

ISSUE 02 | JUNE 2017

METALS MAGAZINE

INNOVATION AND TECHNOLOGY FOR THE METALS INDUSTRY

METALS MAGAZINE
ISSUE 02
JUNE 2017

THE HARMONY OF TECHNOLOGY

The immense technological competence of Primetals Technologies at every step of the iron and steel production process was demonstrated by the record number of technical papers that the company presented at the AISTech 2017 and ESTAD/ECCC 2017 conferences in the music cities of Nashville and Vienna.

HARMONY PERFECTION EXCELLENCE

BRILLIANT SOLUTIONS AND SERVICES
AT EVERY STEP OF THE VALUE-ADDED
PRODUCTION CHAIN

PRIMETALS TECHNOLOGIES
CREATING THE FUTURE
OF METALS AS ONE

primetals.com





Primetals Technologies
is dedicated to serving
its customers with
advanced technological
solutions to ensure
optimized plant
performance and long-
term business success.

EDITOR'S COLUMN



LAWRENCE GOULD

DEAR READER,

At first glance, the image depicted on the title page of this magazine is immediately identified as a violin. However, upon closer inspection, it becomes evident that the image is comprised of thousands of smaller pictures of metallurgical plants and metals-related scenes. With the use of a special computer program and with access to a database consisting of more than 50,000 photographs of plant references of Primetals Technologies, a computer selected and assembled the best metallurgical scenes to generate the targeted violin picture. But why a violin?

Three of the world's most prestigious metallurgical events recently showcased the latest developments in the steel industry: The AISTech 2017 conference was held on May 8-10, 2017 in Nashville, Tennessee, U.S.A.; and the ESTAD and ECCC conferences simultaneously took place in Vienna, Austria on June 26-30, 2017. At these events, Primetals Technologies stood apart from all other companies with a record number of technical presentations that covered every step of the iron and steel production process. 36 company papers were presented at AISTech 2017, 55 papers at the 3rd European Steel Technology and Application Days (ESTAD 2017), and 16 papers at the 9th European Continuous Casting Conference (ECCC 2017) - 107 papers in total dealing with the latest technological innovations, process improvement solutions, and highlights of the most recent plants supplied by Primetals Technologies.

Interestingly, these conferences all occurred in cities that are especially renowned for music. Nashville, site of AISTech 2017, goes by nickname "Music City," and is

widely recognized as the songwriting and country music capital of the world. Vienna, which hosted the ESTAD and ECCC conferences, is universally acknowledged as the world's classical music capital. More famous composers have lived and written music in Vienna than in any other city on the planet.

The violin mosaic image thus symbolizes both the musical heritage of the Nashville and Vienna conference locations, as well as the technological preeminence of Primetals Technologies at all three events. Similar to the compilation of individual plant pictures to form the violin "composition," the selection and integration of the best production facilities as part of a totally harmonized steelworks is decisive for achieving the supreme target: the production of outstanding value-added products of the highest quality to support producers to remain competitive and thrive in their respective markets. Primetals Technologies is dedicated to serving its customers with the most advanced technological solutions to ensure optimized plant performance and long-term business success.

Yours sincerely,

Dr. Lawrence Gould

Managing Editor of Metals Magazine
Primetals Technologies, Limited

PERSONAL NOTE FROM THE EDITOR: This edition of Metals Magazine is the last magazine issue for which I will be serving as the Managing Editor. After more than 35 fulfilling and rewarding years working for Primetals Technologies and its predecessor companies, I will soon be retiring from the company. My highly capable successor, Dr. Thomas Widter, Deputy Managing Editor, will assume command of the magazine as of July 2017. I now look forward to devoting my time and energy to the pursuit of musical excellence on the violin. The picture shown on the cover page of this issue is a vintage Sebastian Klotz violin that was crafted in Mittenwald, Germany in the year 1733. It is a cherished gift from my grandfather.

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Featuring 16 continuous casting papers from Primetals Technologies at the ECCC Conference 2017 in Vienna covering the topics of slab casting, billet casting, bloom casting, strip casting, and the related mechatronic, automation and process-optimization systems.

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72 **Energy & Environmental Care**

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Featuring 7 mechatronics, automation and plant-wide solutions papers from Primetals Technologies at the ESTAD Conference 2017 in Vienna, covering the topics of inline measurements, condition monitoring, maintenance services, production planning, plant optimization and quality control.



Primetals Technologies specializes in the development and application of state-of-the-art solutions to support metals producers to remain successful and excel on the market.

View of the integrated iron- and steelworks of voestalpine Stahl, Linz, Austria

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METALS MAGAZINE IS ALSO AVAILABLE FOR TABLET COMPUTERS

The new "Primetals" app is available for iOS and Android tablets and can be downloaded for free in the respective App Store. The app features a collection of articles from the current and past issues of *Metals Magazine*, as well as interactive presentations of select technologies.

PRIMETALS TECHNOLOGIES APP

Please scan this QR code with your iOS or Android tablet to download the app.



<http://qrs.ly/195ldnx>





DR. ETSURO HIRAI
CTO of Primetals
Technologies

MESSAGE

FROM THE CTO

DEAR CUSTOMERS,

As CTO of Primetals Technologies, it is my responsibility to have a detailed overview of the vast scope of technological solutions we provide. Even more importantly, I am putting much of my focus on the orchestration of our R&D efforts. I am delighted by the fact that the employees of Primetals Technologies have implemented no less than 200 new R&D projects per year on average since the start of the company in 2015. It is our ambition to constantly pioneer new innovations in the field of metals production, because we want you, as our customers, to be the market leaders of tomorrow and to remain in that position for decades to come.

In order to do this successfully, we are tirelessly monitoring economic changes as they occur. Also, we are keeping a close eye on new technological prospects, even beyond the boundaries of the metals industry itself. We have, for instance, built strong alliances with a large group of startup companies in recent years, and these partnerships have already led to invaluable contributions to our internal R&D work. Overall, I can say that the combined efforts of our own extensive research and our collaboration-based innovations have allowed us to widen our portfolio and further improve existing solutions.

This climate of innovation is an integral component of the DNA of Primetals Technologies. It is a large part of why I am so proud to serve as the company's CTO. Conferences such as the ESTAD and the ECCC of 2017, which this issue of *Metals Magazine* is dedicated to, are a fantastic opportunity for us to showcase our determination to offer our customers the most advanced solutions in the industry. Nothing can convey our technological competence more clearly than a presentation of some of our most recent R&D milestones. 71 of them have been brought together in this edition of *Metals Magazine*, and you can read about the objectives of these projects from page 18 onwards.

The subject matter of these conference-paper summaries can be challenging due to their highly technical nature. Therefore, I would like to offer you some guidance in how to read these abstracts by outlining a few distinct trends. Basically, I see four technological areas in which Primetals Technologies has conducted particularly active research, and will continue to do so.

The first area is that of ECO solutions. "ECO" stands for "ecological" and implies that the respective initiatives are directed toward improving the CO₂ footprint of our customers' plants, their energy efficiency, their overall performance when it comes to outperforming even the most stringent environmental regulations, and other aspects of steel production that have an impact on the environment. Most of the savings potential, of course, lies with upstream technologies, because those by and large are the most energy-intensive. We are constantly working on the refinement of our solutions for the production of direct-reduced iron, which yields significant savings in terms of energy needs and CO₂ emissions when used as an input material for steelmaking. Quite appropriately, we are seeing a shift toward increased "material flexibility" among producers, meaning that they are prepared to select the source material for the steel production process on the basis of its respective energy efficiency. We are presenting our current status of energy saving, heat recovery, and many other technological initiatives at this year's ESTAD and ECCC events.

Our second chiefly important R&D field is marked by the terms "Industry 4.0," "Industrial Internet of Things," and "digitalization." These are more than just buzzwords to us. We have already brought a number of corresponding projects into a market-ready stage, and our ambition is that, not very far from now, all equipment supplied by us will be capable of being monitored and »



Dr. Etsuro Hirai with Yasukuni Yamasaki,
CEO of Primetals Technologies

controlled by “intelligent” machines with sophisticated algorithms. The target here is to build bridges between a great number of different technological components. We have isolated several factors that need to be implemented in parallel to reach this goal: Smart sensors will provide detailed condition-monitoring information of all plant equipment and make the creation of an expert system with knowledge-based process models and advanced predictive maintenance a reality; automatic functions will free up

workers to focus on those tasks where human interaction is indispensable; cyber-physical systems will secure the complex site workings of a plant; and advanced human-machine-interface technologies will put the data gathered from production facilities “into the manager’s pocket.” The term that best reflects our larger vision for this approach is that of a “cognitive plant.” Basically, the plant “knows” more about itself and becomes “smarter.” Since Primetals Technologies has the advantage of being a full-line supplier, we

“It is our ambition to constantly pioneer new innovations in the field of metals production, because we want you, as our customers, to be the market leaders of tomorrow.”

Dr. Etsuro Hirai

are in an ideal position to deliver truly groundbreaking results in this future-oriented form of advanced automation.

Linked production processes is the third area I would like to emphasize. What I am thinking of here is actually several different types of production lines that are more streamlined than the traditional manufacturing route. Arvedi Endless Strip Production belongs to this category of highly efficient, extremely future-compatible metals-production methods. Another one is WinLink, a compact plant setup, where a high-speed billet caster is directly connected to a high-availability rolling mill, resulting in a highly energy-efficient steel production process. I also associate a number of technologies that improve overall plant throughput with this area, such as the bar-joining, heavy laser welding, compact cold rolling, and strip-casting solutions we offer. The same applies to our portfolio for the production of non-ferrous metals.

The fourth R&D area I would like to point out is that covered by our Through-Process Optimization (TPO). This area is different from the first three, in that TPO is actually less of an independent component and more of a comprehensive platform that supports many other technologies. The core idea is to take a very detailed, in-depth look at a customer's plant and determine the crucial spots where well-executed adjustments can yield a significantly improved end product. With TPO put to use in a steel plant, knowledge management no longer solely relies on workers passing on what they have learned over the years to their trainees. Rather, a lot of the experience gained within the plant is accumulated in

the TPO system, evaluated, and put into a very large context before it is finally re-applied. Obviously, this know-how-based manufacturing-execution system not only depends on great software that we have developed over the years, but also on good and stable customer relationships. Therefore, we continuously do our best to build trust with our customers.

In general, the signs of our times are that revamps and modernization packages are requested more often by our customers than large-scale greenfield projects. That is completely fine with us. We go where our customers need us the most, partner with them whatever their goal may be, and support them for as long as it takes for them to be fully satisfied with the collaboration. Not only do we offer consultation and project planning, but we also accompany our customers through the entire process of project execution and construction, all the way to the training of their employees. To us, this is what partnering with our customers really means, and the fact that we emphasize this distinction defines us as a company.

Let me come back to what we are presenting to you in this issue of *Metals Magazine*, the conference-paper abstracts reflecting our submissions to the ESTAD and ECCO of 2017. I hope that they will give you a clear idea of the R&D strategy that Primetals Technologies has crafted, and of our determination to support you in making a difference on the market. Our mission is to create the future of metals – with our vast portfolio of proven technological packages, with our constant search for new and innovative solutions, and, most essentially, with you, our valued customers. ●

EXAMPLES OF RECENT PROJECT AND COMPANY NEWS

Primetals Technologies supports its customers throughout the world with advanced solutions, equipment and services at every step of the iron and steel production process.



- | | |
|------------------------------------|---------------------------------|
| 1. Ixtaczoquitlan, Orizaba, Mexico | 11. Bolzano, Italy |
| 2. Cartersville, Georgia, U.S.A. | 12. Dobrá, Czech Republic |
| 3. Becancour, Quebec, Canada | 13. Erdemir, Turkey |
| 4. Avilés, Spain | 14. Kalinganagar, Odisha, India |
| 5. Liège, Belgium | 15. Abu Dhabi, U.A.E. |
| 6. Legelshurst, Germany | 16. Jamshedpur, India |
| 7. Georgsmarienhütte, Germany | 17. Hospet, Karnataka, India |
| 8. Eisenhüttenstadt, Germany | 18. Shanghai, China |
| 9. Linz, Austria | 19. Rizhao, China |
| 10. Bolzano, Italy | 20. Dangjin, Korea |
| | 21. Gwangyang, Korea |

Geographic locations
of the project news topics
addressed in this section



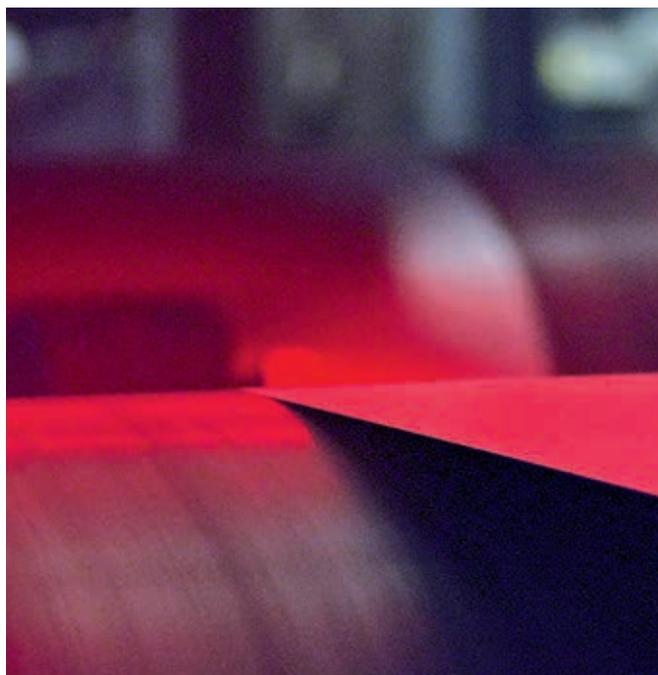
Seamless material tracking along the entire production route provides Tyasa with the genealogical information customers require for flat products.

TYASA ORDERS PRODUCTION-MANAGEMENT SYSTEM FOR STEELMAKING PLANT AND NEW COIL PRODUCTION LINE

1. MEXICO: Talleres y Aceros (Tyasa) placed an order with Primetals Technologies for the supply of a Level 3 production management system for its EAF, billet caster and a new Castrip coil-production line in Ixtaczoquitlan. The system steers order-based production operations by taking into account product routing information and associated instructions for the individual processing facilities. Seamless material tracking along the entire production route – from the steel heat in the electric arc furnace to the final coil product – provides Tyasa with the genealogical information customers require for flat products. The project is scheduled for completion in early 2018.

Control pulpit in Tyasa's steelmaking plant, Ixtaczoquitlan, Orizaba, Mexico (photo: courtesy of Tyasa).

The improved strip-quality control will optimize production costs and maintenance activities.



Inspection of galvanized strip with the SIAS system

LONG-PRODUCT CONTINUOUS CASTER TO BE MODIFIED AT GERDAU CARTERSVILLE

2. U.S.A.: An order was placed with Primetals Technologies for the modification of an existing 4-strand billet/bloom/beam-blank caster at Gerdau Cartersville in Georgia, U.S.A. to enable the steel manufacturer to cast an additional beam-blank format. This will allow Gerdau to roll larger finished products for additional applications in the building and construction industries. Commissioning of the modified plant is scheduled for the end of 2017.

PROJECT LAUNCH OF NEW HBI FACILITY FOR SIM

3. CANADA: On April 19, 2017, the formal project launch event for the new 2.0 million t/a Midrex HBI plant took place at the Becancour project site of the customer, Société Internationale Métallique (SIM), in Quebec, Canada. Plant construction is planned to start in 2018.

COMPLETION OF PICKLING LINE MODERNIZATION AT ARCELORMITTAL ASTURIAS

4. SPAIN: Primetals Technologies has successfully completed the modernization of the Continuous Pickling Line No. 2 of ArcelorMittal Asturias at its Avilés plant in Spain. Key targets of this project included increasing the capacity of the pickling line from 1.5 million t/a to 1.8 million t/a and to further improve working safety.

THREE SIAS SURFACE-INSPECTION SYSTEMS TO BE INSTALLED AT ARCELORMITTAL LIÈGE

5. BELGIUM: ArcelorMittal Liège ordered three SIAS surface-inspection systems for installation at two of its continuous galvanizing lines and on a continuous pickling line, which had been previously supplied by Primetals Technologies. The high-resolution inspection system allows the real-time classification of strip surface defects and also features coil-grading, parallel-classifier and DCR (data coordinator and retriever) functionalities. The improved strip-quality control will optimize production costs and maintenance activities. The surface-inspection systems are scheduled to be commissioned in mid-2017.

NUMEROUS SERVICE PROJECTS FOR THE ELECTRIC STEELMAKING BUSINESS OF PRIMETALS TECHNOLOGIES GERMANY

6. GERMANY: A number of service projects were recently received from electric steel producers that include the supply of: 1) a spare- and wear-parts package for Companhia Siderúrgica do Pecém (CSP) in Brazil; 2) 15 steel ladles for ArcelorMittal Dunkerque in France; 3) an alloying system, ladle heating system, a lower furnace shell and a tapping slide gate for BGH Edeltahlwerke in Freital, Germany; 4) two ladle furnace roofs for the Termitau steelworks of ArcelorMittal in Kazakhstan; and 5) a new roof for a vacuum-degassing plant at Ural Steel in Russia.



Strand-guiding system of the continuous bloom caster at Georgsmarienhütte, Germany

CONTINUOUS CASTER TO BE MODERNIZED AT GEORGS-MARIENHÜTTE

7. GERMANY: A 6-strand continuous bloom caster is currently being upgraded by Primetals Technologies for the German steel producer Georgsmarienhütte GmbH (GMH) at the company's main production site in Georgsmarienhütte, Lower Saxony. The goals of this project are to refurbish the caster to meet future market requirements – especially for the automotive industry – improve the quality of the cast products, increase plant availability and productivity, and ensure greater casting flexibility. Upgrading activities comprise modifications to the casting platform area, machine head, strand support, the withdrawal and straightening areas, and the dummy-bar system. Furthermore, specialized equipment and technological packages will also be installed, including a system for measuring the casting-powder thickness; a strand stirrer; the Dynacs 3D secondary cooling system, and the DynaGap 3D strand-guiding system to enable dynamic soft reduction. This stage of the ambitious modernization program will be completed in the summer of 2017.

The goals of this project are to refurbish the caster to meet future market requirements.



Eco Slide Discs mounted on the side beam at the entry side of a downcoiler in a hot-strip mill at voestalpine Stahl Linz, Austria

ARCELORMITTAL EISENHÜTTENSTADT ORDERS ECO SLIDE DISCS FOR HOT-STRIP MILL

8. GERMANY/U.S.A.: Eco Slide Disc side guides will be installed on the side beams of the entry section a downcoiler in a hot-strip mill at ArcelorMittal Eisenhüttenstadt. They will replace the conventional wear plates used for strip guiding into the coiler. The reference plant at voestalpine Stahl has shown that the rotatable discs can be used for up to several months, whereas the previous equipment had to be replaced every few days. The new strip side guides have an inherent self-cleaning effect, which reduces the risk of material deposits falling onto the strip and damaging its surface. The Eco Slide Discs are scheduled to be installed at ArcelorMittal Eisenhüttenstadt in July 2017.

Just in: Two additional orders for the installation of Eco Slide Discs in the entry section of downcoilers in hot-strip mills were received from Salzgitter Flachstahl GmbH in Germany and from AM/NS Calvert LLC, Alabama, U.S.A.

SERIES OF CASTER AUTOMATION PROJECTS FOR PRIMETALS TECHNOLOGIES AUSTRIA

9. AUSTRIA: Primetals Technologies received a number of autonomous orders for the upgrading of the automation systems of continuous casting plants as follows: 1) Level 2 automation upgrades for two casters at Tata Steel IJmuiden in the Netherlands; 2) Level 1 and Level 2 automation grades for two slab casters at Eregli Demir ve Celik Fabrikalari (Erdemir), Turkey; 3) Level 2 automation upgrade for one caster at Tata Steel, Port Talbot, in the U.K.; and 4) Level 2 automation upgrades of two casters at Nanjing Nangang Industry Development Co. Ltd. (Nisco).



3-strand continuous billet caster from Primetals Technologies at the Bolzano plant site of Acciaierie Valbruna, Italy

UPGRADED BILLET CASTER STARTS UP AT VALBRUNA

10. ITALY: A 3-strand billet caster modernized by Primetals Technologies was started up at the Bolzano production site of Italian steel producer Acciaierie Valbruna S.p.A. The caster, which has an annual casting capacity of 200,000 tons, is now able to cast stainless steel and special-alloy billets with larger cross sections up to 180 mm. The machine radius of the plant was also increased from seven to nine meters, which will allow billets with cross sections up to 200 mm to be cast at a later date. The project scope also included modifications to the hydraulic oscillator, the supply of a new secondary cooling system, and the installation of a vertical hydraulic shear in the caster runout area. Modernization work on the caster was carried out during a planned shutdown. An additional contract was signed with Acciaierie Valbruna for the supply of six new Red Ring Series 5 horizontal-vertical rolling units, which will replace the older Red Ring stands of in the roughing train of a long-rolling mill. Installation is scheduled for August 2017.

NEW RED RING ROLLING STANDS FOR RIVA ACCIAIO CERVENO

11. ITALY: Two new Red Ring rolling stands will be installed in a long-rolling mill at Riva Acciaio Cerveno as part of an overall modernization plan. The stands will replace several existing stands, which will allow the company to enlarge the range of it rolled products. Start-up of the new stands is scheduled for early 2018.



Example of an automatic bar manipulator of a section mill from Primetals Technologies

MODERNIZATION OF A SPECIAL SECTION ROLLING MILL AT VÚHŽ

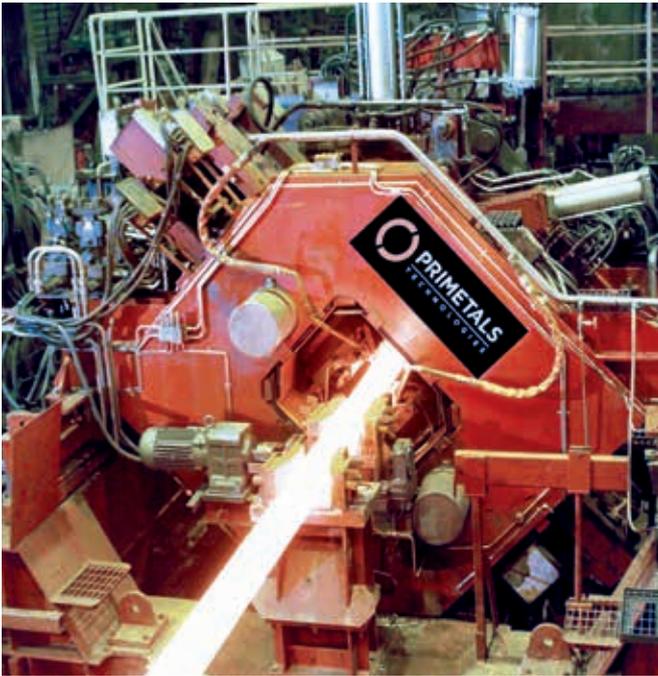
12. CZECH REPUBLIC: VÚHŽ a.s., a 100% subsidiary of Czech steel producer Třinecké železárny a.s., placed an order with Primetals Technologies for the upgrading of the company's special-section rolling mill at its production site in Dobrá. The aim of the project is to increase the production capacity of special sections from 8,000 tons to 12,000 tons per year. In the future, it will also be possible to cast larger square billets with sizes up to 150 mm. The modernized section mill is due to be completed in late 2017.

BLAST FURNACE AUTOMATION SYSTEMS COMMISSIONED AT ERDEMIR

13. TURKEY: Commissioning of the new Level 2 automation systems that were installed by Primetals Technologies at two blast furnaces in Turkey took place in April 2017 for the Turkish steel producer Erdemir.

SUCCESSFUL OPERATION OF TATA STEEL'S KALINGANAGER BLAST FURNACE

14. INDIA: Tata Steel's No. 1 Blast Furnace in Kalinganagar, Odisha, has recently completed its first year of operation. The furnace is working well and has achieved a production rate of 8,500 t/d. It is expected to reach its contractual production figure of 9,150 t/d with coal injection.



The ERT-EBROS billet-welding system from Primetals Technologies. A similar system will be installed at the Emirati Union Iron & Steel Company LLC (Union Iron & Steel) company.

ERT-EBROS BILLET-WELDING SYSTEM FOR A ROLLING MILL AT UNION IRON & STEEL

15. U.A.E.: Emirati steel producer Union Iron & Steel Company LLC (Union Iron & Steel) placed an order with Primetals Technologies for the supply of ERT-EBROS endless rolling technology for the company's existing bar rolling mill in Mussafah Industrial Area, Abu Dhabi, United Arab Emirates. The target of this investment is to increase overall mill utilization and allow up to 420,000 tons of billets to be rolled per year to boost the total plant output.

In the ERT-EBROS process, billets are welded together and continuously rolled, which results in a consistently high product quality. Start-up of the system is planned for late 2017, and it is expected to pay for itself within less than two years. It is the first time that this endless rolling solution will be installed in the Middle East.

INSTALLATION OF CONDITION-MONITORING SYSTEMS FOR CASTER LADLE TURRETS AT TATA STEEL

16. INDIA: Primetals Technologies received an order to supply and install condition-monitoring systems for three caster ladle turrets at the Jamshedpur steelworks of Tata Steel Ltd. The systems will carefully monitor the condition of the swivel bearings in 24/7 operation. During each rotation of the ladle turret, a measurement is carried out, which allows premature wear or bearing damage to be detected in support of optimized maintenance planning.



High-speed delivery system of a bar mill from Primetals Technologies

FINAL ACCEPTANCE CERTIFICATE ISSUED FOR ELECTRIC STEEL PLANT AND MERCHANT BAR MILL SUPPLIED TO BMM ISPAT

17. INDIA: In February 2017, Primetals Technologies received the final acceptance certificates for an electric steel plant and a merchant bar mill supplied to the Hospet production site of the Indian steel company BMM Ispat. The electrical steel plant includes an electric arc furnace with a tapping weight of 110 tons, a 110-ton ladle furnace, a vacuum-degassing plant, the alloying and additive systems, as well as the associated automation and dedusting facilities. The EAF is designed to allow the combined charging of direct-reduced iron (DRI) and hot metal.

For the merchant bar mill, Primetals Technologies supplied the complete mechanical and electrical equipment for the rolling line and the cooling zone, in addition to systems for bundling and tying up the produced bars. The rolling line includes a 6-stand roughing mill, a 6-stand intermediate mill and an 8-stand finishing mill. Furthermore, a quenching system, a 102-meter-long cooling bed, the finishing shop as well as process automation (Level 2), mechatronic components, the main and secondary drives, and also the motors were supplied.

The new electric steel plant and the bar-rolling mill have allowed the company to expand its production of structural steels to include a wide range of end products such as reinforcing steels, round bars, flat and square bars, angles and channel sections. Low- and medium-carbon steels, low-alloy steel grades as well as spring and free-cutting steels can now be manufactured. Hot commissioning took place in August 2016.



Casting of 357-mm-thick slabs will be possible at Baosteel following the modernization of their slab caster.

ORDER FOR SLAB CASTER MODERNIZATION AT BAOSTEEL

18. CHINA: An order was placed with Primetals Technologies by Baoshan Iron & Steel Co. Ltd. (Baosteel) for the modernization of the Continuous Slab Caster No. 3 at the company's Steel Works No. 1 in Shanghai. A host of sophisticated technological packages will be installed with the goal to enable the production of the highest-quality slabs to meet the requirements of the most demanding downstream applications.

The machine head and the complete strand-guide system will be replaced. This will enable slabs to be cast at thicknesses of 250 mm, 300 mm and 357 mm, and at widths between 1,200 mm and 2,300 mm. The cast steels will include extremely low- to high-carbon grades, micro- and low-alloyed, peritectic and HSLA grades, as well as structural steels, pipes and sheet steels. The modernized casting plant is scheduled to come into operation in early 2018.



Side-trimming section of the continuous pickling line installed at Rizhao Steel, Rizhao, China

RIZHAO STEEL ISSUES FAC FOR CONTINUOUS PICKLING LINE

19. CHINA: Chinese steel producer Rizhao Steel Group Co., Ltd. (Rizhao Steel) issued the final acceptance certificate (FAC) for a continuous pickling line supplied by Primetals Technologies. The line, which is part of a new cold-rolling complex built in the city of Rizhao in Shandong province, is designed to treat around 2 million tons of hot strip per year. Processed materials include ductile and forming steels, as well as two-phase and HSLA (high-strength, low-alloy) steel grades. With a line speed of 400 m/min, it is one of the fastest plants of its type in the world.

A host of sophisticated technological packages will be installed with the goal to enable the production of the highest-quality slabs to meet the requirements of the most demanding downstream applications.



Continuous bloom caster from Primetals Technologies at Hyundai Steel in Dangjin, Korea

HYUNDAI STEEL ISSUES FINAL ACCEPTANCE CERTIFICATE FOR CONTINUOUS BLOOM CASTER

20. KOREA: Primetals Technologies received the final acceptance certificate from Hyundai Steel Co., Ltd. for a 4-strand bloom caster that was installed at the new Dangjin special- steel production facility. The caster, which was started up in October 2015, one month ahead of schedule, is designed to cast 1.1 million tons of blooms per year that are subsequently rolled to a variety of long products for use in the automotive industry.



Tilting drive from Primetals Technologies on Converter No. 1 in Posco's Steel Works No. 1 in Gwangyang, Korea

CONVERTER WITH MODERNIZED TILTING DRIVE RESUMES OPERATION AT POSCO'S GWANGYANG STEELWORKS

21. KOREA: In January 2017, Posco (formerly Pohang Iron and Steel Company Ltd.) recommenced operation of the modernized No. 1 LD (BOF) Converter in its No. 1 Steel Works at the company's Gwangyang site. Primetals Technologies had equipped the converter with a new tilting drive.

TECHNOLOGY

SUPERIOR TECHNOLOGIES AND SERVICES

COVERING THE
ENTIRE VALUE-
ADDED IRON
AND STEEL
PRODUCTION
CHAIN

**PRIMETALS TECHNOLOGIES SPECIALIZES
IN THE DEVELOPMENT AND APPLICATION
OF STATE-OF-THE-ART SOLUTIONS
TO SUPPORT METALS PRODUCERS
TO REMAIN SUCCESSFUL AND
EXCEL ON THE MARKET.**

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TECHNICAL PRESENTATIONS FROM PRIMETALS TECHNOLOGIES AT THE ESTAD/ECCC CONFERENCES

As a global technology powerhouse in service of the metals industry, Primetals Technologies offers a comprehensive portfolio of products, equipment, solutions, systems and services for each step of the iron and steel production route, including nonferrous rolling. The integrated and optimized performance of all production facilities within a steelworks is supported by the latest process-optimization models and plant-wide systems for production management, product tracking and quality control. On the basis of the experience acquired from the successful implementation of thousands of metallurgical plant projects throughout the world, holistic and integrated solutions are offered to maximize plant performance and ensure the sustainable production of high-quality, value-added products.

The vast technological capabilities of Primetals Technologies is demonstrated by a record number of 71 technical presentations held at the 3rd European Steel Technology and Application Days (ESTAD) 2017 and at the 9th European Continuous Casting Conference (ECCC) in Vienna on June 26–30, 2017. Abstracts of the ESTAD and ECCC papers from Primetals Technologies papers are presented in the following pages.



VOESTALPINE STAHL LINZ, AUSTRIA

COMPRISING A TOTAL OF 2,000 PHOTOGRAPHS COMPILED FROM A DATABASE OF MORE THAN 50,000 PICTURES OF METALLURGICAL PLANTS SUPPLIED BY PRIMETALS TECHNOLOGIES AND ASSOCIATED METALS-RELATED SCENES.
(WITH THE KIND COURTESY OF VOESTALPINE STAHL LINZ GMBH AND VOESTALPINE AG)



AN OUTSTANDING PARTNERSHIP WITH A RENOWNED STEEL PRODUCER

Since the founding of VAI (originally VOEST-ALPINE Industrieanlagenbau – a predecessor company of Primetals Technologies) in 1956, more than 500 individual steelworks projects have been completed and successfully implemented for the renowned quality steel producer voestalpine at their Linz- and Donawitz-based steel mills in Austria. This parade of projects, which commenced with the turnkey supply of the LD Converter Plant No. 2 in Linz in the year 1959, has grown over the years to eventually cover every step in the iron and steel production process. The list of plant projects includes coking plants, sintering plants, blast furnaces, steelmaking converters and contin-

uous casters of all types all the way to rolling mills, strip-processing lines and finishing lines. Project references also include plate mills, bar and wire rod mills, tube and section mills in addition to the associated electrical, automation, environmental, media-supply and water-treatment systems. Many of the depicted plant references shown on this 4-page mosaic photograph of the voestalpine Stahl Linz steelworks are projects that voestalpine and Primetals Technologies have jointly implemented together.

Primetals Technologies wishes to take this opportunity to thank voestalpine for the outstanding and exemplary cooperation over the years that has proven to be a win-win business relationship for both partners.





FEATURING 12

IRONMAKING

papers from Primetals Technologies at the ESTAD Conference 2017 in Vienna covering the topics of ore preparation, sintering, direct reduction, blast furnace ironmaking, process control, and cold-briquetting of coal and ferrous by-products.

The direct-reduction plant of voestalpine, Corpus Christi, Texas, U.S.A.



Customers benefit by achieving maximum production efficiency at lowest processing costs.

COMPREHENSIVE COMPETENCE IN BENEFICIATION TECHNOLOGIES – FROM THE RAW MATERIALS TO STEEL

Paper number: 43
Principal author: Reinhard Redl

Efficient iron and steel production is of vital importance for any producer in the world. The source and quality of the iron ores has a major impact on the overall costs in the downstream steelmaking area. Impurities originating from the ore account for a large portion of the processing costs in the blast furnace and meltshop because undesirable elements have to be removed in the form of slag, which requires additional thermal or electrical energy.

In order to optimize the selection and use of iron ores, Primetals Technologies has intensified its efforts in the field of beneficiation. A single-calculation model was developed that takes into account the complete production chain in a steelworks – from the incoming raw materials to the liquid steel. The model is capable of assessing the suitability of iron ores for steelmaking, calculates the mass and energy balances of each individual plant, and also the overall mass and energy balance of the complete production route. Furthermore, the required beneficiation measures and the most feasible production route is identified by the model in accordance with customer requirements. Upgrading processes for dumped tailings were also developed in order to recover the otherwise lost iron minerals and generate a valuable additional iron ore concentrate.

Through a holistic evaluation of the entire value-added production chain, Primetals Technologies is now in a position to offer a complete range of proven industrial-scale plant solutions that extends from the beneficiation of run-of-mine ores, including the recovery of tailings, up to steel production. Customers benefit by achieving maximum production efficiency at lowest processing costs.

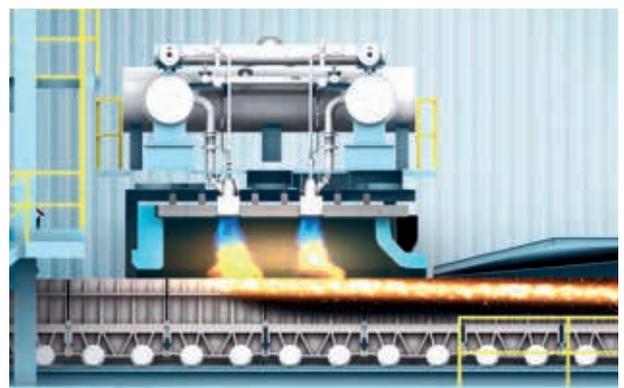
NUMERICAL SIMULATION OF THE SINTER PROCESS AND OPTIMIZATION OF THE TOP-BURNER SYSTEM BY CFD SIMULATIONS

Paper number: 46
Principal author: Edmund Fehringer

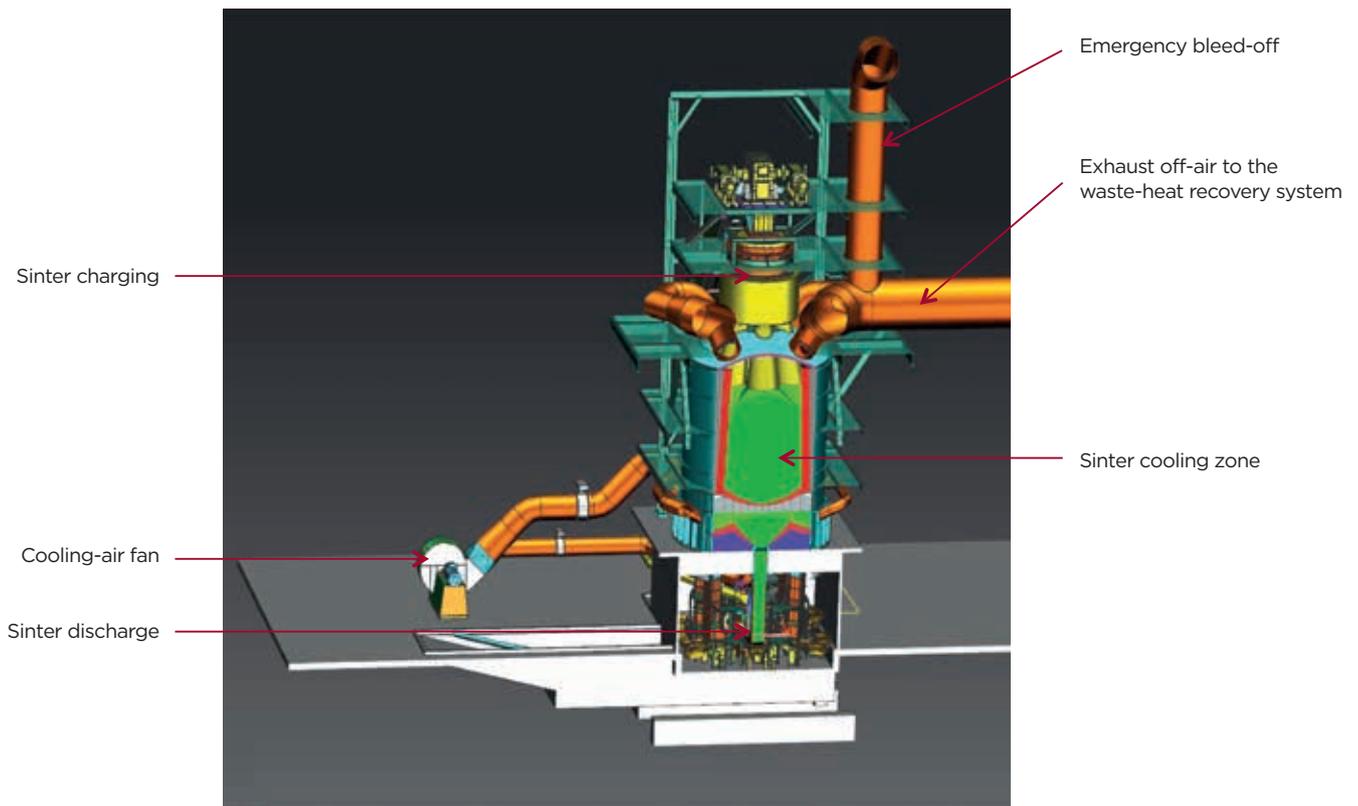
There are a number of factors that constantly challenge iron and steel producers: decreasing iron ore quality, the need to use lower-quality iron ores due to economic pressure, and ever-stricter environmental standards. The use of different raw materials, however, can have a significant impact on the sintering process. Adjusting all process parameters to regain stable and productive operation can take a lot of time and usually results in production loss. Raw material changes also lead to variations in the process-gas flows and emission concentrations.

Primetals Technologies has therefore developed an advanced model for the numerical simulation of the sintering process. Solid and gaseous flows that take place during sintering can be simulated, and all influencing factors are entered into the model either as input values (such as the chemical composition of the raw materials), boundary conditions (for example, suction pressure), or are calculation results. The simulation tool, which utilizes integrated calculation models, is highly flexible to evaluate different processing scenarios. It provides an accurate prediction of operational parameters and sinter offgas emissions.

Primetals Technologies has also improved the design of the top-burner system with the use of computational fluid dynamics (CFD). The CFD software simulates not only the burner flame itself but also the complete combustion process within the ignition furnace and annealing hood. The results can be used to support the engineering of the ignition hood and, if necessary, to efficiently implement design changes at an early stage of a project. Use of the numerical simulation tool is a well-proven and cost-efficient alternative to conducting serial tests on a laboratory scale.



Newly designed top-burner ignition furnace for the sinter plant



Schematic drawing of a shaft-type sinter cooler

EFFICIENT AND ENVIRONMENTALLY FRIENDLY SINTER COOLING BASED ON THE COUNTER-FLOW PRINCIPLE

Paper number: 45; Principal author: Dr. Michaela Böberl

Most state-of-the-art sinter coolers apply a cross-flow cooling principle. With plant setups based on this concept, only a portion of the thermal energy contained in the hot off-air can be used for heat-recovery applications and the remaining energy is lost to the environment. Considerable improvement potential for recovering and utilizing the heat from sinter coolers therefore exists. At the same time, environmental regulations are becoming increasingly stringent, and further reductions in dust emissions and a more intelligent use of energy are required.

For these reasons, Primetals Technologies has developed two types of sinter coolers based on the counter-flow principle. The first type consists of a stationary shaft into which the hot sinter is charged. Hot sinter descends through the shaft from the top to the bottom in the opposite direction of the ascending cooling air. The second cooler type is a circular hopper cooler. Hot sinter is charged onto the top of a moving sinter bed that moves in a circular path. The cooled lower portion of the sinter bed is scraped from the hopper with the use of a so-called scrapper prior to

the sinter-charging station. Cooling air flows through the sinter bed from the bottom to the top in the opposite direction of the gradually descending sinter (counter-flow principle). This type of sinter cooler was first built at the Wakayama Works of Nippon Steel & Sumitomo Metal Corporation (NSSMC) by the Metals Division of Mitsubishi Heavy Industries, which is now part of Primetals Technologies.

In both types of sinter coolers based on the counter-flow principle, a direct heat transfer from the hot sinter to the cooling air takes place. Because the total heat energy of the hot sinter is transferred to the cooling air, the temperature of the exhausted off-air is maximized. This allows it to be ideally used for subsequent applications such as for the generation of steam and even electrical energy. Since sinter cooling takes place in a closed system, diffusive dust emissions are reduced to zero. Depending on available space and the quantity of sinter to be cooled, both counter-flow sinter cooler types is available to customers for the efficient cooling of hot sinter and a maximum recovery of the inherent heat energy.

COMMISSIONING AND FIRST OPERATIONAL RESULTS OF WORLD'S LARGEST, TEXAS-BASED MIDREX HOT-BRIQUETTED IRON PLANT OWNED BY VOESTALPINE

Paper number: 59; Principal author: Wolfgang Sterrer

voestalpine Stahl Linz launched its largest foreign-investment project to date in July 2013. The undertaking centered on the construction of a 2 million t/a Midrex direct-reduction plant in Corpus Christi, Texas, U.S.A. A consortium comprising the companies Primetals Technologies USA LLC and Midrex Technologies, Inc. was awarded the contract that included the supply of equipment, engineering and technical services for the ironmaking facility, which was executed on a green-field basis. The plant is highlighted by a reduction shaft with a diameter of 7.15 m and a 20-bay reformer, both of which are designed to achieve the large output of direct-reduced iron, which is hot-compacted to hot-briquetted iron (HBI). The HBI facility is equipped with a hot-fines recycling system, and HBI cooling takes place by means of cooling conveyors.

Following integrated plant tests and a dry-out period, the Midrex plant was started up on September 27, 2016, and officially inaugurated on October 26, 2016. The HBI product has an average metallization degree of 93% and a carbon content of 1.5%. It is shipped to the voestalpine steelworks in Austria and additionally sold on the North American market.

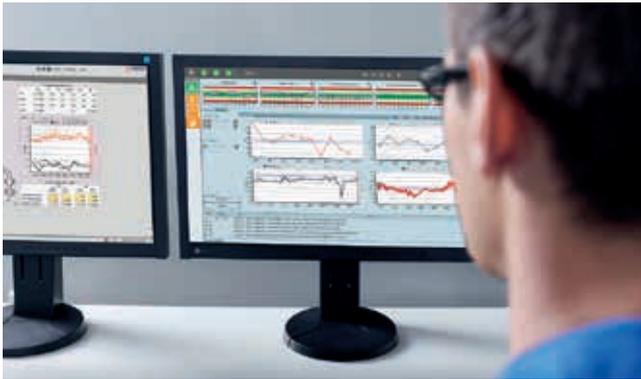


The direct-reduction iron-making plant of voestalpine, Corpus Christi, Texas, U.S.A.

DIRECT-REDUCTION PLANT PROCESS OPTIMIZATION WITH THE DRIPAX™ EXPERT SYSTEM

Paper number: 93; Principal author: Dieter Bettinger

An integrated process-optimization system for Midrex direct-reduction (DR) plants was jointly developed by Primetals Technologies and Midrex Technologies. The new product-quality prediction models achieve a high degree of prediction accuracy – already hours before measured data is available. This supports a quick decision-making process toward maintaining the



Monitor display of the DRIPax process-optimization system for direct-reduction plants

quality targets and consistency of the direct-reduced iron (DRI) product. Due to improved quality control, significant operational savings can be expected at the downstream production facilities.

The DRIPax expert system, a rule-based advisory system that assists panel operators, is the next step for improved process control in direct-reduction plants. The expert system was first launched as part of the process-optimization system of the new Midrex direct-reduction plant of voestalpine Texas LLC in the U.S.A.

“The DRIPax system has already shown its value in contributing to the production of high-quality HBI at the new voestalpine direct-reduction plant in Texas.”

Christopher Harris, voestalpine Texas LLC

THE FUTURE OF DIRECT REDUCTION IN EUROPE – MEDIUM- AND LONG-TERM PERSPECTIVES

Paper number: 60; Principal author: Robert Millner

Driven by global demands to reduce CO₂ emissions and improve energy efficiency, a changing trend in the use of energy systems can be noted. The E.U. roadmap, for example, suggests CO₂ emission reductions by 80% between 2005 and 2050. This is already having an impact on the way steel is produced in Europe.

Ironmaking technologies such as natural-gas-based direct-reduction processes are characterized by smaller CO₂ footprints compared to integrated iron and steel mills. Direct-reduction plants are therefore seen as a medium-term bridge solution on the path toward industrial decarbonization and to reduce process-related CO₂ emissions by more than 60%. Certain European iron and steel producers are already producing or plan to produce hot-briquetted iron (HBI) at locations with low-cost natural gas and electricity. The simultaneous use of HBI at their own steelworks will further contribute to lower CO₂ emissions.

In order to eventually reach the targeted CO₂ reduction figure set by the E.U., the additional or sole use of “green” hydrogen from renewable natural resources in iron and steel production will be required over the long-term. The direct reduction of iron ores or iron ore pellets is a highly

efficient and well-proven technology that potentially allows natural gas to be supplemented or replaced by hydrogen for DRI or HBI production. Hydrogen would then serve as the basis for ironmaking. Additional synergy benefits could then be achieved in steelmaking by combining direct-reduction plants and electric arc furnaces (EAF). An example for this is the linking of the direct-reduction facility and the EAF at Saudi Iron & Steel Company (Hadeed) by a hot-transport system, which further decreases energy requirements and related emissions.



Direct linking of the direct-reduction plant (right) and EAF steel mill (left) at Saudi Iron & Steel Company (Hadeed) by means of an insulated DRI hot-transport system. This allows DRI to be charged to the EAF at temperatures in excess of 600°C, leading to major electrical energy savings for melting work.

TATA STEEL LIMITED KPO BLAST FURNACE 1 - DESIGN, COMMISSIONING AND START-UP

Paper number: 49

Principal author: Mark Geach

In 2012, Tata Steel Ltd. commenced construction of an integrated iron and steel plant in Kalinganagar, Orissa, India. The first phase of the project included steelmaking facilities, a coking plant, a sintering plant and Blast Furnace No. 1. A contract had been previously awarded to Primetals Technologies in January 2007 to design and supply the new 14-m-hearth-diameter blast furnace and additional facilities as part of the overall site arrangement.

The project comprised the supply of equipment required for a modern free-standing blast furnace, including a copper-stave cooling system, a flat-floor casthouse arrangement, bell-less top-charging facilities and a full suite of blast furnace unit equipment. Also supplied were wet-slag granulation facilities, three external-combustion-chamber hot-blast stoves, and a gas-cleaning plant with a top-gas recovery turbine arrangement. The furnace is designed with a capability to produce 9,150 tons of hot metal per day. Blow-in took place on February 29, 2016.

This paper discusses the project scope and highlights some of the design features such as pneumatic dust conveying, the cyclone and dust-catcher combination, trough-forced cooling, and the latest stove-crossover design. Some of the challenges faced during the various phases of the project (design, supply, construction, commissioning and operation) are also reviewed.



View of the new Blast Furnace No. 1 at the Kalinganagar steelworks of Tata Steel Ltd. - the largest blast furnace in India

New dry-slag granulation technologies are in development to cool the molten slag with air and recover the thermal energy.

INSTALLATION OF A DRY-SLAG-GRANULATION PILOT PLANT AT BLAST FURNACE A OF VOESTALPINE

Paper number: 71

Principal author: Thomas Fenzl

With a tapping temperature of around 1,500°C and an annual worldwide output of approximately 400 million tons, blast furnace slag represents a huge - and largely unused - source of energy that potentially can be recovered. Current state-of-the-art practice is to granulate blast furnace slag in wet-granulation plants without utilizing the thermal energy. However, new dry-slag granulation technologies are in development to cool the molten slag with air and recover the thermal energy for applications such as steam production or the generation of electrical energy.

On the basis of their acquired experience with dry-slag-granulation testing facilities and from various research programs, Primetals Technologies and its partners are now taking the next step. A large-size pilot plant has been installed on the casthouse floor of Blast Furnace A of voestalpine in Linz, Austria, for the treatment of blast furnace slag. The slag is granulated applying so-called rotating-cup technology to produce a saleable product. Cooling of the slag then takes place under dry conditions with the use of air. Through a gradual step-by-step increase of the off-air temperature, significant potential exists to utilize the inherent energy of the heated air for various applications such as steam generation. Extensive tests at the pilot plant are expected to provide the technical expertise required for the commercialization of the process. Valuable insight will be acquired related to factors such as the layout and arrangement of a slag-granulation plant, operational factors and the feasibility of the dry-slag-granulation process.



Aerial view of the Finex 2.0M plant with a nominal capacity of 2 million ton of hot metal per year

ENHANCING PERFORMANCE OF INTEGRATED STEEL PLANTS BY COMBINING EXISTING BLAST FURNACES WITH FINEX TECHNOLOGY

Paper number: 280; Principal author: Norbert Rein

Growing energy demands and steadily deteriorating raw material quality are major challenges for steel producers today. The Finex process, jointly developed by Korea's Pohang Iron and Steel Company (Posco) and Primetals Technologies, offers the ironmaking sector the capability to lower hot-metal production costs and environmental emissions while simultaneously increasing operational flexibility and the choice of suitable raw materials. The process combines gas-based iron ore reduction in a series of fluidized-bed reactors with smelting in a melter-gasifier. The innovative Finex solution produces hot metal that is identical in quality to blast furnace hot metal, however, without the need for coke oven or sintering plants.

The first commercial Finex plant with an annual production capacity of 1.5 million tons of hot metal was started up at Posco's Pohang steelworks in Korea in April 2007.

This was followed by the installation of a 2.0 million t/a third-generation (3G) Finex 2.0M facility at the same site, which has been reliably operating since its initial blow-in in January 2014.

Based on the well-proven plant concept, new process features, highly competitive production costs and environmental benefits, the Finex process represents an ideal alternative or supplement to blast furnace-based ironmaking. Integration of Finex plants within the existing infrastructure of an integrated steelworks allows producers to benefit from the available synergies between the blast furnace and Finex plant for an enhanced overall performance of the steelworks. This is because all generated coke and sinter fines can be ideally used at each ironmaking facility. Producers can therefore increase their total iron output in a highly cost-efficient and environmentally compatible manner.



Example of a ferrous by-production recycling plant supplied by Primetals Technologies

BRIQUETTING OF FERROUS AND COAL FINES – SAVING RESOURCES, CREATING VALUE

Paper number: 55

Principal author: Stefan Hötzing

One of the global trends that constantly challenges the iron and steel industry is related to the generation of fines, slurry, sludge and scale – summed up as “ferrous by-products.” The recycling of these by-products is regularly done in many steel plants. Normally, such materials cannot be directly used in primary production processes. With consideration to their chemical composition and grain-size distribution, ferrous by-products are usually added to the sinter raw mix. However, other solution possibilities exist. In this paper, the latest developments by Primetals Technologies dealing with the cold briquetting of ferrous by-products are presented. Examples of executed projects for the direct charging of cold briquettes to the direct-reduction shaft are described, and other solutions for integrated steel mills reviewed.

Furthermore, briquettes made from coal fines that arise during coal transport and handling can be used in smelting-reduction processes such as Corex or Finex, or for enhanced coke-oven operations in the traditional blast furnace ironmaking route. The target of Primetals Technologies is to enable the production of coal briquettes that are superior to normal coal with respect to their mechanical properties and hot strength. The use of such briquettes leads to higher productivity and reduced costs. Different technological applications and solutions from Primetals Technologies in the area of coal briquetting are highlighted in this paper.

TOWARD A CLEANER FUTURE – TRENDS IN GAS-CLEANING TECHNOLOGY FOR IRONMAKING

Paper number: 66

Principal author: Andreas Steinwandter

Traditional approaches to blast furnace gas cleaning using wet scrubbers are being challenged by the reemergence of dry-gas cleaning technologies because of their successful application in other parts of the iron and steel production chain. Wet-gas cleaning of blast furnace top gas is a proven solution that removes dust and certain trace substances contained in the gas in a single step. However, wet-gas cleaning requires cleansing the water of dissolved solids and then treatment of these solids. Blast furnace upgrades offer an opportunity to consider improving existing wet-gas cleaning systems. This paper reviews how such upgrading measures can be implemented in a cost-effective manner.

Technologies to remove nitrous oxides (DeNO_x) are now widely used in many high-temperature processes. With consideration to ever-stricter regulations governing emission limits that need to be met, Selective Catalytic Reduction (SCR) technology will therefore find an increased application in the future. The paper also presents an overview of the implementation of SCR technology in sinter plants, and the special considerations that need to be made.

The target is to enable the production of coal briquettes that are superior to normal coal with respect to their mechanical properties and hot strength.

HOLISTIC OPTIMIZATION MODELS – RECENT DEVELOPMENTS IN IRONMAKING-RELATED PROCESS CONTROL

Paper number: 87; Principal author: Dieter Bettinger

State-of-the-art process-control systems are currently used with the intention to optimize production processes at each step along the iron and steel production route. This is achieved on the basis of local, only temporarily available information. In accordance with the ideas behind “Industry 4.0,” holistic optimization models go much further by enhancing the performance of a plant through a detailed analysis of historical data and by connecting information from different plant facilities. Primetals Technologies considers its holistic optimization models for ironmaking an important step toward

the implementation of the vision of a Smart Factory. In this paper, the most recent developments from Primetals Technologies related to Level 2 process-optimization systems for blast furnaces and sinter plants are presented. Improved decision support and detailed process analyses are two areas among many that benefit from this holistic approach. Several case studies from recent plant installations demonstrate how operators and process engineers can derive maximum value from the seamless integration of holistic optimization models into a proven process-optimization solution.

IRONMAKING HIGHLIGHTS OF PRIMETALS TECHNOLOGIES

Agglomeration

- Use of up to 80% pellet feed in the sintering process with the Intensive Mixing and Granulation System
- 25% reduced fuel consumption with vertical-type roof burners in the ignition furnace of sintering plants
- Up to 50% reduction of the waste-gas volume of sintering plants with the Selective Waste-Gas Recirculation System
- 99% reduction of sinter-plant emissions with the Meros waste-gas treatment process
- Generation of 15 kg to 25 kg of steam in a heat-boiler system per ton of sinter at the sinter cooler
- 50% reduced space requirements for the induration furnace with Circular Pelletizing Technology (CPT)

Blast furnace ironmaking

- Injection of >200 kg of pulverized coal per ton of hot metal into the blast furnace for major coke savings
- Generation of 30 kWh to 40 kWh of electricity per ton of hot metal through the recovery of the hot-blast pressure energy with a top-gas recovery turbine
- >25% increased generation of electricity in a blast-furnace top-gas recovery turbine with the application of the Merim dry-type blast-furnace dedusting system

Direct reduction (Midrex process)

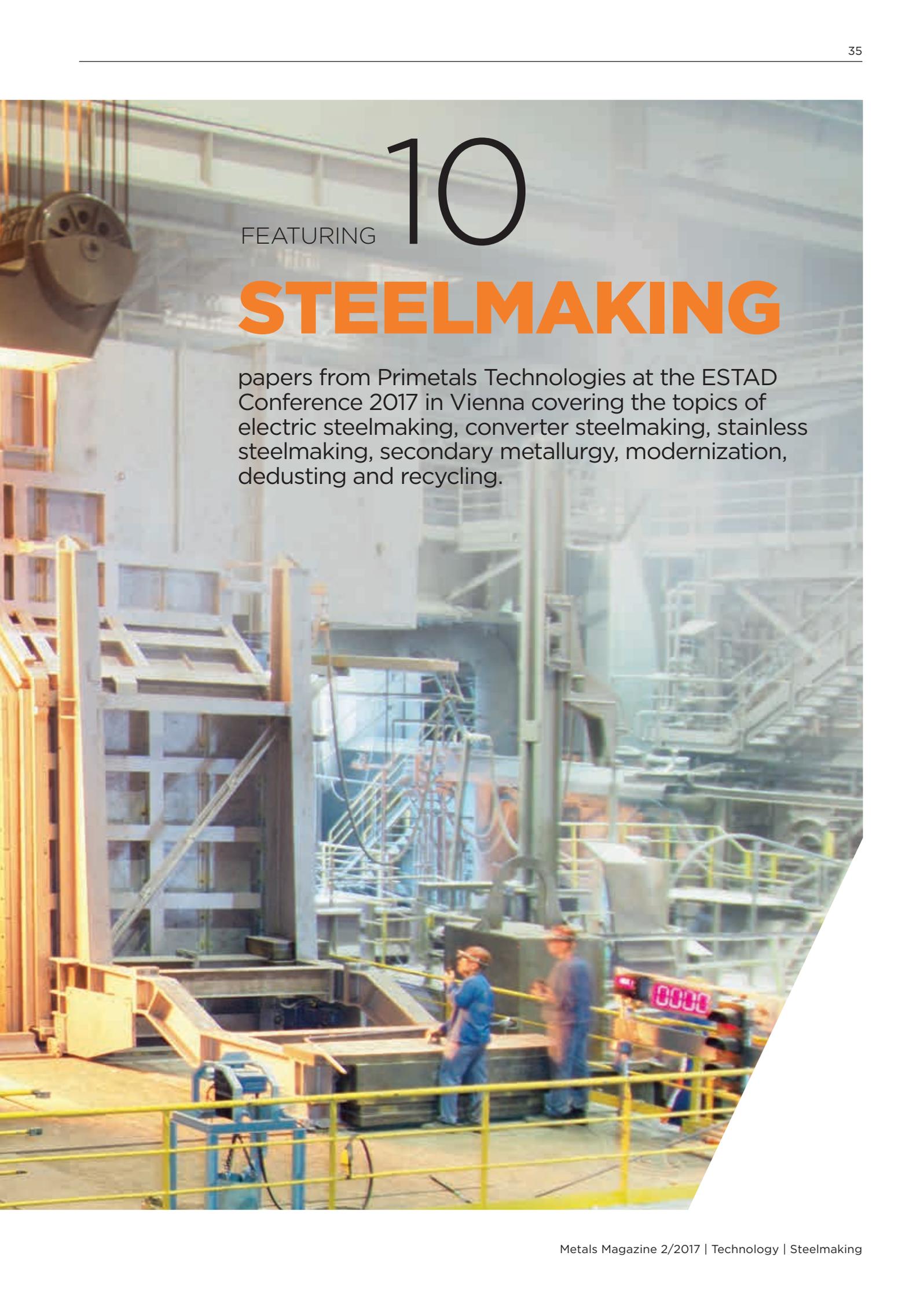
- 500,000 t/a to 2,500,000 t/a production capacity range of Midrex direct-reduction modules
- >60% reduction of process-related CO₂ emissions compared to coal-based ironmaking plants
- Direct charging of hot DRI from the direct-reduction plant to the EAF with a temperature of 600°C leads to the following benefits compared to cold DRI charging: 15% to 20% productivity increase, 120 kWh/t to 140 kWh/t reduced electricity consumption, 0.5 kg/t to 0.6 kg/t lower electrode consumption, and 1.8 kg/t to 2.0 kg/t lower refractory consumption

Smelting reduction

- 8% to 14% OPEX (operational expenditures) advantage of coal-based Corex ironmaking plant compared to the blast furnace route
- 15% to 33% reduced CO₂ emissions in a plant configuration comprising Corex, a direct-reduction plant (based on the use of Corex export gas) and an electric arc furnace, compared to the integrated blast furnace - LD (BOF) production route
- Use of iron ores with up to 4% Al₂O₃ content in coal-based Corex and coal- and fine-ore-based Finex plants

The first heat of the 95-ton AOD stainless steelmaking converter supplied by Primetals Technologies at SIJ Acroni, Jesenice, Slovenia (April 24, 2017)



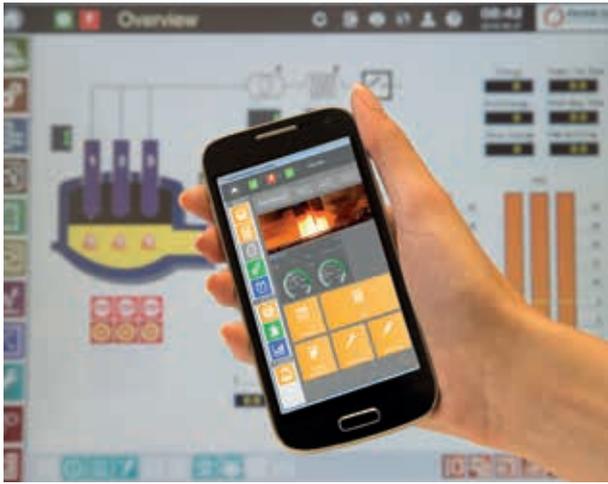


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FEATURING

STEELMAKING

papers from Primetals Technologies at the ESTAD Conference 2017 in Vienna covering the topics of electric steelmaking, converter steelmaking, stainless steelmaking, secondary metallurgy, modernization, dedusting and recycling.



The design of the Melt Expert electrode control system is based on Industry 4.0 principles.

PRACTICAL USER EXPERIENCE WITH AN INDUSTRY 4.0 ELECTRODE CONTROL SYSTEM

Paper number: 85

Principal author: Christoph Sedivy

Industry 4.0 is slowly but surely making its way to the melt shops. Furnaces are being equipped with more and more sensors, digital models are increasing the degree of automation, and information is being shared between different aggregates within the plant. Because the electrode control system plays a key role in electric steelmaking, it naturally assumes an important position in the Industry 4.0 strategy of the melt shop. In addition to reliable, state-of-the-art core regulation functionality, monitoring and reporting tools as well as the ability to communicate with other equipment are also crucial. The latest generation of the Melt Expert electrode control system has therefore been developed according to Industry 4.0 design principles.

Intelligent plant condition diagnostics, performance monitoring and user-defined reporting are essential modules in this new system. Thanks to these functionalities, electrode control systems are becoming the information and control center of the furnace. A newly developed software app forwards the most relevant process information to mobile devices. This feature allows steelmakers to monitor the performance of their equipment any time and anywhere.

This paper describes the new features of the electrode control system and shares operational experiences of customers. Special focus is placed on the practical aspects of plant status monitoring, KPI (key performance indicator) reporting, diagnostic functionality and the resulting improvements.

EXTENDED NEW OVERVIEW OF CHEMICAL INJECTION SYSTEMS AT THE EAF

Paper number: 94

Principal author: Hannes Beile

This paper provides an overview of state-of-the-art chemical injection systems for the EAF and the benefits of modern injection solutions: lower consumption costs, increased productivity and improved safety.

These systems are easily upgradable for any EAF. With only a short downtime period, the installation of modern combined injection systems can lead to huge productivity gains and process improvements. The chemical injection portfolio of Primetals Technologies includes solutions for every steelmaking process route.

The following topics are addressed in this paper:

- History of chemical injection into the EAF
- Overview of state-of-the-art injection systems for all electric arc furnace types
- Detailed description of the new RCB (Refining Combined Burner) 3.0 system
- Preview of the future RCB Move technology



The Refining Combined Burner for enhanced electric arc furnace performance

LATEST MODERNIZATION DEVELOPMENTS FOR ELECTRIC ARC FURNACES

Paper number: 96

Principal author: Patrik Zipp

Electric arc furnaces (EAF) can achieve high performance and productivity rates through maximum utilization of equipment and products and by applying an optimized process know-how. Producers also benefit from a more uniform and safe operation. The furnace components and supporting products have to be designed for maximum power input, utilization and operational safety. Power-on and power-off cycle times can be reduced toward achieving a faster and safer process.

This paper discusses the latest EAF modernization solutions from Primetals Technologies, which lead to the following benefits:

- Increased productivity
- Lower conversion costs
- Operation with a symmetrical power input
- Reduced refractory wear
- Improved plant availability and lifetime with the use of heavy-duty components
- Improved operational safety thanks to the application of fully automatic systems

100-ton FAST DRI electric arc furnace installed by Primetals Technologies at Qatar Steel Company, Mesaieed Industrial City, Qatar



ROBOTIC-GUIDED TAPHOLE MAINTANENCE ON ELECTRIC ARC FURNACES – A MAJOR INCREASE OF WORKER SAFETY

Paper number: 221; Principal author: Mario Hirth

There are many areas within metallurgical plants where dust, smoke, gases and liquid steel can pose a danger for site personnel. Carrying out manual work in these unsafe environments should therefore be avoided whenever possible. Today, an increasing number of manipulators and robotic solutions are being used to perform tasks in hazardous working areas, such as for taphole opening of electric arc furnaces. This is usually done with an oxygen lance burner held to the taphole, which requires the operator to stand right next to the dangerous taphole area. Owing to the weight of the lance, two people are often required to work in this exposed area.

This paper describes the highly versatile LiquiRob system of Primetals Technologies and its newly developed feature “taphole-opening for EAF.” The robot functions as an extension of the operator’s hand. Heavier lances can be manipulated since there are no work safety restrictions for the robot. More energy is therefore available for the burning process, and the taphole-opening rate can be significantly increased. Standing at a safe distance, the operator can guide the burning lance with the robot to the taphole with the greatest precision. Using a closed-circuit television (CCTV) system, this task can even be performed from the control room. The first operational results using robot-guided oxygen lances in dangerous working areas are presented.



The robot system for fully automated handling of probes for the converter substance (voestalpine Stahl, Linz, Austria)

FULLY AUTOMATIC CONVERTER STEELMAKING

Paper number: 51; Principal author: Dr. Gerald Wimmer

The intensive use of automation solutions, process models and expert systems is well established in converter steelmaking, and it is widely recognized that automated procedures have a positive influence on productivity, product quality and operational safety. The combination of existing technologies, new support systems and the efficient use of information management tools supports plant operators to run their plant almost fully automatically, allowing them to focus on the supervision and optimization of the process.

This paper takes a bottom-up approach and includes reference examples of how an LD (BOF) steelmaking plant can be upgraded to maximize automatic operation. This approach comprises several steps: it begins with basic-automation requirements such as totally automated transfer cars and reliable measurement systems; it then proceeds to more advanced automation

solutions such as robotics for probe handling or crane logistics for automated charging; and concludes with completely coupled data management systems for through-process quality control.

The paper presents early practical references such as ICE Tag technology – a high-temperature RFID (radio-frequency identification)-based identification technology for tracking of ladles and slag pots; converter monitoring; Lance Guard for closed-loop diagnosis of substance measurement systems; and Fluid Guard for leakage detection in safety-critical applications. Fully automatic converter steelmaking also requires the installation of additional condition-monitoring systems to ensure maximum plant availability and reliability at lowest maintenance costs. Finally, solutions for the automation of critical maintenance tasks in converter steelmaking, such as lining maintenance or converter relining, are discussed.

UPGRADE OF STAINLESS SPECIAL STEEL PRODUCTION BY IMPLEMENTATION OF AOD PROCESS AT ACRONI

Paper number: 54; Principal author: Bernhard Voraberger

In mid-2015, Acroni, a Slovenian steel producer and part of the Slovenian Steel Group (SIJ), commissioned Primetals Technologies to supply a new 95-ton AOD (argon oxygen decarburization) converter and dedusting system for its steelworks in Jesenice. Less than two years later, in April 2017, the new process route was put into operation, which allowed the annual liquid steel output to be increased by 35% up to 530,000 tons. With an additional electric arc furnace (EAF) upgrade and the installation of an AOD top lance, a maximum annual liquid steel capacity of 650,000 tons can be expected. Stainless steel scrap had been previously melted in an EAF and decarburized in two VOD (vacuum oxygen decarburization) treatment stations with a capacity of 90 tons each. Because the treatment of stainless steel in a VOD requires more time than for carbon steels, the existing plant configuration meant that there was a bottleneck in stainless steel production. This was eliminated by the installation of an AOD converter, which not only increased the production capacity but also the flexibility of the steelworks. Heat-processing times for stainless steel were reduced significantly. For example, tap-to-tap times at the EAF were shortened by 55 minutes, and more than two hours are saved by switching treatment at the VOD station to the new AOD converter for the production of duplex and ferritic stainless steel grades.

Additional advantages of an AOD converter are the higher yield of alloying elements, such as chromium, and the use of less expensive ferrochromium grades with a higher carbon content as an alloying addition. Acroni was therefore able to significantly reduce its production costs and can look forward to a short return on investment for its AOD converter investment.

Numerous other sophisticated technologies and systems were installed by Primetals Technologies at the Acroni melt shop that included a new material-handling system and Level 2 process automation specifically designed for AOD converters. This ensures that raw materials are used efficiently and that treatment times are minimized. The converter is equipped with a patented drive damper system to reduce vibrations caused by injection processes. This reduces wear and maintenance costs and additionally lengthens the service life of the plant. A dedusting system was also installed at the same time as the AOD converter. Not only can emissions be kept well below current limits, but also energy efficiency and occupational safety are greatly increased in the production area.

The paper summarizes the technical highlights and execution of the project, as well as the achieved steel-making results.



Charging of the 95-ton AOD stainless steelmaking converter at SIJ Acroni, Slovenia

BOOSTING THE VALUE OF YOUR STEELMAKING SLAG AND DUST

Paper number: 53

Principal author: Dr. Gerald Wimmer

Considerable amounts of slag and dust are produced in integrated iron-ore-based steelmaking plants as well as in EAF scrap-based steel mills. These by-products still contain considerable amounts of metals in metallic and oxide form, which are only partly processed and recycled. The rest is used for landfill purposes or, after mechanical processing, is suitable for low-value external applications such as in road construction or as filler materials. Internal recycling of slags and dust in a steelmaking plant is typically via the sinter plant and the blast furnace, or by means of briquetting and subsequent charging to the blast furnace, LD (BOF) converter or electric arc furnace.

Primetals Technologies has developed an innovative process that reduces all metallic oxides in the slag or dust, extracts the metallic portion, and returns all metals to the primary process. The basicity of the remaining mineral fraction can be modified, if necessary, to allow its usage as a high-value material for binding purposes or in the cement industry. For example, slags from converter steelmaking processed in this way can be directly used as a cement clinker substitute. Recovered metals are first dephosphorized and can then be recycled as a hot metal or scrap substitute in the converter. The process itself takes place in a modified electric arc furnace with coal injection and quasi-continuous liquid slag charging. The process principles and different ways of utilizing the mineral fraction are presented in the paper, together with business cases for an integrated steel plant for carbon steel production, and for EAF steelmaking based mainly on the use of direct-reduced iron.

INNOVATIVE SOLUTIONS FOR BOF DEDUSTING SYSTEMS - ACHIEVING MINIMUM EMISSION LEVELS

Paper number: 64

Principal author: Herbert Pasteiner

The importance of environmental protection has greatly increased in the iron- and steelmaking industry over the previous decades. Environmental protection measures must now comply with increasingly stricter regulations set by government agencies. Dry-dedusting systems (DDS) represent the latest technology for cleaning the primary offgas of LD (BOF) basic oxygen furnaces. However, due to their relatively high investment costs in revamping projects, this type of dedusting system may not be as feasible as other dedusting solutions.

Primetals Technologies therefore offers alternative cost-efficient dedusting systems to the DDS, in particular, in connection with revamping solutions for existing wet-dedusting systems (WDS). A new application is the wet electrostatic precipitator (WESP). Installed downstream of a WDS, the WESP treats the particulates typically contained in the water-saturated WDS offgas to further reduce dust emissions. After construction of the WESP is completed, it is then connected to the WDS offgas duct by means of a bypass system. This considerably shortens the shutdown period required for installation work and also allows independent maintenance of the WESP when necessary.

Another innovation is a new scrubber design for increasing the gas-cleaning efficiency of a venturi-type WDS. Separation efficiency is improved by injecting water into the gas flow at a 45° angle. Implemented innovations and improvements are presented in detail in the paper, and the results are discussed.

DEVELOPMENT OF HIGH-QUALITY-STEEL PRODUCTION TECHNIQUES USING A VOD PLANT AT VOESTALPINE GIESSEREI

Paper number: 142; Principal author: Andrea Pezza

Research, development as well as plant and production route optimization are some of the ways to drive the steel business forward. This paper describes a new operating concept from Primetals Technologies for a VOD (vacuum oxygen decarburization) plant that was developed on the basis of plant-design experience and customer feedback. Joint and close collaboration with the customer voestalpine Giesserei Linz GmbH was crucial for the new improvement measures. All possible vacuum-degassing solutions were investigated and assessed toward developing a new approach for the use of tank degassers in the production of high-quality steel.



Joint investigation of new vacuum-degassing techniques for the production of high-quality steel grades together with voestalpine Giesserei Linz at the producer's VOD plant in Austria

OPTIMIZATION OF CONVERTER DESIGN WITH CFD – PRACTICAL APPLICATION FOR CONVERTER REVAMPS

Paper number: 52; Principal author: Dr. Erich Wimmer

Computational fluid dynamics (CFD) has continuously evolved over recent decades and has come to play an important role in the development of modern LD (BOF) steelmaking converters. Flow inside the converter is highly complex and comprises several physical phenomena such as supersonic flow, chemical reactions, heat transfer and the flow of gas bubbles in the liquid melt. For numerical reasons, not all flow processes can be taken into account, but it is possible to describe major effects, show tendencies and gain valuable insight on multi-phase flow processes. The results of these analyses can subsequently be used in the design of new converters.

Primetals Technologies is committed to developing an efficient approach to modeling flow and mixing inside the converter during the refining process within a reasonable time. Investigations were carried out on a 110-ton converter in connection with steel bath mixing, which led to the development of a generally applicable method for modeling the flow and quantification of the mixing intensity. It became clear that two kinds of vortices are generated inside the flow, which are of significant importance for mixing and overall flow. On the one hand, vortices are created near the bubble columns at the stirring elements and, on the other hand, much larger vortices are formed that strongly influence the total flow in a molten steel bath. Furthermore, it could

be shown that the arrangement and type of bottom-purging elements are crucial factors for mixing intensity. An asymmetric alignment of purging elements can result in critical zones inside the converter that are characterized by very low local flow velocities.

Primetals Technologies has drawn on its extensive numerical simulation competence to investigate the influence of varying process parameters in order to optimize the overall design of the converter and blowing lance equipment.



Primetals Technologies is committed to developing an efficient approach to modeling flow and mixing inside the converter.

STEELMAKING HIGHLIGHTS OF PRIMETALS TECHNOLOGIES

Electric steelmaking

- 500 electrode control systems installed during past 35 years
- 20% reduction in electrical energy required for melting with scrap preheating in the shaft-type EAF Quantum furnace
- Anode lifetime of more than 1,500 heats with the DC-EAF fin-type anode
- Two dollar conversion cost savings per ton of liquid steel with the EAF Heatopt holistic process-optimization system
- 50% reduced space requirements with the combined vessel and ladle lifting system (RH CVL)

Converter steelmaking

- Up to 50% scrap or HBI (hot-briquetted iron) charging to the LD (BOF) process with the Jet process
- Less than 2 kg of slag carry-over during converter tapping
- 20-year lifetime of converter suspension system with Vaicon Link 2.0
- 50% reduction of AOD converter vibrations with the Vaicon drive damper
- Less than 10 mg/Nm³ dust emissions with dry-type LD (BOF) dedusting system
- 70 Nm³ to 100 Nm³ recovered CO gas per ton of steel produced in an LD (BOF) converter
- Availability of recycling processes for 100% valorization of slags and dusts from steelmaking

6-strand bloom caster,
Pangang Group Steel Vanadium
& Titanium Co., Ltd., China

FEATURING **16**

CONTINUOUS CASTING

papers from Primetals Technologies at the ECCC Conference 2017 in Vienna covering the topics of slab casting, billet casting, bloom casting, strip casting, and the related mechatronic, automation and process-optimization systems.



HKM OPERATION RESULTS: EFFECTIVE USE OF PRIMETALS TECHNOLOGIES PROCESS MODELS

Paper number: 22; Principal author: Martin Hadler

In May 2015, the modernized Slab Caster No. 3 at the Hüttenwerke Krupp Mannesmann GmbH (HKM) Duisburg-Huckingen plant in Germany went into operation. The revamp was carried out by Primetals Technologies with the following main targets: improvement of the quality and product tolerances of the cast slabs; extension of the product portfolio; and increased process stability, availability and workplace safety.

To achieve these goals, the latest technological packages from Primetals Technologies were installed. Basic and process automation as well as safety equipment were completely overhauled. Sophisticated caster solutions and process models such as DynaPhase, DynaGap Soft Reduction, Dynacs 3D, LevCon, DynaWidth and DynaFlex were implemented. In combination with the air-mist secondary-cooling system, which also

had been renewed, a new surface-temperature control system was applied to ensure the continuous production of high-quality slabs. Thanks to the new process models and technological packages, it was possible to achieve the desired level of slab quality starting with the very first heat.

This paper describes the project and how it progressed, how the plant equipment was modified, the installation of back-up systems, and how the functionality of the slab caster could be extended. The revamp led to increased plant availability, casting of a broader product range and an optimized yield of the cast slabs. In addition to enhanced process stability and product quality, occupational health and safety at Slab Caster No. 3 were also improved. A selection of long-term quality-improvement and optimization measures are additionally outlined in this paper.



Modernization of Slab Caster No. 3 at Hüttenwerke Krupp Mannesmann, Duisburg-Huckingen, Germany



Ladle turret of the Arvedi ESP slab caster at Rizhao Steel, China

ARVEDI ESP'S CASTER SKILLS TO ENTER A NEW WORLD OF ENDLESS PRODUCTION

Paper number: 8

Principal author: Irene Watzinger

Thin-slab casting and rolling processes are well known and have been in continuous development since their introduction at the end of the last century. In an attempt to find the optimum configuration to be able to economically operate and fully load the rolling mill, several different concepts have emerged that include up to three casting strands fed into a single rolling-mill line. These different concepts are based on complex furnace constructions, which have numerous drawbacks. The key is to simplify all of these concepts to a single-strand concept. The main target is to ensure a stable and high mass flow.

Arvedi ESP technology represents the benchmark technology in this field. A steel mass flow of up to an annual throughput of 3 million t/a is possible thanks to fully endless operation and several other technological highlights implemented at Arvedi ESP casting machines. This paper focuses on the advanced mold system, including mold monitoring and mold-level stabilizing systems.

Arvedi ESP technology represents the benchmark technology in this field.

STUDY ON SPRAY COOLING FOR THE VOESTALPINE CC4 SLAB CASTER

Paper number: 24

Principal author: Dr. Josef Watzinger

The dual-strand casting machine CC No. 4 at the Linz steelworks in Austria is the company's oldest machine still in operation. It casts 225-mm-thick slabs comprising ultra-low carbon, low-carbon and HSLA (high-strength, low alloy) steel grades. Recently, edge defects began to appear on the hot strip that was produced from slabs cast on this caster, appearing along a strip-width range of around 1,000 mm to 1,200 mm when casting micro-alloyed construction steel. Such defects had not been seen on hot strip when rolling slabs from the other casting machines at the plant.

Primetals Technologies, in cooperation with voestalpine experts, carried out a comprehensive study of the entire air-mist spray-cooling process. The cooling setup and various operational adjustments were investigated. The spray performance of each nozzle was checked in a test facility of Primetals Technologies. During these tests, the water distribution across the slab width was simulated using the appropriate simulation tools. A realistic spray pattern for each cooling loop as well accumulated patterns at certain specific positions were established and subsequently reviewed. Exceptional situations arising from the collision of sprays with installed equipment were also taken into account in the nozzle tests and simulations.

Critical situations and issues that led to local over-cooling could be subsequently identified, which were directly related to the above-mentioned quality issues. A stepwise improvement plan was then developed. Most of the major product quality issues were resolved with the implementation of the first short-term modifications.



Investigation of the spray performance of different nozzle designs

UNSTEADY BULGING COMPENSATION AT OUTOKUMPU TORNIO'S CASTERS 1 AND 2 - STABLE MENISCUS DURING CASTING OF FERRITIC STAINLESS STEEL

Paper number: 10

Principal author: Paul Felix Dollhaeubl

Process stability during continuous casting is essential for the production of high-quality stainless steels. In particular, the meniscus, which is the most sensitive zone of the entire strand, has to maintain a constant shape and steady position. The liquid core of the strand acts like a hydraulic hose, so each radial movement of the strand shell has an impact on the level of steel in the mold. Hence, strand-shell bulging between the containment rollers leads to a coupled effect of the transient strand volume and the position of the steel meniscus. The crucial factor is that mold-level fluctuations have an impact on the generated strand shell in terms of thickness variations. Ferritic stainless steel grades, which typically have a soft and creeping material behavior during casting, are known for their affinity for high and unsteady bulging.

The roller geometry of a casting machine also has an influence on bulging behavior. For instance, many consecutive identical roller pitches will lead to a superposition of the pumping effect of the roller pairs and an increased bulging tendency. Therefore, state-of-the-art slab casting machines have defined variations of the consecutive roller pitches within the caster segments. Slab casters with a single-unit casting bow are equipped with staggered rollers between the inner and outer bow due to the difference in the number of installed rollers. The offset between inner- and outer-bow rollers reduces the bulging tendency with this machine type.

At Outokumpu Tornio, both machine types, i.e., segmented casting bow (Caster 2) and single-unit casting bow (Caster 1), are in operation. Meniscus stability has been significantly improved with the installation of an unsteady-bulging compensation controller in both machines, which suppresses periodical mold-level fluctuations generated by unsteady bulging. This model-based controller is implemented as an add-on software package in the mold-level-control PLC as part of the LevCon technological package.

HIGH-SPEED CASTING AND THE INNOVATIVE WINLINK MINI MILL AT GPH BANGLADESH

Paper number: 21

Principal author: Gerold Schoeftner-Gruebl

WinLink is a pioneering technology from Primetals Technologies that allows both endless and semi-endless production of long products from liquid steel without interruption. The solution directly links a high-speed billet caster to a high-availability rolling mill by using an advanced induction-heating unit instead of a conventional billet-reheating furnace.

GPH Ispat Ltd. in Chittagong, Bangladesh, is the first customer where Primetals Technologies will implement the WinLink solution. The plant configuration allows full flexibility to run the mill in various production modes. One strand of the three-strand WinLink billet caster is linked directly to the rolling mill in the endless mode, which allows up to 70 t/h of rolled products to be produced at casting speeds of about 6 m/min without cutting and heat losses. The two additional billet strands are used for the production of about 50 t/h saleable billets, which are cooled on the cooling bed and rolled at GPH's existing rolling mill. This multi-strand configuration significantly improves the productivity of the plant by ensuring greater flexibility in the face of unpredictable market changes.

This paper provides an overview of different WinLink variants that are offered for production capacities of up to 640,000 t/a of rolled products. The technologies that will enable high-speed billet casting are also discussed.

The multi-strand configuration significantly improves the productivity of the plant by ensuring greater flexibility in the face of unpredictable market changes.

TECHNOLOGICAL SOLUTIONS FOR THE REVAMP OF LONG-PRODUCT CASTERS

Paper number: 23; Principal author: Andreas Eichinger



The modernized 5-strand billet caster in operation at ESF Elbe-Stahlwerke Feralpi, Riesa, Germany



6-strand billet caster in operation at the Abinsk Electrometallurgical Plant

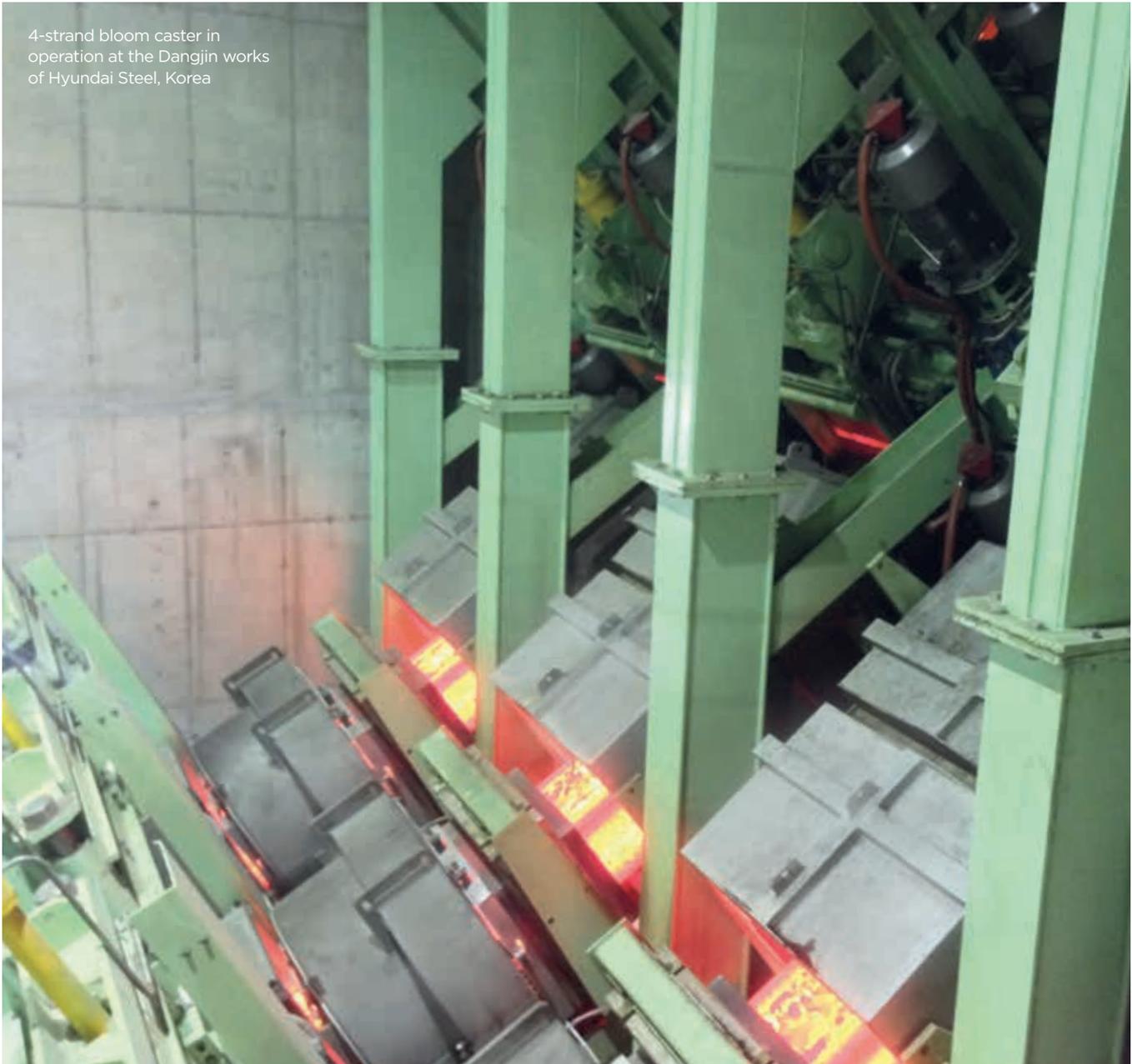
Primetals Technologies provides technological solutions for the revamp of long-product casters. This paper presents recent examples of successful project implementations at ESF Elbe-Stahlwerke Feralpi GmbH and OOO Abinsk Electric Steel Works Ltd (AEMZ), which underline the qualitative results that can be achieved within short project execution times.

EFS, located in Riesa, Germany, awarded Primetals Technologies a contract for the modernization of a 5-strand billet caster, which was restarted in 2015. The aim of the project was to increase productivity and to further improve the internal as well as the surface quality of the billets. The caster was equipped with a new machine head that included DiaMold mold tubes and retractable DynaFlex hydraulic oscillators, and the secondary cooling system was also upgraded. In order to optimize the shutdown period and keep installation time to a minimum, the new equipment was pre-assembled and tested.

OOO Abinsk Electrometallurgical Plant (AEMZ) is one of Russia's leading producers of reinforcing bars and other long products. The company operates an electrical steel plant and two rolling mills in Abinsk, which is located in the Krasnodar region of southern Russia. In March 2016, Primetals Technologies was awarded a contract to revamp the electric arc furnace, ladle furnace and the 6-strand billet caster.

The main project targets were to increase productivity, lower production costs, improve billet quality, and broaden the product scope with the casting of quality steel grades such as cord, spring, cold-heading and welding steel grades. Casting speeds will be increased to 5 m/min for 130-mm-square billet sections to enable AEMZ to expand the plant's annual production output to 1.5 million tons of billets. The casting of quality steel grades will be possible with the installation of stopper equipment, electromagnetic stirring systems, tundish shroud manipulators and automatic mold-powder feeders. The new machine head, which features a DiaMold high-speed casting mold, DynaFlex hydraulic oscillation units and electromagnetic stirring in the mold, will ensure a high quality of the cast billets. Furthermore, the new Level 2 automation system will safeguard consistency in the production of high-quality billets cast at high casting speeds.

4-strand bloom caster in operation at the Dangjin works of Hyundai Steel, Korea



LATEST INNOVATIONS IN BLOOM CASTING AT HYUNDAI STEEL DANGJIN

Paper number: 15; Principal author: Dr. Denijel Burzic

This paper provides an overview of the latest solutions implemented by Primetals Technologies for continuous bloom casters. The heavy-section bow-type bloom caster at the Dangjin works of Hyundai Steel Co., Ltd. in Korea serves as an example for the range of solutions and technological packages that are offered for quality steel producers. Bars and wires, which are rolled from the blooms, are used as the primary material for engine and gearbox parts by the Hyundai Motors Group.

The caster is equipped with mold-level control and an instrumented mold that features breakout prevention. Consistently high bloom quality is additionally supported

by the combination of the following: air-mist spray cooling and interior-cooled rollers in the strand-guidance system; DynaGap Soft Reduction; and electromagnetic mold stirring and final strand stirring. Blooms are directly fed into the bar line while they are still hot. This not only saves energy costs during reheating, but also improves operating safety because there is no need for the use of cranes to handle the blooms. An inline bloom-quenching facility is foreseen for the production of special steel grades. An overview of the bloom-quality results achieved during the start-up of the Hyundai Steel bloom-casting machine is also presented in the paper.

**This is the
first plant
of its type
worldwide.**

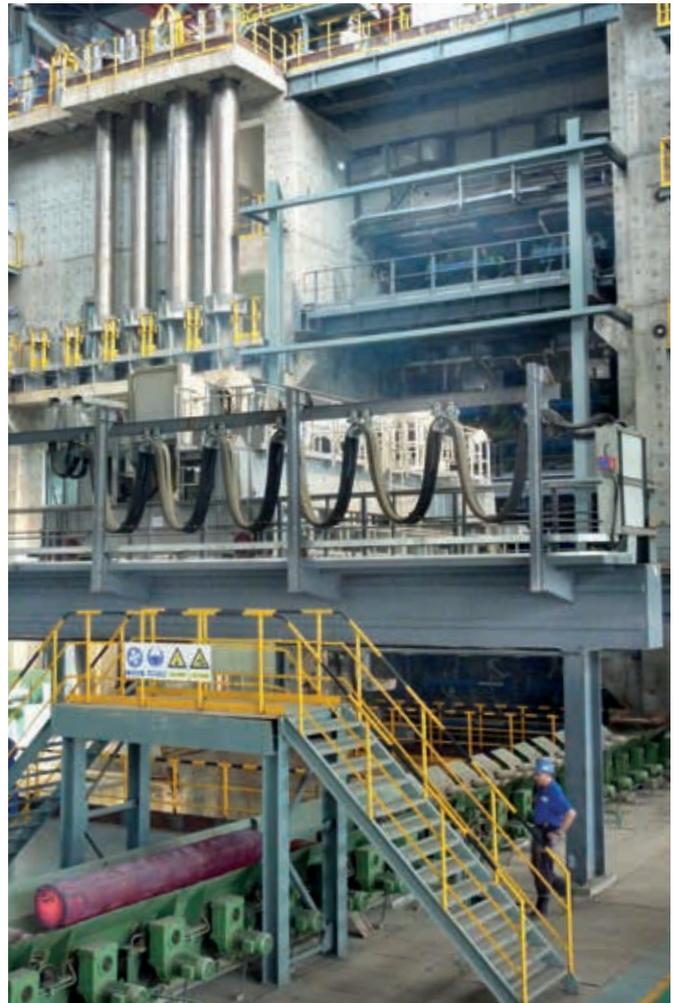
OPERATION RESULTS OF VERTICAL CASTING OF HEAVY ROUND BLOOMS AT ZHONG YUAN SPECIAL STEEL

Paper number: 27; Principal author: Franz Wimmer

A new vertical caster for the casting of special steel grades went into operation at Zhongyuan Special Steel Co., Ltd., in Jiyuan, China, in June 2015. The 2-strand vertical round-bloom machine has a casting capacity of up to 370,000 tons per year, which enables Zhongyuan to produce additional high-quality steel grades. The company previously only had an ingot-casting plant for the production of mainly steel forgings. A newly designed multi-roller driver unit provides for optimum support of the 120-ton strand during casting.

This is the first plant of its type worldwide. The new continuous caster is designed as a vertical plant with a height of 40 meters and a metallurgical length of 23 meters. It produces heavy blooms with diameters of 400 mm, 600 mm and 800 mm, and bloom lengths of between 2.5 m and 6 m. The maximum casting speed is 0.55 m/min. The caster is equipped with a straight DiaMold tubular mold that is 700 mm long. The DynaFlex tubular mold oscillator allows for flexible adjustment of oscillation parameters. Technology packages such as the LevCon mold-level control system and the Mold Expert breakout-detection system ensure trouble-free casting. An advanced air-mist secondary-cooling system, which includes the Dynacs 3D metallurgical cooling model and DynaJet cooling nozzles, is the basis for achieving optimum product quality.

The latest solution for heavy-bloom round casting and the corresponding operational results are presented in the paper to illustrate the special features of vertical bloom casting.



The 2-strand vertical round-bloom caster at Zhongyuan Special Steel Co., Jiyuan, China

MAINTENANCE OF CONTINUOUS CASTERS FOR HIGH-PRODUCT QUALITY: SIMPLE MEASURES AND ADVANCED TOOLS

Paper number: 11

Principal author: Dr. Martin Hirschmanner

The modern continuous casting machine is a highly complex mechatronic system where absolute precision is critical to ensure high-product quality and where equipment has to be designed to withstand harsh ambient conditions. These two requirements alone would be challenging, but in addition to that, operational costs have to be kept to a minimum to remain competitive under current market conditions.

Good maintenance procedures is a prerequisite for achieving high product quality at low cost during the operation of a continuous casting plant. The design of each component needs to be optimized for maintenance reasons. An example of such a component is the newly developed Single-Roll Dynagap (SRD) segment. Designed from scratch, the segment is a sophisticated system where the emphasis was placed on assuring a high degree of maintenance-friendliness. The single roller unit exchange contributes to improved plant availability.

Modern technologies subsumed under the buzzword "Industry 4.0" are applied to improve caster maintenance procedures. Examples include an intelligent equipment-tracking system, an automatic test procedure and a data-saving system to "smarten up" equipment. The combination of maintenance-friendly procedures, an efficient maintenance workshop concept, automated test procedures with built-in quality checks as well as efficient equipment reinstallation will ultimately improve product quality and reduce operational costs.

This paper includes several examples of how components of continuous casters can be exchanged quickly, checked for problems, repaired, tested and reinstalled. Examples of how the performance of a plant can be improved through technology consulting are also discussed.

3-D representation of a Single-Roll Dynagap (SRD) segment



Good maintenance procedures is a prerequisite for achieving high product quality at low cost during the operation of a continuous casting plant.

ROLLING TECHNOLOGIES FOR THE DIRECT STRIP-CASTING PROCESS

Paper number: 17

Principal author: Kenji Horii

The direct strip-casting process has attracted attention as a near-net-shape technology. Baosteel Group Corporation and Primetals Technologies have jointly developed technologies for a direct strip-casting process for carbon steel. A demonstration plant equipped with 800-mm-diameter and 1,340-mm-long casting rolls was installed in China and was put into operation in 2014. The stable casting and rolling of 1,340-mm-wide strips and long-term sequence casting of more than 350 tons have already been achieved.

This paper outlines the specific downstream equipment technologies for a direct strip-casting process such as an in-line reduction mill, a strip-cooling system and the carousel-reel-type coiler. The paper also focuses on measures to achieve stable rolling conditions, such as with the use of the Dynamic Pair Cross Mill and strip-temperature control.

LIQUIROB – NEXT-LEVEL SHROUD MANIPULATION – FROM AN IDEA TO AN INDUSTRIAL SOLUTION IN THREE MAJOR STEPS

Paper number: 28; Principal author: Juergen Meisel

This paper explains how a robotic solution can be successfully implemented – from the initial idea to a working industrial solution. Primetals Technologies can refer to ten years of experience in the installation of the so-called LiquiRob robotic solution in the harsh environment of steelmaking plants. Driven by the desire to enhance an existing shroud-manipulation system, and based on the requirements of a well-known steel producer, the idea to connect the shroud to the ladle nozzle by means of a bayonet mechanism was born.

This paper reviews the development steps from the first simulations and prototype testing in the laboratory, the intensive system testing carried out under workshop conditions, and also the successful integration of LiquiRob at a slab caster. Furthermore, operational experience and the advantages of the LiquiRob solution are compared to other shroud-manipulation systems.

Operation of the LiquiRob robotic solution in the casting platform area





2-strand slab caster at Companhia Siderúrgica do Atlântico (CSA), Santa Cruz, Rio de Janeiro (RJ), Brazil. Primetals Technologies is responsible for a wide range of caster services at this plant.

ADVANCED MOLD COPPER PLATING – VARIABLE HIPER COATING

Paper number: 18; Principal author: Franz Kolmbauer

At the workshop of Primetals Technologies Brazil in Santa Cruz, Rio de Janeiro, mold coppers are electroplated for continuous casting by means of tank plating, i.e., submerging the copper in the bath of the plating solution. This is the most common method of plating and it is applicable for both broad-face and narrow-face copper plates.

Mold copper plates have a decisive impact on product quality as well as on the costs of maintenance and

production. A comprehensive understanding of the operational influences on the plates and performance factors is the first step toward selecting the best copper-plating method. Variable Hiper Coat allows copper plates to remain in operation 50% to 100% longer than with conventional plating solutions, because the required hardness can be imparted to the copper plate where it is needed. Primetals Technologies offers a solution that meets and even exceeds the demands of today and tomorrow.

DynaJet Flex
water-spray
nozzle



DYNAJET FLEX – ULTIMATE FLEXIBILITY IN SECONDARY COOLING

Paper number: 6

Principal author: Thomas Fuernhammer

Cooling zones in casting machines are typically equipped with air-mist nozzles to enable a wide turn-down ratio (typically 1:9) from the highest to the lowest water-flow rates with a constant spray pattern. To prevent strand corner cracks, the zones are additionally split into center and margin cooling strips across the casting width.

DynaJet Flex from Primetals Technologies is a new cooling system that takes the discretization of cooling zones in casting machines to the next level. By using water-only nozzles, which can be driven with a pulse-width modulated signal, it is possible to extend the turn-down ratio from 1:9 to 1:15 – and higher. Simultaneously, operational costs can be cut by more than 70% owing to less air consumption compared to conventional air-mist nozzles.

The system can be installed and tested on a segment during a planned maintenance cycle. After reinserting the segment into the machine, the air for controlling the nozzles is activated. From this point, the segment is ready to operate in accordance with the casting width to ensure the optimal temperature of the slab in and across the casting direction. The DynaJet Flex nozzle is equipped with a robust standard flange so that the nozzle can be securely fixed to the segment. Different nozzle tips can be mounted onto the nozzle head to generate the required spray pattern.

This paper shows how a caster can be modernized with DynaJet Flex nozzles, how caster productivity is increased, and how operational costs can be reduced.

One of the most important developments in recent years is the integration of process parameters across the entire production route – from ironmaking up to strip finishing.

NEW GENERATION OF CONTINUOUS CASTING PLANTS WITH AN INTELLIGENT MANUFACTURING STRATEGY

Paper number: 196

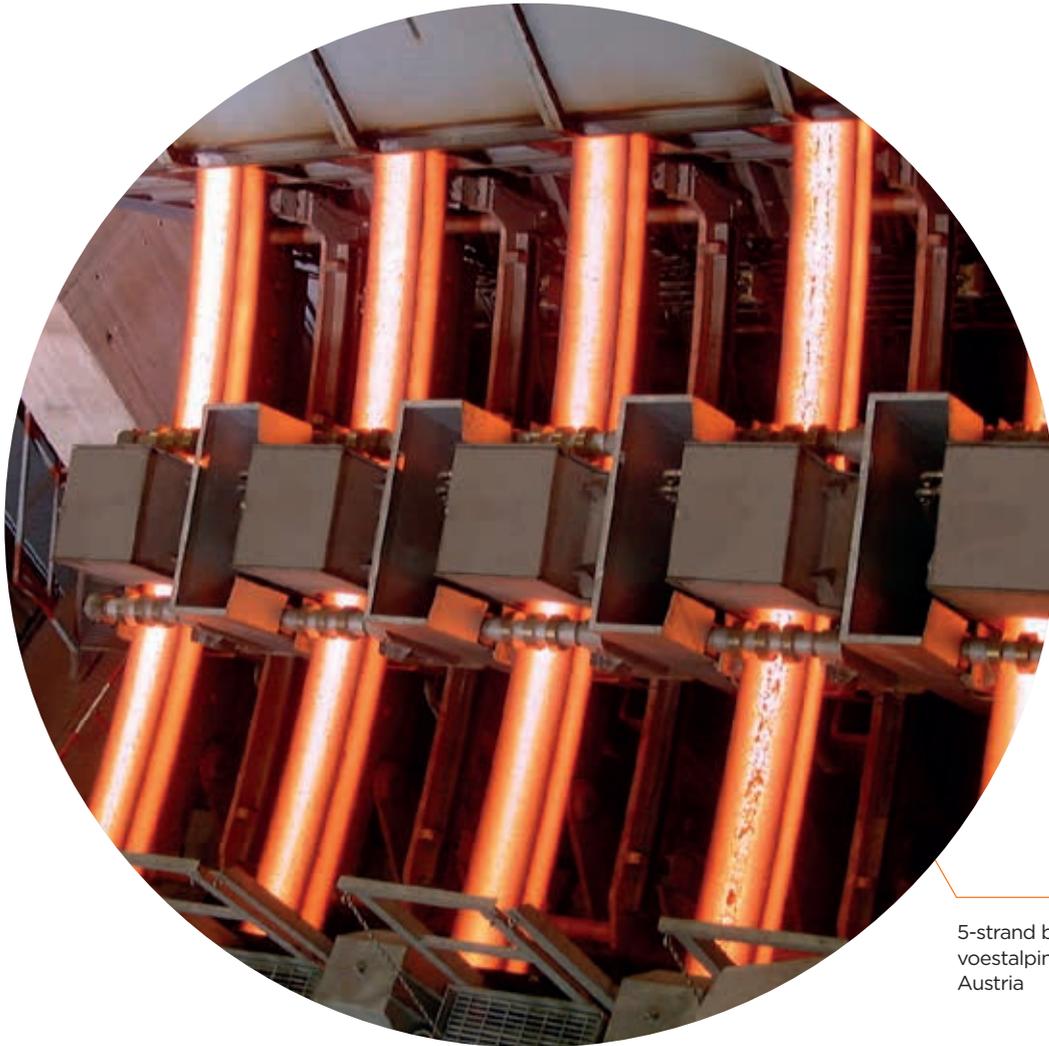
Principal author: Johann Penn

Changing market conditions demand the sustainable use of newly available technologies to support steel producers with highly flexible plant configurations and process tools. Investments are therefore targeted toward optimizing production costs and product quality while achieving a short-term return. The modular design of upgrading solutions allows the optimization of metallurgical processes to be individually configured, and takes into account a holistic overview of the steelmaking and continuous casting routes.

One of the most important developments in recent years is the integration of process parameters across the entire production route – from ironmaking up to strip finishing. This was also considered for continuous casting plants by using the steel chemical analysis data from secondary metallurgy as input parameters for the caster process model DynaPhase for modeling phase transformations. Consequently, the casting process can be controlled more predictably and with a high degree of accuracy. This also allows an exact determination of the final point of solidification for state-of-the-art soft reduction.

Recent developments have also focused on reducing energy costs on the one hand, while improving product quality on the other. This has led, for example, to the development of the completely new DynaJet Flex secondary-cooling system. This system no longer requires operation air and thus allows the cooling turn-down rate to be doubled. This contributes toward meeting the growing demands of special steel casting.

This paper features an overview of the above new developments in continuous casting during the last two years and the corresponding operational results. Highlights of the Industry 4.0 setup of caster process modeling and various plant configurations are also presented.



5-strand billet caster at voestalpine Stahl Donawitz, Austria

CCM 4.0 – DIGITALIZATION FOR INTELLIGENT PRODUCTION IN CONTINUOUS CASTING

Paper number: 16; Principal author: Kurt Herzog

Digital transformation brings about a structural change in automation – a transformation of process automation into a new and more efficient structure. Today's hierarchical automation pyramid is replaced by a flat structure of intelligent, flexible and autonomous units. It is important that the metals industry makes an active contribution to implementing digitalization in production plants throughout the entire value chain.

Digitalization for intelligent production synchronizes process, machine and product data for integration with business data in a “smart factory.” “Smart services” enable data-based services such as predictive or data analytics. “Smart work” helps to improve maintenance and operation. This paper provides examples for the caster area.

The next stage of model-based process-automation control is to link the real-world plant with the virtual plant in a cyber-physical system. This is done by modeling and simulation of the casting process, for example by the integration of material properties according to their actual composition, strand-surface temperature profiles and dynamic soft reduction before the final point of strand solidification. The aim of digital transformation and the crosslinking of production is to ensure maximum flexibility and efficiency in production, high plant availability and superior product quality.

Primetals Technologies is committed to digitalization and to implementing the connected plant by continuously pushing latest innovations forward in close cooperation with its customers.

SEMI-CONTINUOUS CASTING TECHNOLOGY COMBINING TECHNOLOGICAL ADVANTAGES OF TWO DIFFERENT CASTING PRACTICES

Paper number: 9; Principal author: Andreas Eichinger

Bow-type continuous casters as well as vertical casting machines achieve high productivity and yield at high casting speeds. Nevertheless, for continuous production, the speed is limited by the metallurgical length of the machine and the required high cooling rates, which cause pronounced radial orientation of the crystallization front within the strand. Particularly for the casting of special high-alloyed steel grades, the strand center becomes prone to higher porosity and the formation of cavities.

Contrary to this, conventional ingot casting is characterized by low productivity and yield, and cooling takes place at low cooling rates. This low cooling rate results in an axial orientation of the crystallization front within the strand, and consequently to the best inner strand quality – especially for special high-alloyed steel grades.

The objective of semi-continuous casting technology from Primetals Technologies is to combine the benefits of ingot casting and continuous casting for the production of most special steel grades such as tool-, die- and stainless steels. Special attention is therefore placed on optimizing key equipment and component areas of the caster, such as the mold and oscillator, to achieve an optimum strand-surface quality and low operating expenditures (opex). Additionally, other proven continuous casting solutions and technologies are applied for special steel casting. This includes electromagnetic mold and strand stirring and the use of advanced process models such as DynaPhase and Dynacs 3D to dynamically control segmented heat zones for achieving the lowest possible cooling rates – the major benefit of ingot casting. This combination of these solutions leads to improved steel quality with respect to a symmetric crystal

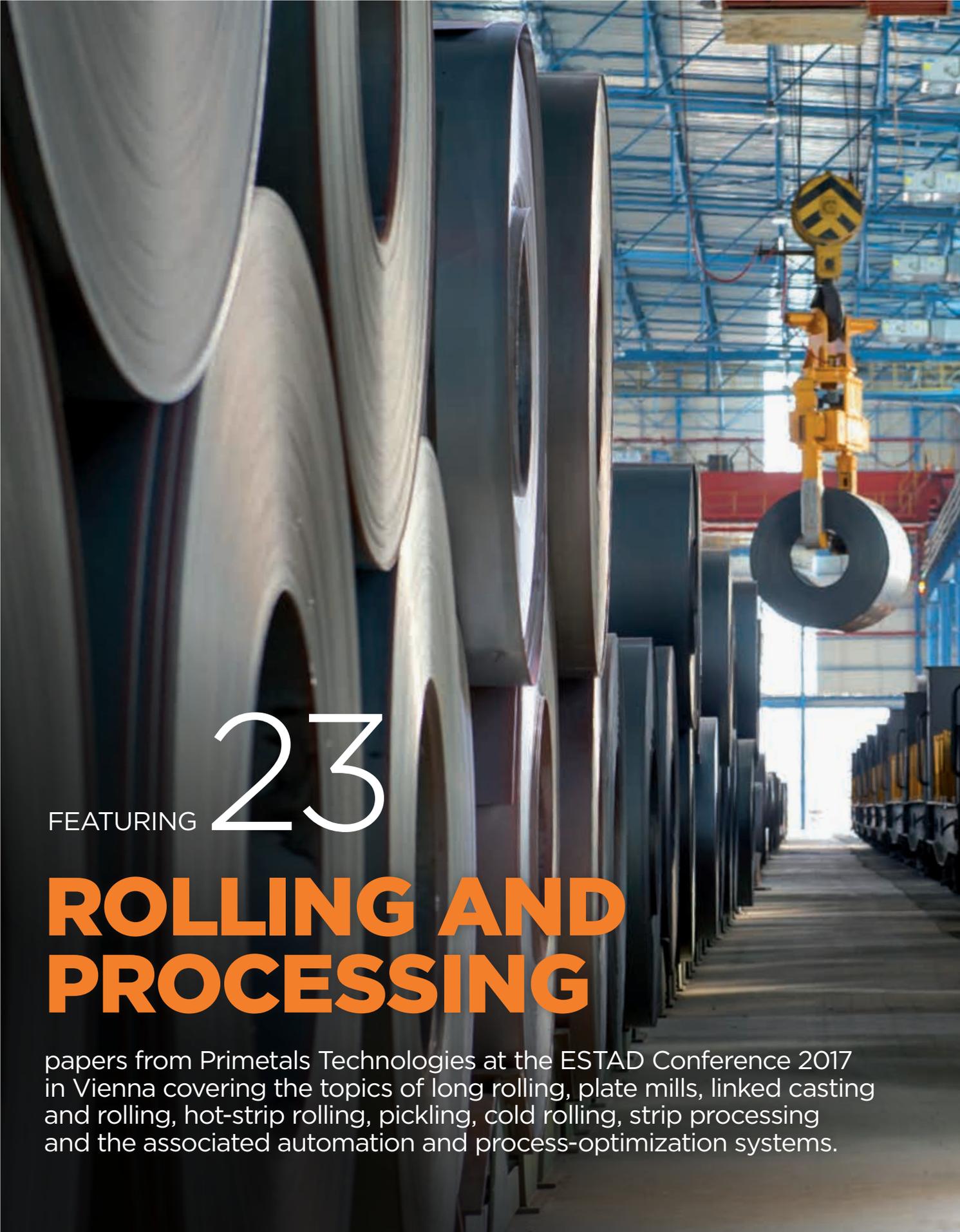
structure, the prevention of center cracks and cavities, and highest internal cleanness together with an optimized yield.

This paper outlines different aspects of semi-continuous casting machines for small and large strand sections. The resulting quality, yield, operation, investment and running costs compared to conventional continuous casting and ingot casting are also described.

The objective of semi-continuous casting technology is to combine the benefits of ingot casting and continuous casting for the production of most special steel grades.

CONTINUOUS CASTING HIGHLIGHTS OF PRIMETALS TECHNOLOGIES

- More than five decades of experience in the supply of continuous casting machines
- More than 1,700 continuous casting machine references worldwide
- More than 470 slab casters supplied worldwide since 1968
- 2,156 non-stop casting sequences with a 2-strand slab caster
- Up to 400 mm thick slabs cast in ultra-thick slab casters
- World's widest slab (3,250 mm) cast in a slab caster
- More than 2,500 installed square and round billet strands
- World's largest beam blank (1,024 mm x 390 mm x 90 mm) cast in a beam-blank caster
- 160 casters equipped with the Mold Expert systems for minimized strand breakouts
- World's leading supplier of secondary cooling systems and strand soft-reduction technology

A large industrial facility, likely a steel mill, with rows of massive metal coils. A yellow overhead crane is visible in the background, lifting a coil. The scene is brightly lit, suggesting a large, open industrial space.

FEATURING 23

ROLLING AND PROCESSING

papers from Primetals Technologies at the ESTAD Conference 2017 in Vienna covering the topics of long rolling, plate mills, linked casting and rolling, hot-strip rolling, pickling, cold rolling, strip processing and the associated automation and process-optimization systems.



ENDLESS PRODUCTION
of high-quality, thin-gauge
hot-rolled coils at Rizhao
Steel, China

FORGING-LIKE ROLLING WITH HIGH REDUCTION OF SBQ LONG PRODUCTS

Paper number: 98

Principal author: Francesco Toschi

The special bar quality (SBQ) family comprises a wide range of steel grades that are mainly requested by the automotive, energy and engineering sectors. These steels are primarily used for demanding applications where significant performance is required related to high stresses, high temperatures and severe working conditions. To meet the performance demands, it is necessary to achieve precise control of both the mechanical properties and the metallurgical structure of the steel along the entire production route. For semi-products with large dimensions – equivalent to diameters of around 300 mm – the required control is traditionally obtained in a manufacturing route that comprises ingot casting followed by reheating, forging and rolling.

Since 2010, new processes have been investigated and technologies developed to replace the ingot route for the production of special steels with continuous casting followed by controlled high-reduction rolling. In these processes, the seamless integration of continuous casting and rolling is implemented for the precise control of material flow, the applied deformation forces and rolling temperatures. By using the proper combination of roll diameter, speed and applied reduction forces, excellent control of the metallurgical structure across a complete section can be obtained with the additional benefit that internal material voids generated during continuous casting are eliminated.

These casting-rolling processes, which can be described as "forging-like," are applicable to several steel grades cast with large semi-product dimensions (300 mm and higher). By dispensing with the ingot route, yield and productivity are increased, which is highly beneficial for the overall economy of a plant. An example of a forging-like process is shown by the high-reduction blooming stand installed by Primetals Technologies at the Camin mill of Acciaierie Venete S.p.A in the Italian province of Padova. This paper reviews the applied rolling concepts, the mill technology and the main process features.



Rails on cooling bed at the ARBZ rolling mill, Kazakhstan

THE PRODUCTION OF RAILWAY RAILS IN MODERN AND EFFICIENT PLANTS – THE NEW ARBZ RAIL MILL

Paper number: 103

Principal author: Francesco Toschi

A growing trend in the production of rails can be noted worldwide as a consequence of the market interest in high-speed and heavy-haul transport. Evidence for this is seen by the updating of the main international rail standards, or their re-issue, in China, Europe, India, Russia and the U.S.A. since 2010. In 2014, global rail production was approximately 12 million tons, of which 8 million tons were produced in plants commissioned after 2010. Head-hardened rails account for some 1.2 million tons, and this growth is expected to be in the double-digit range by 2025.

In order to ensure the required efficiency and flexibility for cost-effective rail production, modern rolling mills for rails and sections must operate at high quality and productivity levels. The latest generation of mill installations incorporate the most recent advances in processing, equipment and control. These mills are comprised of sophisticated mechatronic systems that can consistently replicate the manufacturing processes, and all operations are fully automated throughout the complete production route. This leads to a number of advantages in terms of product quality, productivity, flexibility and conservation of energy and materials.

This paper describes the main innovations introduced by Primetals Technologies for the production of rails, and presents, as an example, the Aktobe Rail and Section Works LLP (ARBZ) in Kazakhstan.

MODERNIZATION OF THE KROMAN WIRE ROD MILL TO INCREASE PRODUCTIVITY, UTILIZATION AND PRODUCT QUALITY

Paper number: 132; Principal author: Wade Krejdosky

A mill modernization project was undertaken by Kroman Celik Sanayii A.S. in Turkey to improve product quality, consistency and shape of the coil package, as well as to reduce maintenance and production delays in the rod mill in order to increase utilization and productivity. The project, which was executed jointly with Primetals Technologies, included the installation of a new Morgan Intelligent Pinch Roll and High Speed Laying Head, modifications to the existing cooling conveyor, and replacement of the coil-reforming station. The new pinch roll and laying head were provided to ensure better control in forming the ring

and consistency of the coil shape on the conveyor, while reducing delays on the conveyor. Changes to the cooling conveyor included the installation of new nozzle decks and an Optimesh air-distribution system in addition to the rearrangement of existing fans to improve both cooling rates and uniformity of cooling. This paper explains details and features of the newly-installed equipment. Resulting product and process improvements are presented, which include increased tensile strength and uniformity of product, reduction in delays on the conveyor and reform tub, and enhanced coil quality.



Morgan High-Speed Laying Head installed at Kroman Celik, Turkey

Primetals Technologies has developed a new control concept for rolling ultra-thin hot-rolled strip in the finishing mill of an ESP line.

ROLLING INTO THE FUTURE BY DIGITALIZATION

Paper number: 78

Principal author: Paul Riches

Today's steel producers face the dual challenge of ensuring on-time delivery and ever-demanding product requirements while also running a lean operation. Daily management of a long products rolling facility requires continuous optimization of both operating and business practices.

Due to the evolution in technology (data collection, communication, Internet of things, control techniques and intelligent sensors), there is more information available today than at any time before. Using this information and monitoring the performance of a plant will revolutionize the control of rolling mills worldwide. This will lead to the optimization of the entire value chain along with advanced flexible production. New concepts are therefore being developed to improve the operational management of critical areas within a long-products rolling mill. Existing installed technology is being outfitted with smart sensors, such as non-contact measurement devices, vision systems, intelligent temperature measurement and RFID (radio frequency identification), for better product tracking. Such devices will provide real-time data to enable a higher level of automation to be achieved that will substantially improve product quality, rolling processes and flexibility, operating and maintenance costs, operational set up, operator intervention in the rolling process, and product storage and logistics.

This paper describes how the digitalization of information collection and distribution will lead to a revolution in long-product rolling mill control systems. The benefits of adding intelligent sensors are highlighted because they are critical to enhancing mill performance in all areas.

NEW STRIP-TENSION CONTROL FOR BETTER THICKNESS PERFORMANCE AT FINISHING MILLS

Paper number: 79

Principal author: Daniel Kotzian

The stable and reliable rolling of thin strip in the finishing mill of linked casting and rolling processes such as Arvedi ESP (endless strip production) and Compact Strip Production (CSP), or in conventional hot-strip mills, has increased the requirements for precise mass-flow and thickness control. As an initial step to meet these demands, Primetals Technologies has developed a new control concept for rolling ultra-thin hot-rolled strip in the finishing mill of an ESP line. Referred to as "ultra-thin rolling control," the system is essentially an adapted control concept that has been successfully applied many times in tandem cold mills. When rolling below a certain strip thickness, the control mode is switched from speed control to roll-gap control while the strip tension is kept constant.

In this solution approach, the looper measures the strip tension between the stands and the looper position remains constant. This type of switchable control is applied at each finishing mill stand. A flexible control approach allows a smooth strip transition between the mill stands. This type of mass-flow control was applied at the No. 3 Arvedi ESP line at Rizhao Steel in China. The required strip tension and thickness reductions are obtained in the endless rolling mode with the use of fast actuators and by compensating for periodic disturbances. Moreover, the control system is linked to the thickness monitor, which regulates the exit thickness at the finishing mill. As the next step, Primetals Technologies is developing an extension of ultra-thin rolling control to roll thin hot strip in a finishing mill of a CSP line and in a conventional hot-strip mill. The goal is to achieve improved strip thickness performance and operational stability.

BROADENING THE STEEL MARKETS BY DIRECT APPLICATION OF HIGH-QUALITY ESP STRIP

Paper number: 33

Principal author: Dr. Bernd Linzer

The steel feed stock for the final fabrication of flat steel products is mainly met by cold-rolled and final-annealed or galvanized strip. Depending on the required strip thickness and surface requirements, conventional batch-production processes account for a certain share of flat-steel production, however, without cold rolling this portion is quite limited. Arvedi ESP (endless strip production) technology, featuring the direct linking of a slab caster and hot-rolling mill in a continuous, uninterrupted production line, is providing new impulses for the flat-steel market. With this game-changing technology, it is now possible to produce hot-rolled feed stock for numerous applications that previously could not be directly met with the hot-rolling step alone. Thinner and at the same time wider steel strip can be produced in an Arvedi ESP line that is able to replace a large portion of previously cold-rolled steel strip. Joint development efforts by Rizhao Steel and Primetals Technologies at recently commissioned ESP lines in China are setting new standards to supply even more demanding products for high-end applications. The paper provides an overview of the products and results achieved with Arvedi ESP technology that allow cold-rolled strip to be directly substituted.

ARVEDI ESP: THE TECHNOLOGICAL CONTRIBUTION FOR PERFORMANCE OPTIMIZATION

Paper number: 34

Principal author: Andreas Jungbauer

For every final product there is a carbon foot print that is primarily determined by the raw materials used and the applied production route. The steel industry is seeking to minimize its carbon footprint not only because of environmental reasons, but also to reduce plant energy costs.

Significant improvements have been achieved by optimizing each process step and also by linking individual manufacturing steps. Arvedi ESP technology decisively reduces energy consumption during hot rolling thanks to the advantages offered by a fully endless production process.

Furthermore, it is possible to gain even higher energy reductions through the direct utilization of hot-rolled strip – thereby dispensing with the need for cold rolling and annealing – or by an optimized combination of the rolling and annealing steps. This approach is leading to totally new production possibilities and concepts. This paper provides an overview of different process routes and their respective advantages in the production of final rolled products and their market applications.



Production of ultra-thin hot-rolled strip at low energy costs with Arvedi ESP technology (Rizhao Steel, China)



View of the Mulpic plate-cooling facility at China Steel, Taiwan

RECENT APPLICATIONS OF THE MULPIC PLATE COOLING TECHNOLOGY

Paper number: 111; Principal author: Ian Robinson

The current market is seeing an increased demand for value-added products that include high-strength plates. However, because of economic reasons, the use of high-cost alloys must be ideally kept to a minimum. Steel used for applications such as oil and gas pipelines, offshore structures and shipbuilding require good control of both mechanical properties and the final shape of the plates. The production of such plates is more economic with Mulpic (multi-purpose interrupted cooling) plate-cooling technology coupled with advanced process control. This paper describes the recent modernization project implemented at the plate line at China Steel's Kaohsiung Works, Taiwan. The target was to increase the product mix and improve the quality of the final products. China Steel and Primetals Technology worked closely together to install the Mulpic system upstream of the existing laminar water-flow cooling section to enable higher cooling rates to be applied than is possible with direct-quench cooling

technology. The modular design of Mulpic considerably shortened its installation time, and final acceptance was awarded with all guaranteed values met. An overview of this project is presented together with a description of the cooling system. The importance of the associated advanced model-based automation system is highlighted, including its sophisticated adaptation to the mill. Mulpic is designed to provide the high cooling rates and temperature-control precision needed to achieve the combination of high strength and toughness that is essential for plates destined for demanding downstream applications. The required plate-flatness accuracy is regulated by edge masking, crown valves and head and tail masking. The new valve technology from Primetals Technologies is also described, which allows water-flow rates to be precisely controlled in accordance with plate cooling requirements. Typical performance results are presented, which demonstrate the high degree of accuracy attained.



7-stand 4-high finishing mill installed at Allegheny Technologies Incorporated, Brackenridge, Pennsylvania, U.S.A.

THE MOST UNIQUE HOT-STRIP MILL IN THE WORLD

Paper number: 38; Principal author: Franz Xaver Schmoller

Primetals Technologies received a contract from Allegheny Technologies Incorporated (ATI) to design, engineer and supply a new, fully integrated hot-rolling mill on a process-turn-key basis. The order also included the installation of a water-treatment plant. ATI had embarked on this strategic investment in order to shut down an old hot-rolling mill that had been operating since the 1950s, to enhance its production capabilities, to strengthen its leading position in the market, and to support future material developments. Primetals Technologies successfully executed this project thanks to the close interaction of different in-house engineering locations for mechanical equipment and fluids (Canonsburg, U.S.A. and Linz, Austria) and electrics and automation (Alpharetta, U.S.A. and Erlangen, Germany). The unique specialty metals hot-rolling and processing facility (HRPF) was jointly put into operation with ATI at Brackenridge, Pennsylvania, U.S.A. in 2014. The mill is capable of rolling a wide

range of highly diversified carbon and stainless steels and specialty metals at widths up to 2,083 mm. The rolling forces are the highest ever to be supplied in a hot-strip mill. The HRPF facility is designed to produce an exceptional and highly diverse product mix that includes flat-rolled austenitic, ferritic and martensitic stainless steel alloys; grain-oriented electrical steel; titanium and titanium alloys; nickel-based, corrosion-resistant and high-temperature alloys; zirconium alloys and other specialty metals.

The rolled and processed products are used in the aerospace, automotive, defense, petroleum, chemical, construction, mining and power industries, as well in various medical, food-equipment, machine and cutting-tool applications. The rolling of special carbon steels, for example API pipe grades up to X100 and dual-phase steels, also lies within the overall capability of this remarkable mill.

Excellent robustness of the LSM has been confirmed as shown by an LSM that has been successfully operating in a hot-strip mill for more than ten years.

DEVELOPMENT OF LOOPER SHAPE METER IN HOT ROLLING

Paper number: 106

Principal author: Naoto Migakida

Primetals Technologies has developed a contact-type in-line shape meter for hot-rolled strip, which is known as the Looper Shape Meter (LSM). It is now available for hot-strip mills where continuous in-line strip shape measurements have been long-awaited. The LSM consists of a roll divided into seven segments across the width of the mill. Low hysteresis is obtained by applying torque meters to each segment in combination with internal water cooling of the rolls. Excellent robustness of the LSM has been confirmed as shown by an LSM that has been successfully operating in a hot-strip mill for more than ten years. This paper describes the development details of the LSM.

MILL STABILIZING DEVICE FOR REDUCTION OF MILL VIBRATION IN HOT ROLLING

Paper number: 108

Principal author: Jiro Hasai

As the demand for harder and thinner hot-rolled strip has been increasing, so have the requirements placed on the finishing mill stands to achieve higher reductions, larger rolling forces and higher rolling speeds. With the increase in rolling forces, the impact forces during the threading of the strip front end also increase and mill vibrations can start to occur.

The Mill Stabilizing Device was developed by Primetals Technologies to counter these effects. The device consists of hydraulic cylinders equipped with damping orifices, which are installed between the roll chocks and entry side of the mill housing.

These cylinders eliminate the clearances between the roll chocks and housing and provide a damping effect. The device can be installed in new facilities, as well as added to existing mill stands.

This paper presents Mill Stabilizing Device technology and the results achieved toward reducing mill vibration and impact forces in an actual production line.



Looper Shape Meter in operation in a finishing stand of a hot-strip mill



Eco Slide Disks installed in the hot-strip mill of voestalpine Stahl Linz GmbH, Austria

A PIONEERING HOT-STRIP MILL SIDE-GUIDE SYSTEM THAT ELIMINATES STRIP SURFACE DEFECTS AND OFFERS A CONSIDERABLY EXTENDED SERVICE LIFE

Paper number: 122; Principal author: Friedrich Moser

In the field of downcoiler technology for hot-strip mills, Primetals Technologies has developed innovative products that eliminate mill-operator headaches by simplifying operational and maintenance work with a simultaneous reduction in operational and maintenance costs. Contrary to conventional wear plates where the passing strip always cuts into the plates along the same line, wear on Eco Slide Discs, developed by Primetals Technologies, is

distributed across the entire disc surface. This avoids strip edge defects and extends the service life from a few days using conventional wear plates to several weeks without any service requirements. Another key feature of the Eco Slide Discs is their inherent self-cleaning effect, which reduces the risk of material deposits falling onto the strip, and thus eliminates an important cause of surface damage on hot-rolled strip.



The Minimum Quality Lubrication spray bar

ADVANCED ROLL-GAP LUBRICATION SOLUTIONS IN HOT AND COLD ROLLING

Paper number: 35; Principal author: Dr. Martin Bergmann

The need for more effective and flexible roll-gap lubrication in hot- and cold-rolling mills is steadily increasing due to ever-greater requirements placed on the rolling process and the final products. This paper focuses on two innovative technologies for highly efficient roll-gap lubrication in rolling. For cold-rolling mills, a new generation of roll-gap lubrication technologies called MQL (Minimum Quantity Lubrication) was successfully installed and commissioned at the Tandem Cold Mill No. 1 of the Bruckhausen steelworks of ThyssenKrupp Steel Europe. MQL replaces the conventional roll-gap lubrication system using emulsion in stands 1 and 2 with minimum amounts of pure rolling oil that is finely atomized with pressurized air and directly aimed onto the work-roll surface. As a consequence of the improved lubrication efficiency, the rolling forces, motor

torques and energy consumption can be reduced and the strip surface cleanliness significantly improved thanks to reduced strip wear in the first stands of the mill.

A solution concept for removing residual oil from the work-roll surfaces in hot-rolling mills is also presented in this paper. In a typical hot-rolling mill, work-roll lubrication in a specific finishing mill stand is switched on immediately after thread-in of the strip head and switched off before thread-out of the strip tail. This is to prevent insufficient friction during thread-in and contamination of the roll bite during tail-out. Due to the efficient cleaning procedure, a safe strip thread-in is assured that is independent of the lubrication conditions of the previously rolled strip.

HOT-FLAT-PRODUCT SURFACE INSPECTION – LATEST DEVELOPMENTS

Paper number: 117

Principal author: Laurent Dorel

Monitoring surface quality is generally implemented in the final steps of steel manufacturing before shipment to the end user. However, a growing trend is to address quality issues in the upstream stages, such as at the hot-rolling mill. This is being tackled by Primetals Technologies to offer steel producers the possibility to optimize yield management and benefit from “lessons-learned” processes.

Recent developments in the next-generation platform of the SIAS automatic surface-inspection system from Primetals Technologies now include high-resolution and near-infrared vision techniques. This paper discusses site results applying these techniques in highly specific applications and operational constraints such as in Arvedi ESP (endless strip production) lines and plate mills.

THE IBOX PICKLING TANK FOR PRODUCTION IMPROVEMENTS OF ADVANCED HIGH-STRENGTH STEELS – AN UPGRADING SOLUTION FOR DEEP-BATH PICKLING TANKS

Paper number: 114

Principal author: Takafumi Nakaya

The growing demand for advanced high-strength steels (AHSS) means that steel manufacturers are increasingly confronted with capacity bottlenecks of their pickling lines. Primetals Technologies has therefore developed the so-called iBox pickling tank to improve the throughput capacity of pickling plants. This highly advanced solution is particularly characterized by its reduced energy consumption and ease of maintenance.

Since the iBox pickling tank is equipped with storage tanks to drain the acid pickling solution to prevent over-pickling in the case of a line stoppage, a wider line width is necessary. To reduce the required space, a new and uniquely designed iBox pickling tank is offered by Primetals Technologies as a revamp solution for conventional deep-bath pickling tanks.

DEVELOPMENT OF A NEW MASH SEAM WELDER – THE CROSS SEAM WELDER – FOR CARBON STEEL PICKLING LINES

Paper number: 145

Principal author: Takafumi Nakaya

Primetals Technologies had developed a new mash seam welder known as the Cross Seam Welder (CSW). This solution offers the benefits of the mash seam welder, such as low cost and compactness, and it is ideally suited for the joining of strip with thicknesses up to 6.5 mm in continuous rolling mills.

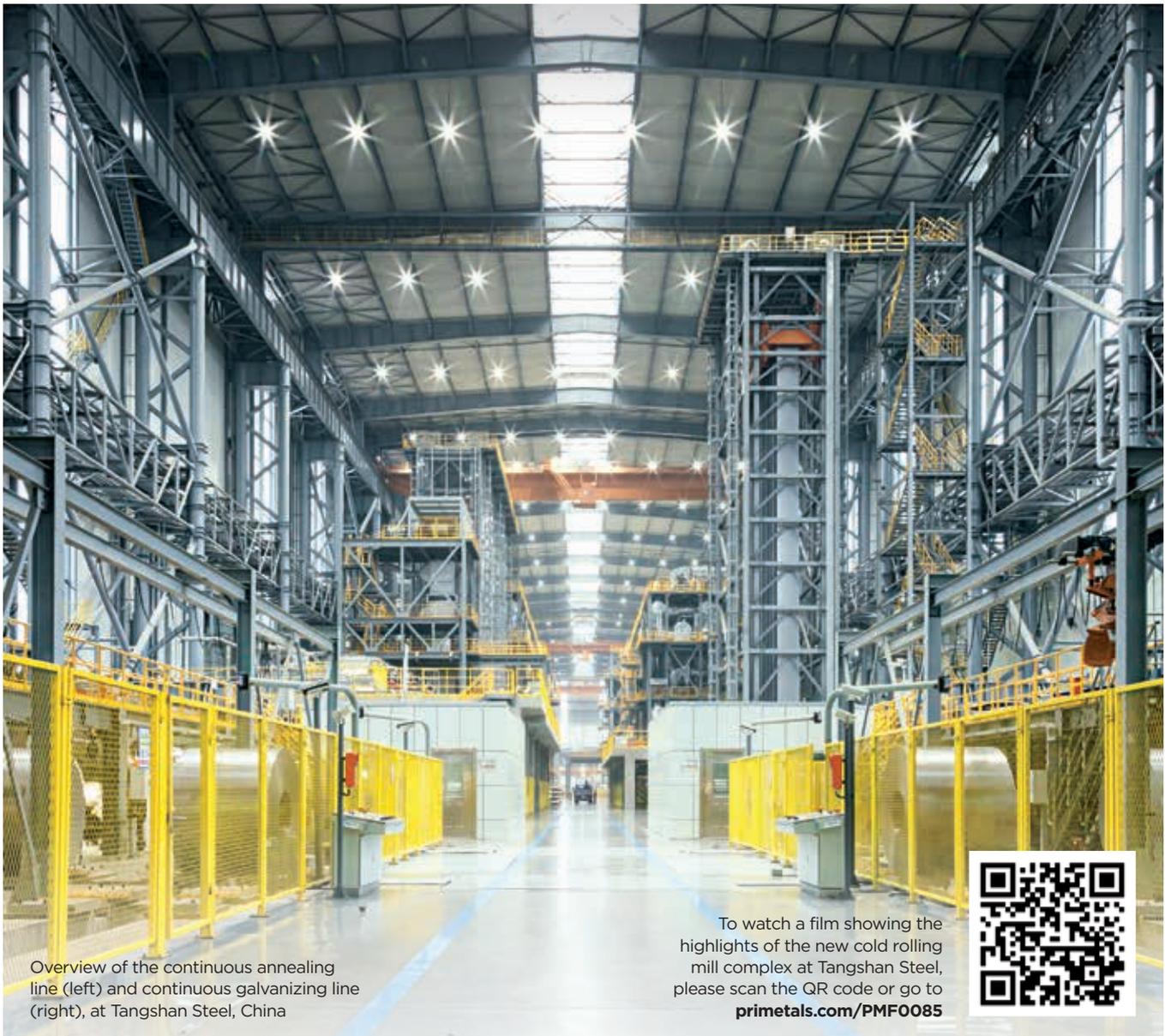
The first and second orders for the CSW were received from JFE Steel Corporation in Japan where the CSWs were installed in a continuous pickling line. As part of revamping projects, the previous flash butt welders were replaced with CSWs. Additionally, a black-scale remover was also developed and installed for use in pickling lines to enable CSW welding after the surface scale has been removed in the vicinity of the weld. This is the first time in the world that this solution has been implemented.

LATEST PL-TCM TECHNOLOGIES FOR ADVANCED HIGH-STRENGTH STEEL APPLICATIONS

Paper number: 115

Principal author: Frank Beddings

Safety and environmental considerations have significantly increased the demand for advanced high-strength steels for automotive applications. Primetals Technologies has incorporated various advanced technologies in the latest supplied continuous pickling lines coupled with tandem cold mills (PL-TCM) to satisfy the increased process demands to produce these harder and thinner steels, achieve the faster rolling speeds required to meet today’s production targets, and provide cost-effective solutions in an extremely competitive market environment. This paper introduces several of these advanced technologies, including highly efficient iBox pickling technology with polypropylene tanks, the 6-high Universal Crown Control Mill (UCM Mill) for unmatched shape-control capability, the Hyper UCM Mill for stable rolling of ultra-high-strength steels, and the flying-width-change (FWC) side trimmer for continuous trimming operations. The advantages of these technologies to produce these difficult steel grades are discussed, as well as the implementation of these solutions in new installations or for the modernization of existing facilities to maintain high availability of the production equipment.



Overview of the continuous annealing line (left) and continuous galvanizing line (right), at Tangshan Steel, China

To watch a film showing the highlights of the new cold rolling mill complex at Tangshan Steel, please scan the QR code or go to primetals.com/PMF0085



TANGSHAN STEEL'S NEW NO. 2 COLD ROLLING MILL COMPLEX TO PRODUCE ADVANCED HIGH-STRENGTH STEELS FOR THE AUTOMOTIVE MARKET

Paper number: 37; Principal author: Dr. Christian Westermayer

Tangshan Iron and Steel Group Co., Ltd. (Tangshan Steel) and Primetals Technologies achieved a remarkable project execution and fast implementation of Tangshan Steel's new No. 2 Cold Rolling Mill Complex. The facility is dedicated to the production of high-value-added cold-rolled, annealed and coated coil products. The project scope was not only limited to equipment delivery and line start-up, but also included the commissioning and optimization of the cold rolling, annealing and the strip-galvanizing production steps to ensure that the required plant throughput and product quality fully meets the market demands. The key time-to-market milestone was successfully reached with the first produced coil within the targeted 21-month period following contract effectiveness. Ramp-up of the coupled pickling line and tandem cold mill

as well as the continuous annealing line and continuous galvanizing line to commercial production was also accomplished on schedule. A so-called Through-Process Know-How (TPKH) package that extends from the up-stream to the finishing production stages was also supplied to support an optimized and reliable plant production and overall plant coordination. The know-how package additionally aids in the development of new advanced steel grades, in particular, advanced high-strength steels for use primarily in the automotive market. The combination of Tangshan Steel's experience in steel manufacture with the expertise of Primetals Technologies in steelmaking equipment, process technologies and metallurgical know-how was decisive for the rapid product acceptance and certification on the Chinese market.

INTRODUCTION OF A COLD-ROLLING COMPLEX FOR TIN PLATE

Paper number: 120

Principal author: Takayoshi Tomino

Demand for cold-rolled tin-plated and galvanized steel sheet products is rapidly increasing in Turkey as a consequence of the country's economic expansion. A new cold-rolling complex built at Tosyali-Toyo Celik Anonim Sirketi in Turkey was recently put into operation in response to this trend. Primetals Technologies supplied a pickling line linked to a tandem cold mill (PL-TCM), a tinfoil continuous annealing line (Tin-CAL) and a two-stand double-cold-reduction (DCR) temper mill for the rolling complex. This paper introduces the latest technologies installed in these facilities for the production of tin-plated steel sheet. Examples include highly efficient and energy-saving iBox pickling technology for the PL-TCM, the 6-high Universal Crown Control Mill (UCM Mill) for the PL-TCM, the temper DCR mill, and a vertical furnace equipped with tension leveler for the CAL to ensure high-speed and steady operations.



Completed 5-stand 6-high tandem cold mill in the cold-rolling complex of Tosyali Toyo Çelik Anonim Şirketi, Turkey

NEWLY DEVELOPED UNIVERSAL CROWN CONTROL MILL (HYPER UCM) FOR ROLLING OF HIGH-HARDNESS AND THINNER STEEL

Paper number: 116

Principal author: Daisuke Hikino

The demand for harder and thinner steels, such as advanced high-strength steel (AHSS) sheet for the automotive industry, tin plate and electrical (silicon) steels, has accelerated rapidly in recent years. Particularly in the field of cold-rolling, new rolling techniques for the production of harder and thinner strip have become urgent requirements that must be dealt with. The Hyper Universal Crown Mill (Hyper UCM) was developed by Primetals Technologies to roll harder and thinner strip to a higher degree of accuracy and quality than previously possible. It features the use of smaller-diameter work rolls that are driven by special highly rigid spindles.

The Hyper UCM is the most advanced version of the 6-high Universal Crown Control Mill (UCM Mill), and it offers an optimal combination of work-roll diameters, intermediate roll diameters and back-up roll diameters to ensure advanced strip shape control and minimized Hertz stress between the rolls. Hyper UCM Mills have work rolls that are 20% to 40% smaller in diameter than in conventional UCM Mills.

Another technological highlight of the Hyper UCM Mill is the high-performance work-roll drive system that consists of a special gear reducer and unique spindles. To drive the smaller work roll, gear reducers and spindles are designed to maintain the required rigidity and stability for high component revolutions.

In this paper, the basic configuration, performance and references of the Hyper UCM Mill for tandem and reversing mills are presented.

Particularly in the field of cold-rolling, new rolling techniques for the production of harder and thinner strip have become urgent requirements that must be dealt with.

Power X-Hi is a specially designed 18-high mill stand that offers considerable flexibility in fully continuous rolling operations and includes specific patents to allow for endless rolling.



20-high split-housing HZ-Mill supplied to Shougang Co., Ltd. by Primetals Technologies for the rolling of silicon steels (mill speed: 800 m/min, strip dimensions: 0.17 mm x 1,300 mm)

DEVELOPMENT OF THE ADVANCED 20-HIGH SPLIT-HOUSING ZR-MILL FOR STAINLESS AND ELECTRICAL STEELS

Paper number: 121

Principal author: Hajime Higuchi

The Advanced 20-high Split-Housing ZR-Mill (HZ-Mill) was developed by Primetals Technologies for the heavy reduction of hard materials such as stainless steel and electrical steel during cold rolling. The mill is designed as a 20-high cluster mill with a split inner housing to replace the conventional mono-block 20-high Sendzimir rolling mill (ZRM). An improved ease of operation of the HZ-Mill is met thanks to an increased roll clearance between the work rolls during threading and an optimized construction that ensures the required equipment rigidity. The mill is additionally equipped with a fast-response hydraulic screw-down system and a double roll-bending (AS-U) mechanism, which further enhances strip thickness and shape control.

STAINLESS STEEL ENDLESS CONTINUOUS COLD ROLLING WITH POWER X-HI STAND TECHNOLOGY

Paper number: 127

Principal author: Sebastien Maillard

Pushing the horizon of cold-rolling mill performance for stainless steel to provide even greater strip quality while maintaining yield and productivity has reached a new milestone with the introduction of Power X-HI technology by Primetals Technologies. The technology was first installed in a tandem mill at the direct-rolling annealing and pickling line (DRAPL) of Baosteel Desheng Stainless Steel Co., Ltd. and subsequently in a continuous tandem cold mill (CTCM) at Beihai Chengde Stainless Steel Co., Ltd. (both in China). Power X-HI is a specially designed 18-high mill stand that offers considerable flexibility in fully continuous rolling operations and includes specific patents to allow for endless rolling. Among the various differentiating features of Power X-HI technology, the specific design, position and control of the rolls are particularly decisive for providing the stability and precision required in order to extend the capabilities of continuous stainless steel mills.

The Beihai Chengde reference is a continuous 5-stand tandem mill that is equipped with mill-entry and mill-exit strip loopers to enable uninterrupted rolling. This significantly decreases out-of-tolerance strip thicknesses and thus increases total mill yield. An innovative solution allows fully automatic roll changes to be carried out while the strip is still traveling through the mill stand. This shortens production downtime by several minutes and also further reduces off-gauge material. When the roll gap is open during roll change, the thickness reduction for that stand is taken over by another active rolling stand. Work-roll changes are possible for stand speeds up to 120 m/min. Roll replacements during production can be carried out for all rolls with the exception of the back-up rolls. This type of operation is a world premiere and offers considerable improvement potential for the rolling of stainless steel and other high-strength steels.

INDUSTRIAL RESULTS OBTAINED WITH THE NEW GENERATION OF LASER WELDERS

Paper number: 118; Principal author: Thomas Vallée

Primetals Technologies has undertaken an important research & development effort in the field of laser welding. The latest step in this program is the further evolution of its laser-welding and -cutting range with the application of solid-state technology to generate the laser beam. A total of 12 welders equipped with this technology have since been manufactured by Primetals Technologies.

After more than six years of industrial feedback, the results demonstrate a high level of performance, reliability and constant cutting and welding quality. A diverse range of steel grades can be welded that extend from silicon steels to high-strength steels, including dual-phase (DP) and transformation-induced plasticity (TRIP) grades. Welding operations based on this technology are highly

reliable; allow complete operator control; and ensure high welding quality, excellent weld-geometry control and perfect strip centering. Reduced maintenance is another customer benefit that results from the use of optic fibers, a solid-state laser source and the application of an improved preventive-maintenance system with integrated control monitoring.

Industrial results and the main benefits of this new laser system are discussed in this paper on the basis of recent installations at Chinese continuous processing lines.

ROLLING AND PROCESSING HIGHLIGHTS OF PRIMETALS TECHNOLOGIES

Long rolling

- Up to 10% increased bar mill output with the ETB-EBROS billet-welding system and endless rolling
- Up to 60% savings in operational expenditures with the endless and semi-endless WinLink long product production line
- 300% higher wear resistance with IDRHA+ inline rail-hardening technology
- Up to 60% increased productivity with the Morgan rod reducing/sizing mill

Flat-product rolling

- More than 3,350 Morgoil bearings installed in some 1,200 hot-strip and cold-rolling mills worldwide
- 22 Mulpic (multi-purpose interrupted cooling) plate cooling systems installed since 2002 for extended product range, reduced alloying costs and improved plate weldability
- Up to 45% reduced energy consumption with Arvedi ESP endless strip production compared to conventional casting and rolling processes
- Nearly 160 Mill Stabilizing Devices (MSD) installed in the work and backup rolls of Pair Cross mill stands and other types of mill stands since 2000 for reduced impact forces, reduced amplitude of mill vibration and more stable rolling conditions
- More than ten years of operation of Looper Shape Meters (LSM) in hot-strip mills for the accurate measurement of strip shape under tension conditions during rolling
- 80 mm maximum work-roll opening clearance in the Advanced Split-Housing ZR-Mill (HZ-Mill) for the production of high-quality stainless and silicon steels

- 65% market share of supplied coupled pickling lines and tandem cold mills worldwide
- Development of a new mash seam welder type known as Cross Seam Welder (CSW) for welding steel sheets with thicknesses of up to 6.5 mm for use in pickling lines, tandem cold-rolling mills and reversing mills
- 30% reduced work-roll diameters in 6-high Hyper Universal Crown Control Mills (Hyper UCM) for greater thickness reductions in cold-rolling mills

Strip processing

- 584 strip-processing lines supplied to date
- 25% reduction of heating losses and 30% reduction of pickling time with the iBox pickling tank compared to deep-bath pickling tank
- Zero cutting knives and no wear with the use of a combined laser cutting and welding system
- More than 450 skin-pass mills supplied to date
- 340 tension levelers installed in processing lines throughout the world
- 82 air knives supplied worldwide
- More than 130 SIAS strip surface inspection systems supplied to date
- 100 GB of data converted into meaningful information with the TCOptimizer process expert system for just-in-time warnings to ensure sustained and reliable performance in processing lines

FEATURING 3

ENERGY & ENVIRONMENTAL CARE

papers from Primetals Technologies
at the ESTAD Conference 2017 in Vienna,
covering the topics of energy efficiency
and carbon dioxide reduction.





**“ Technology in harmony
with the environment
has become a
key challenge of
our times.”**

The integrated iron- and
steelworks of voestalpine
Stahl, Linz, Austria

SINTER PLANT AND BASIC OXYGEN FURNACE WASTE-HEAT UTILIZATION – NEW CONFIGURATION WITH ORC MODULES FOR POWER GENERATION*

Paper number: 67

Principal author: Dr. Thomas Steinparzer

The demand for increasing energy efficiency and CO₂ reduction is one of the global megatrends of our times. Although the steel industry suffers from a volatile economic environment, steel plants welcome opportunities for sustainable cost reductions and are committed to finding healthy solutions for the environment. Considerable efforts are therefore being made to cut electrical power and energy costs in integrated steel plants, as these count among the biggest cost factors that can be influenced. In integrated iron- and steelmaking routes, the complex interrelationship between process energy demands, waste energy utilization, the use of natural- and metallurgical gases, the requirements for steam- and heating systems as well as for power generation must be carefully analyzed. Potential energy sources, such as the sinter plant, the cooling stack of basic oxygen furnaces (BOF) and reheating furnaces, can be assessed in order to develop a more fully integrated energy concept.

When the direct local use of waste heat is limited, the best option is to convert the waste heat to mechanical-electrical power in a Rankine cycle. Electrical power generation is an especially attractive option for steel plant operators since it can easily be connected to the existing power grid of the steel plant. Such units must be compactly designed as stand-alone systems in order to fit into the existing steel plant layout, and operational costs have to be kept to a minimum.

The objective of this paper is to demonstrate economically feasible opportunities for energy recovery in sinter coolers and basic oxygen furnaces. The focus is placed on electrical power generation via ORC (Organic Rankine Cycle) modules, while at the same time achieving CO₂ reductions by utilizing waste heat from the process. Typical plant arrangements of such solutions are presented in the paper, as well as basic economic calculations.

*This paper was written together with Turboden s.r.l., a Mitsubishi Heavy Industries company that specializes in the development, production and supply of Organic Rankine Cycle modules.

CARBON RECYCLING AT ITS BEST – UTILIZATION OF BY-PRODUCTS FROM PROCESS-GAS FERMENTATION

Paper number: 69

Principal author: Tobias Plattner

Technological solutions that allow process gases from the iron and steel industry to be utilized in other production facilities, such as in the chemical industry, are becoming more and more attractive. With the use of a microbiological process, it is now possible to convert the available energy contained in carbon- and hydrogen-rich offgases from coke ovens, blast furnaces, direct-reduction plants and LD (BOF) converters into liquid-based energy sources.

LanzaTech and Primetals Technologies offer a unique microbial fermentation system to produce chemicals, most commonly ethanol, from the process gas of metallurgical plants. An integrated fermentation system with additional downstream facilities is required to treat the fermentation product and waste streams to generate a number of by-products that are usable for various applications such as for the generation of electrical or thermal power. By returning the by-products to an integrated steelworks, the fermentation system can be operated as a zero-waste facility that compensates for portions of external input materials such as natural gas or carbon-based materials.



Example of a LanzaTech gas fermentation plant in China



Industrial implementation of an EAF waste-heat recovery system for steam generation at Acciaieria Arvedi S.p.A., Cremona, Italy

WASTE HEAT RECOVERY FOR THE EAF – INNOVATIVE CONCEPTS AND INDUSTRIAL IMPLEMENTATION

Paper number: 70

Principal author: Paul Trunner

Over the last years, waste heat recovery in the steel industry has attracted ever-increasing attention. Environmental regulations and public funding, as well as required revamps of old dedusting systems, have led steel plant operators to discuss and evaluate possibilities for recovering waste heat.

The development of a waste-heat recovery plant requires extensive knowledge and long-term experience with the entire plant, including the water-steam cycle, the EAF (electric arc furnace) process, dedusting systems and downstream waste-heat consumers. Primetals Technologies provides innovative and reliable waste-heat recovery solutions for the EAF, which are presented in this paper.

An innovative waste-heat recovery plant is also introduced, which was installed at Acciaieria Arvedi S.p.a., Italy. Waste heat is used to produce steam for two pickling lines located at a considerable distance from the EAF. The substitution of the existing gas-fired boilers led to a decisive reduction of operating costs for the steel plant. Another heat-recovery plant was installed at the electric arc furnace of Höganäs in Sweden, where hot water at high pressure is produced and utilized for the local district-heating system. The industrial implementations of waste-heat recovery systems for the EAF are presented in detail, along with the operational results achieved.

ENERGY & ENVIRONMENTAL CARE HIGHLIGHTS OF PRIMETALS TECHNOLOGIES

Energy efficiency

- Generation of up to 100 kg of steam per ton of liquid steel from the LD (BOF) process with waste-heat recovery
- Up to 25 kWh electric power generation per ton of sinter with waste-heat recovery from the shaft cooler
- Up to 11% energy savings of the total energy input for minimills
- Up to 40% energy savings for electrostatic precipitators with Precon
- Up to 30% reduced energy consumption for secondary emission control with a dynamic process-control system
- Generation of up to 450 kg of steam per ton of blast furnace slag with the Dry Slag Granulation process (DSG)
- Production of up to 0.23 kg ethanol per Nm³ feed gas (CO/H₂) with the bio-fermentation of waste-gas from metallurgical plants

Emissions

- Less than 3 mg/Nm³ particulate emissions from bag-filter systems
- Less than 0.1 ng/Nm³ I-TEQ PCDD/F (dioxins/furans) emissions from any type of metallurgical plant
- Up to 98% SO_x and 90% NO_x reductions in the waste gas from sinter plants with Meros technology
- Zero-waste water discharge with dry-type waste-gas dedusting/gas-cleaning solutions
- Up to 99% plant reliability and availability of any type of ECO gas-cleaning plant
- 65% lower specific CO₂ emissions in the direct-reduction route compared with the integrated blast furnace route
- 65% reduction of specific CO₂ emissions in the direct-reduction route compared to the integrated blast furnace route
- Up to 50% reduction of waste gas with Selective Waste Gas Recirculation (SWGR) in sinter plants

By-products

- Up to 3% raw material savings with the briquetting and recycling of oxide fines (sludges, dust, scale)
- Up to 2% metal-yield improvement with the valorization of steelmaking slags (metallic oxide recovery)
- Up to 15% boost in cokemaking productivity with the fine-coal-briquetting process
- 60% (and higher) upgrading of iron content of mining tailings via tailings beneficiation

FEATURING **7**

MECHATRONICS, AUTOMATION AND PLANT-WIDE SOLUTIONS



Example of a continuous casting control pulpit supplied by Primetals Technologies

papers from Primetals Technologies at the ESTAD Conference 2017 in Vienna, covering the topics of inline measurements, condition monitoring, maintenance services, production planning, plant optimization and quality control.



INLINE MEASUREMENT OF ELECTROMAGNETIC PARAMETERS FOR CHARACTERIZATION OF MATERIAL PROPERTIES OF STEEL STRIP, WITH A FOCUS ON MAGNETIC VALUES

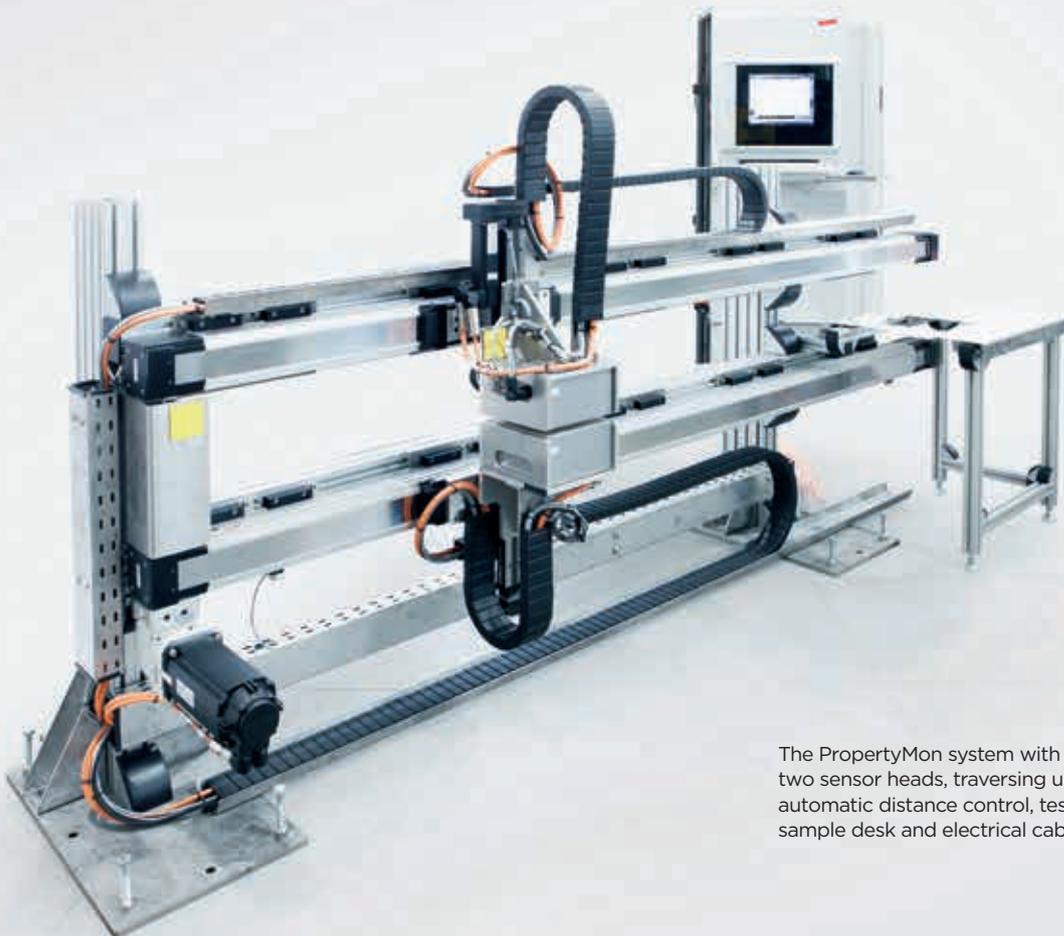
Paper number: 40; Principal author: Dr. Alois Koppler

Inline measurement of mechanical and magnetic properties of steel strip with contactless, non-destructive techniques offers considerable potential for further technological optimization and new applications. Such techniques are available with the PropertyMon system from Primetals Technologies, which employs state-of-the-art methods for indirect measurements using electromagnetic signals. By measuring the hysteresis curve of the steel strip, mechanical and magnetic properties can be determined using regression calculations. The required coefficients are obtained via regression analysis of test measurements and corresponding laboratory samples. This method gives reliable results for tensile strength, yield strength, hardness, magnetic losses and magnetic polarization.

Recently, test trials to determine magnetic power losses P and polarization J were carried out

on an annealing line at thyssenkrupp Steel Europe in Bochum, Germany, for non-grain-oriented (NO) electrical steel. This paper presents test results for these magnetic parameters, which are particularly important for electrical steel strip-production processes. Continuous calculations of P and J can be achieved with a high degree of accuracy for online process monitoring and quality control.

The PropertyMon system exhibits several unique features such as the simultaneous detection of mechanical and magnetic properties, directional measurements for anisotropic properties, and space-resolved measuring in which compact sensors are passed across the strip width. This approach therefore complements or outperforms standardized destructive laboratory testing procedures in many ways.



The PropertyMon system with two sensor heads, traversing unit, automatic distance control, test sample desk and electrical cabinet

The 24/7 acoustic monitoring system can be ideally installed at environmental plants, steel mills, casting and rolling facilities.

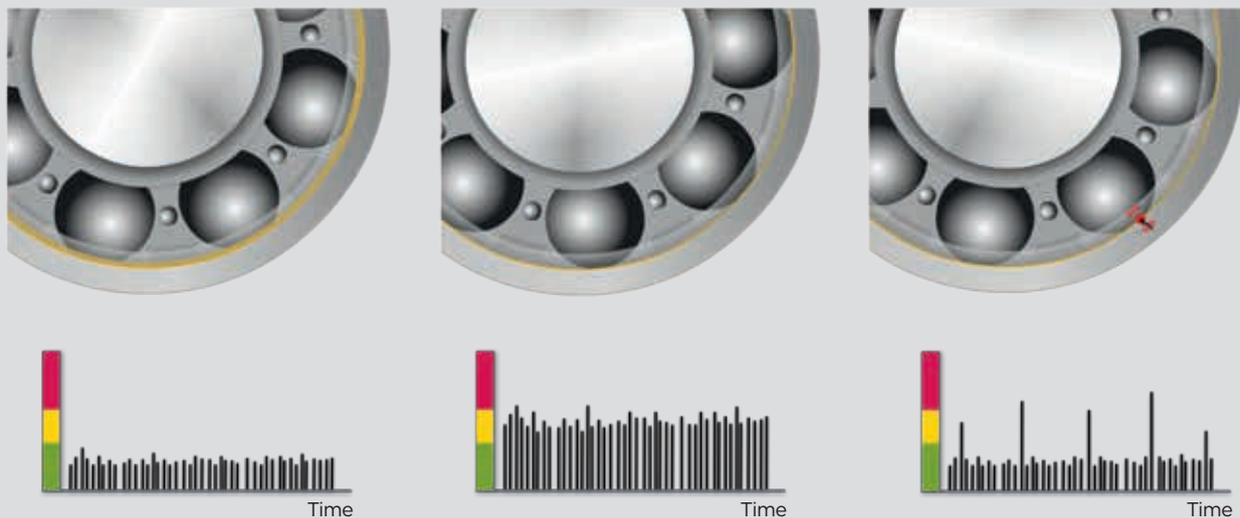
OFF THE BEATEN PATH: NEW CONDITION-MONITORING APPLICATIONS IN STEELMAKING

Paper number: 86; Principal author: Anna Mayrhofer

For fast-rotating equipment (bearings, pumps, motors, gears, etc.) various condition-monitoring techniques, predominantly vibration analysis, allow predictive maintenance practices to be applied. For slow-rotating equipment – in the range of one revolution per minute (rpm) – the situation is quite different. Vibration monitoring is not typically possible, because there is not enough energy in the vibrations to be measured and analyzed. However, with the proven technique of shock-pulse measurements, it is possible to obtain accurate information about the condition of this type of equipment. Application of the shock-pulse measurement technique is presented for two

examples of very slowly rotating equipment – the ladle turret and the LD (BOF) converter.

Another new approach for condition-based maintenance assistance is the Acoustic Expert System from Primetals Technologies. Recording and analysis of sounds produced by plant equipment and components leads to a wide field of applications for monitoring assets and production processes. This 24/7 acoustic monitoring system can be ideally installed at environmental plants, steel mills, casting and rolling facilities as well as material-handling areas, which underlines the versatility of the system. The paper outlines several installation examples and the results achieved.



- Acceptable shock-pulse levels
- Abnormal shock-pulse levels
- Shock-pulse levels indicating component damage

Monitoring of bearing condition using shock-pulse measurements

Left: new bearing delivers a characteristic noise level (carpet level)

Center: worn bearing with increased noise levels (no repetitive pattern visible)

Right: damaged bearing showing repetitive peaks that allow the damage type to be identified

HOW TECHNOLOGICAL ADVANCEMENTS IN PROACTIVE AND PREDICTIVE MAINTENANCE CAN INCREASE THE LIFECYCLE OF PLANT EQUIPMENT

Paper number: 72

Principal author: Arno Haschke

Maintenance is gaining increasing attention in the steel industry, as companies realize that it is critical to monitor the condition of assets to increase plant availability and reduce the risk of unplanned shutdowns. Due to global overcapacity, modernization investments have been reduced, which pushes existing plant equipment to operate up until their maximum lifetime limits. To minimize unplanned shutdowns, increase operational availability and enhance plant performance, steel producers are turning to the latest maintenance solutions and technologies. An integrative solution based on the installation of mechatronic packages with monitoring functions in steel mills, continuous casters, rolling mills, processing lines and others can be used to monitor critical equipment or processes that are at risk of causing bottlenecks in the production chain.

Condition monitoring from Primetals Technologies includes the evaluation of mechatronics, technological controls, process models, third-party systems as well as a lifecycle service concept. Upstream and downstream examples from metallurgical plants show how an intelligent monitoring system can be used to supervise advanced production.



Mobile and user-friendly access to key plant data



VALUABLE PRINCIPLES FOR EFFECTIVE PLANNING & SCHEDULING: A HOLISTIC APPROACH

Paper number: 81

Principal author: Rene Grabowski

Iron and steel companies are permanently challenged to optimize utilization of production facilities, reliably meet due dates and reduce raw material and energy consumption. An APS (Advanced Planning and Scheduling System) helps iron and steel producers meet such challenges and increase their competitiveness.

A sophisticated APS supports the overall planning process by applying complex rules based on product and order mix, production routings with corresponding processing and transport times, and resource availability. Specific technological constraints, including those related to steel grade and energy, are also considered to ensure that company-specific key performance indicators are met.

Orders describe the type and amount of products to be produced by a required due date in a specific production plant. In general, the task of an APS is to support the preferred work-to-order scheduling by assigning work orders to available production facilities along the product-specific process route and by generating optimized material sequences for critical work centers.

KNOW-HOW BASED ROOT-CAUSE ANALYSIS TOOL TO ENSURE HIGH PRODUCT QUALITY AND PROCESS STABILITY

Paper number: 92; Principal author: Gerhard Kurka

The challenging and competitive market situation caused by worldwide excess capacity is forcing an ever-increasing number of steel producers into the market of high-quality, high-price products in order to improve profitability. Compared to commodity grades, high-quality products pose substantial demands on quality management, with the need to operate and manage a plant within tight tolerances across the entire production route. Additional documentation is required to fulfill product- and customer-related quality standards. All of these activities rely on advanced IT (information technology) system support and appropriately trained employees.

To support steel producers who want to improve product quality and production efficiency, Primetals Technologies has developed the TPQC (Through-Process Quality Control) system. TPQC is a know-

how-based, through-process quality management and control system that performs automated rule-based quality checks at each step of the value-added production chain. The system is driven by a unique know-how based root-cause analysis from Primetals Technologies. TPQC provides product-specific assistance for quality engineers and operators to help them identify the causes of detected quality deviations. Thanks to the root-cause analysis, detailed instructions for eliminating the causes of nonconformities are made available. TPQC is thus both a quality system and a learning tool, which improves quality and process sustainability through supplemental technological know-how. The specific root-cause analysis feature is the result of teamwork between IT specialists, automation experts and metallurgists at Primetals Technologies, who contribute to the required product- and steel-grade-specific know-how.



The combination of rule-based quality grading and process-parameter evaluation across the entire production route is decisive for ensuring outstanding product quality.



Example of a blast furnace control pulpit supplied by Primetals Technologies

INTEGRATED STEEL PLANT OPTIMIZATION BY MEANS OF A PROCESS-INTEGRATION FLOWSHEETING PLATFORM

Paper number: 65; Principal author: Dr. Bernd Weiss

Iron- and steelmaking requires a wide range of different raw materials that significantly influence process performance. This demands a continuous optimization of process routes with respect to energy efficiency as well as environmental emissions. Steadily changing raw material prices and qualities, market conditions and product variations pose major challenges for integrated steel plant operators with respect to production planning and cost optimization.

In terms of investment planning, in-depth knowledge and comparisons of possible process routes is necessary. For greenfield plant investment decisions, a thorough comparison of available processes is essential, taking into

consideration all site conditions and raw material specifications. For analyses of brownfield plant investments, detailed knowledge about existing process routes and a comparison with the desired route is required.

Up until now, the steel industry has not been able to generate accurate overall mass and energy balance models covering integrated steel plants that can be used by both producers and engineering companies alike. Detailed evaluations by Primetals Technologies confirmed this situation, which led to the development of a holistic metallurgical model library in a flexible flowsheeting environment. This paper presents an introduction to the iron- and steelmaking process-integration platform.

THE DIGITALIZATION OF STEEL PRODUCTION

Paper number: 91; Principal author: Kurt Herzog

State-of-the-art automation information technology and connectivity supports the digitalization of steel production that goes far beyond conventional industrial automation. Initiatives around the globe are fostering digitalization, such as IIoT (Industrial Internet of Things) in the U.S., Industry 4.0 in Germany, and the Chinese industrial program “Made in China 2025.” Primetals Technologies is actively driving digitalization that is shaping the future of steel production.

Intelligent combination of sensor technology with digital models, as well as quality and production planning and control systems, leads to new dimensions in product quality and production-cost reductions. New diagnostic techniques allow intuitive fault tracing or processing to achieve faster maintenance. Digital assistants support both operation and maintenance using context-oriented or self-learned information.

Primetals Technologies is actively driving digitalization that is shaping the future of steel production.

MECHATRONICS & AUTOMATION HIGHLIGHTS OF PRIMETALS TECHNOLOGIES

- Team of 1,260 automation and mechatronics specialists dedicated to the iron and steel industry – the world’s largest
- Vast experience of Primetals Technologies in the supply and installation of Level 1 automation systems and Level 2 process-option systems available for the benefit of customers. Number of references since 2000:

Process step	Level 1 basic automation	Level 2 process optimization
Sintering	25	30
Blast furnace ironmaking	24	79
Hot-metal desulfurization	3	18
LD (BOF) steelmaking	63	103
Electric steelmaking	36	42
AOD stainless steelmaking	38	32
Secondary metallurgy	112	167
Continuous casting	302	276
Long rolling	175	135
Plate rolling	84	74
Hot-strip rolling	120	100
Cold rolling	270	190
Strip processing	295	180

ALWAYS AT YOUR SERVICE

PRIMETALS TECHNOLOGIES OFFERS A HOST OF ADVANCED TECHNOLOGICAL SOLUTIONS AND SERVICES TO MAXIMIZE THE PERFORMANCE OF METALLURGICAL PLANTS

With a total of 1,800 employees at more than 30 locations, the Metallurgical Services department of Primetals Technologies is committed to supporting customers in the metals industry on a global scale. On the basis of the immense service experience and know-how accumulated over many decades, in combination with close proximity to producers and a ever-increasing number of dedicated workshops, customers can be assured of fast, cost-efficient, reliable and optimized services.

The service team of Primetals Technologies works hard to excel in a wide array of disciplines: regular maintenance work is carried out; faulty, worn-out or outdated steel-making and rolling equipment is replaced; solutions are proposed to optimize production processes; and new and improved production and maintenance methods are successfully introduced. Detail-oriented consultation and training sessions are also in high demand, and the company's strong emphasis on digitalization is leading to a growing portfolio of e-services available to customers. With this proven approach, even more custom-tailored service bundles are offered to improve plant performance and product quality.

For this issue of *Metals Magazine*, we have collected a selection of case studies that exemplify the many areas in which the Metallurgical Services department is currently active. Due to the large service portfolio, the case studies we have chosen are extremely varied in both overall size and application areas. For example, urgent repair work is featured alongside installations of state-of-the-art condition-monitoring and predictive maintenance systems, or roll-bearings are upgraded in some plants, while others receive new modernization packages. However, all of these projects have one thing in common. The core ambition that the Metallurgical Services department of Primetals Technologies has always put first is to optimally serve its customers. To achieve this goal, the company's technology experts and service specialists listen closely to the needs of their customers



Service specialist of Primetals Technologies, checking the alignment of stand-guide rollers with the use of the Opal system, a company-developed optical measurement tool.

and persistently strive to deliver the best-possible solutions under all circumstances. Ultimately, the goal is to create win-win situations and to build reliable long-term partnerships with customers. This commitment is clearly evident in the results delivered every day, as demonstrated by the following case studies.



Improved monitoring and supervision of an LD (BOF) converter for a Brazilian steel producer

CASE STUDY NO. 1

Installation of a Condition-Monitoring System Based on a Shock-Pulse Technique at LD (BOF) Converters, Brazil

After serious problems with a loose bearing in the trunnion ring of one of their LD (BOF) converters, a Brazilian producer contacted Primetals Technologies and requested a solution to avoid similar problems in the future. After a detailed consultation, Primetals Technologies recommended the installation of a condition-monitoring system that would give the customer sufficient pre-warning time before the bearing would reach the end of its lifetime. As this type of bearing moves very slowly (at approximately 1 rpm) and does not perform diagnostic checks based on a full rotation, it was a challenge to provide the bearing with a predictive-maintenance system.

Primetals Technologies offers a full range of condition-monitoring solutions for converters. These systems not only monitor the trunnion ring bearings, but also the

tilting drive and the converter shell itself. One method employed in this context is that of shock-pulse technology, which is particularly suited for slowly rotating bearings. Immediately after the damaged bearing was replaced, Primetals Technologies performed regular offline shock-pulse measurements on the bearings of the trunnion ring of both converters. Having successfully monitored the condition of the bearings for almost a year, an online system was installed, which now observes not only the bearings of the trunnion ring, but also the main bearings of the tilting drive.

Data is collected with every movement of the converter. The system is integrated into the local automation system and delivers a status report to the customer's Level 1 system after each measurement. For a more detailed analysis of individual measurements, Primetals Technologies has the ability to remotely connect to the condition-monitoring system and create a detailed report based on the findings. »»

The team of Primetals Technologies completed installation activities within only one working shift, which required less time than the scheduled maintenance activities.

Installed condition-monitoring system in the ladle-turret of a Polish caster continually supervises the condition of the bearing.



CASE STUDIES NO. 2 AND NO. 3

Replacement of Swivel Bearing in a Ladle Turret, Poland

The replacement of a swivel bearing in a ladle turret of a continuous casting machine is a complicated undertaking. Careful planning and preparation work are required to ensure a quick and safe execution of the necessary tasks. Generally, this type of procedure is carried out only very rarely. Therefore, steel producers typically have little to no prior experience in this kind of work. To be sure that the ladle turret of a continuous casting plant in a Polish steel mill was again in perfect condition after the planned replacement time, a Polish customer contracted Primetals Technologies to exchange the bearing of their ladle turret. After a short preparation phase, onsite work commenced. The upper part of the turret had to be lifted and was kept in an elevated position for the entire duration of the work so that the old bearing could be removed and the new one inserted. When the old bearing was dismantled, an inspection of the bearing seats showed that the required tolerances defined by the bearing supplier were still within range and that no machining was necessary. The new bearing could thus be installed without further delay, and the turret was put into operation again. The work was carried out well within the scheduled completion time and without any safety incident. Since then, the turret has been flawlessly working without any reported issues. The ladle turret is now ready for a new operational campaign of at least 15 to 20 years.

Installation of Condition-monitoring System at a Ladle Turret, Poland

At the same plant, a new condition-monitoring solution for the swivel bearing of the ladle turret was installed so that accurate data about the bearing condition could be generated in the future. Condition monitoring of this type of bearing typically consists of regular grease analyses and deflection measurements.

Due to safety reasons, it is not possible to enter the turret while the caster is in operation. Therefore, the installation of the condition-monitoring system had to be coordinated and executed during a regular maintenance shutdown in the melt shop. The team of Primetals Technologies completed installation activities within only one working shift, which required less time than the scheduled maintenance activities. The streamlined project execution ensured that there were no additional losses in production time.

The new condition-monitoring system “listens” to the metal-to-metal contact that occurs when the bearing rotates. With each rotation, data is generated that is pre-processed, pre-analyzed, and finally stored in a local database. Primetals Technologies remotely connects to this database, analyzes the data on a regular basis, and deliver a report about the findings as part of a multi-year service contract.

CASE STUDY NO. 4

Urgent Reconditioning Work Performed at the Drive Housing of a Reducing and Sizing Mill, China

Primetals Technologies Services China always puts the customer and their goals first, and is ready to provide immediate support whenever required. This ambition was put to the test during the reconditioning work on one set of drive housings for a reducing and sizing mill of Yonglian Steel Group Co., Ltd.

Before the start of any on-site activities, the China Services team did precise planning and a complete risk analysis. Working day and night together with the manufacturing team, the Services team completed the reconditioning within just three days and despite a challengingly short lead time. These achievements were appropriately recognized and highly praised by the customer. The Services team of Primetals Technologies China always aims to build strong relationships with customers and to swiftly respond to their needs, as this leads to win-win situations and reliable long-term partnerships.

CASE STUDY NO. 5

Copper Coating: Improved Mold-Coating Increases Service Life of Caster Mold, Canada

A Canadian steel producer had standardized its equipment and spares to conform with the caster mold copper coating from a competitor that had been used in the producer's plant for more than a decade. Mold coatings are designed to retard mold wear, extend the mold-service time and increase reliability. Primetals Technologies was asked to evaluate the performance of the existing mold coating with the main objective to increase the mold service life with no adverse effects on cast-slab product quality.

After a thorough chemical and mechanical evaluation of the existing coating, Primetals Technologies was able to determine the causes of the coating failure, which were the limiting factor of the mold service life. The main issue that was identified with the coating and its suitability for casting was that a ceramic coating had been used. This coating type has very low impact strength and fails by chipping, breaking and flaking as a result of extensive thermal cycling and impact loading. Based on the findings from the evaluation, Primetals Technologies was able to customize a copper mold coating that would be optimally designed and specific for this customer's applications. Additionally, the magnitude of improvement that would result from the customization was anticipated in advance. The customer's target was a 10% improvement in service life without a negative effect on product quality. The first trial yielded a service life improvement by more than 30%. The second trial is on target for a 50% improvement in service life.

During the reconditioning process of the used plates, Primetals Technologies discovered an additional benefit associated with the change in coating. Due to the failure mode of the previous ceramic coating, this type of

coating required 20% more copper to be removed from under the ceramic coating during refurbishment, compared to the customized coating solution from Primetals Technologies. This added benefit resulted in a reduction of the amount of new copper that will have to be reapplied each year. The customer was extremely satisfied with these results, and chose to standardize its equipment and spares on the basis of the new customized coating for the respective application.

CASE STUDY NO. 6

Upgrade to Morgoil Back-up Roll Bearings for Increased Load Capacity at a Hot-strip Mill, Argentina

Motivated by the desire to produce higher-quality products at increased capacity and lower cost, Ternium-Siderar in San Nicolas, Buenos Aires, contracted Primetals Technologies to perform a back-up roll-bearing upgrade on their hot-strip mill, which had been in operation for over 50 years. The goal of the upgrade was to increase operating loads, which were outside the design rating of the original bearings, while utilizing the existing chocks and without an increase in space requirements.

When attempting to achieve the demanding levels of quality required by today's flat-steel market, Ternium-Siderar had realized that this was not possible with the equipment it owned at the time. The problems were first identified in the form of bearing seizures in some stands, and later in that of cracks that formed in the back-up-roll neck areas due to fatigue and overload.

Engineers from Primetals Technologies worked together with engineers from Ternium in analyzing the problem and toward determining a method to upgrade the mill using the latest and most economical technology. The upgrade consisted of changing the bearings to the latest-generation Morgoil bearings: the KLX. Within the same space, this bearing allows the bearing capacity to be increased by approximately 25%. This was accomplished re-utilizing all existing chocks. The new bearing allowed for a re-design of the geometry of the back-up-roll neck, making it much stiffer than the original design and thus eliminating fatigue failures.

Furthermore, an upgrade of the hydraulic mounting and dismounting components using the Morgoil HB (hydraulic bayonet) lock was also implemented, and the latest Morgoil HD (Hydrodynamic) seals were introduced. With the Morgoil KLX upgrade, the hot-strip mill of Ternium-Siderar showed increased load capacity, allowing the company to roll products that were not even considered a few decades ago.

CASE STUDY NO. 7

Plant-Performance Improvements Based on Advanced Design Technology, Brazil

Primetals Technologies, in its role as a lifecycle partner for the steel industry, was contacted by CSA (Companhia Siderúrgica do Atlântico) Brazil to optimize and reduce the cooling-water consumption of its condenser and »

These case studies are recent examples of the many thousands of service projects that Primetals Technologies has implemented throughout the world over nearly four decades.

Installed RCB burners in the scrap-preheating shaft of the Quantum EAF at Tyasa, Mexico reduce steel skull formations, hanging-scrap issues, energy consumption and operating costs.

the superheated steam of its the steam-ejector vacuum pump. After an evaluation of different design proposals, the technologies were identified that would offer the best results at the lowest-possible costs. The solution was presented to the customer who then agreed to have it installed. New steam-ejector nozzles were designed and delivered to the customer's site for installation and testing during a scheduled plant shutdown. Plant performance was evaluated before and after the new installation that demonstrated a savings of 25% in steam consumption and 20% in condenser-cooling water without negative effects on the minimum vacuum level and the pump downtime. The financial result of this improvement is savings of approximately half a million euros per year.

CASE STUDY NO. 8

Electric Arc Furnace and Ladle Furnace Upgrades, Russia

Primetals Technologies performed various upgrades on the existing electric arc furnace and ladle furnace at the Abinsk Electrometallurgical Plant (AEMZ) steel plant in Abinsk, Russia. The improvement measures on the electric arc furnace involved the replacement of existing burners with Refining Combined Burner (RCB) technology and the supply of a new oxygen-valve stand; implementation of a new programmable logic controller (PLC) based electrode regulation system, exchange of the high-current system for improved reliability; installation of a furnace-pressure measurement device, including a new off-gas flap to control the off-gas suction; and the replacement of the existing off-gas elbow on the furnace roof. The combination of these measures increased the productivity of the arc furnace to more than 200 t/h, while the respective energy consumption was reduced to 370 kWh/t,

which corresponds to energy savings of 10%. Improvements at the ladle furnace comprised the replacement of the existing 2-strand wire feeder with a new 4-strand wire feeder, and the installation of a new lime-injection system. These measures enabled the customer to increase the productivity and quality of the produced steel grades at the ladle furnace.

CASE STUDY NO. 9

Electric Arc Furnace Upgrade, Germany

Primetals Technologies was contacted to conduct a revamping and upgrading project for the electric arc furnace at BGH Edelstahl Freital GmbH. Detailed project planning was carried out and plant innovations were implemented in different phases. The project comprised the substitution of major plant components; implementation of a new technological solution in the lower furnace shell; and modification of the spout-tapping-type furnace shell to a modern, high-performance eccentric-bottom-tapping (EBT) solution. Less oxide slag now escapes the furnace during tapping, which has a highly positive impact on the final steel quality and also lowers the consumption of expensive deoxidation agents. A new furnace roof was also supplied together with auxiliary parts such as ladle cars, a ladle pre-heating system and alloying systems. Additionally, dedicated risk analyses were performed to verify that all furnace components conformed with machine guidelines. The furnace upgrades were conducted at different stages to minimize any adverse effects on production output. This project highlighted the organizational and design capabilities of Primetals Technologies in electric steelmaking, which were implemented to the full satisfaction of the customer.



CASE STUDIES NO. 10 AND NO. 11

Large-scale Modernization of Electric Arc Furnace at Simec, Mexico

Grupo Simec, S.A.B. de C.V. (Simec), part of Industrias CH Group, is one of the largest steelmakers in Mexico. The company has plants in the states of San Luis Potosí, Tlaxcala, Jalisco, Baja California and Tamaulipas, as well as in Brazil and the U.S.A. Its product portfolio includes long products for the construction and automotive industries. To meet the increasing demand for long products in Mexico, in June 2015, Simec placed an order with Primetals Technologies for the modernization of a 70-ton-capacity AC electric arc furnace (EAF) at the San Luis Potosí plant. The project scope included a new design for the upper furnace shell and roof, the complete ductwork and the installation of current-conducting electrode arms. Engineering was carried out by Primetals Technologies Mexico with the support of the electric steelmaking center of competence in Legelshurst, Germany.

After the installation of the new equipment, the furnace successfully recommenced operations in October 2016. The most striking improvement was the significantly reduced tap-to-tap time, which was a result of the higher power input due to the new current-conducting electrode arms. This gave the customer the possibility to increase their steelmaking capacity from 18 heats per day up to 24 heats per day on a regular basis.

Productivity Gain Due to Installation of Refining Combined Burners in EAF at Tyasa, Mexico

Talleres y Aceros S.A. de C.V. (Tyasa), located in the southern Mexican state of Veracruz, is arguably the most innovative steelmaker in the region. Primetals Technologies

had already installed a new EAF Quantum furnace with an advanced scrap-charging and scrap-preheating system at the Tyasa site. This has allowed the customer to reduce their electrical energy consumption for scrap melting by approximately 20%.

In 2016, Primetals Technologies was entrusted with an additional order to supply two RCBs (Refining Combined Burners) in the Quantum EAF. The need for these burner lances was due to scrap-hanging issues and the formation of steel skulls in the scrap-preheating shaft. Following local design modifications and installation, the RCB lances were commissioning in June 2016. After several heats, the results showed that skull formations and scrap-hanging issues in the shaft area were significantly reduced. In addition to the operational improvements, a 4% reduction in energy consumption was observed, which is equivalent to approximately 13 kWh/t per heat. Customer expectations were fully met with the supplied RCB equipment, which has further contributed to a reduction in EAF operating expenditures (opex).

SERVING WITH SOLUTIONS

The above service case studies are recent examples of the many thousands of service projects that Primetals Technologies has implemented for metals producers throughout the world over the course of nearly four decades. As a lifecycle partner for the metals industry, innovative solutions, advanced technological packages and specialized services are offered to ensure that the metallurgical facilities of customers operate reliably, efficiently and at peak performance throughout their entire lifetime. ●



PRIMETALS TECHNOLOGIES FRANCE

100 YEARS OF METALLURGICAL EXCELLENCE



In 2017, Primetals Technologies France celebrates the 100th anniversary of the founding of its workshop in Montbrison, France. Starting from the first day, Primetals Technologies France has continuously evolved up until the present. What remains is its tradition of quality, technology, innovation and leadership to always offer its customers state-of-the-art solutions.



A PROUD HISTORY AT THE HEART OF THE METALS INDUSTRY

In June 1857, Etienne Chavanne, a mechanic, opens his first foundry in Saint-Chamond (Loire, France) where he specializes in the manufacture of mill cylinders in tempered cast iron. The company “Chavanne-Brun” is established. In 1913, the name changes to “Société Anonyme des Anciens Etablissements Chavanne-Brun Frères,” and new products are manufactured that are mostly related to the steel industry (gasifiers, rolling mills, etc.). During the First World War (1914-1918), Chavanne-Brun Frères continues its work and various products for the National Defense are manufactured. Because of production growth and the lack of available space in Saint-Chamond, a new workshop is built in Montbrison in 1917.

In 1947, Chavanne-Brun Frères and Delattre et Frouard Réunis establish a common subsidiary: Secim (Société pour l'Etude et la Construction d'Installations Métallurgiques) sets out to sell equipment for rolling mills (essentially under a license granted by the U.S. company

United Engineering and Foundry Company). Secim rises to global dimensions by working with steel companies across the world. Delattre et Frouard Réunis takes control over the “Rolling Mill Division” of Chavanne-Brun Frères in 1959 and the company becomes “Etablissements Delattre-Levivier.” In 1965, the Schneider group acquires a major share of the Etablissements Delattre Levivier, and an industrial company is created with the goal to design, study and manufacture rolling mills under the name Secim. With two factories in Montbrison and Ferrière-la-Grande, Secim has a privileged relationship with Forges et Ateliers du Creusot (SFAC).

Clecim was founded in 1982 as a result of the merger of two subsidiaries: Creusot-Loire Secim and Clesid. The Montbrison site continues to design and construct medium-size equipment such as hot and cold mills for steel and non-ferrous metals, extrusion presses, continuous casting equipment for steel and aluminum, presses and many other applications. The company then fully integrates with major renowned international groups of the metal industry such as Siemens VAI in 2005.

“ One of the keys to the sustained success of the company is based on an experienced and expert workforce that supports its customers at every step of their projects.”

Continuous galvanizing line
from Primetals Technologies
at Ansteel ThyssenKrupp
Auto Steel Company in
Chongqing, China

PRIMETALS TECHNOLOGIES FRANCE IN FIGURES

- 100 years of metallurgical excellence
- Around 280 employees working in Montbrison, France
- 20,000 m² of floor space area in the workshop
- 3 certifications: ISO 9001, 14001 and OHSAS 18001
- 1 nickel-coating facility
- 584 processing lines installed worldwide (for the entire Primetals Technologies group)
- 459 skin-pass mills, tension levelers and scale breakers, designed and installed around the world since 1953
- 210 welders designed and supplied since 1972
- 136 SIAS strip-surface inspection lines in operation since 1994
- 7 TCOptimizers supplied since 2010
- 500 service orders per year for steel mills

A STRONG TECHNOLOGICAL LEGACY WITH SUCCESSFUL INSTALLATIONS

Finally, on January 7, 2015, a new company era is born with the founding of Primetals Technologies, Limited. Primetals Technologies France serves as a center of competence within the group for carbon steel processing lines, stainless steel rolling and processing lines, mechatronics solutions for rolling and processing plants and metallurgical services.

One of the keys to the sustained success of the company is based on an experienced and expert workforce that supports its customers at every step of their projects, thereby enabling the development of countless innovative solutions and guaranteeing the success of new installations. The workforce of Primetals Technologies France covers the whole lifecycle of its customers' projects: commercial and project management, technical design acquisition, engineering and purchasing to manufacturing and logistics via services, as well as in-house metallurgical and process competences. »



1953

- First tension leveler

1964

- First CAL*

1962

- First CGL*
- First CPL*

1973

- License for tension leveler transferred to Mitsubishi

1978

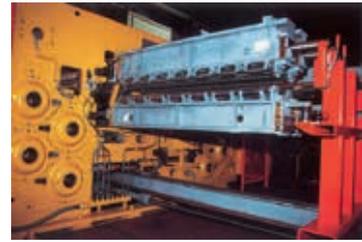
- First scale breaker for pickling line
- 100th processing line

1984

- 200th tension leveler

1980

- First PLTCM* in the world



1992

- New tension leveler for tinplate with integrated multi-roll unit

1995

- First CPGL*

1999

- First tandem DRAPL line in Europe

| 1950

| 1970

| 1990

| 2000

1994

- 200th processing line

1993

- First SIAS* installation



1991

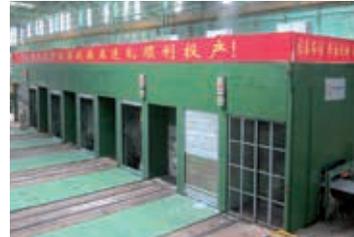
- 100th welder

*** Legend:**

- CAL:** Continuous annealing line
- CPGL:** Continuous pickling and galvanizing line
- DRAPL:** Direct rolling, annealing and pickling line
- SIAS:** Automatic surface-inspection system
- CGL:** Continuous galvanizing line
- GI/GA/AISI:** Galvanized/galvannealed/aluminum silicon
- CPL:** Continuous pickling line
- PLTCM:** Pickling line tandem cold mill
- DSR:** Dynamic Shape Roll
- CGCCL:** Continuous galvanizing and color-coating lines
- TCO:** TCOptimizer
- TTMG:** Tianjin Tiantie Metallurgical Group
- CTCM:** Continuous tandem cold mill

2005

- Introduction of metallurgical know-how for processing lines at Maanshan Iron and Steel, China



2006

- 300th processing line

2011

- 100th SIAS*

2015

- First 5-stand Power X-HI CTCM (Beihai Chengde, China)
- First CGL* with 3 combined coatings in China (GI/GA/AISI*) at Pangang, China

2009

- First guarantee of strip mechanical properties for CAL*

2018

- Erdemir CGL* with automotive quality expert system and TCO*

| 2010

| 2015

| 2020

2004

- First CGCCL* (Galvasid, Mexico)
- First light laser welder



2008

- First heavy laser welder (Dunaferr, Hungary)

2007

- 50th strip side trimmer
- 400th tension leveler

2010

- First TCO* introduction at TTMG*

2013

- 200th welder
- First 4-stand tandem Power X-HI Mill in a Chinese DRAPL* at Baosteel Desheng Nickel Co.



2017

- First flying-roll change concept on an endless X-HI CTCM*
- Celebration of 100th anniversary Primetals Technologies France



2003

- First DRAPL* in China



DRIVING THE NEXT GENERATION THROUGH INNOVATION

What new developments lie ahead in steel processing? Which are the areas that future research efforts should focus on? From the beginning, Primetals Technologies France has always seen itself as a partner to its customers, helping them to find the right answers to their problems and transforming their ideas into reality. As an experienced plant builder and solution provider, Primetals Technologies France understands the technological requirements and the needs of its customers. It combines its expertise in equipment design and control with proven metallurgical and process competences to promote the development of next-generation processing lines. Thanks to in-house testing and development facilities, which include a surface-inspection test platform, rolling and leveling trial facilities, heat treatment and galvanizing simulators, Primetals Technologies France develops future-oriented solutions for an optimized operation and a higher efficiency of processing lines. A high-end product mix makes a decisive contribution to driving plant operation toward a quality-oriented approach. For more than ten years now, Primetals Technologies has implemented the necessary solutions to efficiently track

all relevant process and quality data within steel plants, and to conduct data analyses in real time by use of dedicated expert systems. Having pioneered this concept with TCOptimizer, which is the module dedicated to a more process-focused monitoring at continuous annealing and continuous galvanizing lines, Primetals Technologies is now expanding this principle at plant level with the Through-Process Quality Control system. This approach incorporates comprehensive tracking and analysis over the full production chain, from the liquid steel to the saleable coil.

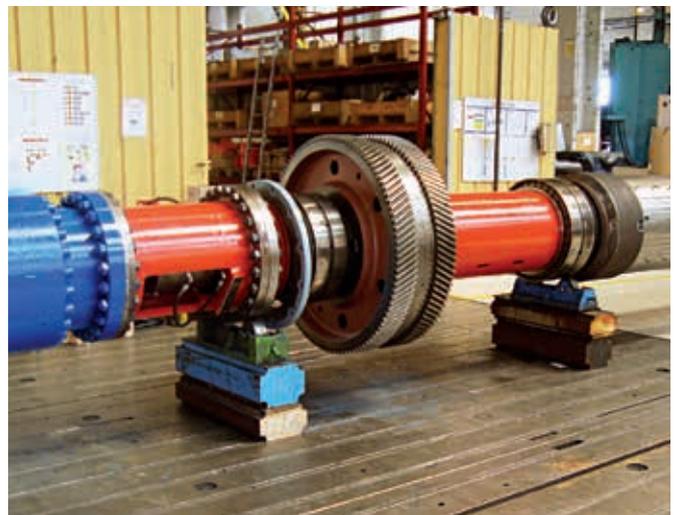
CUSTOMIZED SOLUTIONS FOR CUTTING-EDGE PROCESSING LINES

Aside from the already discussed areas of competence, the France location of Primetals Technologies also specializes in carbon-steel processing lines and stainless-steel rolling and processing lines. A complete range of facilities is supplied that includes pickling lines; galvanizing lines; continuous annealing lines; color-coating lines; electrolytic tinning and tin-free lines; inspection, tension leveling and skin-passing lines; stainless-steel rolling mills; and annealing and pickling lines. An optimized integration of mechanical and hydraulic equipment, including furnace,

The advanced solutions from Primetals Technologies France combine in-house technology, mechanical engineering and automation expertise.

Final set-up of a side trimmer in the Montbrison workshop of Primetals Technologies France

Coiler mandrel before and after modernization



electrical and automation systems, is ensured by Primetals Technologies France in turnkey-supplied plants. Additionally, metallurgical services and end-to-end process expertise is provided for each type of processing line.

MECHATRONIC PACKAGES: BENEFITS OF BUNDLED EXPERIENCE

The advanced solutions from Primetals Technologies France combine in-house technology, mechanical engineering and automation expertise. The company location provides a wide range of mechatronic packages that include laser or resistance welders, scale breakers, in-line skin-pass mills, tension levelers, the fully automated SIAS surface-inspection system, roll coaters, the Dynawipe air knives, side trimmers and scrap choppers. These are manufactured, assembled and tested in the workshop facilities of Primetals Technologies France and are offered for both new lines and existing plants. Immediate operational improvements and a fast return on investment is assured. Since 2012, the mechatronic products of Primetals Technologies are equipped with condition-monitoring systems to support an optimal use of supplied plants and equipment in addition to accurate maintenance scheduling and the prevention of downtime. Remote-

access functionalities and dedicated hotlines have also been implemented to ensure a broader field of support. Advantages include timely hardware diagnosis, support over a longer time period and defect-detection analysis.

LONG-TERM PARTNERSHIPS TO OPTIMIZE THE LIFECYCLE OF PRODUCTION LINES THROUGH MAINTENANCE AND CONTINUOUS IMPROVEMENT

Service has always been at the center of the company's priorities with four cornerstones, namely: reactivity, adaptability, efficiency and closeness. The department for maintenance services provides:

- Supply of spare parts: A-class components, capital project spares, genuine spare parts on drawings
- Long-term service agreements with yearly maintenance contracts, expertise, upgrades, advanced solutions, training (on site or in-house)
- Offline maintenance services: expertise, repair, state-of-the-art modernization, testing facilities
- Line projects: revamps and additional equipment, mechatronic projects. ●

François Mignard, CEO, Primetals Technologies France

Hélène Bulteau, Marketing and Communication, Primetals Technologies France



The recently inaugurated Hyperspace Demonstration Center is now open to visitors.

THE MECHATRONICS CENTER OF PRIMETALS TECHNOLOGIES

DEVELOPING THE SOLUTIONS FOR OPTIMIZED PLANT PERFORMANCE

The Mechatronics Lab, a new demonstration facility based at the Linz location of Primetals Technologies, allows visitors to discover the company's solutions and references in a highly informative manner.

Linz is the mechatronics competence center of Primetals Technologies. More than 50 mechatronics specialists work closely together in the development of specialized systems that extend from individual measurement devices up to completely integrated mechatronic packages for all types of production and processing lines. The focus, as always, is to maximize benefits for producers related to product quality improvements, efficiency, maintenance, safety and environmental protection. More than 1,000 mechatronics references at metals production plants throughout the world underline the experience, competence and dedication to excellence of the mechatronics team of Primetals Technologies.

THE MECHATRONICS LAB

At the dedicated Mechatronics Lab of Primetals Technologies in Linz, Austria, state-of-the-art mechatronics systems and solutions are pioneered, tested and optimized

before they find application in metallurgical plants. The lab also serves as a demonstration center for visitors where the functioning and advantages of tailored mechatronic solutions for metallurgical plants and equipment can be presented and discussed with customers. Three demonstration highlight areas are now on display at the Mechatronics Lab: Hyperspace, the Multi-Purpose Annealing Simulator and the LiquiRob robotic solutions, which are outlined in the following.

HYPERSPACE

A Futuristic Technology Demonstration Center for Visitors

A unique, interactive demonstration center referred to as Hyperspace has recently been inaugurated at the Linz-based Mechatronics Lab of Primetals Technologies Austria. Using cutting-edge technology such as animated virtual reality environments and videos, the company's »



The Multi-Purpose Annealing Simulator supports customers in the development of new steel grades and production processes.

The LiquiRob robotic solution is a multipurpose robot that increases worker safety and plant efficiency.



vast product portfolio is showcased and explained in an intuitive and highly impressive manner. A touch-controlled, large-sized monitor allows customers to selectively study the many references that Primetals Technologies has accumulated over time. The monitor also presents many of the most striking technological solutions that the company has at its disposal. All of this is underscored by a huge media library that consists of both short movies and photographic impressions of various reference projects.

The virtual reality room is outfitted with a multi-functional presentation system that includes high-resolution 3D glasses and an ultra-high-definition monitor. All of these devices let the viewer explore the technologies and recently completed, large-scale projects of Primetals Technologies. Have you ever wanted to fly up to the top of the reduction tower of voestalpine's Corpus Christi-based hot-briquetted iron plant in Texas, U.S.A.? This and many other adventurous undertakings can now be safely tackled with ease – thanks to the wonders of virtual reality.

Technological solutions may sometimes be incredibly complex. The full scope of solutions at work in a state-of-the-art steelmaking plant take even the most passionate metallurgist years to grasp. In the Hyperspace showroom of Primetals Technologies Austria, many of the most innovative solutions of the company can be inspected in a completely new and exciting manner. So be sure to stop by and visit Hyperspace Center on your next trip to Linz!

THE MULTI-PURPOSE ANNEALING SIMULATOR **Optimize the Product or Process in the Lab** **Before You Install It!**

Primetals Technologies has recently installed a Multi-Purpose Annealing Simulator (MPAS) also at the Mechatronics Lab in order to increase the company's capability to support customers in the development and optimization of new steel grades and production processes. The MPAL enables the influence of different process parameters on the mechanical properties of strip (tensile strength, elongation, hardness, magnetic properties, etc.) to be simulated, tested and optimized in the laboratory. The process parameters necessary to achieve the desired mechanical properties of strip can then be applied in an industrial environment. All types of annealing, heating and cooling parameters in processing lines, such as annealing and galvanizing lines, can be simulated.

Customer services are also offered This includes the execution of trials to develop and optimize products as well as the associated technological processes. A particular benefit of the MPAS is that it can handle relatively large sample sizes at high throughput rates. This supports fast and cost-effective development cycles and a short time to market (TTM). Contrary to actual production conditions, the unique water-quenching feature of the

MPAS makes it possible to “freeze” the material structure during each phase of a treatment process. This allows detailed metallurgical analyses (grain size, precipitation, phase transformations) to be carried out for a deeper understanding of the evolution of the material inner structure and material properties.

The Multi-Purpose Annealing Simulator underlines the metallurgical and process design competence of Primetals Technologies. The simulator supports the validation and further development of the physical-metallurgical process models that are vital for optimized plant performance.

“It is much more cost-effective to do initial testing and development work in the laboratory before a product or process is implemented at the industrial production line. This minimizes risk and costs and even permits detailed investigations to be carried out that are simply not possible to do during industrial production.” (Dr. Thomas Pfatschbacher, Vice President of Technology & Innovation for continuous casting, endless strip production and rolling).

THE LIQUIROB ROBOTIC SYSTEM **Meet Your Future Colleague!**

In a steel plant there are many tasks that could be dangerous for human workers to execute. The work is especially precarious in plants areas where liquid metal is produced, treated or handled, or in the vicinity of moving equipment and components. Measuring the temperature or taking samples of liquid steel is one such example. Others include the manual exchange of substance probes, opening ladles with oxygen lances and conducting tap-hole maintenance work.

When it comes to outsourcing this type of labor from humans to robots, the LiquiRob robotic solution of Primetals Technologies is the ideal choice. The robot acts as a remotely controlled extension to the human operator's arm, and eliminates the need for plant personnel to be physically present in the danger zones. With LiquiRob as a colleague, workers in steel plants no longer have to mount substance probes or take samples of liquid steel themselves. The robot does these tasks for them – in an incredibly fast, reliable and repetitive manner. Many other applications can be performed by LiquiRob, yet all have the preeminent goal of increasing worker safety and maximizing plant efficiency.

You can now meet the LiquiRob robot first-hand in a dedicated showroom of the Mechatronics Lab of Primetals Technologies in Linz. Its extraordinary versatility, rigid construction and “lightning-fast” maneuverability are best studied in person. The Primetals Technologies Mechatronics team looks forward to introducing you soon to Mr. LiquiRob. ●

Dr. Thomas Pfatschbacher, Head of Technology: Casting, ESP and Rolling
Dr. Lawrence Gould and **Dr. Thomas Widter**, Metals Magazine Editors

AISTECH 2017

PRIMETALS TECHNOLOGIES ROCKS “MUSIC CITY” WITH RECORD NUMBER OF TECHNICAL PRESENTATIONS

Nashville has earned its Music City nickname as a destination of choice for musicians, songwriters and music fans. Primetals Technologies has similarly established itself as a technology provider of choice for the metals industry. This reputation was further reinforced at the AISTech Conference and Exposition held May 8–10, 2017 in Nashville, Tennessee, U.S.A.

AISTech 2017 attracted more than 6,200 steel industry producers, suppliers, corporate leaders and academics from all over the world. Attendees exchanged technical information, expanded professional networks, and learned about new process and product technologies. AISTech is organized by the Association for Iron and Steel Technology (AIST).

This year, Primetals Technologies was either a primary author or coauthor for a record 36 technical papers and presentations, spanning every process step in steel production. Technology experts presented the latest trends that are helping steel producers stay competitive by optimizing energy efficiency, product quality and production flexibility. After each presentation, the AIST Technical Committee Session Chairs invited questions from the audience.

Still, many attendees wanted to learn more. That's where the AISTech exposition provided the most value. Numerous attendees visited the 1,000 square-foot (93 square meters) booth of Primetals Technologies, asking about topics that were presented in the technical conference. “There's only so much detail you can get from a half-hour presentation,” said an operations manager from a major U.S.-based steel producer. “So if it's something that we are seriously considering, it helps to have a more in-depth conversation with the presenter.”

Booth visitors could learn about the entire Primetals Technologies portfolio, although a few solutions were presented with greater emphasis. Arvedi ESP – Endless Strip Production, a combined, continuous and uninterrupted casting and rolling process, was the focus topic. A large touch screen allowed booth visitors to run an Arvedi ESP simulation to learn more about its production capabilities. Other interactive technologies such as two touchscreen kiosks allowed visitors to browse through portfolio presentations and videos of Primetals Technologies equipment in action. Booth staff also used



Presentation of Arvedi ESP technology by Andreas Jungbauer at the AISTech 2017 booth of Primetals Technologies

this tool to make impromptu presentations about specific technologies. The Mill360° virtual reality experience made its second appearance at AISTech. This year, an expanded menu of stunning, 360-degree, 3-D views enabled users to see more technologies in a larger-than-life format.

In addition to these electronic displays, a small sample of actual products and equipment were booth highlights. For example, the Mold Checker demo allowed the Metallurgical Services team to explain the advantages of monitoring the condition of mold coppers in continuous casters. And, the Clamp Box exhibit facilitated conversations about copper-clad current-conducting electrode arms for the EAF process.

The next AISTech will be held in May 2018 in Philadelphia, Pennsylvania, U.S.A. Until then, the Primetals Technologies team looks forward to many other opportunities to meet with its valued customers and partners. ●

Tom Suski, Communications, Primetals Technologies USA

TECHNICAL PRESENTATIONS OF PRIMETALS TECHNOLOGIES AT AISTECH 2017

Ironmaking

- Recent developments in ironmaking process control – holistic optimization models

DRI production

- Briquetting of ferrous fines – saving resources, creating value
- Status report of the new-generation technology: DRIpax – Midrex plant process-optimization system

Steelmaking

- Latest improvements in shaft-based scrap-preheating furnaces
- Electric arc furnace injection technology and operational results

Secondary metallurgy

- Development of high-quality grades production techniques using a VOD plant at voestalpine Giesserei Linz
- Vacuum plant metallurgical results – database analysis
- BOF blowing process challenges for high rate of iron ore pellet addition – process development and results at TKCSA

Rolling

Long rolling

- Forging-like rolling with high reduction of SBQ long products
- Pouring reel technology developments for increased productivity and coil quality
- Modernization of the Kroman wire rod mill to increase productivity, utilization and product quality
- The production of railway rails in modern and efficient plants
- Process Expert – cost-efficient and modular process-automation expert-class system for long-rolling plants
- Rolling into the future by digitalization – Primetals Technologies' long-rolling control system
- Modernization of the coil-handling system at Nucor Nebraska for Improved bar-in-coil productivity and quality

Hot rolling (flat)

- The technological contribution to cut the total energy consumption by Arvedi ESP
- Latest development of leveling technologies for high-quality plate production
- Revamping project for Ternium Mexico Churubusco Works hot-strip mill
- New vision-based strip-steering control for hot-strip mill
- Downcoiler modernization project at Nisshin Steel Kure Works

Cold rolling

- Development of advanced 20-high split-housing ZR-Mill (HZ-Mill)
- Cold-rolling complex for tinplate
- Flying roll change for continuous TCM: first successful installation has increased production yield
- Minimum Quantity Lubrication (MQL) substitutes traditional emulsion lubrication in tandem cold mill
- New heavy-gauge cutter-sampling station

Processing, products and applications

- Industrial results obtained with the new generation of laser welders
- U. S. Steel Great Lakes Works No. 5 continuous pickle line (CPL) revamp with iBox pickling technology

Environment, energy and utilities

- Waste-heat recovery for EAF – innovative concepts and industrial implementation
- Saving resources. Creating Value. – Future-oriented sustainable steelmaking solutions with operation examples

Electrics, automation, mechatronics, logistics and maintenance

- The digital transformation of steel production
- Maintenance plan for power distribution equipment for steel mills – a lifecycle business
- A detailed discussion on arc flash hazard reduction methods
- IEC 61850-based protection systems for cable and bus protection
- Inline measurement of electromagnetic parameters and their importance for additional mechanical and electromagnetic material characteristics
- Methodology for sizing transformers for variable process loads
- Increased plant availability and reduced maintenance costs by a smart & integrative condition monitoring system



Link to AISTech video:
www.primetals.com/aistech2017



PRIMETALS TECHNOLOGIES APPS AND SOCIAL MEDIA

THE "PRIMETALS" APP

This is the new company app for iOS and Android, which will replace the "Metals Magazine" and "Metals Technologies" apps in the first quarter of 2017. The app includes the most recent issues of the customer magazine as well as interactive presentations of groundbreaking technologies.



The "Primetals" app is compatible with tablets running iOS or Android. Mobile phones will be supported with a future release.

VIRTUAL REALITY APPS

These apps showcase two distinctive innovations from Primetals Technologies with the use of virtual reality. Each app scans the two-dimensional blueprint of the respective facility and adds three-dimensional objects onto it. This way, the plant architecture can be inspected in great detail, even down to the individual components. The required blueprints are free to download.



CIRCULAR PELLETTIZING TECHNOLOGY

Available for iOS and Android. Please scan the QR code or search for the app name in the App Store of your choice. Download the blueprint at bit.ly/cpt-blueprint



QUANTUM MINI MILL

Available for iOS only. Please scan the QR code or search for the app name in Apple's App Store. Download the blueprint at bit.ly/quantum-blueprint

SOCIAL MEDIA



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OUR FACEBOOK PAGE
www.facebook.com/Primetals



OUR TWITTER PRESENCE
twitter.com/primetals



PRIMETALS TECHNOLOGIES IS NOT ONLY TECHNOLOGICALLY FIT ...

Members of the Primetals Technologies running team at the Linz Marathon (Austria), April 9, 2017. All of the runners completed the race. (photo: Berta Haring)

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