principal author: Christoph Sedivy

Paper number: 247

Within the last two years a new generation of electrode control systems has been developed by Primetals Technologies. It combines the advantages of two well-known solutions, Arcos and Simelt, in a newly designed hard- and software concept. Existing hardware platforms have been consolidated and new regulation strategies have been developed. Advanced functionalities are integrated in the system, which are based on state-of-the-art control philosophies such as impedance, current and arc resistance. The aim is to offer the most modern electrode control system available on the market. Results include more accurate control of electrode movements; improvements with respect to the overall performance of the AC EAF; and reductions in the specific energy consumption, power-on time and electrode consumption. A user-friendly design with many easy-to-understand functionalities is also offered as a central part of the new product. It comprises an integrated condition-monitoring system together with key performance indicators, which allow permanent diagnostics of the EAF to be carried out and much more. This paper describes the new concept and presents initial operational results from a pilot installation.



DC EAF equipped with a Fin-type anode

DC EAF MODERNIZATION WITH THE FIN-TYPE ANODE

Principal author: Patrick Zipp
Paper number: 208

Improved performance and production efficiency can be achieved in DC electric arc furnaces (EAF) by implementing the latest anode technology in combination with the associated process know-how. The modernization concept described in this paper can lead to an extended service life of the anode and a host of additional benefits that include:

- Furnace operation with a stable arc and without arc disruption
- Avoidance of arc deflection and consequently hot spots
- Higher power input with a low current density
- Improved anode heat transfer without the need for water cooling
- Facilitated and fast exchange of the bottom anode
- Performance of anode exchange while keeping the high-current line connected with no risk of anode damage
- Safer working conditions as no cooling water is required

The latest features of DC EAF modernizations are described, including operational performance results.

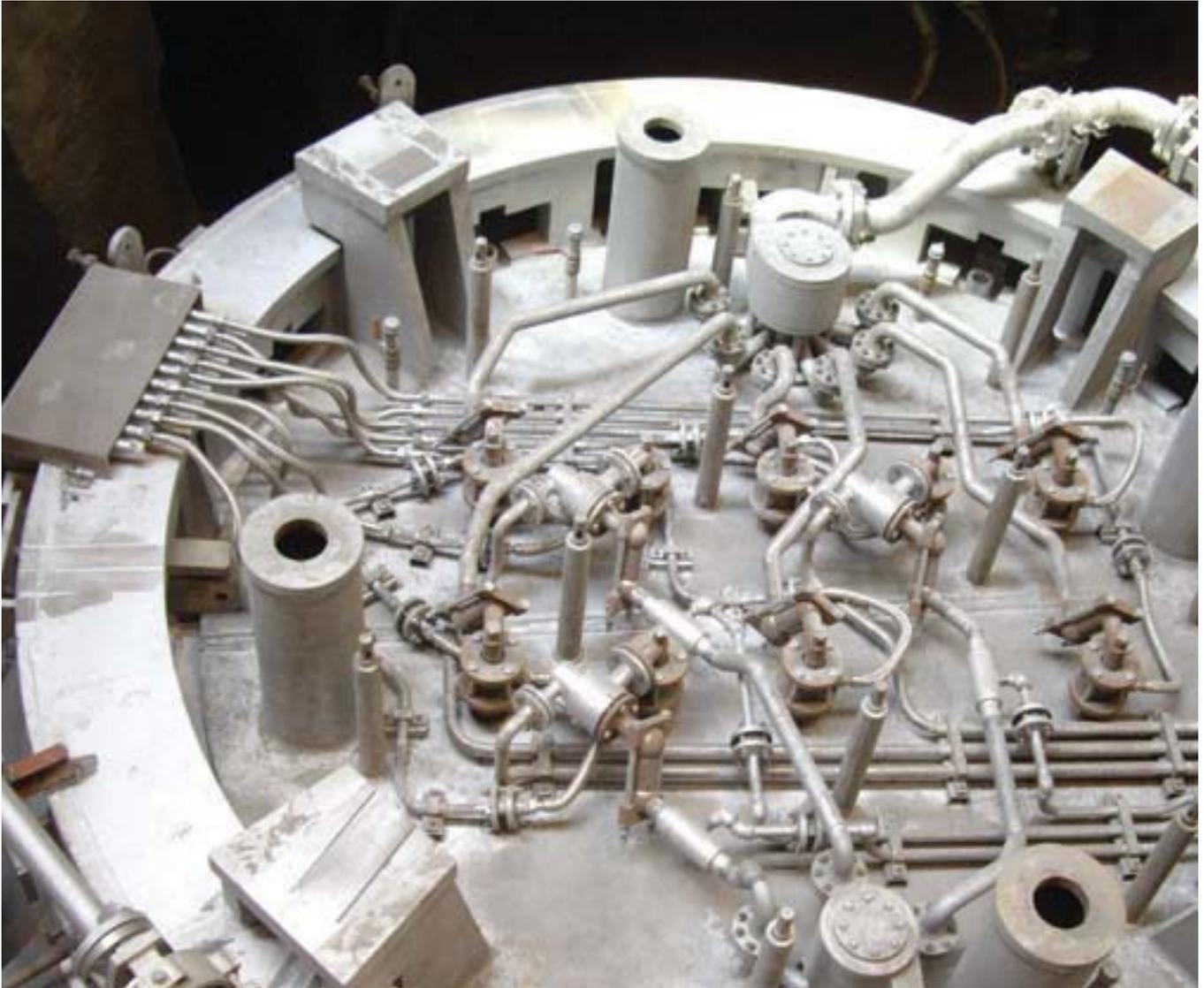
A NEW APPROACH FOR IMPROVED ELECTRIC ARC FURNACE DEDUSTING

Principal author: Dr. Thomas Steinparzer
Paper number: 260

The new approach of Primetals Technologies with respect to offgas dedusting is to create an integrated solution for the complete dedusting line. This is both cost- and energy-efficient. With the competency to provide the full scope of EAF gas-handling systems, an overall optimized dedusting solution is offered that leads to reduced offgas volume flows and to a lower energy demand of each aggregate. Additionally, a modular heat-recovery system is an integral part of the offgas system. Hence, the investment costs for the offgas dedusting system are quickly amortized. Furthermore, improved automation solutions help to minimize the operating costs of offgas systems. Innovations, improvements and results are described in this paper.



An integrated solution approach for the complete EAF dedusting line leads to improved dedusting efficiency and reduced energy consumption.



Converter bottom of a typical bottom-blowing converter with tuyeres for oxygen, coal and lime injection

EFFICIENT SCRAP AND DRI MELTING WITH THE JET PROCESS

Principal author: Dr. Gerald Wimmer; Paper number: 266

As a result of decreasing prices for scrap and direct-reduced iron (DRI) together with efforts to further reduce the CO₂ footprint of steelmaking, integrated steelmakers are becoming more and more interested in increasing the scrap or HBI quantities charged to the converter. The Jet Process was therefore developed to enable higher and variable scrap and HBI charging rates. The process comprises a bottom-blowing converter with coal injection, combined with a postcombustion system. An oxygen-enriched hot blast, generated in a pebble heater, ensures high postcombustion rates and a good heat transfer from the gas to the bath. In this way, the chemical energy of the injected coal can be utilized to the maximum extent possible. Because the total amount of injected coal can be flexibly varied within a very wide range, the scrap- and/or DRI-charging rates into the converter can lie between 0%

and 70%. Several economically attractive market opportunities for this technology exist, such as for plants where scrap or hot-briquetted iron (HBI) are relatively inexpensive compared with hot metal. Additional opportunities can be found where ironmaking bottlenecks occur – whether due to planned increases of total production, a blast furnace blowdown, or restrictions of iron production due to CO₂ limitations. In all of these cases, the Jet Process can be used to increase the total converter output while keeping hot metal consumption to a minimum and avoiding cost-intensive investments to increase iron production capacity. Primetals Technologies has developed and optimized the Jet Process for commercial industrial application. Process features and a detailed economical evaluation are presented in this paper, together with results from tests and first industrial applications.

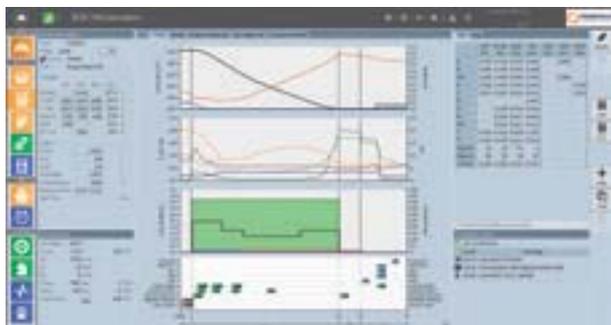
THE LATEST INNOVATIONS IN CONVERTER PROCESS MODELING

Principal author: Rudolf Hubmer

Paper number: 202

Carbon steel producers are increasingly being forced to use iron ores with higher phosphorous contents due to declining ore reserves and escalating raw material costs. LD (BOF) converter shops must therefore cope with higher phosphorous contents, which affects steelmaking performance. In stainless steel production, the use of phosphorous-rich ores has led many producers to include a hot metal dephosphorization step for the production of ferritic and manganese austenitic grades – particularly in China.

Such process changes are fully accounted for by the Steel Expert process model package for carbon and stainless steelmaking. Steel Expert comprises dynamic process guidance, a prediction model to simulate the complete production process, and a number of setpoint models for the different production steps. The extended functionality for LD (BOF) converters features an enhanced MgO and lime saturation model; calculation of the weight and chemical composition of the solid and liquid slag; and automatic blow-stop functionality for LD (BOF) converters based on substance measurements. The functionality of the AOD converter has been upgraded through the introduction of a desiliconization phase for premelts with a high silicon content, heating with FeSi, and with intermediate deslagging. In addition, a completely new human-machine interface (HMI) for the Level 2 automation system has been developed and successfully installed in recent projects. Model predictions were verified against laboratory samples and measurements. In this paper, the implemented innovations, improvements and results are presented in detail, including the achievable savings by applying this Level 2 process-optimization system.



Monitor screenshot of a typical HMI of the precalculation model for simulating BOF heats



Visualization of the Precon system with energy savings, energy consumption and plant performance data shown

INNOVATIVE AUTOMATION PACKAGES FOR CONVERTER STEELMAKING PLANTS

Principal author: Thomas Kurzmann

Paper number: 204

Intelligent automation and process-optimization systems are decisive factors for assuring excellent product quality, enhanced safety and increased plant performance in steel mills. This paper covers various recently developed innovations from Primetals Technologies for improved and cost-efficient converter steelmaking, three of which are outlined in the following. One of the main electrical energy consumers in a LD (BOF) plant is the electrostatic precipitator of the dry-type primary dedusting system. As shown by the first installations of the Precon (Precipitator Economizer) system, substantial energy savings can be achieved. Another issue in steel mills is that a broad range of equipment is used, which has to be monitored and checked using specialized sensor systems to guarantee proper functioning and a long lifetime. The new Acoustic Expert system from Primetals Technologies is based on measuring noise, which is emitted by almost every device or process. The application of this system considerably facilitates the reliable and efficient monitoring of plant equipment. Limited equipment accessibility or other technical restrictions often result in inaccurate or delayed measurement data. Wiplant, a wireless, self-organizing network system, overcomes these limitations. A broad range of data transmissions from previously inaccessible areas is now made possible, thus opening new opportunities for fast and reliable data transmission. Features and advantages of these technical solutions are highlighted in this paper, including the achievable operational improvements.

OPTIMIZED ENERGY RECOVERY FROM THE CONVERTER COOLING STACK THROUGH DYNAMIC SIMULATION

Principal author: Dr. Thomas Steinparzer
Paper number: 259

Maximum energy efficiency in a steel mill is a key factor to minimize costs. For example, cooling stack systems for basic oxygen furnaces (BOF) use the offgas heat for steam generation and therefore create value. However, the circulation pumps of the cooling stack boiler system have a high electric power consumption. Therefore, waste-heat boiler systems that are based on the natural circulation of the water/steam mixture instead of forced circulation using pumps lead to further improvements in energy efficiency. Nevertheless, an issue that arises in connection with natural circulation systems is that strong fluctuations in offgas temperature and flow may affect the performance of a boiler system. Unstable water flow regimes have to be avoided to ensure the reliable and stable operation of the cooling stack. But predicting these flow instabilities is extremely complex. On the basis of its extensive experience in this field, Primetals Technologies has the competence required to perform dynamic simulations of two-phase flows within boiler systems. The advanced process simulation model developed by the company comprises dynamic process behavior, a prediction model for simulating the complete cooling stack system – including the steam drum and steam buffers – and the possibility to analyze various automation setups. Thus, the transient behavior of the water/steam flow can be investigated in detail. These simulations help to achieve an optimized cooling-stack design for each BOF. The theoretical simulations have been successfully compared with measurement data and the experience acquired from commissioning a natural circulation cooling stack. It can be shown that the dynamic simulation model portrays the circulation flows with a high degree of accuracy. In this paper the simulation model and the simulation results of the natural cooling stack system are presented. Furthermore, measurement data of a cooling stack and a comparison with simulation results is discussed.

On the basis of its extensive experience in this field, Primetals Technologies has the competence required to perform dynamic simulations of two-phase flows within boiler systems.



A particular highlight of this technique is that almost the entire metallic content of the slag can be recovered.

A NEW METHOD TO PROCESS CONVERTER SLAG FOR USE IN THE CEMENT INDUSTRY

Principal author: Dr. Gerald Wimmer
Paper number: 267

During typical LD (BOF) converter steelmaking roughly 120 kg of slag are produced per ton of tapped steel. Conventional uses of LD converter slag from steelmaking, such as in construction or to produce fertilizer, are becoming less attractive due to stricter environmental regulations, decreasing market volume and falling prices. Simply dumping slag in the slag yard is no longer acceptable at many steel plants, as it generates dust, incurs energy loss and requires considerable land space. Economically attractive methods to process and market slag, in addition to closed processes for slag modification and handling to minimize dust emissions and space requirements, are therefore gaining interest with steelmakers. A promising development underway by Loesche, Primetals Technologies and partners is the modification of LD slag so that it can be used as a cement clinker substitute. A particular highlight of this technique is that almost the entire metallic content of the slag can be recovered. The process comprises three steps: In the first step the iron oxides in the slag are recovered in a reducing atmosphere and the slag composition as required for the formation of clinker is adjusted. This is done by coal injection, the addition of additives (when required) and electrical heating. In the second step the modified liquid slag is solidified in a way that a considerable mass percentage of alite (C_3S) is formed. This imparts the hydraulic properties to the slag that allows it to be used as a cement clinker substitute. In the last step the solid slag is ground and the remaining iron content is recovered. A detailed description of the process is presented, including mass, energy and CO_2 balances, as well as results from testing. Finally, an economical evaluation of the entire process is described in detail.



AOD stainless steelmaking converter, Carinox, Belgium



New damper system to reduce AOD converter vibrations

Vibration measurements before and after installation of the damper show a reduction of converter vibrations by more than 50%.

A NEW VIBRATION DAMPER SYSTEM FOR AOD CONVERTERS

Principal author: Dr. Gerald Wimmer; Paper number: 264

The AOD process is the current standard solution all over the world for converter-based stainless steelmaking. During the process, gas is blown via side tuyeres into a vessel filled with liquid metal, causing intensive reactions. As a consequence, AOD converters tend to vibrate strongly, which increases maintenance costs and shortens equipment lifetime. To reduce such vibrations, a simple, redundant and highly efficient damper system was developed. In a first step, detailed analyses of the AOD vibration phenomenon were done in cooperation with universities using FEM and CFD simulations, laboratory experiments and on-site measurements in several plants. This analysis provided a full understanding of the characteristics of such

vibrations. With this understanding, a hydraulic damper system was developed by means of virtual prototyping and testing. Finally, a prototype was built and after intensive laboratory testing the first damper system was successfully implemented in a steel plant in China. Vibration measurements before and after installation of the damper show a reduction of converter vibrations by more than 50%. The robust damper system has been in full operation now for more than a year with almost 100% availability. The cost-effective and patented damper design is suitable for installation in new plants and existing converters. The basics of AOD vibration, the design of the damper system and results from operations are presented in this paper.

THE LATEST TECHNOLOGIES FOR VACUUM DEGASSING PLANTS (VD/VOD AND RH/RH-OB)

Principal author: Andreas Harter

Paper number: 211

The demands placed on modern steel plants are continually changing. This is also true in the secondary metallurgical area where installed equipment and systems need to be regularly updated to ensure optimized and efficient operations despite variations in production speed, material flow and overall plant logistics. Other trends and developments in this area need to be considered by steel-makers. For example, during the past few years, dry mechanical pump systems are increasingly being installed in vacuum degassing plants, especially for heat sizes below 150 t with pure degassing operation (VTD). Safety issues need to be addressed during oxygen blowing in VOD plants equipped with mechanical pump systems. A new highly compact lifting system for RH degassers from Primetals Technologies combines ladle lifting and vessel exchange in a single unit. Referred to as RH CVL (Combined Vessel and Ladle lifting), this solution improves the flexibility and logistics in a steel mill in that the unit can be accessed from both sides and allows a “drive-through” material flow – even in areas inaccessible for cranes. This paper covers various modernization solutions and the latest technological developments for vacuum degassing plants.

A new highly compact lifting system for RH degassers from Primetals Technologies combines ladle lifting and vessel exchange in a single unit.

RH degassing plant installed at Companhia Siderúrgica Paulista (Cosipa), Brazil



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CONTINUOUS CASTING

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of slab, billet and bloom casting in addition to automation, logistics and modernization solutions.



“ Through the modernization of our continuous slab-casting machine we have acquired one of the most advanced casters of its kind in the world. This increases our production potential.”

Company manager,
Acroni, Slovenia



State-of-the-art casting platform at voestalpine Stahl, Austria

THE CONTINUOUS SLAB CASTER IN THE TWENTY-FIRST CENTURY

Principal author: Dr. Martin Hirschmanner; Paper number: 278

The first continuous casting machine built by VAI in the year 1968 already had several features that are still state of the art today. These include a straight mold, a continuous bending and unbending curve, and small, intermediately supported rollers for minimum bulging. It might be assumed that the mechanical development of the continuous slab caster was completed a long time ago. However, the opposite is true. Modern design methods make it possible to engineer a substantially improved caster that meets the ever-increasing demands of plant operators. In every critical performance parameter – including low maintenance costs, low operational costs and high-quality steel grades – improvements can still be achieved.

In recent years, the combination of mechanical equipment with hydraulic, electrical and automation systems has transformed the casting machine into a complex mechatronic system. The deep integration of all disciplines is essential for casting sophisticated steel grades with perfect process control, while still maintaining low operational costs. The ongoing fourth industrial revolution will also influence the design of continuous casting machines in a practical way that offers major advantages to plant operators. Several examples of mechanical features integrated in the caster mechatronic system are presented in this paper.

INNOVATION HIGHLIGHTS IN CONTINUOUS CASTING AUTOMATION

Principal author: Reinhold Leitner

Paper number: 201

Sophisticated automation models are a prerequisite for state-of-the-art steelmaking. VAI has always been a driver of innovation in this area, especially by providing expert models for continuous casting machines. This capability is impressively demonstrated by recent advancements in automation solutions that include DynaPhase, Dynacs 3D and DynaGap. This state-of-the-art suite of dynamic secondary cooling and soft-reduction packages take into account thermodynamic effects such as shrinkage and phase transitions, and thereby significantly contribute to direct quality improvements during the solidification phase in the continuous casting process.

Speed Expert calculates an optimum casting speed for every casting situation, and additionally recommends a strand speed so that the point of final solidification is positioned at the end of a segment for optimum soft reduction. Nozzle Expert is a completely new model that detects clogged nozzles and broken hoses in secondary cooling systems. The first installations were highly successful and customers are pleased with improved steel quality and impressive reductions in maintenance costs. In the case of steel grade changes, the Intermix model precisely calculates the chemical properties of the mixed steel, thereby minimizing losses due to deviations from required specifications. Furthermore, a completely new human-machine interface (HMI) for the Level 2 automation system has been developed and successfully installed in recent projects. These solutions and operational results are described, and an outlook on future developments is presented.

The first installations were highly successful and customers are pleased with improved steel quality and impressive reductions in maintenance costs.



Slab width adjustment with DynaWidth on CC6 at voestalpine Stahl, Austria

ADVANCED MOLD TECHNOLOGIES IN SLAB CASTING

Principal author: Dr. Josef Watzinger

Paper number: 297

This paper deals with flexible mold equipment for the setup of single-, twin- or triple-strand casting machines and the associated technological packages to enable a fine adjustment of key process parameters. A newly developed and installed hydraulic divider for twin-slab casting allows fast and flexible width and taper changes to be made, even during casting. Cassette-type molds with flat and funnel-shaped copper plates at the wide sides are in operation. Specially designed narrow-face copper plates for specific functions are described. This includes plates with convex and concave shapes, chamfered or negative-chamfered copper plates, and specially combined narrow faces for rolling yield improvements. A new lateral strand-guide system is introduced, which features independent taper regulation of narrow-face copper plates and lateral foot rollers. Hydraulic-force control of the narrow side foot rolls enables optimum strand support that results in improved slab quality. The automation package DynaWidth ensures the correct narrow-side adjustments during cold and hot strand-width changes. The reliable S-mode empowers fast and large width changes at operational casting speeds, which allows extremely short tapered lengths to be achieved. Automatic narrow-face control is applied in order to keep well-balanced mold-heat extraction and consequently improved casting process stability.

SMART MODERNIZATION TO MAKE SLAB CASTERS FIT FOR FUTURE DEMANDS

Principal author: Josef Guttenbrunner; Paper number: 294

In the mid-1970s, VAI received its first order for the re-vamp of a slab caster, which marked the beginning of a long success story of caster upgrades. The goals during that era were to increase product quality and productivity, to meet the market requirements for low operational and maintenance costs, and to ensure high plant availability. These targets have not changed. Today, regular upgrading of continuous casting machines is becoming more and more important in order to fulfill these objectives at low investment costs. On the basis of the experience acquired from decades of upgrading slab casters, Primetals Technologies offers a complete portfolio of upgrading

packages to meet the specific demands of producers. These packages can be easily integrated into existing casters and implemented within short production down-times. The latest developments in caster upgrade concepts are presented. Solutions for upgrading casting platforms, machine heads, strand guides, secondary cooling systems and the caster maintenance area are described in detail. Examples of recently implemented upgrading projects are outlined, such as at Hüttenwerke Krupp Mannesmann in Duisburg, Germany, where a new hydraulic mold divider for the online-width adjustment of the twin slabs was installed.



Hydraulically adjustable twin divider installed in the Continuous Slab Caster No. 1 at Hüttenwerke Krupp Mannesmann, Germany



Continuously cast strand in straightener segments during dry-casting

IT'S ALL ABOUT TEMPERATURE – DRY CASTING FOR OPTIMUM SURFACE QUALITY

Principal author: Paul Pennerstorfer
Paper number: 301

In the future, high-temperature casting, or so-called dry casting, will be used to a much greater extent for the production of surface-crack-sensitive steel grades, such as medium-micro-alloyed steel grades and advanced high-strength steels. To achieve this goal, the caster can operate with or without minimal external spray cooling in the bow and straightener area. The objective, however, is to keep the surface temperature above the ductility trough during unbending. To prepare for a higher demand for dry casting, Primetals Technologies has created the DynaTac package, which can be installed in both new and existing machines for high-temperature casting. The package covers everything from metallurgical process modeling to heat resistance and reliable strand-guide structures. This paper deals with the package itself and recent installations, especially on heavy-plate casters.

NEXT STEPS IN HIGH-SPEED BILLET CASTING AT EGE ÇELİK IN ALLIAGA, TURKEY

Principal author: Jeffrey Morton
Paper number: 285

Billet-casting trials were successfully executed at the Ege Çelik steelworks in Alliaga, Turkey, where a casting speed of 6.2 m/min. for 130 x 130 mm sections was achieved on the existing CCM4 machine. Additional investigations were subsequently carried out to stabilize the process in terms of steelmaking requirements and the casting machine setup. Unique measuring instrumentation was utilized to collect a vast array of data, including temperatures in the mold, actual negative strip time measured below the mold, and laser measurements of the actual casting speed. An evaluation of the acquired data helped to define the best machine characteristics for high-speed casting of long products and led to the development of the latest high-speed billet mold design from Primetals Technologies. The most recent results obtained from the high-speed trials at Ege Çelik are outlined and the novel features of the next generation of high-speed/high-quality molds are highlighted.

LATEST BLOOM CASTER SOLUTIONS FOR AUTOMOTIVE STEEL GRADES

Principal author: Dr. Denijel Burzic

Paper number: 303

The latest solutions for continuous bloom casters are described in this presentation on the basis of an installed heavy-section, bow-type caster equipped with sophisticated technological packages. Bars and wires rolled from the blooms serve as a high-quality material for engine and gearbox parts. The caster features mold-level control and an instrumented mold for breakout prevention. In combination with air-mist spray cooling and internally cooled rollers in the strand-guidance system, DynaGap Soft Reduction and other technological packages ensure a uniformly high quality of the cast blooms. While still hot, the blooms are directly fed to the bar line. This saves reheating energy and improves operational safety because there is no need for bloom handling using cranes. For special steel grades, an inline bloom-quenching facility is planned.



5-strand bloom caster installed by Primetals Technologies at voestalpine Stahl Donawitz GmbH, Austria

DynaGap Soft Reduction and other technological packages ensure a uniformly high quality of the cast blooms.



SOLUTIONS FOR THE EFFICIENT MODERNIZATION OF BILLET AND BLOOM CONTINUOUS CASTERS

Principal author: Heinrich Thöne

Paper number: 276

For fast access to new or changing markets that cannot be served by a producer's installed continuous casting machine (CCM), modification of an existing caster is the most cost-efficient way to meet demands. During the past decades, Primetals Technologies has successfully executed numerous revamping projects for billet, bloom and beam-blank casters. Modernization can involve the installation of advanced technological packages such as the DynaFlex hydraulic oscillator, DiaMold mold tube, or LevCon mold-level control to increase casting speed – and therefore throughput – with simultaneous improvements in casting reliability and product quality. Modernization may also be a comprehensive transformation into a high-end bloom or beam-blank caster within the footprint of the existing machine.



New caster machine head at Acciaierie di Calvisano, (Feralpi Group), Italy

The handling, storing and treatment of cast products, including their preparation for the rolling process, is a highly complex logistical challenge

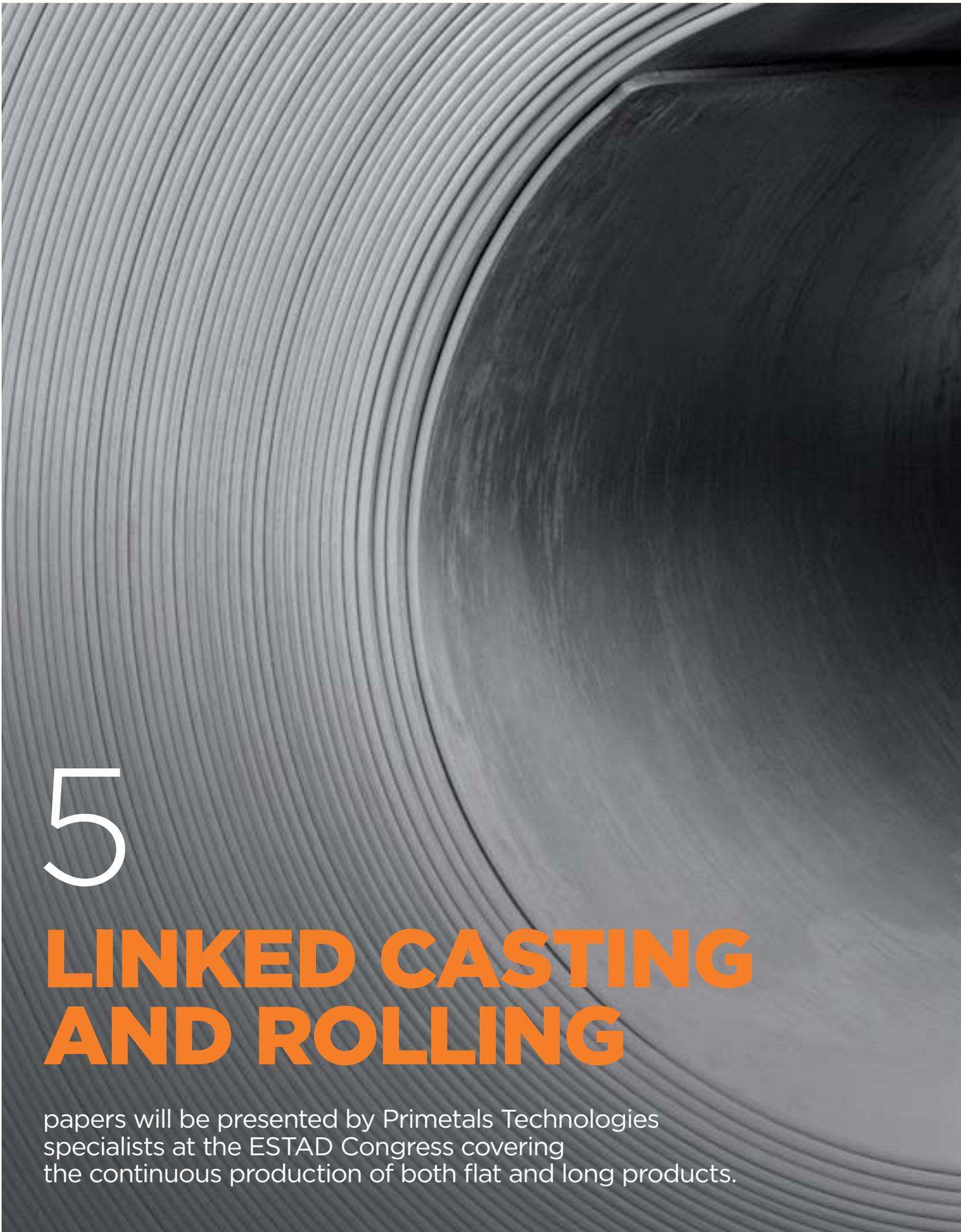


FROM THE CASTER TO THE ROLLING MILL – TRANSPORT, INSPECTION, CONDITIONING AND TREATMENT OF CAST PRODUCTS

Principal author: Philipp Wieser; Paper number: 287

The handling, storing and treatment of slabs, blooms, billets and beam blanks after casting as well as their preparation for the rolling process is a challenging procedure in a metallurgical plant. The hot strand leaving the casting machine – typically with a surface temperature in the range of 800°C to 1,100°C – must be cut, marked, inspected and, if necessary, conditioned. In the case of hot charging to the rolling mill, heat loss from the cast product must be minimized to reduce the energy consumption in the reheating furnace. For several steel grades, special ambient conditions (e.g., heat insulation) are required during the cooling process. In order to manage all of these requirements, this process must be thoroughly controlled and planned. The first step immediately after casting is product classification using a quality-prediction model based on the casting parameters and conditions (e.g., Quality Expert). A benefit of this powerful system is that it provides assistance regarding the decision whether

conditioning (grinding or scarfing) is necessary or not with the goal to optimize yield. Automatic surface inspection of the hot products can further support conditioning decisions. The logistically complex process of handling and transporting cast products is ideally simulated using appropriate tools in order to avoid collisions and to calculate the cooling rate during the handling time. Multi-strand casters (even with 8 strands) in particular require extensive discharge cycle-time studies. Slab yards, cooling beds, quenching boxes and slow cooling boxes, all of which consume a lot of space in a steel mill, must be designed using thermal calculations. When quenching or slow cooling are required, additional calculations regarding precipitation and continuous cooling transformations must be considered. These and other logistical, thermal or quality-related aspects in the casting-rolling area of a steel mill are covered in this paper.



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LINKED CASTING AND ROLLING

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the continuous production of both flat and long products.



**“ Operation of the
Arvedi ESP line at
Acciaieria Arvedi has
fully met expectations
and overall product
quality is excellent.”**

Giovanni Arvedi,
Acciaieria Arvedi S.p.A.,
Italy

High-quality 0.8-mm-thick hot-rolled strip from an Arvedi ESP line



THIN IS BEAUTIFUL – ARVEDI ESP PRODUCTS SUBSTITUTE A WIDE RANGE OF COLD-ROLLED PRODUCTS

Principal author: Andreas Jungbauer

Paper number: 288

High-strength but lightweight car bodies, ultra-thin structures that possess the highest tensile strength, and lowest-possible production costs – innovative processes are required to meet the demands for automotive and other high-end steel applications. After years of successful operation in Italy, and with five additional lines ordered from China, today Arvedi ESP is accepted as a proven technology that provides innumerable rolling possibilities to meet the highest downstream requirements. The use of 0.8 mm-thin hot-rolled products as a cold-rolled substitute – either directly or by processing the hot-rolled coils in continuous pickling and galvanizing lines – makes the cold-rolling process unnecessary for many applications. Operational results of the new Arvedi ESP plants as well as possible configurations for Arvedi ESP and processing lines are described.

After years of successful operation in Italy, and with five additional lines ordered from China, today Arvedi ESP is accepted as a proven technology that provides unlimited rolling possibilities to meet the highest downstream requirements.

AHSS PRODUCTION WITH ARVEDI ESP: A NEW DOOR OF OPPORTUNITY OPENS

Principal author: Bernd Linzer

Paper number: 290

Pipe grades, high-strength but lightweight automotive steels, ultra-thin rolled strip with the highest tensile strength – and all at the lowest production costs. A new process achieves these defined targets: Arvedi ESP, standing for endless strip production. With precise thermomechanical rolling and rigorous temperature guidance in the narrowest possible operational windows, Arvedi ESP opens the door for the development of new and demanding steel grades in the shortest possible implementation time and with reduced alloying expenses. Low operational costs are also made possible by efficient induction heating and the resulting energy savings. The potential of producing advanced high-strength steel (AHSS) with Arvedi ESP is described in this paper, including results from the first industrial plant in operation since 2009 at Arvedi Steel, Italy, and from the five ESP plants recently purchased by the Chinese steel producer Rizhao Steel, which focuses on the highly valuable local and export markets for high-quality, thin-gauge strip products.

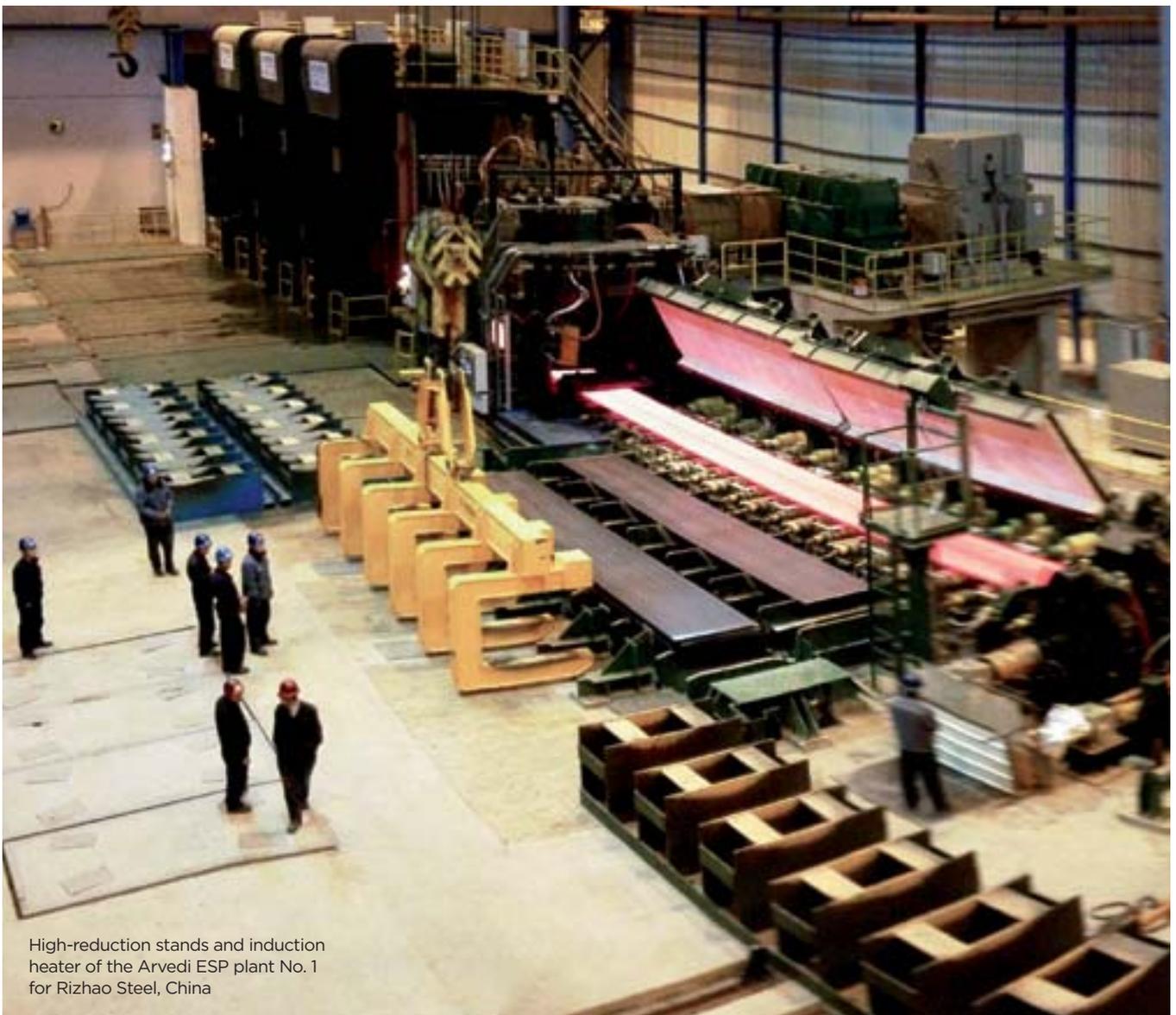
RIZHAO STEEL COUNTS ON ARVEDI ESP FOR HIGH-QUALITY HOT-STRIP PRODUCTION

Principal author: Andreas Jungbauer; Paper number: 281

With five Arvedi ESP lines, the Chinese steel producer Rizhao Steel is now focusing on the highly attractive local and export markets for high-quality, thin-gauge strip products. The first line commenced operation in the spring of 2015. The new casting-rolling complex is designed for a total annual production capacity of 11 million tons of high-quality, ultra-thin, hot-rolled strip products with widths of up to 1,600 mm and thicknesses down to 0.8 mm. The energy consumption and related costs are reduced by up

to 45% compared with conventional casting and rolling processes. This also means a major reduction in CO₂ emissions. During the project phase, plant personnel from China received extensive training at the licensor's plant – Acciaieria Arvedi S.p.A. in Italy – to prepare them to deliver the best operational performance with the new state-of-the-art endless casting-rolling facility. The plant setup, the training and support program, as well as the latest results from the start-up are presented in this paper.

The new casting-rolling complex is designed for a total annual production capacity of 11 million tons of high-quality, ultra-thin, hot-rolled strip products with widths of up to 1,600 mm and thicknesses down to 0.8 mm.



High-reduction stands and induction heater of the Arvedi ESP plant No. 1 for Rizhao Steel, China

WINLINK - INNOVATIVE SOLUTIONS FOR THE DIRECT ROLLING OF BARS

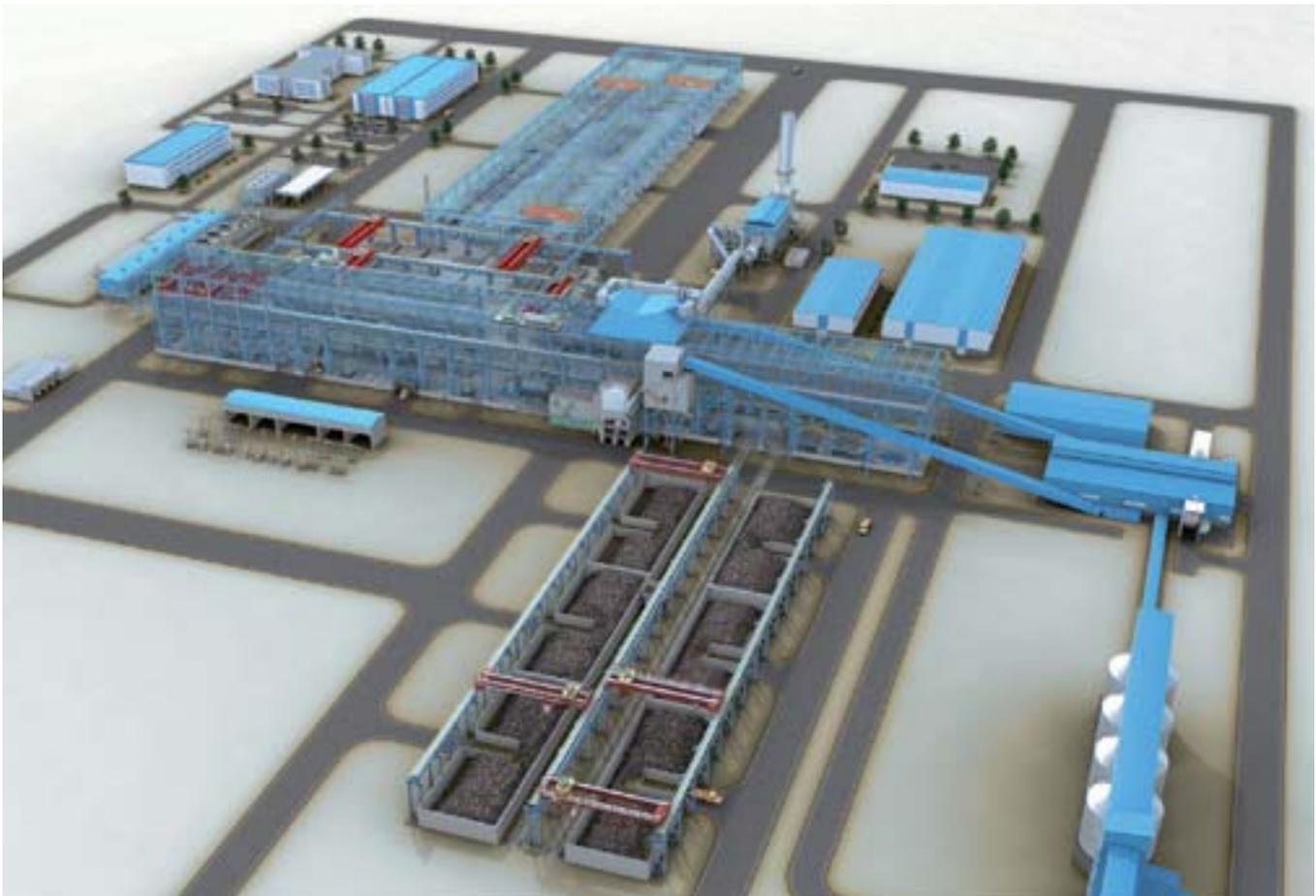
Principal author: Francesco Toschi; Paper number: 216

WinLink is the name of the innovative technology from Primetals Technologies for the direct and endless rolling of bars from liquid steel. In this process a high-speed billet caster is directly linked to a rolling mill with high availability, and the conventional billet-reheating furnace is replaced by an advanced induction heating unit. The result is a highly compact and energy-efficient production line. Bar producers benefit from the overall lower product costs that are the result of low investment expenditures, re-

duced transformation costs, significant energy savings, higher yields, a smaller plant footprint and reduced CO₂ emissions. WinLink is ideally suited for new minimills that are designed to replace costly imports with locally rolled bars. In comparison to other direct-rolling solutions, WinLink can also process liquid steel from a full-sized meltshop and balance production among rolled products and saleable billets.

WinLink can process liquid steel from a full-sized meltshop and balance production among rolled products and saleable billets.

General layout of a compact WinLink minimill installation





2-strand CSP caster at Bruckhausen, Germany
(Copyright by ThyssenKrupp AG 2012)

TECHNOLOGICAL AND AUTOMATION UPGRADE OF THE CSP PLANT AT TKSE BRUCKHAUSEN, GERMANY

Principal author: Reinhold Leitner; Paper number: 200

In July 2011, ThyssenKrupp Steel Europe (TKSE) in Bruckhausen, Germany, awarded a contract to Primetals Technologies for the modernization of the existing automation system in the casting section of their Compact Strip Production (CSP) plant. The solutions are based on proven CC automation packages from VAI. The scope of supply comprised the replacement of the process-control and visualization system with a new PCS7-based automation package, as well as the installation of technological control packages that included DynaWidth mold-width adjustment, DynaFlex oscillator control and LevCon mold

level control for improved quality, in addition to the breakout-prevention system Mold Expert for increased plant availability. This paper discusses the technical concept of the time-critical system upgrade that was carried out without additional interruptions to the production process. The results of the installed packages LevCon, DynaWith, DynaFlex and Mold Expert after the successful completion of the acceptance tests are presented. Feedback from TKSE after two years of operation with the new technological and automation systems rounds off this paper.

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ROLLING

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of plate rolling, hot-strip rolling, cold rolling and long rolling.





ADAPTIVE ECCENTRICITY COMPENSATION FOR ROLLING MILLS

Principal author: Andy Maierhofer

Paper number: 249

Keeping strip thickness within narrow tolerances is particularly important to ensure good strip quality, also at high rolling speeds. The thickness variations at the mill exit occur not only due to incoming strip variations and the forward slip effect that influences the tension, thickness variations are also caused by eccentric rolls as well as coil eccentricities. Roll eccentricities are the result of various factors that include non-uniform thermal expansion of the rolls, grinding inaccuracy or asymmetrical adjustment of the bearing roll shells via drive keys with the result that each roll causes oscillations with an eccentricity frequency. Coil eccentricities are caused by the beginning of the metal sheet on the mandrel, followed by wrapping with the next strip layers. A rapid diameter change of the coil occurs at this point, and hence tension oscillations in the strip are induced with each rotation of the coil. These tension oscillations lead to periodic thickness defects of the strip.

Utilizing an adaptive algorithm, it is possible to eliminate nearly the entire eccentricity oscillations of rolls and coiler up to their third harmonics. The new Roll Eccentricity Compensation (REC) as well as the Coil Eccentricity Compensation (CECO) algorithms were developed using automated code-generation techniques based on Matlab/Simulink. This innovative development process, first utilized at Primetals Technologies, speeds up the controller implementation process significantly and at the same time increases reliability.

Utilizing an adaptive algorithm, it is possible to eliminate nearly the entire eccentricity oscillations of rolls and coiler up to their third harmonics.

Standardized, scalable hardware and modularized software secure investments today and tomorrow, and enable notable productivity increases to be achieved.

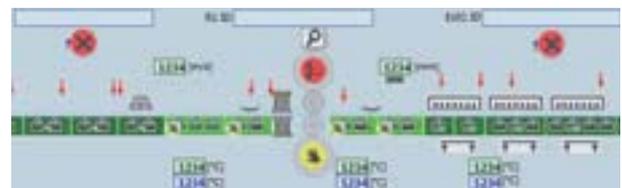
TRENDSETTING BASIC AUTOMATION SOLUTIONS FOR ROLLING MILLS

Principal author: Andreas Mantel

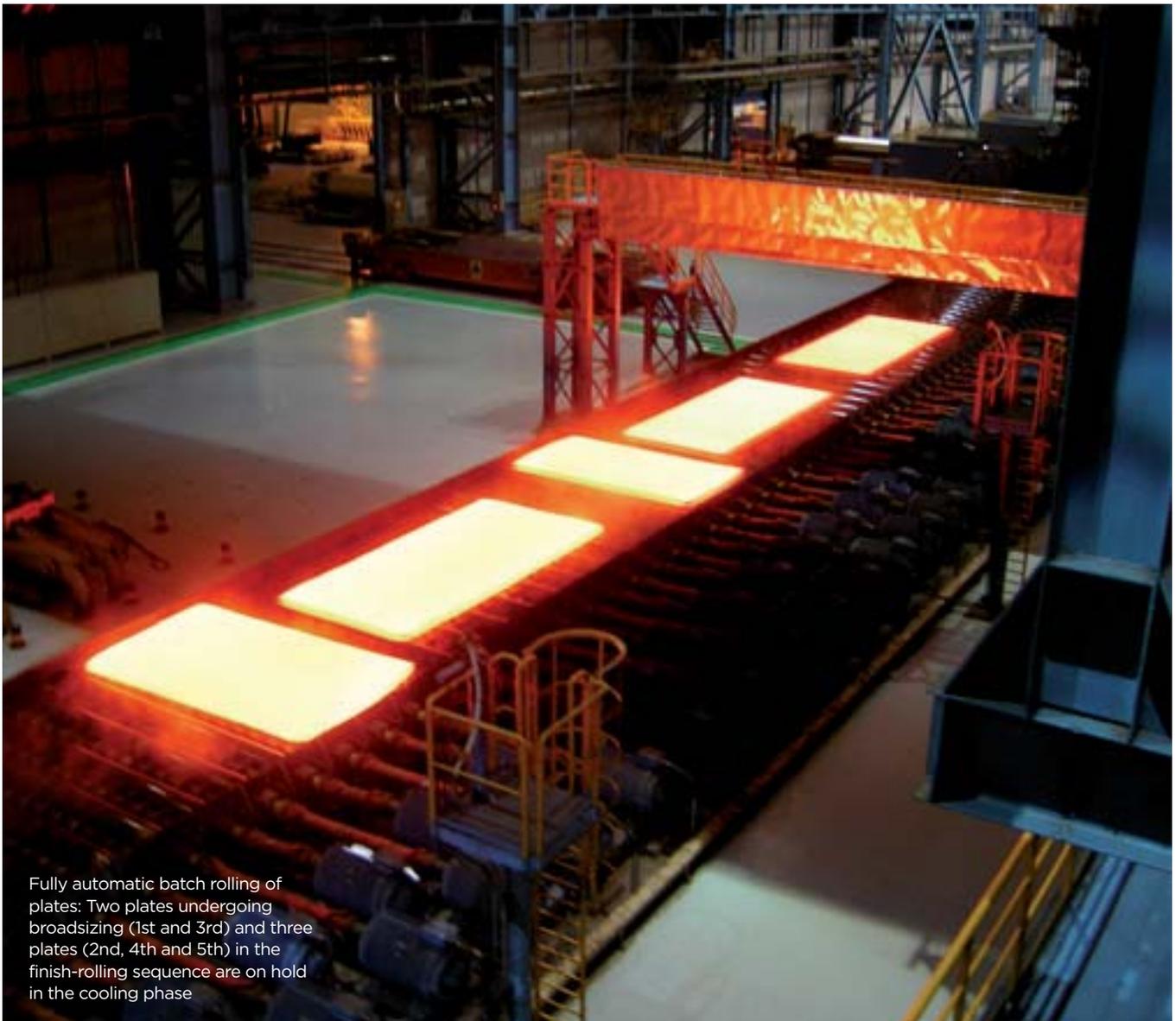
Paper number: 304

Today's challenging markets require producers to permanently improve and modernize their plant operations, and this includes basic automation systems. New concepts such as Profinet and Profisafe – easy-to-use and intuitive HMI – and powerful closed-loop controls, combined with decades of proven know-how, are the fundamentals of the innovative basic automation system. Standardized scalable hardware and modularized software secure investments today and tomorrow, and enable notable productivity increases to be achieved. Such features are the key for an optimal solution, whether for a partial or even complete automation exchange.

The innovative basic automation concept for rolling mills is introduced with special attention placed on virtualization of operational equipment. This contributes to hardware standardization, server consolidation and independency of operating systems.



Example of a monitor screenshot for intuitive visualization of the innovative basic automation system



Fully automatic batch rolling of plates: Two plates undergoing broadsizing (1st and 3rd) and three plates (2nd, 4th and 5th) in the finish-rolling sequence are on hold in the cooling phase

FUNCTIONAL ENHANCEMENTS TO IMPROVE THE ROLLING PROCESS IN PLATE AND STECKEL MILLS

Principal author: Dr. Matthias Kurz; Paper number: 223

Since 2002, Primetals Technologies has commissioned more than 20 plate and Steckel mills worldwide in close cooperation with its customers. On the basis of the extensive knowledge acquired, process automation has been enhanced and state-of-the-art, model-based functionalities have been developed to provide customers with optimized solutions to boost their business. Fully automatic thermomechanical rolling using modern physical models and intelligent sequencing strategies achieves an optimum grain refinement and thus improves the mechanical properties of rolled plates. Monitoring and modeling of the material temperature as a function of thickness in combination with the advanced process automation of the cooling sections enables tighter control of the mechanical properties of the final plate/strip and an expansion of the product portfolio to include, for example, X70 and X80

grades. The novel profile and flatness strategy that was developed by Primetals Technologies relies on physical modeling, which enables large reductions to be taken without risking poor flatness. Head and tail tapering – based on process- dependent force deviations during thread-in/thread-out – significantly reduces the load impact to the mechanical equipment. Introduction of model-based roll-alignment control has been proven to be a key factor for camber- free rolling as it allows a significant increase of throughput and rolling stability to be achieved. Advanced pacing strategies within the mill area and cooling-bed charging optimization provide an optimized material transport throughout the entire production chain, including speed- optimized crop-shear sequencing. In this paper, the operational features and performance of these and other solutions are described.



Mulpic plate-cooling technology installed in a Chinese steel mill

MULPIC – THE MOST POWERFUL METALLURGICAL TOOL IN MODERN PLATE PRODUCTION

Principal author: Sandip Samanta; Paper number: 195

The inline accelerated cooling process has become a standard solution for modern plate mills in order to produce higher-strength steels and higher-value grades. Since 2002, Siemens VAI has commissioned numerous Mulpic (multi-purpose interrupted cooling) cooling systems at plate mills throughout the world. The high cooling accuracy and temperature uniformity of plates processed with Mulpic – in combination with intelligent sequencing, accurate speed and flow control and a fully optimized cooling model – have made Mulpic the metallurgical tool of choice for plate cooling.

Until recently, all of these installations were standard Mulpic machines of 24 m in length. However, with low capital-investment levels, plate producers are looking for performance improvements by adding high-flow-density headers in front of existing laminar cooling sections. This hybrid configuration provides several challenges for process control as well as engineering. The challenges and benefits associated with such a hybrid cooling machine are discussed, as well as the steps taken to ensure an optimum design, rapid installation, fast start-up and excellent results.

PROCESS KNOW-HOW – THE KEY TO UNLOCKING THE MILL’S HIDDEN POTENTIAL

Principal author: Andrew Harvey

Paper number: 198

During the first decade of the 21st century, there was a boom in new plant installations and steel production. Primetals Technologies alone installed and commissioned 18 plate mills and 30 aluminum mills. Since market conditions changed virtually overnight in 2008, producers have been seeking to maintain profits by improving production processes in installed mills. On the basis of its mill expertise and process know-how combined with its metallurgical skills, Primetals Technologies has supported several established plate manufacturers to reduce costs, increase quality and enhance production. A number of these improvements are discussed in this paper.

One of the significant improvements was in the production of normalized rolled steel plates, which eliminated the need for subsequent heat treatment of these plates. The burden on the heat treatment line is reduced, and overall throughput for high-value plates is increased. Another example is the improvement of thin plate flatness off the mill to reduce the amount of cold leveling required. This reduces costs and broadens the customer’s market portfolio. Primetals Technologies worked with another plate producer to improve thickness accuracy and yield, reducing the number of rejected plates in one month by more than 50%. Recent work with an aluminum plant has required changes to rolling schedules, resulting in a doubling of the achievable rolling speeds. Although different customers have different problems, the considerable process know-how and experience of Primetals Technologies helps producers to optimize their mill performance.

THROUGH-PROCESS LEVELING TECHNOLOGIES TO MEET EVER-INCREASING DEMANDS FOR FINAL PLATE FLATNESS

Principal author: Sebastien Maillard

Paper number: 194

End users of steel plate are looking for high-strength plate with better flatness and minimum residual stress in finished products. Technologists are facing tremendous challenges to design machines that can meet those requirements with a wide variety of plate thicknesses, widths and strengths. The recent development of process routes in plate manufacturing with sophisticated inline cooling such as the Mulpic machine has further complicated leveling requirements. To strike a balance between these design requirements and the investment, Primetals Technologies has developed two solutions to cover current and future process demands. With a specific focus on thin and medium gauges, the first of these solutions has been designed where flexibility is brought in different roll configurations through the positioning of selected rolls actuated by dedicated wedge assemblies in a flexible single cassette. For thick plate leveling, different roll configurations are applied through the use of specific cassettes with different roll diameters and pitch, achieved by an innovative spindle support adaptive design. For both solutions, the intelligent control system along with an adaptation algorithm based on observable neural network ensures precise control of roll gaps along with individual torque and speed control of each motor, which results in best flatness and minimum residual stress in the final leveled product. When implementing these solutions into existing or new plants, decisions on design selection are made considering the overall manufacturing path for the related product mix. Examples of strategies to master flatness are highlighted, considering the various stages of plate manufacturing from rolling, cooling and shearing.



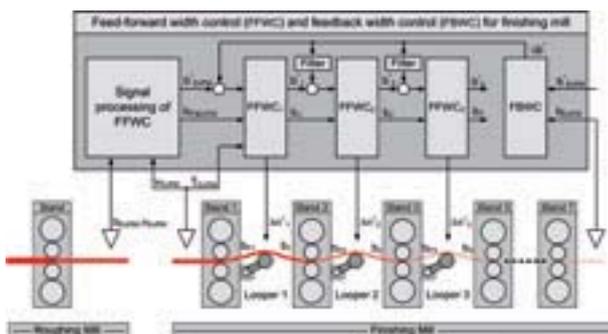
High-quality heavy plates on the cooling bed following hot leveling

It was recognized that tension can be used to manipulate the strip width in the finishing mill.

MODEL-BASED WIDTH CONTROL IN FINISHING MILLS

Principal author: Daniel Kotzian
Paper number: 224

Reduction of strip-width deviations and the avoidance of overwidth and below-minimum widths after the finishing mill are key challenges for today's basic and process automation systems in hot-strip mills. Logically, the strip width in a hot-strip mill is mostly influenced by pressing or vertical rolling of the strip in the roughing mill. Width deviations after the finishing mill arise from width deviations in front of the finishing mill or from a width spread anomaly that takes place inside the finishing mill. The behavior of width spread in a finishing mill depends on effects in roll bite and on the creep deformation between the stands. As a result, the width spread in a roll bite is influenced by, for example, thickness reduction, back tension and change of the strip-crown ratio. The creep deformation between the stands depends on, among others, yield stress, strip temperature, specific tension, distance between stands and strip speed. It was recognized that tension can be used to manipulate the strip width in the finishing mill. Entry width deviation is compensated by a feed-forward width control. Residual exit width deviation is compensated by a feedback width control. Moreover, the model-based feed-forward width control considers effects of width spread in the roll bite and the creep deformation between the stands. The concept and test results of model-based width control are described in this paper.



Control overview of feed-forward width control and feedback width control for finishing mills

ENHANCED TECHNOLOGIES FOR ROLLING ADVANCED HIGH-STRENGTH STEEL GRADES IN HOT-STRIP MILLS

Principal author: Julian Thoresson
Paper number: 293

New market opportunities in the area of advanced high-strength steels (AHSS) – including dual-phase, martensitic, complex-phase, transformation-induced plasticity (TRIP), and highest-strength pipe grades – are discussed in this paper. When attempting to produce these steel grades, existing mills often reach their limits in terms of power and flexibility.

Primetals Technologies offers a number of solutions for cooling and coiling AHSS grades in hot-strip mills. For example, the recently developed Power Cooling solution combines the advantages of laminar cooling and pressurized high-power cooling with high cooling rates to enable more flexible cooling strategies to be applied. High-strength and thick-gauge materials are reliably coiled using the Power Coiler from Primetals Technologies. Fully integrated mechanical equipment design and sophisticated process-optimization models are decisive for the reliable and economic production of high-strength steels for a wide range of strip dimensions. Possibilities for finishing mill equipment upgrades in addition to other aspects related to cooling technology and the coiling area are also presented.



With the Power Cooling solution a wide range of advanced steel grades can be produced in the cooling section of a hot-strip mill

Primetals Technologies offers a number of solutions for cooling and coiling AHSS grades in hot-strip mills.



View of an electromagnetic spectroscopy (EMSpec) sensor in the workshop (unit length: approximately 300 mm)

REAL-TIME PHASE-TRANSFORMATION CONTROL IN HOT-STRIP MILLS

Principal author: Peter Hunt

Paper number: 199

Following the successful development and site trials of the electromagnetic spectroscopy (EMSpec) sensor, the focus has now moved to integrating multiple sensors into the cooling model to allow hot-strip mills to produce higher-grade steels. The EMSpec sensor employs the principle of measuring the complex impedance of the target steel over a range of frequencies, which in turn varies with the transformation fraction of the steel. For the successful production of dual-phase, TRIP¹⁾ and TWIP²⁾ steels, better control of the cooling regime is required. The use of surface temperature measurements is not sufficient to achieve the desired microstructure. The EMSpec sensor can directly measure the percentage transformation of the steel in the cooling area, typically in the accelerated water-cooling zone. The sensor is engineered to work in this harsh environment. By enhancing the mill model to predict the transformation profile in the cooling zone, the EMSpec sensors can be used as feedback to control the cooling rates to achieve the desired microstructure.

A full-scale implementation of the real-time transformation control has been installed at a large European quality-steel producer to show the benefits of such a system. A total of three EMSpec sensor heads have been installed between the exit of the finishing mill and the entry coiler to allow the mill to be controlled to produce these high-grade steels commercially. The number of heads can be tailored to suit the specific application. The technology of the EMSpec sensor will be evaluated in an endless strip production mill and in other heat-treatment processes, such as annealing furnaces.

¹⁾TRIP = transformation-induced plasticity

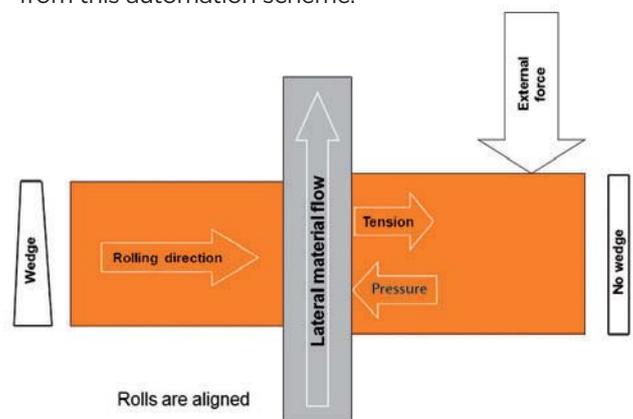
²⁾TWIP = twinning-induced plasticity

WEDGE AND CAMBER CONTROL

Principal author: Dr. Matthias Kurz

Paper number: 226

Reducing wedge without causing camber is a big challenge for today's process-automation systems in hot-strip mills. Modern, so-called camber-free rolling systems apply cameras to swivel mill stands in roughing or finishing mills to minimize the lateral curvature (camber) of the rolled strip. Hence, all shape errors on the slab – initial camber or wedge – are transferred into a wedge on the final strip. This resulting wedge has to be accepted if no additional actuator is employed. This paper shows that lateral forces acting on the strip can induce lateral material flow in the roll bite. Furthermore, an automation scheme is presented that allows wedge to be reduced in a roughing mill stand without generating camber. Therefore, camber is fully decoupled from wedge, and roll tilting in the roughing mill stand can be used to control the wedge in the rolling process. A slab-to-slab control algorithm is presented using the measured wedge of the finished strip as input and the tilting of the roughing mill stand as the actuator. As a key to success, Primetals Technologies applies the edger to induce the required lateral forces in the upstream passes. Because only equipment that is available anyway is applied, no further investment in hardware is required to benefit from this automation scheme.



Basic principle of wedge elimination without generating camber employing an external lateral force

Reducing wedge without causing camber is a big challenge for today's process-automation systems in hot-strip mills.

ELIMINATION OF THIRD-OCTAVE MILL CHATTER VIBRATION IN COLD ROLLING – FIRST SUCCESSFUL PILOT INSTALLATION

Principal author: Georg Keintzl

Paper number: 296

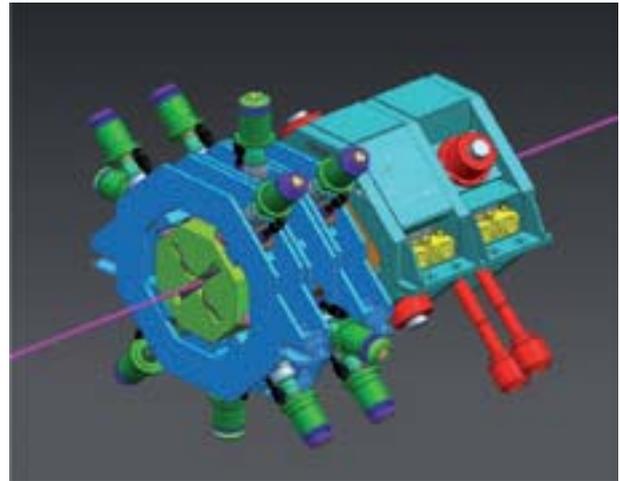
For decades, engineers have investigated the origin and elimination of third-octave mill chatter. Up until now, only chatter-monitoring systems have been successfully deployed, and for certain products, mills are often forced to operate at far lower speeds than the mill design would actually allow.

As the leading supplier of vibration consultancy service and solutions, Primetals Technologies has developed a unique solution for active vibration damping in order to eliminate third-octave mill chatter. The hydraulics-based system known as ChatterBlock Control has been successfully implemented for the first time. Third-octave mill chatter, typically occurring in a frequency range between 90 Hz and 150 Hz, is a self-excited vibration phenomenon that normally takes place in the final stands of tandem cold-rolling mills. It can produce significant gauge variations, strip defects and even cause strip breakage. This phenomenon severely limits mill productivity.

ChatterBlock Control was first installed on a 5-stand tandem cold-rolling mill where its effectiveness in suppressing third-octave mill chatter was confirmed. The technological solution and impressive results of this first industrial implementation are described in this paper.



The ChatterBlock active-vibration-damping system



The new 2- and 4-roll sizing mill from Primetals Technologies

THE NEW 4-ROLL SIZING MILL: EVOLUTION OF BAR SIZING

Principal author: Marco Langé

Paper number: 214

Primetals Technologies has developed a new 4-roll sizing mill to improve product quality and productivity of mills that roll high-end steels, such as engineering and stainless grades. This solution for precision rolling, which has been validated in experimental tests, was developed using modern numerical modeling techniques. The applied finite element analysis (FEA) technique is based on DEFORM 3D, which enables a detailed investigation of various rolling process parameters to be performed. This tool is enhanced by subroutine models that are derived from experimental results. This helps to identify the parameter's subset, which optimizes the FEA prediction and leads to the best course for technology development.

Among the main advantages of 4-roll configurations are the improved accuracy of roll gap adjustment due to the high rigidity of the mill; the wide range of dimensions that may be rolled within tolerance without changing the groove; the negligible spread deformation that simplifies the dimensional control; and the improved metallurgical issues through the control of recrystallization and grain growth.

Primetals Technologies has developed a new 4-roll sizing mill to improve product quality and productivity of bar mills.



Hot testing of idRHa+ at Baogang Rail Mill No. 2 in Baotou, China

WORLD'S FIRST APPLICATION OF THE NEW IDRHA+ RAIL-HARDENING TECHNOLOGY AT THE BAOGANG RAIL MILL IN BAOTOU, CHINA

Principal author: Federico Pegorin; Paper number: 283

Heavy-haul and high-speed railways call for long rails with precise linear tolerances and increased resistance to wear and rolling contact fatigue. This drives the development of new rail grades as well as improved manufacturing processes. In late 2013, the installation of the world's first application of a breakthrough technology for rail hardening commenced at Baogang Iron & Steel (Group) Co. Ltd., one of the world's leading rail producers. The Injector Dual-phase Rail Hardening (idRHa+) system was jointly developed by Primetals Technologies and the Italian technical center Centro Sviluppo Materiali. idRHa+ provides tailored inline cooling protocols, which serve to obtain an accurate

fine-pearlitic microstructure and hardness distribution across the rail crown. With a unique level of flexibility, it can process more than 150 t/h of rails in a wide range of sizes, grades and standards. The design of idRHa+ is based on thermal, mechanical and metallurgical models, validated by experimental trials in an industrial pilot unit. During 2014, the system was commissioned at Baotou Rail Mill No. 2. This paper presents an overview of the key concepts behind idRHa+, as well as the progression of its commissioning and testing for several rail grades. Ramp-up to consistent industrial operation is also discussed.

2

ENERGY & ENVIRONMENTAL CARE

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of energy recovery and the recycling of carbon emissions from steelworks.





**“ An investment in
the environment is
an investment
in the future.”**



Schematic view of a waste-heat recovery system for an electric arc furnace

INTEGRATED ENERGY RECOVERY AND UTILIZATION OF WASTE HEAT FOR INTEGRATED PLANTS AND THE EAF ROUTE

Principal author: Paul Trunner

Paper number: 261

In order to determine the most feasible solution for increasing energy efficiency in a steelworks, a holistic understanding of all processes in the steel production chain is required.

In order to determine the most feasible solution for increasing energy efficiency in a steelworks, a holistic understanding of all processes in the steel production chain is required. In integrated iron and steel production sites, energy from waste heat sources such as the coking plant, the sinter plant, the converter cooling stack and reheating furnaces can be recovered and efficiently used elsewhere within the plant. Many opportunities to improve energy efficiency in EAF-based steel mills can also be identified. By combining multiple sources of waste heat from, for example, a direct-reduction plant, the hot exhaust gases from the EAF and the reheating furnace, sufficient energy can be retrieved to economically generate electrical power, steam or hot water for heating purposes as well as to produce chilled water by means of absorption heat pumps. Different possibilities for energy recovery and utilization for integrated steelmaking and electric steelmaking process routes are discussed. A focus is also placed on the economic feasibility of energy-saving systems in steel mills.

THE CIRCULAR ECONOMY: CARBON RECYCLING AND THE STEEL INDUSTRY

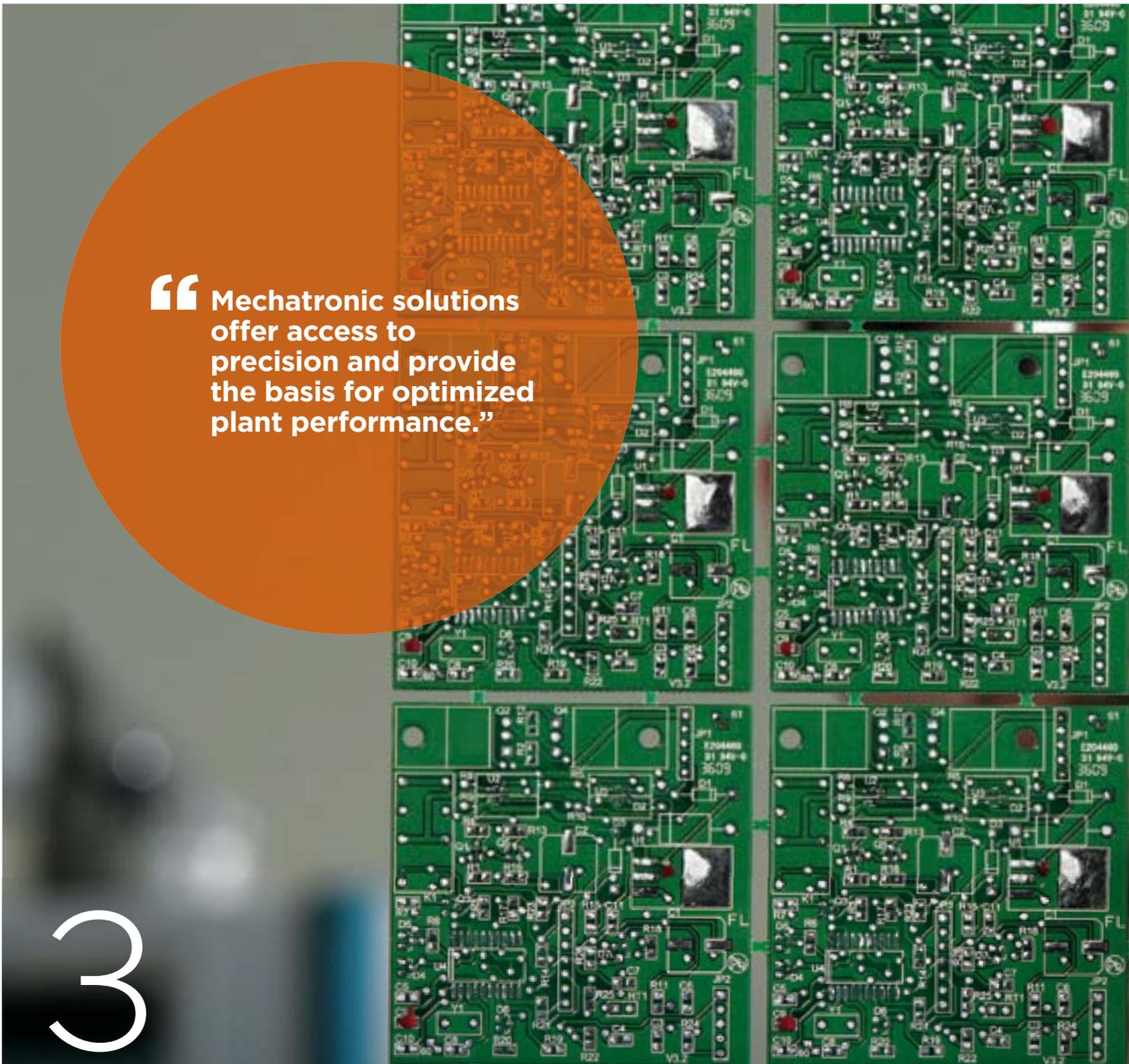
Principal author: Dr. Alexander Fleischanderl; Paper number: 292

Recycling carbon emissions from steel mills offers an important new source for fuels and chemicals production while simultaneously reducing the carbon footprint of a steel mill. The watchword is circular economy. Carbon-rich gases should be recycled wisely when the use of carbon is unavoidable, such as for the production of chemicals, fuels and plastics. However, for the generation of electricity, sustainable solutions exist that include wind, solar and hydropower to substitute the combustion of carbon-rich gases.

Pre-commercial bio-fermentation plant at Shougang, China (courtesy of LanzaTech)

A new development in offgas recycling substantially improves a steelmaker's economic competitiveness. LanzaTech's microbial fermentation of carbon- and hydrogen-rich offgases – such as coke oven gas, blast furnace top gas, direct-reduction gas and converter gas – can be applied to produce ethanol or other basic chemicals. The result is a major reduction of CO₂, NO_x, SO_x and particulate emissions to the environment. The fuels and chemicals produced in this manner deliver superior economic returns. Compared with conventional gasoline, when ethanol is used as a fuel blend up to 70% less greenhouse gases are emitted. The technology is ready for commercial implementation.



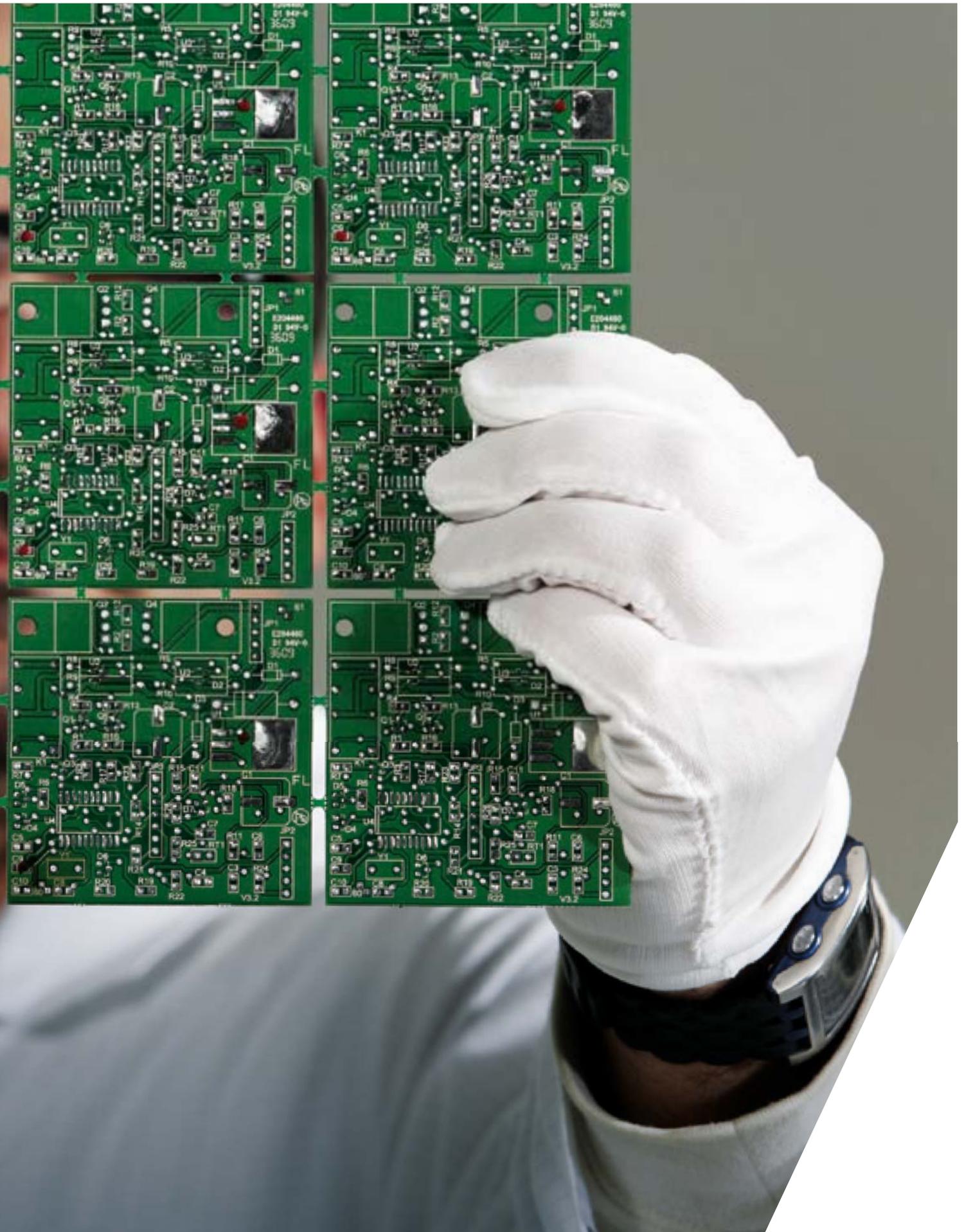


“ Mechatronic solutions offer access to precision and provide the basis for optimized plant performance.”

3

MECHATRONICS

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of improved strip-steering control using an optical measurement device, inline determination of the mechanical properties of steel strip on the basis of electromagnetic parameters, and improved strip side trimming applying optical inspection devices.



A stable and straight strip run without cobbles is crucial for system stability and safety of the rolling process in a finishing mill.

NEXT-GENERATION STRIP-STEERING CONTROLLER BASED ON OPTICAL MEASUREMENTS OF STRIP ALIGNMENT AND CURVATURE FOR HOT-FINISHING MILLS

Principal author: Andreas Lorenz
Paper number: 225

A stable and straight strip run without cobbles is crucial for system stability and safety of the rolling process in a finishing mill. This is a precondition to attain high shape quality and the required mill output. A new integrated robust control structure is presented that stabilizes strip run. Using asymmetric roll-stand models, including a roll-gap model and a finite element (FE)-strip model, a holistic simulation of the strip run in a finishing mill is achieved. This includes the simulation of lateral displacements and the resulting tension distribution of the whole strip. The control structure consists of a combination of strip position and differential tension controllers. Operators may choose between different modes. The measurement of the strip position between the mills was solved by the installation of an optical measurement device based on area-scan cameras positioned between each mill stand. New image processing algorithms were developed in order to obtain reliable results, even under the extremely harsh conditions prevailing between the mill stands. The equipment transmits strip alignment data as well as curvature data of the strip at each mill stand to the position controllers. Differential force and sum force are delivered by encoders mounted at the drive and operator sides of the looper and serve as input for the differential tension controller. Simulation results demonstrate the achievable improvements.

INLINE MEASUREMENT OF ELECTROMAGNETIC PARAMETERS AND THEIR APPLICATION FOR CHARACTERIZING THE MECHANICAL PROPERTIES OF STEEL STRIP WITH A FOCUS ON HARDNESS

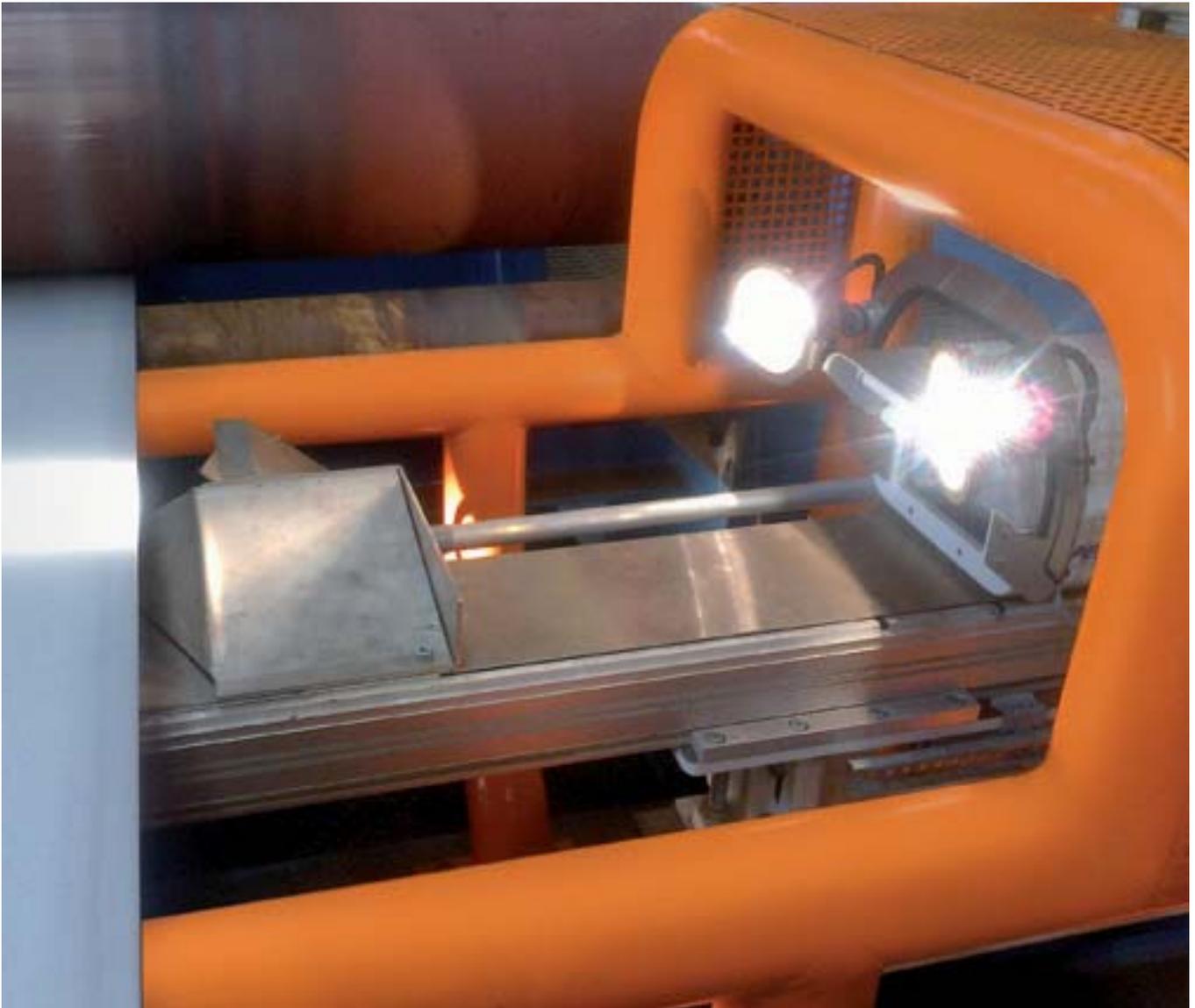
Principal author: Dr. Alois Koppler
Paper number: 219

Inline measurement of the mechanical properties of steel strip with contact-free and non-destructive techniques offers considerable potential for further technological optimization and new applications. Up until now, it has not been possible to perform direct inline strip measurements. The PropertyMon system from Primetals Technologies employs state-of-the-art methods that allow indirect measurements to be carried out using electromagnetic signals. By measuring the magnetization of steel strip, the mechanical and magnetic properties can be calculated. This is done by applying regression calculations where the coefficients are derived from laboratory sample testing. This leads to reliable results for tensile strength and yield strength, etc. – as demonstrated by system installations.

PropertyMon exhibits some unique features such as the combined measurement of strength and electromagnetic properties or directional measurements, i.e., longitudinal and transversal to the rolling direction. For the first time, test trials to determine strip hardness were carried out in a heat-treatment line of a German steel producer. The initial results are presented and show that the measurement system can provide continuous hardness calculations with a high degree of accuracy for online process monitoring and quality control. This approach complements and supports standardized, destructive testing procedures in the laboratory.



The PropertyMon measurement system with a two-sensor-head setup



Improved strip side-trimming quality based on the use of the EdgeMon optical inspection device (Strip: left side of picture; EdgeMon sensor seen on the right side of picture. The sensor is inspecting the strip edge.)

IMPROVEMENT OF SIDE-TRIMMING QUALITY BASED ON THE USE OF OPTICAL INSPECTION DEVICES

Principal author: Helmut Hlobil; Paper number: 218

Problems arising during the side-trimming process in pickling lines may lead to strip-edge defects. This, in turn, can cause lower yield performance, loss in product quality, unnecessary maintenance efforts as well as higher tool costs. The paper describes project results that show the improvements that were achieved in the side-trimming process. This was done in two steps: The first step was the identification of the quality defects and the impact to the

subsequent processes and on maintenance. The second step was the implementation and evaluation of specific improvement measures that were carried out at the plant. The installed optical inspection device known as EdgeMon served as the basis for strip-edge examinations and the subsequent improvements in side-trimming quality. Its functionality and its positive impact on the project results are described in this paper.



4

AUTOMATION

papers will be presented by Primetals Technologies specialists at the ESTAD Congress covering the topics of process optimization, condition monitoring, the Process Expert system and intelligent warehouse logistics.



The JSW Steel Vijayanagar plant in Toranagallu is the first integrated steel plant in India to reach a 10 million t/a steelmaking capacity at a single location.

COMPREHENSIVE PROCESS-OPTIMIZATION SYSTEM FOR JSW STEEL TORANAGALLU, INDIA

Principal author: Rudolf Hubmer
Paper number: 203

JSW Steel Ltd. has become India's largest private-sector steel company with an installed capacity of 14.3 million t/a. The JSW Steel Vijayanagar plant in Toranagallu is the first integrated steel plant in India to reach a 10 million t/a steelmaking capacity at a single location. In October 2013, the company placed an order with Primetals Technologies for the installation of a comprehensive Level 2 process-optimization system at this site for more than 20 existing production facilities from various suppliers. For Steel Melting Shop I (SMS-I), new Level 2 systems were provided for two hot metal pretreatment stations, three hot metal desulfurization stations, three ladle furnaces, two single-strand slab casters, a ladle-tracking system as well as a shop supervisory system. Additionally, the existing Level 2 system for one single-strand slab caster is being upgraded in the course of the project. In SMS-II, new Level 2 systems for the seven hot metal desulfurization stations, four ladle furnaces, the new RH vacuum degasser, the ladle-tracking system and a shop supervisory system were supplied. The acceptance test was passed in July 2014, and the commissioning of the single facilities started less than 12 months after the contract became effective. The process-optimization systems and their integration into JSW Steel's automation environment are discussed in this paper in addition to project progress and achieved results.

ENHANCED DIAGNOSTIC CAPABILITIES WITH THE INTEGRATION OF DIGITAL MODELS INTO A CONDITION-MONITORING SYSTEM

Principal author: Arno Haschke
Paper number: 231

Offline simulation is often used by plant builders for the design of metallurgical plants and to ensure that performance expectations are met. Whereas some simulation models cover operations across the complete plant (e.g., throughput calculations), smaller simulation models focus on individual topics such as closed-loop control, vibration behavior and the functionality of single components. The concept of using offline simulation in an online mode for plant operation is not new. Nonetheless, the necessary steps for its application are complicated and time-intensive. This requires extensive technological know-how, the buildup of digital models (using, for example, Matlab or Simulink) and the compilation of software that is ready to be used in the automation platform or in a condition-monitoring system.

As a plant builder with IT competency, Primetals Technologies has mastered this challenge and has defined a concept known as Control Builder. As described in this paper, Control Builder allows the reuse of offline digital models or simulations in the condition-monitoring system (CMS). These digital models support condition-based maintenance activities by providing deep insight into parameters that cannot be measured directly (soft sensor methods), or by comparing complex operation states with design parameters. An example is the monitoring of hydraulic closed-loop control and the associated cylinder to determine the degenerative status of valves or the presence of internal cylinder leaks. Key performance indicators (KPIs) that are the output of such simulations can be further monitored with the condition-monitoring system, and they also serve as an additional indicator for root causes.

As a plant builder with IT competency, Primetals Technologies has mastered this challenge and has defined a concept known as Control Builder.

PROCESS EXPERT – FROM COST-EFFICIENT AND MODULAR PROCESS AUTOMATION TO THE EXPERT SYSTEM

Principal author: Paul Riches

Paper number: 227

While in the past process-automation systems were used to control complex industrial production processes, in recent times those tasks have been extended even further. It is now essential to continuously record, evaluate and analyze the performance of the product, the plant and the operator team to reveal areas for optimization. Ideally, key performance indicators (KPIs) are defined and seamlessly recorded and supervised. The Process Expert system from Primetals Technologies provides the tools necessary to monitor and evaluate the performance of a plant, and it is even possible to compare different plant facilities around the world.

Optimization of a long-rolling facility can cover many areas: improvement of product quality and quantity; increased plant and machine availability for higher plant output; higher product flexibility and development of new products; reduction of material and consumables; measures to save energy; and other activities to increase profitability. The Process Expert system for a long-rolling facility collects data through the full product lifecycle from the billet yard management for incoming raw material stock to the finished-product storage yard, including the auxiliary processes such as maintenance management and roll shop management. It can also be linked to the enterprise resource planning (ERP) system of a company, which then builds a bridge to ordering and purchasing raw materials, consumables and tools. A connection is also established to customer orders for shipping the final products. Furthermore, the Process Expert system features a modular architecture and its functionality can be easily extended. It has an operator-friendly user interface, provides access via web and smartphone, can be configured by the user, and is able to create and send messages and e-mails. Finally, a safety and protection mechanism is included to protect the Process Expert system and the recorded long-term data, and it has a remote interface for fast and easy help and maintenance support.

The Process Expert system from Primetals Technologies provides the tools necessary to monitor and evaluate the performance of a plant, and it is even possible to compare different plant facilities around the world.



Slab storage area at ArcelorMittal Eisenhüttenstadt, Germany

STORAGE IMPROVEMENT BY INTELLIGENT WAREHOUSE LOGISTICS AT ARCELORMITTAL EISENHÜTTENSTADT, GERMANY

Principal author: Rene Grabowski

Paper number: 233

Steel producer ArcelorMittal Eisenhüttenstadt GmbH uses a new storage logistics system from Primetals Technologies in its finishing department. This system for warehouse logistics now provides the company with a precise picture of its stock at all times and the over 40,000 slabs that pass through the slab storage area each year. It not only supports the crane operator to stack slabs in an ideal sequence on the basis of their composition and the order processing schedule, it also automates logging of manual restacking operations. The solution thus improves workflows and simplifies stock control. Cycle times have also been reduced because the slabs can be fed to the rolling mills at a higher temperature. The expandable, modular system is based on the Simatic IT and Primetals Technologies' IT4Metals Logistics product platform. It provides a large number of organizational and commercial metrics in the form of clear graphics and tabular evaluations. For example, the system can show how many crane movements have been made per shift for any category of slab, so that the time and cost for each operation can be calculated exactly. This paper outlines the features and additional benefits of the logistics system on the basis of operational experience.

PANORAMA

A NEW WAY TO EXPERIENCE METALS

**PREVIEW OF THE PRIMETALS TECHNOLOGIES
EXHIBITION STAND AT METEC 2015
(JUNE 16-20, 2015)**

Held every four years, METEC is the world's most important event in metallurgical technology. In 2011, more than 19,000 people attended the enormous fair that featured 486 exhibitors from 33 countries. With top ratings of 98% from visitors and exhibitors, it is no surprise that METEC enjoys a reputation as the world's preeminent metallurgy forum for experts to meet, exchange ideas and share experiences.

The background image shows a modern, multi-level exhibition stand for Primetals Technologies. The stand is constructed from white metal trusses and railings, with a clean, industrial aesthetic. On the upper level, the Primetals Technologies logo is prominently displayed. Below, on a lower level, a large digital screen shows the slogan "AS ONE" in white text against a dark blue background. The stand is set within a large, bright exhibition hall with high ceilings and visible lighting rigs.

**PRIMETALS
TECHNOLOGIES**

AS ONE



TOP SECRET
Unveil to find out more.

CREATING... AS ONE

PANORAMA

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The background of the image shows a modern exhibition stand for Primetals Technologies. It features a white structure with a staircase on the left and a large screen on the right. The screen displays the company logo and the slogan "AS ONE". The stand is set in a bright, open hall with a high ceiling and industrial lighting.

PRIMETALS
TECHNOLOGIES

AS ONE

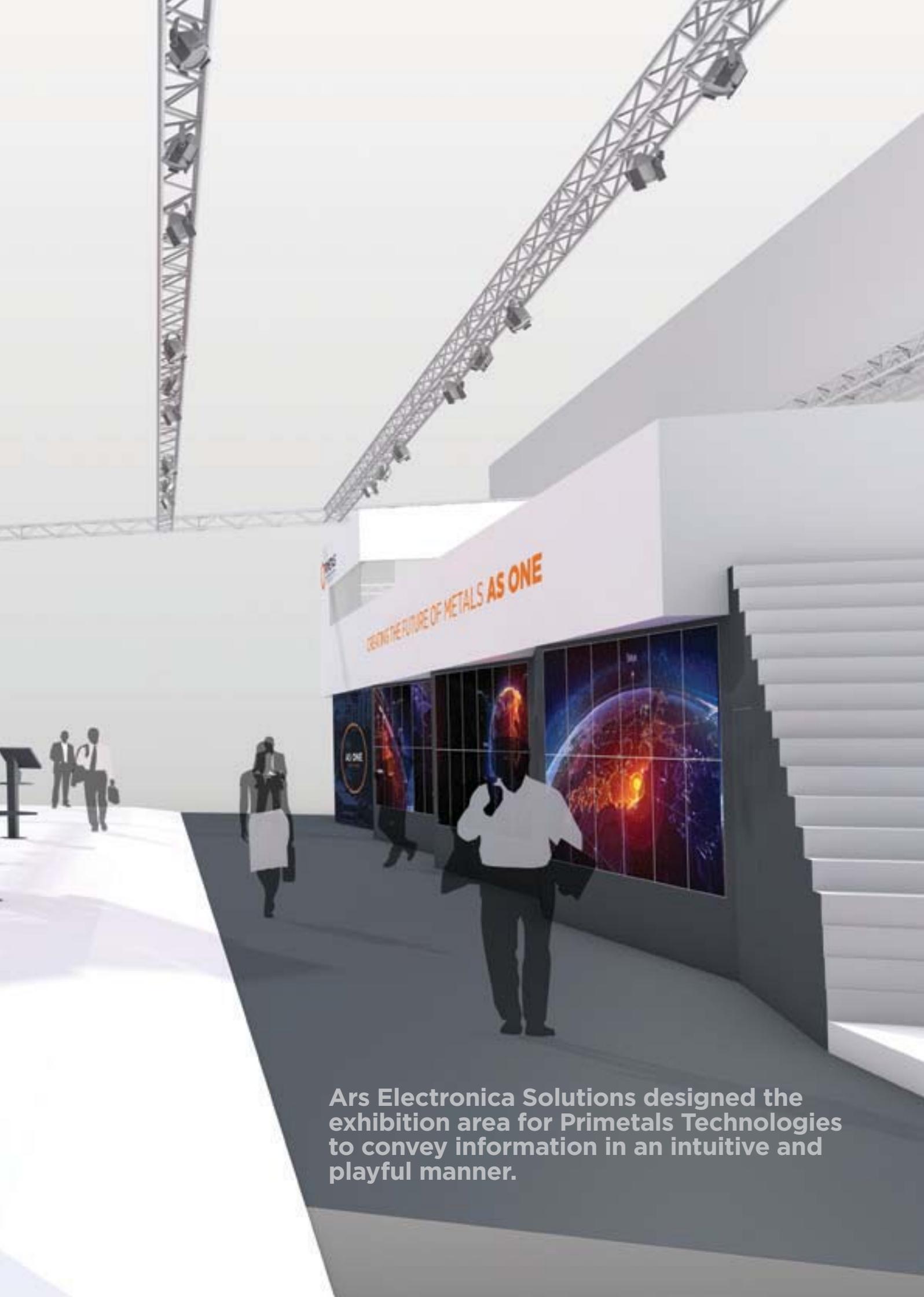


primetals.com/en/metec2015

Register at this website
to receive your personalized
voucher to attend
METEC 2015.

CREATING THE FUTURE AS ONE





Ars Electronica Solutions designed the exhibition area for Primetals Technologies to convey information in an intuitive and playful manner.

SEE YOU AT
METEC 2015!

A unique exhibition area with an immersive environment was developed to allow visitors to explore the company's multifaceted portfolio.

In June 2015, METEC will introduce a new global player in the field of metals production: Primetals Technologies. To celebrate this new partnership between Mitsubishi-Hitachi Metals Machinery and Siemens VAI Metals Technologies, Primetals Technologies will present its technology, product and service portfolio in the context of an interactive exhibition. Together with Ars Electronica, the world's leading institution in digital arts and futuristic media technology, a unique exhibition area with an immersive environment was developed to allow visitors to explore the company's multifaceted portfolio. Interactive walls and terminals invite visitors to find out about the company's products and services that can help them achieve win-win results and enter long-term partnerships with their customers. The exhibits are spread out in an open space and are inspired by elements from metallurgical processes.

A landmark object in the middle of the exhibition area is certain to draw attention: moving screens displaying scenes of metallurgical process steps will perform a baffling choreography. This artistic interpretation of the iron and steel production route – as well as all other interactive exhibits – was developed by Ars Electronica Solutions, the most recently established division of Ars Electronica.

Starting at the welcome desk, visitors will be provided with general information about Primetals Technologies and the display area. Staff will be on hand to put visitors in touch with company experts. Information about upcoming events and lectures at ESTAD, the congress associated with METEC, will be provided at the welcome desk and shown on interactive walls. In addition to up-to-date details about the ESTAD program, these walls will present an overview of projects implemented by Primetals Technologies all over the world. At the centerpiece display,

a large interactive table with a slab-inspired aesthetic will allow visitors to retrieve basic information about the company's portfolio. Other installations will provide information about key technologies via an augmented-reality interface. Process highlights along the entire iron and steel production chain, including environmental technologies and lifecycle services, will be available at the numerous terminals that are situated in the networking area. Another central element of the exhibition area will be a zone that resembles an open-pit mine – the starting point where the metals-production journey begins. The Primetals Technologies stand will also have an executive lounge where individual customer needs can be discussed in more detail.

Ars Electronica Solutions designed the exhibition area with the aim to convey information in an intuitive and playful manner, while also reflecting the company's status as one of the world's leading high-tech, innovative enterprises. This creative approach to launching the new company name and corporate design mirrors the unique global standing of Primetals Technologies. ●



Link to Primetals Technologies
METEC Website:
primetals.com/en/metec2015

METEC 2015, the 9th International Metallurgical Trade Fair with Congresses, will take place in Düsseldorf, Germany, from June 16 to 20, 2015. For more information, please refer to www.metec.de.

Dr. Roland Reiter, Marketing Management, Ars Electronica Solutions, Linz, Austria

BEYOND TOMORROW

DIALOGUE WITH MICHAEL BADICS, SENIOR DIRECTOR OF ARS ELECTRONICA SOLUTIONS

Michael Badics is the driving force behind new developments at the Solutions division of Ars Electronica, an Austrian-based center of innovation focused on implementing radical presentation and media technology. In this insightful dialogue with Metals Magazine editor Dr. Lawrence Gould, Badics describes how his creative team is preparing a futuristic and highly interactive exhibition for Primetals Technologies at METEC 2015. In addition to highlighting some of Ars Electronica's amazing achievements in the past, he also provides a glimpse of several visionary developments now underway.

Dr. Lawrence Gould: What developments and solutions from Ars Electronica could be of potential interest and benefit for metals producers?

Michael Badics: We help businesses to improve their external and internal communications. This is done by visualizing a company's ideas and by making the ideas interactive for their clients and employees. Our work helps to improve the understanding of what a particular company does and offers. This also applies to the steel industry where we can implement new and completely different visualization techniques for technologies and technological processes.

Ars Electronica is supporting Primetals Technologies at METEC 2015 with the company's futuristic exhibition

area. What are the goals and what impressions are you trying to create?

Badics: We want to create a fantastic impression of the world of Primetals Technologies, showing the processes and the unbelievable scope of products. The goal is to underline the USPs [unique selling propositions] of the company. By creating a balance between the playful or interactive elements and the technology, we demonstrate what your company is all about and what it stands for.

We at Primetals Technologies were quite proud that our customer magazine Metals Magazine [Issue 3/2014, pages 28-31] recently included an augmented-reality topic for the first time in a Siemens magazine and



“ We help businesses to improve their external and internal communications.”

perhaps for the first time ever in a metallurgical journal. When I showed the article to my son Paul, he said, “C’mon Dad, when I worked as an Arc Electronica guide ten years ago, they were already developing augmented reality.” So what new media tools are now underway at Ars Electronica that we may be publishing in future issues of our magazine?

Badics: In fact, we were already involved with augmented reality in 2002 or 2003. At that time, there were screens that you could carry around to visualize a room in different perspectives. Virtual reality was a key topic at Ars Electronica back in 1996. We applied the first 3-D “cave” for the public in the same year. Maybe in one of the soon-to-be published issues of your magazine, we may be able to

see what is called E-Paper displays. With this technology, a video or animation automatically starts by simply opening the page. We can already make invitation cards that show a short video clip when the card is opened.

I was told that the activities and developments going on at Ars Electronica are something that is truly unique in Austria, perhaps even in Europe. Is this true?

Badics: What goes on here at Ars Electronica is unique in the world. This is due to the intensive interaction between our Futurelab and Solutions divisions, cooperation with universities around the world, the Ars Electronica festival that attracted some 100,000 visitors in 2014, and the Prix Ars Electronica contest that is held each year. During »



“ With all of these futuristic developments, it is the human factor that must always remain as the central element.”

the 2014 contest, for example, some 4,000 ideas were submitted by thousands of artists and technologists from all over the world that cover nearly the complete spectrum of technological fields. The synergy effect resulting from this unbelievable worldwide network is immense and it helps us to optimize developments in a certain direction and to spotlight the ideas of tomorrow.

Do you cooperate with other centers or think tanks in the development of new media tools?

Badics: In Austria, we closely work together with the Softwarepark Hagenberg – Austria’s Silicon Hill – JKU [Johannes Kepler University], and the Linz Kunst-Uni [The University of Art and Design Linz]. There are worldwide activities going on that include PhD programs, in-residence artists and scientists, and intensive cooperation with Japan. This is underlined by the fact that our website is also in Japanese. In general, we find that the Japanese are far more open than the Europeans for digital art and to applying new technologies.

Creativity. What generates it at Ars Electronica? I’m sure you guys don’t sit around doing yoga and chanting waiting for some burst of inspiration to come.

Badics: Our sources of inspiration come from two directions. The first one is our team. Our people include computer specialists, game designers, contour scientists and sociologists. The staff members also come from completely different backgrounds and cultures that include Eastern European, Japanese, American and others. This is very important. Through this diversity, new ideas are generated within the group, which individual people would not have. Secondly, as already mentioned, our immense international networking and the continuous exposure to new ideas is the perfect stage for the generation of innovative concepts and developments. We also have here a very flexible and open system that fosters creativity.

With big data, augmented reality and ever-present touchscreens, it seems that science fiction has become part of the mainstream. According to Time Magazine (Issue 6/Feb. 9, 2015), which quoted the Edelman Trust Barometer report (2015), the majority of people feel that these developments are moving far too fast and that not enough thinking is being done about the possible consequences. How do you evaluate these developments?



Michael Badics: This is a fundamental question. It is not only true for most people, it applies to everyone. No one can foresee what impact these developments will have on people one year from now. And the spiral is accelerating beyond belief. The purpose of the Ars Electronica museum and festival is therefore to make these technologies known and to help people better understand them and recognize the impact they may have on their lives. Big brother is not just watching. He already knows.

What “Area-51”-type* super-secret projects are now underway at Ars Electronica that you perhaps would like to reveal for the first time ever to some 10,000 readers of Metals Magazine?

Badics: Well, we have a lot of secret R&D projects going on which we are not allowed to discuss at this time. But I can say that we are involved with future technologies dealing with communication between machines, and not just between people and machines. We expect that brain interfacing will come around in five to ten years, which will become a widely applied communication technology that will help people in their everyday lives. This means that one day someone will be able to turn on a radio just by thoughts. But again, it is extremely important that we have

to think about the potential consequences and misuse of such technologies.

Finally, is there anything else that you would like to say?

Badics: Yes, in my earlier days I worked in the steel industry for around one and a half years. I’ll never forget watching an operator looking through a glass at liquid steel. He was able to roughly determine the steel composition and how much more of which additives were still needed to obtain a certain quality. This is the human touch – the result of a lifetime of experience. Let me emphasize this: that with all of these futuristic developments, it is the human factor that must always remain as the central element. ●

More information about the activities and far-reaching developments of Ars Electronica, including its Solutions division, is available at www.aec.at.

*Area 51 is a top-secret U.S. military installation located in southern Nevada that the CIA only publicly acknowledged for the first time in July 2013. Due to the intense secrecy surrounding the base, it was often the subject of conspiracy theories and unidentified flying object (UFO) rumors.



As a reliable and dedicated partner for the metals industry, Primetals Technologies is committed to technological excellence across the metals value chain – which is backed by a comprehensive service portfolio. This ensures that supplied metallurgical plants will operate at peak performance throughout their entire lifetime.

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From the steam engine to the steam locomotive to the futuristic series of Japanese bullet trains, trailblazing industrial developments have improved the standard of living and created a more positive future for billions of people around the world.

Special note: the LO series of a high-speed, wheel-less maglev (magnetic levitation) train is currently being developed by Mitsubishi Heavy Industries – one of the parent companies of Primetals Technologies. The train, which will be the world's fastest commuter train, is planned to run at a maximum speed of more than 500 km/h and is scheduled to enter service in 2027 when a special rail link between Tokyo and Osaka is completed.



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Combining the complementary strengths of Siemens VAI Metals Technologies and Mitsubishi-Hitachi Metals Machinery, Primetals Technologies is dedicated to creating the future of metals as one. This will be accomplished in close cooperation with our customers, business partners and R&D associates.

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