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METALS MAGAZINE

INNOVATION AND TECHNOLOGY FOR THE METALS INDUSTRY

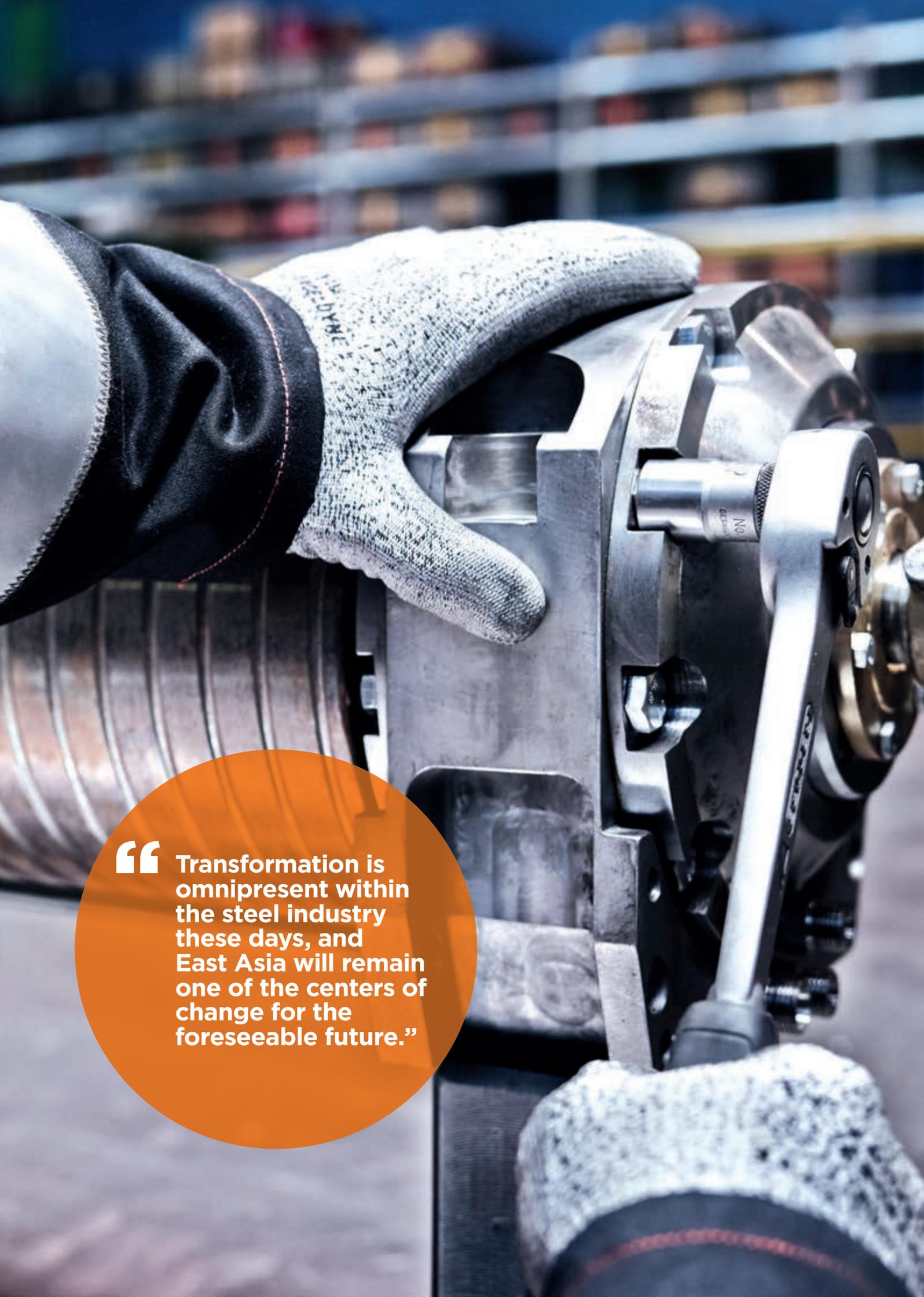
STEEL IN EAST ASIA

THE HIROSHIMA LOCATION OF
PRIMETALS TECHNOLOGIES

COMPREHENSIVE COMPETENCE IN
BENEFICIATION TECHNOLOGIES

MELT EXPERT: THE FURNACE
AT YOUR FINGERTIPS

CONTINUOUS CASTING
PROCESS AUTOMATION



“ Transformation is omnipresent within the steel industry these days, and East Asia will remain one of the centers of change for the foreseeable future.”

EDITOR'S COLUMN



THOMAS WIDTER

DEAR READER,

"May you live in interesting times" – this expression is thought by many to have originated in China in the early 1600s. At first encounter, the farewell seems to have a positive connotation, but its actual meaning is less that of blessing, and more that of a curse. This is because peaceful times make it much easier for individuals to lead comfortable lives. "Interesting times" might leave you with better stories to tell, but generally have an element of unrest at their heart that makes one's existence far more challenging. It is this difference between the saying's apparent meaning and its real implication that made it famous.

The steel industry has also seen some interesting times as of late. Years of impressive growth in certain areas of the world have led to a state of oversaturation, if not partial paralysis. China is now actively working on reducing its total steel production capacity. Everywhere in the world, producers are looking into potential upgrading measures for their facilities. Under the current conditions, one of the few recipes left for success is to target high-end steel grades through modernization and to look for distinct market niches.

Transformation is omnipresent within the steel industry these days, and East Asia will remain one of the centers of change in the foreseeable future. It has been a major growth area, become one of striking overcapacity, and will increasingly turn into a region known for its cutting-edge products – if the indicators can be trusted. In this issue of *Metals Magazine*, we take a thorough look at an area that is once again changing rapidly.

Change, of course, is a theme present not only in the steel business. It has been prevalent on the political stage, with the U.S. presidential election and South Korea's conflict with its country leader serving as two prominent examples. The interesting times we live in almost seem to demand change, and it is certainly best to approach this development by looking for solutions

wherever possible and making the most of the outcome. Most changes have positive as well as negative ramifications; they bring about joy and sadness. As you read this, you are actively witnessing one such change. This is my first editorial for *Metals Magazine*, and I am honored to have been given the opportunity. I write these lines by request of the magazine's Managing Editor, Dr. Lawrence Gould, who I will be succeeding later this year. I would like to thank Dr. Gould for the fantastic working relationship, and I am positive that he will remain on board with *Metals Magazine* in one way or another for a long time.

As with every issue of *Metals Magazine*, the one you are holding in your hands is meant to provide you, as its reader, with the most interesting information we could source. We have not only selected stories portraying the East Asian region, but also articles that cover the portfolio of Primetals Technologies in detail. The latter examine some of the solutions we offer – as tried and tested means to introduce change and to ensure success even in situations that are indeed of an "interesting" nature.

Tan Wenzhen, Vice President of Tangshan Steel, states in his interview (see pages 96–97) that the steel industry is far from having become a "sunset industry." I am convinced that his assessment is correct. With the right amount of optimism, pragmatism and resourcefulness, we will work our way toward a more peaceful future, united with our customers, and one step at a time.

Yours sincerely,

Dr. Thomas Widter

Deputy Managing Editor of Metals Magazine
Primetals Technologies, Limited



18 FEATURE STORY

- 03 **Editor's Column**
- 04 **Table of Contents**
- 06 **Message from the CEO**
- 08 **Recent Project and Company News**

FEATURE STORY

- 18 Steel in East Asia**
A thorough look at the current state of the steel industry in the East Asian region
- 28 A Unique Legacy of Craftsmanship**
A multi-faceted portrait of the Hiroshima location of Primetals Technologies, with a focus on the site workshop, its products, and its people
- 34 Leading Innovation in Japan**
Interview with Dr. Takehiko Saito, Head of Technology and Innovation for Cold Rolling at Primetals Technologies Japan

TECHNOLOGY

- 40 Quality Starts with the Ore**
Primetals Technologies offers a host of beneficiation solutions to identify the most feasible iron- and steel-making production route
- 46 Greener Sintering for China**
The first Chinese Selective Waste Gas Recirculation system is now being installed at Shansteel Technologies

- 50 Taking a Large Step into the U.S.A.**
voestalpine celebrated the official start-up of its prestigious Texas-based hot-briquetted iron direct-reduction plant on October 26, 2016
- 54 The Furnace at Your Fingertips**
Electrode control system, now with "Industry 4.0"-inspired universal accessibility
- 58 Eminent Quality for Automotive Applications**
Hyundai's new benchmark 4-strand bloom caster at the company's Dangjin plant in Korea showcases the continuous casting solutions of Primetals Technologies
- 62 Cast to Perfection**
Recent innovations and developments in continuous casting automation
- 68 Meeting Market Demand with Arvedi ESP**
Rizhao Steel's new Arvedi ESP lines have raised the bar of excellence with several production records and a strong, market-oriented business strategy
- 70 Promoting Transformation**
Interview with Meng Ling Xue, Vice President of Rizhao Steel Holding Group Co. Ltd.
- 72 Unleash the Water**
Power Cooling - Production of new steel grades and reduced alloying costs in hot rolling
- 76 Constant Refinement**
Interview with Yoichi Kira, Global Head of the Hot Mill Business Segment and Senior Vice President of Primetals Technologies Japan



Blast furnace tapping at China Steel Corporation, Taiwan

Steel production in East Asia, and indeed the world, is dominated by the output from China, which in 2015 produced 803.8 million tons of crude steel accounting for 49.6% of total world production.

80 A Better Way to Produce Stainless Steel Strip

Background and benefits of the Power X-HI mill for cold-rolling mills

84 Incredible Strip Quality

Design highlights of two Chinese PL-TCM facilities for the production of steel strip for tinplate applications

88 Combining Competences

Interview with Shunsaku Kasai, Global Head of the Cold Rolling & Processing Line Business Segment and Executive Vice President of Primetals Technologies Japan

92 Driven by the Power of Light

Excellent customer feedback underlines the competence of the laser welding solutions developed by Primetals Technologies

96 Reason for Optimism

Interview with Tan Wenzhen, Vice President of Tangshan Iron and Steel Group Co. Ltd., China

98 Introducing Metals Orchestra

Primetals Technologies has developed a specific approach for the future-oriented implementation of the "Industry 4.0" concept in the context of today's steel production

NEWS & UPDATES

100 Fairs and Events

Primetals Technologies participated in several conferences and other important industry events such as the Middle East Iron and Steel Conference and ABM Week 2016

102 Primetals Technologies Apps and Social Media

An overview of the iOS and Android apps that Primetals Technologies is offering as free downloads

103 Publication Details

METALS MAGAZINE IS ALSO AVAILABLE FOR TABLET COMPUTERS

The new "Primetals" app is available for iOS and Android devices 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

Search for "Primetals" in the App Store of your choice to download the app.





YASUKUNI YAMASAKI
CEO and Chairman of
Primetals Technologies

“ Readily available solutions have always made a big difference, and in times of change, their importance is even more pronounced.”

Yasukuni Yamasaki

MESSAGE FROM THE CEO

DEAR CUSTOMERS,

This issue of *Metals Magazine* takes a detailed look at East Asia and the region's steel industry. Over the last few decades, the changes that have happened there were vast: China became the world's largest steel producer, Japan built on its long legacy of delivering precision technology, South Korea became the country with the highest steel use per person worldwide, and Taiwan saw its producers find the right market niches to sustain its highly export-driven business orientation.

As I have worked in the steel industry for several decades now, I have witnessed many of the changes that the East Asian steel industry implemented over time. I have been very impressed by East Asia's willingness not just to grow but also to adapt to new trends. Within the last ten years alone, the market underwent a succession of changes, and the East Asian steel producers always showed great resourcefulness and made remarkable achievements.

It is certainly true that, in 2017, the steel industry is also moving at a fast pace. Global overproduction of steel has led to substantial overcapacity. While some steel manufacturers have remained largely unaffected by this development, others are struggling. Those who have not yet started to target value-added, high-quality steel grades as their main production output are often confronted with very low coil prices, which render them unable to sustain complete operational profitability.

In times of great changes, there is a call for great solutions. And for these solutions to arise, the right innovations have to be made at the right time. This is where Primetals Technologies is at its best. Our technology specialists are constantly working incredibly hard to improve our already available technologies – and to design completely new ones. Our approach to supporting the steel industry is customer- and innovation-driven. An important factor fueling this approach is our

extensive, multinational company structure that unites the efforts of many local R&D facilities. These facilities are all state-of-the-art and have long histories of well-applied innovation power. The result is an unparalleled selection of highly sophisticated solutions. One good example is Cross Seam Welder technology, which was chiefly invented in Hiroshima, and this issue of *Metals Magazine* features an interview with one of its creators (see pages 34–39).

Whether it is a large-scale greenfield project, an upgrade for an existing plant, or a new maintenance arrangement: at Primetals Technologies, we will provide you with the most innovative and future-proof solution available. This applies to dedicated hardware components as well as to more software-based control and monitoring systems, which can also bring decisive advantages when aiming to ensure a consistent production of high-quality steels. Readily available solutions have always made a big difference, and in times of change, their importance is even more pronounced.

As CEO of Primetals Technologies, it is my responsibility to ensure that we as a company always support our customers in the best-possible way, no matter what their needs are. Maintaining our culture of innovation and our future-oriented focus are two of the most crucial tasks on my CEO agenda. Therefore, I am constantly in conversation with our customers, trying to get a clear idea of where their problems lie, and what will help them in resolving their most pressing issues.

Whether you are a steel producer located in the East Asian region or elsewhere: if there is a need to adapt to changing market conditions, we will be there as a reliable partner – with our technology experts, our deep knowledge, and our large array of solutions. Let us rise to the challenges and create the future of metals as one. ●

RECENT PROJECT AND COMPANY NEWS

**PRIMETALS TECHNOLOGIES SUPPORTS ITS CUSTOMERS THROUGHOUT
THE WORLD WITH ADVANCED SOLUTIONS, EQUIPMENT AND SERVICES**



The combination of highly innovative technologies from steelmaking to rolling results in enormous savings in investments, energy requirements and overall operating costs.

REPEAT ORDER FOR ELECTROSTATIC OILER

ARMENIA: Rusal Armenal CJSC placed a repeat order with Primetals Technologies for the supply of an electrostatic oiler for the company's aluminum mill in Yerevan.

MODERNIZATION OF FLAT-ROLLING BLOCK AT BÖHLER EDELSTAHL

AUSTRIA: Primetals Technologies received an order from Böhler Edelstahl GmbH & Co KG (Böhler Edelstahl), a company of the Special Steel Division of voestalpine, to modernize the flat-rolling block of the company's long-rolling mill at its Kapfenberg plant in Austria. The plant will be equipped with new drives and an automation system. The "RollMaster," specially developed for long-product rolling mills, will handle the generation and management of roll pass schedules. This software is the link between the production planning system and plant automation. The project is designed to increase plant availability, improve product quality, boost energy efficiency and cut maintenance costs. Modernization work is scheduled to take place during a one-month plant shut-down period in mid-2017.



The existing flat-rolling block of Böhler Edelstahl in Kapfenberg, Austria, will be equipped with new drives, automation and the RollMaster roll-pass management system. (Photo: Böhler Edelstahl)

WORLD PREMIERE: NEW MINIMILL WITH EAF QUANTUM AND WINLINK FOR GPH ISPAT

BANGLADESH: GPH Ispat Ltd. placed a major order with Primetals Technologies for the supply of a new minimill with an annual capacity of 815,000 tons of finished products and billets. The project scope includes a shaft-type EAF Quantum electric arc furnace for the preheating of scrap, a ladle furnace, a 3-strand, high-speed billet caster, a bar and section mill as well as the associated basic automation and process-optimization systems. The billet caster and rolling mill will be directly linked in a highly compact WinLink Flex plant configuration, which will enable virtually uninterrupted casting and rolling. The combination of highly innovative technologies from steelmaking to rolling results in enormous savings in investments, energy requirements and overall operating costs. The new minimill meltshop is scheduled commence operation in early 2018.



The EAF Quantum electric arc furnace (shown above) will supply the liquid steel for a WinLink plant configuration as part of a new minimill now being supplied to GPH Ispat in Bangladesh.



2-strand slab caster in operation at CSP, Brazil

START-UP OF CONVERTERS, LADLE FURNACE AND CASTERS AT CSP

BRAZIL: Two 300-ton LD (BOF) steelmaking converters, a 300-ton ladle treatment furnace and a 2-strand slab caster that were supplied by Primetals Technologies were recently started up at Brazilian steel producer Companhia Siderúrgica do Pecém (CSP). The plant, which is located in São Gonçalo do Amarante in the state of Ceará, is capable of producing 3 million tons of a wide range of steel grades that are rolled to plates and sheets for use in shipbuilding and for the production of machinery, boilers and pipelines.

CONVERTER REPLACEMENT AT CAP ACERO

CHILE: Compania Siderurgica Huachipato S.A. (CAP Acero) placed an order with Primetals Technologies for the replacement of the existing LD (BOF) Converter No. 2 at its Talcahuano steelworks. The project scope includes detailed engineering of the new converter vessel and trunnion ring, supply of a maintenance-free Vaicon Link 2.0 converter suspension system, new converter bearings and tilting-drive bearings. The converter will have a tapping weight of 100 tons and a larger reaction volume for improved metallurgical reactions. The replacement converter is scheduled to come into operation in November 2017.



Existing LD (BOF) converter at CAP Acero, Chile

FAC FOR POWER X-HI STAINLESS STEEL MILL

CHINA: Primetals Technologies received the final acceptance certificate from Beihai Chengde Stainless Steel Co., Ltd. for the supplied Power X-HI stainless steel tandem cold mill. The mill features five Power X-HI-type mill stands and a heavy laser welder. (See separate topic on pages 80–83).

CERTIFICATION OF IDRHA+-HARDENED RAILS

CHINA: Following the certification from China Railway Construction Company (CRCC), idRHa+-hardened rails produced at the Primetals Technologies-supplied rail mill in Baogang, Inner Mongolia, were fully certified by China Academy Rail Society (CARS) in November 2016.

FAC FOR FLAT-BAR MILL AT QINGDAO

CHINA: In November 2016, the final acceptance certificate was issued for a flat-bar mill that Primetals Technologies supplied to Qingdao Iron and Steel Co. Ltd. for the production of special steels. The mill is equipped with a prestressed sizing stand group in the finishing train, three cooling sections, equipment and technology for the thermal treatment of flats as well as accessory equipment. Approximately 600,000 tons of round and flat bar products can be produced per year, which are mainly used for automotive applications.

SPECIALIZED ALUMINUM FOIL EQUIPMENT FOR DINGSHENG

CHINA: Chinese aluminum producer Jiangsu Dingsheng Aluminium placed an order with Primetals Technologies for the supply of 60 sets of Air Bearing Shapemeters, ISV (integral solenoid valve) Spraybars, Magnescale Transducers and four packages of spare parts for Dingsheng's foil mill. Air Bearing Shapemeters provide accurate in-line flatness measurements of rolled foil material, and the ISV Spraybar systems will improve strip quality by controlling the thermal profile of the mill rolls. Jiangsu Dingsheng Aluminium is the largest producer of aluminum foil in China.

PROCESS-OPTIMIZATION SYSTEMS FOR JIANGSU SHAGANG SLAB CASTERS

CHINA: On October 21, 2016, Chinese steel producer Jiangsu Shagang Group Co. Ltd. signed a contract with Primetals Technologies for the upgrading of the process-optimization systems of the CCM1 and CCM2 continuous casting machines. The existing systems were originally installed together with the supply of the casting machines in 2004, which will be equipped with a completely new generation of state-of-the-art Level 2 process models for slab casters.

FAC FOR COLD MILL FROM TANGSHAN STEEL

CHINA: Primetals Technologies received the final acceptance certificate from Tangshan Iron and Steel Group Co. Ltd. for the supplied rolling line of a new cold-rolling complex located in Tangshan, Hebei province. The 5-stand, 6-high rolling mill is designed to produce a total of 1.6 million t/a of high-strength, high-quality steels for the Chinese automotive industry.

FAC FOR Z-HI REVERSING COLD MILL

CHINA: A Z-Hi reversing cold mill supplied by Primetals Technologies to Zhejiang Nisshin Worthington Precision Specialty Steel Co. (ZNPSS) in Pinghu City (near Shanghai), Zhejiang province, received the final acceptance certificate on December 1, 2016. The mill is designed to roll 120,000 tons of precision specialty steels per year, mainly for automotive applications.



Z-Hi reversing cold mill at (ZNPSS), Pinghu City, China

GALVANIZING LINE START-UP AT BAOSTEEL

CHINA: The new No. 2 Continuous Galvanizing Line supplied by Primetals Technologies was put into operation on March 30, 2016, at Baosteel's Zhanjiang steelworks in Guangdong province. The line is designed to galvanize 465,000 tons of a wide range of steel grades per year for use in numerous downstream applications such as in the automotive and home-appliance industries. Primetals Technologies was the main contractor for all imported equipment such as the furnace, cooling equipment and the associated instrumentation and software.



Continuous galvanizing line at Baosteel Zhanjiang, China

INSTALLATION OF ERT-EBROS BILLET-WELDING SYSTEM IN BAR ROLLING MILL OF YONGFENG STEEL

CHINA: An ERT-EBROS billet welding system will be supplied by Primetals Technologies for the existing bar rolling mill of Shandong Laigang Yongfeng Steel Corp. (Yongfeng Steel) in Qihe, Shandong province. This system allows billets to be endlessly rolled, which leads to an increase in mill utilization and output levels by 3%–6%. Uninterrupted billet rolling also means a consistently high product quality. The new ERT-EBROS plant is scheduled to commence operation in the second quarter of 2017 and is expected to pay for itself within 18 months. It is the first system of its type to be installed in China.

NEW BILLET STAND AND COMBINATION SAW FOR TŘINECKÉ ŽELEZÁRNY

CZECH REPUBLIC: Primetals Technologies will install a new billet stand, combination saw and the corresponding fluid, mechatronics, electrical and automation systems for the rolling mill of Třinecké Železářny, A.s. This will enable the production of bar steel with round and square cross-sections. The billet stand is designed to roll the received blooms to billets with square cross-sections up to 155 mm x 155 mm, and then to round bars with diameters of 150 mm, 180 mm and 210 mm. The mill produces a wide variety of steel grades that include low- to medium-carbon steels, and also special steels such as stainless, tool, bearing, spring steels, ledeburitic and manganese Hadfield steel grades. Start-up: November 2017.

START-UP OF FINAL REPLACEMENT CONVERTER AT SSAB'S RAAHE STEEL WORKS

FINLAND: The last of three LD (BOF) replacement converters supplied by Primetals Technologies commenced operation at the Raahe Steel Works of SSAB Europe Oy in Finland. The first converter was started up in October 2015 and the second one in May 2016. The new converters have a larger reaction volume, and the installed maintenance-free Vaicon Link 2.0 converter suspension system minimizes shell stress caused by heat-induced vessel deformation. The tip of the blowing lance is adapted to the new converter geometry, and each of the three converters features a detachable bottom, a bottom-stirring system and the pneumatically activated Vaicon Stopper to minimize slag carryover during tapping. A new refractory concept will ensure long converter lining campaigns.

AUTOMATION UPGRADE OF MILL COOLING SECTION AT RAAHE

FINLAND: Also at Raahe Steel Works, new Level 1 basic automation and Level 2 process-optimization systems from Primetals Technologies will be supplied to replace the existing obsolete software of the cooling section of the hot-strip mill. This will allow for improved cooling control as required for the demanding steel grades produced in Raahe. The project is scheduled for completion in April 2018.

CONVERTER REPLACEMENT AT ARCELORMITTAL RUHRORT

GERMANY: A new LD (BOF) converter with a tapping weight of 150 tons will be supplied by Primetals Technologies to substitute the existing "K2" converter at the Ruhrort steelworks of ArcelorMittal Ruhrort GmbH. The project scope encompasses the converter vessel, trunnion ring, the maintenance-free Vaicon Link 2.0. suspension system, slag protection and doghouse gates. A newly developed device for horizontal steel measuring and sampling of the tilted converter will also be provided. The replacement converter is scheduled to be put into operation in October 2017.

NEW PROCESS-OPTIMIZATION SYSTEM FOR RH PLANT AT SALZGITTER FLACHSTAHL

GERMANY: A twin RH (Ruhrstahl Heraeus) vacuum-degassing plant and two downstream treatment stations of Salzgitter Flachstahl GmbH will be equipped with a Level 2 process-optimization system from Primetals Technologies. Installation of a cost-optimized charge-control system and dynamic process models will reduce the consumption of alloying agents and support the efficient and cost-effective production of the targeted steel grades. Furthermore, a system for recording relevant process data, variable evaluation options and optimized temperature control will be included as part of this sophisticated automation package. The new system is scheduled for start-up in April 2017.

VIZAG STEEL ISSUES FAC FOR SPECIAL BAR MILL LINE

INDIA: The preliminary acceptance certificate was issued by Rashtriya Ispat Nigam Limited (Vizag Steel) for a straight bar line that Primetals Technologies supplied as part of a bar mill contract. Currently, the focus of activities is to increase productivity in the straight bar line to achieve the targeted performance figures and to complete hot commissioning of the coil line.



Inline thermo-control equipment installed at Vizag Steel, India

FAC FOR BAR MILL AT FERAPI SIDERURGICA

ITALY: The final acceptance certificate was issued for a bar mill equipped by Primetals Technologies at Lonato del Garda, Brescia. A new flying shear was supplied and started up on the existing line, which has allowed Feralpi Siderurgica SpA to expand their product range to include ribbed bars with diameters of up to 60 mm as well as cut bars with improved mechanical properties. An increased maximum cutting speed of 20 m/s could also be achieved.

MEASURING MANIPULATOR BENEFITS TEMIRTAU

KAZAKHSTAN: A Vaicon Measuring Manipulator was installed and put into operation on Converter No. 1 at JSC ArcelorMittal Temirtau. This equipment increases worker safety, improves the measurement efficiency of liquid steel in the converter and leads to a higher sample quality.

RUSSIAN GOST CERTIFICATION FOR IDRHA+-TREATED RAILS AT ARBZ

KAZAKHSTAN: Aktobe Rail and Section Works LLP (ARBZ) operates a 400,000 t/a rail and section mill in Aktobe that was supplied by Primetals Technologies. The mill features the idRHa+ system for the inline hardening of rails. Following official certification according to Kazakh standards, the rails subsequently underwent a rigorous six-month investigation procedure at the JSC Railway Research Institute (VNIIZHT) testing facility near Moscow, Russia. The ARBZ rails successfully passed the required so-called ring test right from the very first lot of rails and were subsequently certified according to Russian GOST standards in November 2016.

TYASA ORDERS NEW REVERSING COLD ROLLING MILL

MEXICO: Talleres y Aceros S.A. de C.V.(Tyasa) ordered a new 4-high, reversing cold-rolling mill from Primetals Technologies for its production facility at Ixtaczoquitlan. The mill will produce 200,000 t/a of a wide range of low-carbon and high-strength steel grades. Strip will be rolled to exit thicknesses of 0.3 mm to 1.0 mm. Process equipment and technology packages will not only ensure tight flatness and thickness tolerances, but also high strip surface quality. Project completion: early 2018.

NEW EQUIPMENT FOR ARCELORMITTAL POLAND

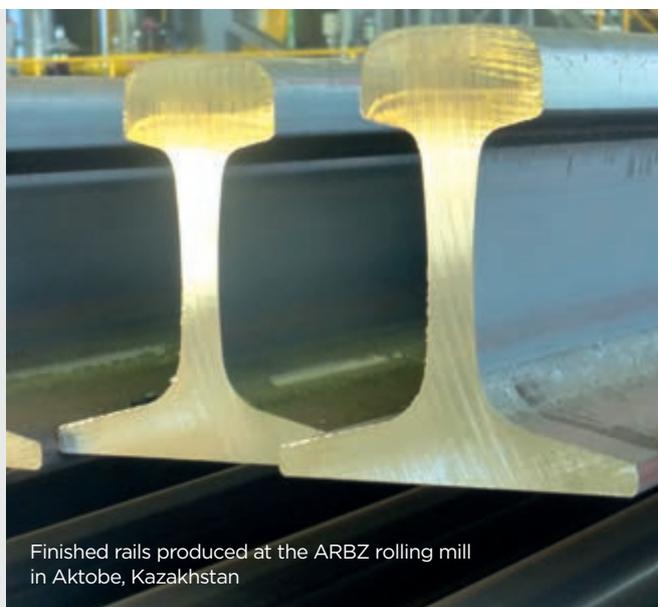
POLAND: Replacement tuyere stocks and cast iron staves were supplied by Primetals Technologies for Blast Furnace No. 5 of the Krakow steelworks of ArcelorMittal Poland S.A. The swivel bearing of the ladle turret of the slab caster was also exchanged. An online condition-monitoring system monitors the status of the new bearing and contributes toward optimizing maintenance cycles.

SUPPLY OF E&A FOR BLAST FURNACE AT EVRAZ NTMK

RUSSIA: Primetals Technologies received an order from Evraz Nizhniy Tagil Metallurgical Plant (Evraz NTMK) for the supply and installation of basic automation (Level 1), process optimization (Level 2), electrical equipment and instrumentation for the company's new Blast Furnace No. 7 located in Nizhniy Tagil in the Swerdlowsk Region. The new equipment will optimize coke consumption and reduce service costs.

SABIC ISSUES FAC FOR MILL REVAMP

SAUDI ARABIA: In September 2016, Primetals Technologies was awarded the final acceptance certificate from Saudi Basic Industries Corporation (SABIC) for the revamping of the roughing mill stands of Rod Mill No. 1 of the Long Products Facility of Saudi Iron & Steel Co. (Hadeed).



Finished rails produced at the ARBZ rolling mill in Aktobe, Kazakhstan



A long-rolling mill supplied by Primetals Technologies for a Central European steel producer

ORDER FOR IMPROVED STOVE CROSSOVER SYSTEM

TAIWAN: In November 2016, Primetals Technologies received an order for the installation of an improved hot-blast stove crossover system for the three hot blast stoves of Dragon Steel's No. 2 Blast Furnace in Taichung, Taiwan.

SUPPLY OF NEW CASTER AND HOT-STRIP MILL UPGRADE AT TATA STEEL IJMUIDEN

THE NETHERLANDS: Primetals Technologies received an order from Tata Steel IJmuiden BV for the supply of a new slab caster with a casting capacity of 2.7 million tons of slabs per annum. A wide range of steel grades will be cast for use in the automotive industry and other industrial segments. Numerous technological packages will be installed to allow online slab-width changes and also to ensure high internal and surface quality of the slabs. The caster also features EcoStar Spiral rollers that will be used in the strand-guiding system as part of the DynaTac high-temperature-casting package. Start-up is scheduled for March 2019. Tata Steel IJmuiden also placed an order with Primetals Technologies to upgrade the existing width-gauge system on its hot-strip mill. Installation work and commissioning are scheduled for February 2017.

FAC FROM ÇEMTAŞ FOR COMPLETION OF LONG-ROLLING MILL UPGRADE

TURKEY: In October 2016, Çemtaş Çelik Makina Sanayi ve Ticaret A.Ş. issued the final acceptance certificate (FAC) to Primetals Technologies for the upgrading of a long-rolling mill that can now produce 200,000 tons of quality rounds and flat bars per year for use mainly in the automotive industry.

The project included the supply of a new housing-type breakdown stand capable of both reversible and sliding operations, six mill stands (RedRing Series 5) in the intermediate train, and accessory mill equipment.

RECORD PRODUCTION FIGURE AT ESI

U.A.E.: In May 2013, a rebar mill supplied by Primetals Technologies to Emirates Steel Industries Co. P J S (ESI) started commercial production. Nominal capacity is 400,000 t/a of rebars with bar diameters from 8 mm to 32 mm. Thanks to the highly capable operator and maintenance teams of ESI, and backed by expert services from Primetals Technologies, the mill achieved an annual record production output of 502,000 tons of rebars in 2016.



The team behind the No. 5 rebar mill production record at Emirate Steel Industries, U.A.E., center (left to right): Jean Liesch (white shirt), COO of ESI; Mirko Di Filippo (blue jacket), Head of Metallurgical Services of Primetals Technologies Italy; Mubarak Al Mansoori, Vice President of ESI, Administration Support

ORDER FOR ISV SPRAY BARS FROM ALERIS CORPORATION FOR ALUMINUM HOT-ROLLING MILL

U.S.A: An extension of a previous order placed in 2016 by Aleris Rolled Products, Inc. (Aleris Corporation) was made to include five sets of ISV Spray Bars for the company's hot aluminum tandem mill at Lewisport, Kentucky.

ORDER FOR SIAS SURFACE-INSPECTION SYSTEM FROM NUCOR STEEL BERKELEY

U.S.A: An order for a SIAS automatic surface-inspection system was received by Primetals Technologies from Nucor Steel Berkeley. The system is being installed in a hot-strip mill at Nucor's production site in Huger, South Carolina. This well-proven quality-control system, which is the world's leading solution for strip surface quality control, optimizes production costs and maintenance activities. SIAS is able to detect surface defects on the top and bottom sides of the strip during production, and classify them in real time into defined defect families. The Nucor Berkeley inspection system is also fitted with width-measurement and coil-grading functionalities.



Example of a SIAS installation in a hot-strip mill

SUPPLY OF STOVE EQUIPMENT FOR BLAST FURNACE

U.S.A: Primetals Technologies received an order for the supply of proprietary equipment associated with the rebuilding of a second stove of the Blast Furnace D-4 plant at US Steel's Great Lakes Works in Ecorse, Michigan. The supply scope includes pre-cast dividing wall panels and special blocks for the hot-blast outlet and chequer supports.

UPGRADING OF DRIVES AND AUTOMATION AT NUCOR STEEL

U.S.A: Nucor Steel placed an order with Primetals Technologies to replace the existing drives and control system in the finishing line of a 1.6 million t/a plate mill located in Cofield, North Carolina. The project scope includes the installation of new Siemens drives, automation, a human-machine interface (HMI), the WinCC software system and a Level 2 process-optimization system for improved control of the side trimmer, cold shear and plate piler. The mill upgrade is scheduled to be completed by May 2017.

This well-proven quality-control system, which is the world's leading solution for strip surface quality control, optimizes production costs and maintenance activities.

CUSTOMIZED TRAINING EVENT FOR TERNIUM SIDERAR PERSONNEL

U.S.A: In late August 2016, management representatives from Ternium Siderar's Argentinian steelworks visited the Worcester company site of Primetals Technologies in Massachusetts, U.S.A. for a customized training event. Following the renewal of a long-term spares agreement between Ternium and Primetals Technologies, visitors had the opportunity to take a first-hand look at the manufacturing and service capabilities of the Worcester facility. "This was one of the best training sessions I ever attended and it far surpassed expectations," commented one of the guests.

IMPROVED WIRE ROD QUALITY AT VINA KYOEI STEEL VIETNAM

VIETNAM: The existing wire rod mill of Vina Kyoei Steel Co. Ltd., located near Ho Chi Minh City in Vietnam, is being upgraded by Primetals Technologies. The scope of supply for this project includes a Morgan Intelligent Pinch Roll and a Morgan High Speed Laying Head with SR Series pipe. Furthermore, motors, drives and an improved automation system will be installed to interface with the existing control system. The new equipment will allow a rolling speed of 120 m/s.

INDUSTRY 4.0 FROM A SINGLE SOURCE

Primetals Technologies and PSI Metals GmbH signed a cooperation agreement for the supply of Industry 4.0 solutions for the steel and aluminum industries. The target of this agreement is to provide customers with complete, perfectly matched tailor-made solutions across the entire supply chain from a single source. The supply scope includes equipment, basic automation and process optimization from Primetals Technologies, and the PSImetals production management system from PSI Metals. Customers will benefit from reduced integration costs, shorter project implementation times and simplified IT processes.

SPECIAL ANNOUNCEMENT



From left to right: Dr. Heiner Röhrl (Primetals Technologies), Vadim Boychenko (Mayor of Mariupol), Roland Neubauer (Primetals Technologies), Yuriy Zinchenko (CEO of PJSC MMKI), Robert Reisetbauer (Primetals Technologies)

CASTING THE FUTURE OF UKRAINE

UKRAINE: A top-level delegation from Mariupol visited the Linz location of Primetals Technologies on September 5-6, 2016, to finalize negotiations and sign a contract for the supply of a two-strand slab caster. The new equipment will extend the existing facilities of PJSC Ilyich Iron and Steel Works of Mariupol (MMKI), which belongs to the Metinvest Group. The reasons for the purchase are two-fold: The total production output will rise by 2.5 million tons of premium-segment steel per year and place Ilyich Iron and Steel Works in an even more competitive position. At the same time, the new technology will have a positive impact on the environmental aspects of the plant, bringing emissions far below the legal requirements for both Ukraine and Europe. One of the interesting facets of the project is that it will be executed in the Donestk basin, a region in Ukraine that is still experiencing some turbulence. We have therefore interviewed the project leaders and asked them to give us some insights about the ramifications of the undertaking.

Interview I:

Yuriy Zinchenko, CEO of PJSC MMKI (Metinvest Group)

Interview II:

Klaus Luger, Mayor of Linz, Austria

Interview III:

Vadim Boychenko, Mayor of Mariupol, Ukraine



Yuriy Zinchenko, signing the slab caster contract with Primetals Technologies on September 5, 2016

YURIY ZINCHENKO

CEO OF PJSC MMKI

Please describe this project to our readers.

Yuriy Zinchenko: The signing of the contract between Metinvest and Primetals Technologies on the construction of the continuous casting machine for Ilyich Iron and Steel Works is the start of a unique technological project that meets the highest European standards in terms of productivity, quality and environmental friendliness. The new two-strand slab caster will produce 2.5 million tons of premium-segment cast slabs per year. The transition to the premium segment became possible due to the usage of innovative technological solutions with the continuous casting machine, the introduction of a third-level automated control system for the technological process, and other measures. It is important to us that the execution of this project improves the environment of Mariupol. The project provides closed loops for equipment cooling. The dust content in the flue gas after gas cleaning will not exceed 12 mg/m³, while the set norms in Ukraine allow a maximum of 50 mg/m³, and 30 mg/m³ in Europe. In addition to the construction of a new continuous casting machine, an upgrade of the steelmaking capacities will also be performed as part of the project implementation.

What was the main factor in choosing Primetals Technologies as a key partner for this project?

Zinchenko: Primetals Technologies is a world-leading company in the field of continuous casting and ladle treatment facilities. Due to the best proposal we received, this company was awarded the contract.

Some regions of Ukraine are now experiencing serious difficulties. Do you see any positive changes?

Zinchenko: Unfortunately, the tension in Eastern Ukraine is not subsiding. The fighting and shooting in the vicinity of Mariupol and Ilyich Iron and Steel Works is a reality in

which we have worked and lived for several years now. Under such conditions, it is difficult to overestimate the importance of the industrial enterprises such as Ilyich Works for the territories where we operate. In addition to reaching production goals, we often have to solve many social problems: repair and rebuild houses, kindergartens and hospitals, purchase public transport, and more. At the same time, we remain optimistic and continue to hope for a timely end to the conflict.

What challenges will the steel industry face in the coming years?

Zinchenko: First and foremost, we are concerned about negative price trends. Under such circumstances, we have to constantly fight for the reduction of production costs. That is why the introduction of innovative projects – such as the one today's event is devoted to – is vital for us.

What is your vision for steel production in Ukraine?

Zinchenko: In addition to the changeable situation of the global steel market, a lot depends on the circumstances in the country. We hope that after the end of the military activities, Ukraine will see economic growth and, as a consequence, an increase in the demand for steel. Without the growth on the domestic market for steel products, we can not anticipate a significant increase in steel production of Ukrainian mining and complex metallurgical enterprises.

What should Primetals Technologies focus on in the future?

Zinchenko: In my opinion, Primetals Technologies should continue to develop new, innovative, efficient and environmentally friendly projects for steelmakers. This is a promising direction.



Klaus Luger is proud of the environmental awareness of the "Steel City" of Linz.

Vadim Boychenko sees Mariupol's steel industry as a cornerstone of his city.

KLAUS LUGER MAYOR OF LINZ

What is the most striking benefit of having a steel producer as an integral part of your city?

Klaus Luger: voestalpine is indeed a world-renowned steel manufacturer and has shaped the image of the city of Linz with its rich history and investments. We are often called the Austrian "Steel City." In my opinion, the largest benefit is that the local steel industry propels both the technological innovation and economic progress for the region.

Linz is almost famous for finding a good balance between industrial production and environmental awareness. Are there any lessons that Linz has learned and that Mariupol might gain from as well?

Luger: It is mostly about accepting the challenges at hand and going into a direction of modernization. I think that Mariupol is on a very good path. Taking proper care of the environment is an extremely high priority in Mariupol.

Is there anything that Linz can learn from Mariupol?

Luger: I think that Mariupol did a remarkable job with the integration of refugees and the necessary medical assistance. Even societies with more resources at their disposal can learn from this. The city's administration outdid itself in this situation.

Both Mariupol and Linz have a history with periods of war, and Mariupol is currently facing tension. How can entrepreneurs and industry leaders still provide stability under such circumstances?

Luger: Besides being good managers, entrepreneurs and industry leaders should focus on bridging any gaps within our societies and make sure that no one is forced to the margins or left out. Without peace, there can be no wealth and no fair future.

VADIM BOYCHENKO MAYOR OF MARIUPOL

How important is this project for Mariupol?

Vadim Boychenko: Mariupol is a city with half a million inhabitants. There are two enterprises that are playing major roles, one of them is the Ilyich division, and the other is the Azovstal division. Both are owned by the Metinvest group. In total, the two divisions have more than 40,000 employees, and most of them are part of my city's population. Metallurgy and the metals industry are integral parts of the soul of Mariupol. This new project is a firm step into Mariupol's future – and into that of our country.

How would you describe Mariupol's development over the last five years?

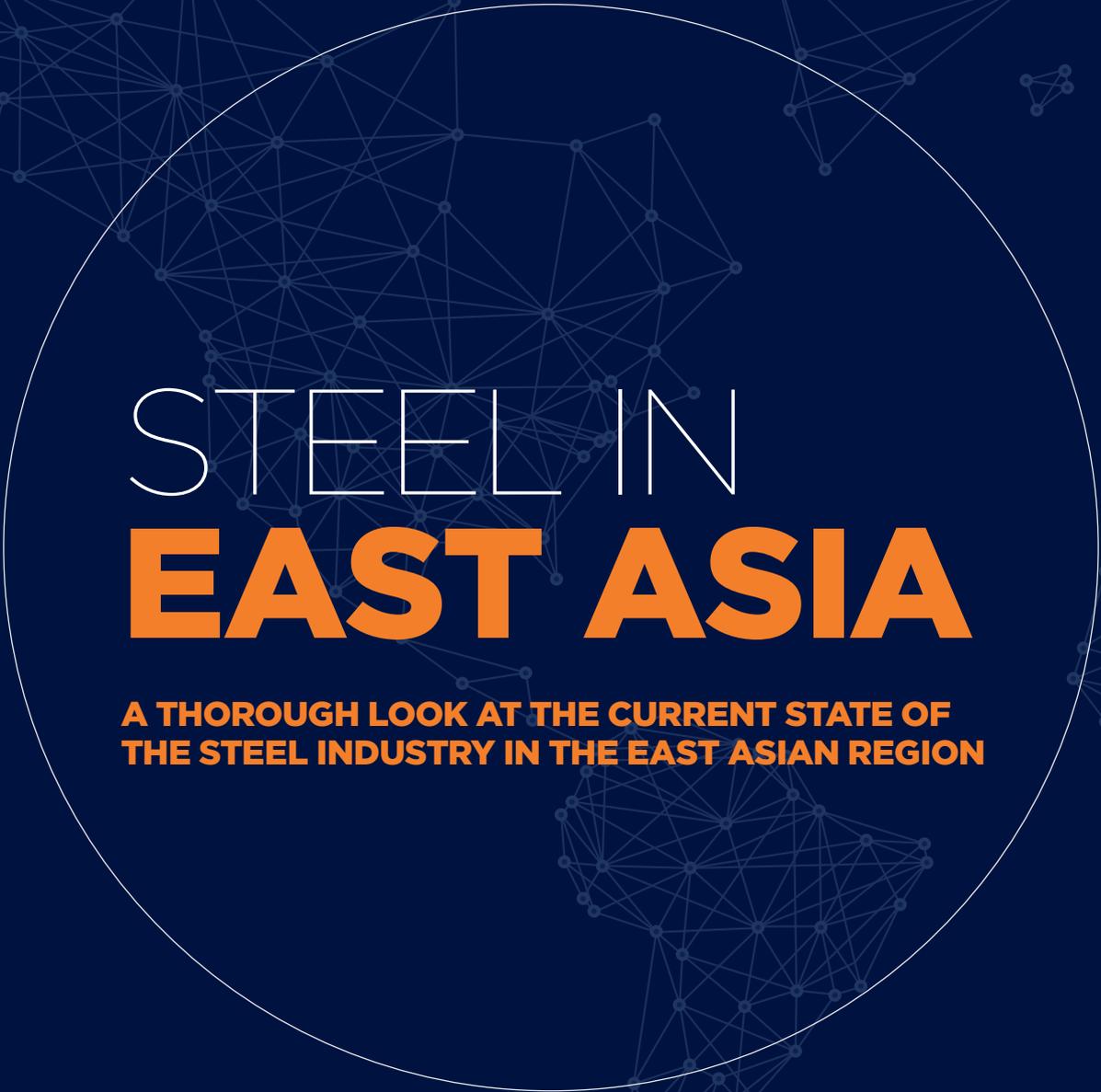
Boychenko: Mariupol is currently experiencing difficult times, just as Ukraine as a whole is facing a challenging situation. As you might know, the front line [of the ongoing military conflict] runs a bare 20 kilometers from Mariupol. We hope that the increased significance of the metallurgical operations will secure at least the number of jobs that we used to have in the past – and contribute to future growth.

Do international companies like Primetals Technologies help to further open up Ukraine?

Boychenko: Yes, absolutely. As we are improving our level of technological competence, our presence on the market will increase and become more prominent. A higher order intake will follow and strengthen us even more.

What goal do you have for Mariupol's inhabitants?

Boychenko: I would want our younger generation to firmly associate their future with the city of Mariupol and have an optimistic perspective. This is why a technological and cultural exchange is so important.



STEEL IN EAST ASIA

**A THOROUGH LOOK AT THE CURRENT STATE OF
THE STEEL INDUSTRY IN THE EAST ASIAN REGION**

East Asia is a of great relevance when it comes to the world's overall steel production capacity. In 2015, China alone manufactured nearly as much steel as the rest of the world combined. But also Japan, South Korea and Taiwan are playing important roles in their region. Consulting Editor Dr. Tim Smith takes a closer look at the East Asian steel industry.

“ Producers have now addressed overcapacity, which had resulted in a steep decline in prices.”

Dr. Tim Smith

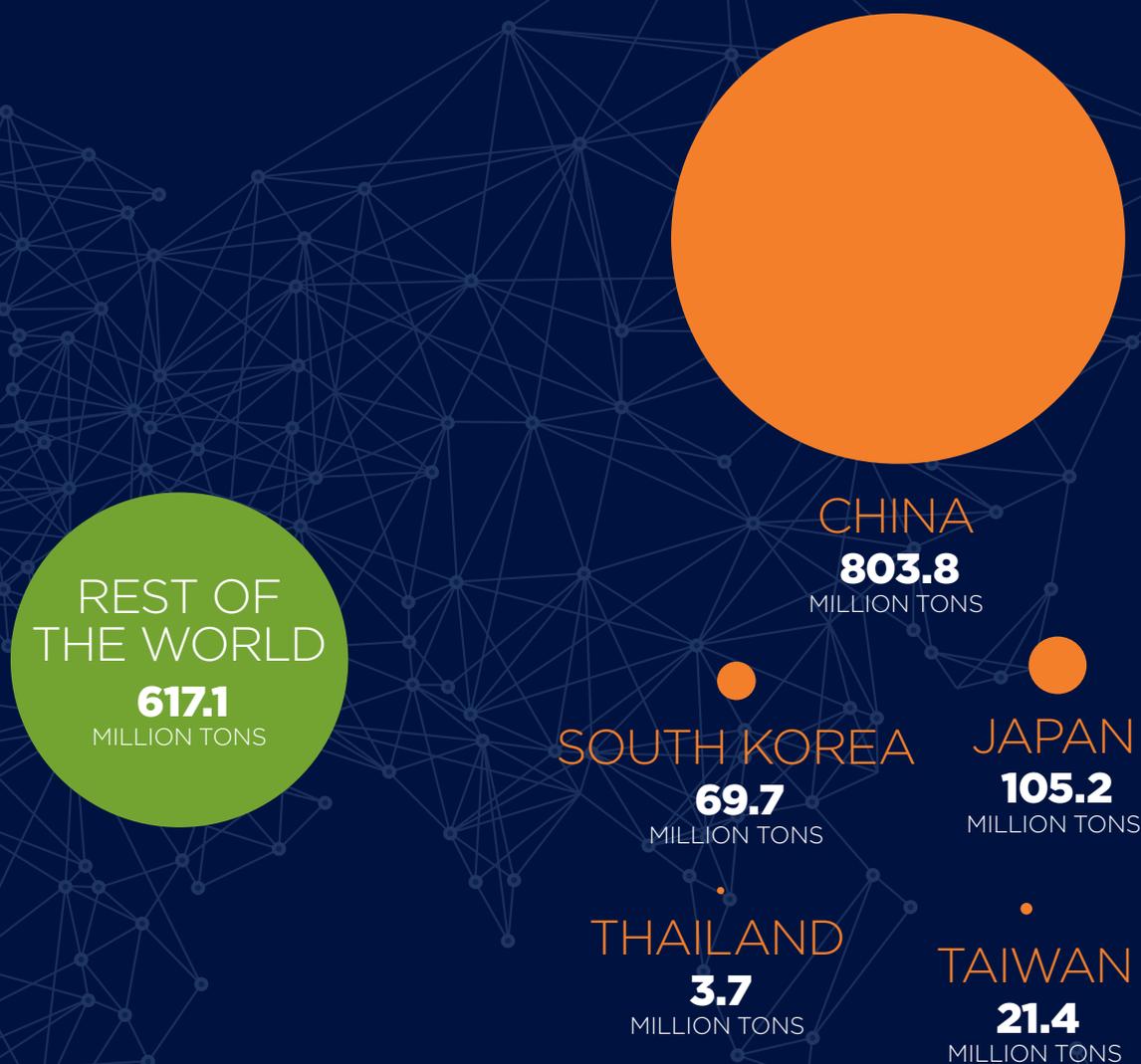


FIG. 1:

The cited figures in this article are based on *World Steel in Figures 2016*, published by worldsteel. In this illustration, "Rest of the World" depicts worldwide steel production minus East Asia.

Steel production in East Asia – and indeed the world – is dominated by the output from China, which in 2015 produced 803.8 million tons of crude steel that accounted for 49.6% of total world production. Nevertheless, there is a slowing trend in Chinese output, as the country produced 822.7 million tons in 2014 and is projected to make around 804 million tons in 2016 – based on the first eight months of the year.

This declining trend is reflected throughout all the major producers in East Asia, and, indeed, across the world. This is in response to addressing the issue of overcapacity, which has resulted in a glut of steel on world markets

and a corresponding decline in prices. Japan is the second-largest producer in the region, making 105.1 million tons of crude steel in 2015, down 5% on 2014, followed by South Korea at 69.7 million tons (-2.6%) and Taiwan at 21.4 million tons (-8%). There is little data available for North Korea, which is estimated to have produced 1.25 million tons in 2014 and no data for Mongolia. Neighboring producers in Southeast Asia – referring to worldsteel statistics for 2015 – are Vietnam (6.1 million tons), Indonesia (4.2 million tons), Malaysia (4.1 million tons), Thailand (3.7 million tons), Philippines (1.1 million tons), Singapore (0.54 million tons) and Myanmar (estimated 35,000 tons).



AT THE LIMIT

The export-driven and investment-led growth model that once propelled China's economic development has reached its limits.

An ERT-EBROS billet welding system from Primetals Technologies at Yongfeng Steel Company

CHINA

CAPACITY CUTS AND MERGERS

China's economy grew by 6.9% in 2015, the slowest in 25 years, as global demand ebbed. Following billions of dollars in government spending and a property boom in the country's top-tier cities, official data in recent months is starting to point to some stabilization in the economy. However, GDP in Q1 2016 fell further, and forecasts for Q3 project a growth of 6.7 to 6.8%.

China has become the world's second-largest economy. However, the export-driven and investment-led growth model that once propelled development has reached its limits. Emerging problems such as industrial overcapacity, high debt levels, pollution and sluggish global demand all weigh on growth. Instead of making any radical stimulus moves, China has resorted to supply-side structural reform to optimize its economic structure, cut industrial overcapacity, slash costs and boost efficiency.

The economy is now more balanced and driven more by consumption than investment. Consumption contributed to over 73% of China's economic growth in the first half of 2016, up 13.2% year-on-year. Torpid state-owned firms are undergoing modernization; steel, coal, power generation and other heavy industries are slashing capacity, and the government is ceding more power to the market.

China's desire to upgrade its manufacturing sector means lucrative business opportunities for multinationals. Foreign investment in high-tech services in China from January to June 2016 nearly doubled over the previous year. Chinese enterprises invested \$88.9 billion in 155 countries and regions from January to June 2016, surging 58.7% year-on-year. They created local jobs and helped upgrade local industries.

STEEL RESTRUCTURING

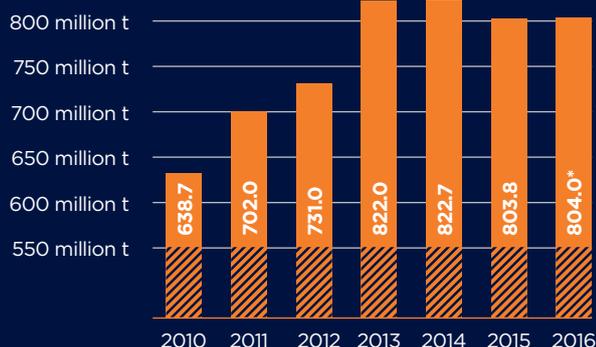
China's steel output is strongly biased toward the integrated blast furnace-converter route. Of the 803.8 million tons produced in 2015, 93.9% was produced in the oxygen converter and just 6.1% in electric arc furnaces. Of total production, 98.3% was continuously cast. China's steel industry has a production and processing capacity in excess of 1.5 billion tons.

Plans are underway to reduce this by 10% by 2020. In the past five years, capacity has been cut by over 90 million tons. In 2015, China closed 31 million tons' worth of iron and steelmaking plants, and intends cuts of 43 million tons during 2016. Reducing overcapacity is high on the central government's reform agenda, as excess capacity in steel and coal weighs on the country's economic per-

China's steel industry has a production and processing capacity in excess of 1.5 billion tons.

TABLE 1:

CHINA'S CRUDE STEEL OUTPUT 2010-2016 (MILLION TONS)



Source: worldsteel

*2016 estimate based on first 8 months

formance. Ironically, the cuts in coal capacity (101 million tons in 2015) have resulted in fairly significant pressure on the supply of coking coal, which has seen the price demanded by suppliers rise to \$200/t compared with \$92.5/t in Q3.

The Ministry of Environmental Protection has set up inspection teams to determine whether the country's steel sector is meeting state technology and emission standards. After visiting 1,019 steel companies, the inspectors found that 173 had broken the rules, with 62 involved in illegal construction.

MERGERS

In addition to capacity cuts, mergers between major steelmakers are happening. The merger of China's two major producers, Shanghai-based Baosteel Group and Wuhan Iron and Steel Group in Hubei Province, was approved by the State Council in September of 2016. In 2015, crude steel output at Baosteel was 34.94 million tons, with Wuhan having produced 25.8 million tons. This gave the newly merged company a total output in excess of that of China's HeSteel Group, to rank first in the country and making it the world's second-largest steelmaker, after ArcelorMittal.

TABLE 2:

CHINA'S TOP STEELMAKERS IN 2015 AND GLOBAL RANKING

World rank	Company	Crude steel (million tons)
2	Hesteel Group	47.8
5	Baosteel Group	34.9
6	Shagang Group	34.2
7	Ansteel Group	32.5
9	Shougang Group	28.6
11	Wuhan Steel Group	25.8
12	Shandong Steel Group	21.7
15	Maanshan Steel	18.8
18	Tianjin Bohai Steel	16.3
20	Jianlong Group	15.1
21	Benxi Steel	15.0

Source: worldsteel

In the latter part of 2015, the price of a ton of steel was lower than that of a ton of purified water.

Baosteel has vowed to cut steel production by 9.2 million tons between 2016 and 2018, and make product upgrading the priority in the restructuring drive. Next on the agenda is the restructuring of Ansteel and Benxi Steel Group, both based in the northeastern province of Liaoning. Ansteel Group Corp is China's fourth-largest steelmaker by output, making 35.2 million tons in 2015, while Benxi made 15.0 million tons. Although the merger stalled in early 2016, it was expected to be completed by the time this article would be published.

Mergers of steel mills are not uncommon in China. Hebei Iron and Steel Group was formed by the merger of Tangsteel and Hansteel in 2008, while Ansteel is the result of the combination of Anshan Iron and Steel Group and Panzhihua Iron & Steel Group in 2010. The State Council has stated that by 2025, 60% to 70% of China's steel output is to be produced by about ten large steel groups, including three to four groups with an annual capacity of 80 million tons, six to eight with an annual capacity of 40 million tons, and some specialty-steel groups.

PROFITABLE STEEL

China's steel industry improved its profitability in the first seven months of 2016 due to rising steel prices. Despite sales revenues of 373 steel companies falling 11.91% to 1.5 trillion yuan (\$225 billion) during the period, their profits hit 16.3 billion yuan (\$2.39 billion). However, market demand remains tepid, with steel consumption falling 3.6% year-on-year in July.

North China's Hebei Province, home to a quarter of China's steel manufacturing, reported strong profit growth in the first half 2016 after a drastic price drop in 2015. Steelmakers in the province made 15 billion yuan (\$2.2 billion) in profits in the first six months, up 181% year-on-year. The profit margin stood at 3.02%. 63 of 78 steelmakers surveyed in the province were profitable during this period, an increase of 15% year-on-year.

In the latter part of 2015, the price of a ton of steel was cheaper than that of a ton of purified water, due to serious overcapacity and sluggish demand amid a slowing economy.

SELECTION OF RECENT CONTRACTS RECEIVED BY PRIMETALS TECHNOLOGIES IN CHINA

Baosteel Zhanjiang Iron & Steel Co. Ltd.

The continuous galvanizing line (CGL) processed the first coil at the end of March 2016.

Baoshan Iron & Steel Co. Ltd. (Baosteel)

Modernization of a 20-year-old DC twin electric arc furnace at its Shanghai plant

Shandong Iron & Steel Group Rizhao Co., Ltd.

Order of two twin-strand continuous slab casters

Shandong Iron & Steel Corporation Ltd (Shansteel)

Order of a Selective Waste Gas Recirculation (SWGR) system from Primetals Technologies for its new sinter plant in Rizhao, Shandong Province

Shandong Laigang Yongfeng Steel Corp. (Yongfeng Steel)

Contract for the supply of ERT-EBROS endless rolling technology for the company's existing bar rolling mill in Qihe, Shandong province

Yongxing Special Stainless Steel Co., Ltd.

Supply of a new combination mill for the rolling stainless bars, bar-in-coil and wire rod

Tangshan Iron and Steel Group Co. Ltd. (Tangshan Steel)

Supply of two continuous galvanizing lines

Zenith Steel (Changzhou Zhongtian Iron & Steel)

Revamp of wire-rod mill

Baosteel Zhanjiang Iron & Steel Co. Ltd. (Baosteel Zhanjiang)

Order for a new Mulpic (Multi-Purpose Interrupted Cooling) system for a plate mill

JAPAN

HIGH YEN HITS EXPORTS

Crude steel production in Japan reached 105.2 million tons in 2015, and is set to reduce to around 105 million tons in 2016, based on the first eight months of the year. In recent years, output has been falling since 2014, following a peak in production of 120.2 million tons in 2007. In 2015, 77.1% of output was by the integrated blast furnace-converter route and 22.9% by electric arc furnaces. Continuous casting accounted for 98.1% of production.

Japan is the second-largest producer of steel in the world, after China, and the world's third-largest economy. The merged company Nippon Steel & Sumitomo Metal Corp. ranked the third-largest steelmaker in 2015, producing 46.37 million tons.

Japan's steel demand declined by 10 million tons in 2015 year-on-year or 15%. Production dropped by 5 million tons while imported steel also contracted by nearly 700,000 tons. Exports increased by 14% year-on-year or around 500,000 tons to 40.4 million tons. The first quarter 2016 saw a decline in profits for Japan's industrial sector, reflected in an 18% fall in the Tokyo Stock Exchange.

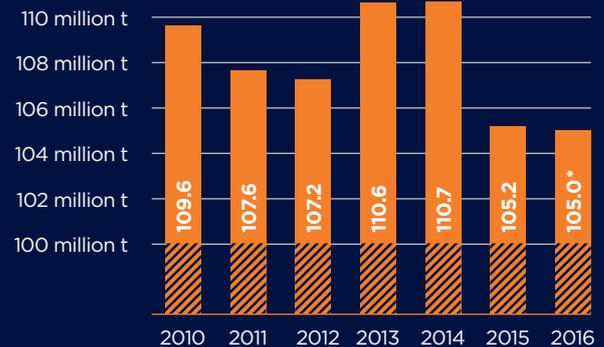
Appreciation of the yen by 11% against the U.S. dollar in April through June 2016 became an increasing negative factor for exporting industries that saw exports of steel fall to 18.6 million tons in the first five months of the year. This was a decline of 3.3% over the same period 2015, while steel imports reached 12.7 million tons, meaning an increase of 4%. All the major steel companies reported losses in Q1 (April through June) 2016. Nippon Steel & Sumitomo Metals Corp. saw a current account loss of 12 billion yen (\$111 million), and JFE Steel a loss of 13.3 billion yen (\$123 million).

However, steel companies are expecting an improvement overall for fiscal year 2016, as steel prices have started to rise both in the domestic and export markets. By June, the spot market for hot-rolled coil in East Asia had improved 20% to \$360/t from its 12-year low experienced at the close of 2015.

However, exports in July suffered their sharpest monthly fall in seven years, dropping 14%, as the yen continued to appreciate. Shipments of steel, cars and ships all fell, but imports dropped 25%, leaving a trading surplus for the month of 513 billion yen (\$1.5 billion), the largest since 2009. In August, exports rose 2.3% to 3.5 million tons, but crude steel output fell marginally (0.65%) to 8.9 million tons from the July figure.

TABLE 3:

JAPANESE CRUDE STEEL OUTPUT 2010-2016 (MILLION TONS)



Source: worldsteel

*2016 estimate based on first 8 months



The UCM-Mill from Primetals Technologies guarantees excellent gauge and shape control.

RECENT CONTRACTS RECEIVED BY PRIMETALS TECHNOLOGIES IN JAPAN

JFE Steel Corporation

Primetals Technologies was entrusted with an order for a combination mill.

JX Nippon Mining & Metals Group

An order for a UCM-Mill for copper foil was received by Primetals Technologies from JX Nippon Mining & Metals Group.

SOUTH KOREA

AN IMPROVING POSITION

In 2015, South Korea produced 69.7 million tons of crude steel, a fall of 2.6% from 2014, but an increase on years prior to that. 2016 is likely to see the decline continue with an estimated output of 67.8 million tons based on eight months of production. In 2015, 69.6% of output was via the integrated route and 30.4% by electric arc furnaces. 98.6% of steel was continuously cast.

South Korea had the highest apparent steel use per capita in 2015, followed by Taiwan at second, Japan at fourth, and China at fifth.

South Korea is the third-largest steel producer in East Asia. Its oldest established integrated company, POSCO, ranked fourth in world production in 2015 with an output of 41.97 million tons. POSCO's largest integrated competitor, Hyundai Steel, produced 20.48 million tons.

POSCO is expected to make an operating profit of \$800 million in the third quarter 2016, thanks to a recovery in global steel prices resulting from downscaling by Chinese rivals, and the company's own cost-saving measures. This is up 33% for the same period 2015 and up 28% from the previous quarter. It is the highest quarterly profit in two years. Profit for 2016 may exceed 3 trillion won (\$2.67 billion), nearly double that of 2015.

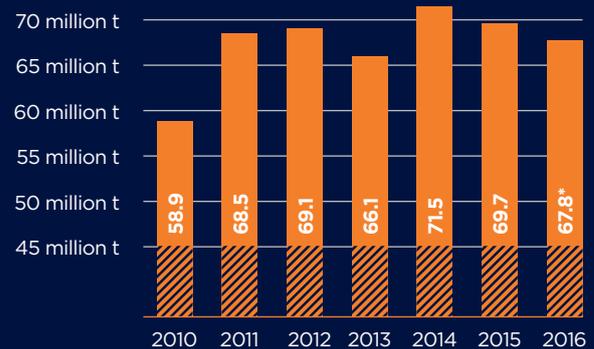
The company's affiliates at home and abroad have also improved, but POSCO's patience seems to have run out regarding its plan to build a 12 million t/a integrated plant in Odisha, India, using the Finex process, which it first launched in 2007. The company decided not to renew its environmental permits after almost ten years in the planning.

While Hyundai Steel Co. is expected to post a significant jump in operating profits for Q2 2016, up 51%, the company has over 5 trillion won (\$4.45 billion) in current liabilities. However, its bonds are graded AA, as it is backed by Hyundai Motor Company and Kia Motors.

Dongkuk Steel (an electric-arc steelmaker, and plate and long-products roller) has close to 3 trillion won (\$2.67 billion) in current liabilities and assets of 1.6 trillion won (\$1.42 billion). Dongkuk bonds are graded BB.

TABLE 4:

SOUTH KOREAN CRUDE STEEL OUTPUT 2010-2016 (MILLION TONS)



Source: worldsteel

*2016 estimate based on first 8 months



Blooms produced at Hyundai's Dangjin plant

ACTIVITIES OF PRIMETALS TECHNOLOGIES IN SOUTH KOREA

Hyundai Steel

A continuous bloom caster, a large bar rolling mill and a small bar and wire rod mill started up at the new special steel mill in Dangjin.

Finex: A Joint Development Effort

Finex, a proven alternative ironmaking technology to the blast furnace, was jointly developed by Posco and Primetals Technologies. Molten iron is produced from ore fines and non-coking coal at reduced costs and lower environmental impact than the blast furnace.

TAIWAN RETURNING GROWTH

Taiwan produced 21.37 million tons of crude steel in 2015, an 8% fall from the 2014 figure, but is on target to grow output to 21.7 million tons in 2016. 62.4% of output in 2015 was via the integrated route and 37.6% by electric furnaces. 99.6% of output was continuously cast.

China Steel Corporation, Taiwan's largest and first integrated producer, made 14.82 million tons in 2015.

Taiwan faced a slowdown in steel demand in 2015, declining 2.6% year-on-year to 18.3 million tons. Domestic production decreased 8%, exports fell 5% to 10.4 million tons, and imports dropped 13.5% to 3.7 million tons compared to 2014.



Blast furnace supplied to Dragon Steel

SUCCESSFUL BLAST FURNACE OPERATION AT DRAGON STEEL

In February 2010, Dragon Steel Co. became the second integrated producer in Taiwan with the start of No. 1 Blast Furnace at the Taichung Works. Designed and supplied by Primetals Technologies, the furnace is rated at 2.5 million t/a. After more than five years of consistent, trouble-free operation, more than 14 million tons of iron have been dispatched to the steel plant to date. Complemented by the similar-sized No. 2 Blast Furnace commissioned three years later, both ironmaking plants continue to exceed their rated production capacity.

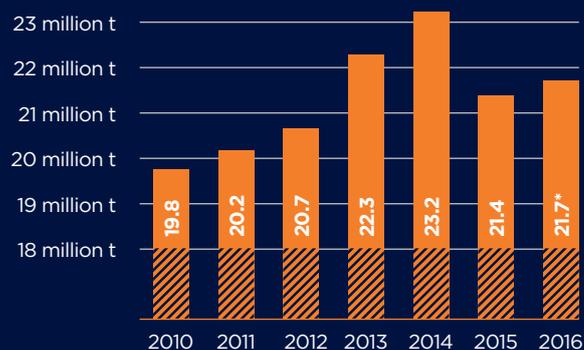
CUTTING-EDGE IRONMAKING TECHNOLOGIES FOR EAST ASIA

Primetals Technologies is the only global provider of the complete spectrum of technological solutions and automation systems for ironmaking plants. Its portfolio of ironmaking equipment, which features the know-how acquired from decades of experience, includes:

- Hybrid Flotation Technology – An innovative technology for processing low-grade ores
- Circular Pelletizing Technology – The world's most compact pelletizing solution
- Sinter plant – High performance and environmentally friendly sinter production
- Blast furnace – Process and cost optimization from a single source
- Corex – Cost-efficient and environmentally friendly cokeless ironmaking
- Finex – Highly cost-efficient ironmaking based on iron ore fines and non-cooking coal
- Midrex – the world's leading DRI production process

TABLE 5:

TAIWANESE CRUDE STEEL OUTPUT 2010–2016 (MILLION TONS)



Source: worldsteel

*2016 estimate based on first 8 months

THAILAND

RECYCLING SCRAP

Thailand produced 3.718 million tons of steel in 2015, down 9.2% from 2014. It is on target to increase output to 4 million tons in 2016.

Steelmaking is by the electric arc furnace route, and the country is the second-largest scrap consumer in the region. Total scrap demand of 3.9 million tons represented a decline of 9.3% year-on-year in 2015. Domestic supply increased slightly, by 1.3% year-on-year to 3.4 million tons. Imports dropped substantially, by 31% year-on-year to 949,340 tons in 2015. Major import sources were U.S.A, Australia, Philippines, South Korea and Japan.

Scrap exports were quite significant at 397,457 tons, which was a moderate increase of 3.6% year-on-year in 2015. Thailand exported scrap to various countries, and major destinations were India, Indonesia, Japan, China, South Korea and Laos. Thailand is a manufacturing hub for other important steel consuming sectors such as the automotive and electrical appliance industries.



A Morgan Reducing/Sizing Mill from Primetals Technologies in a wire rod mill

RECENT CONTRACTS OF PRIMETALS TECHNOLOGIES IN THAILAND

Revamp of NTS Arc Furnace

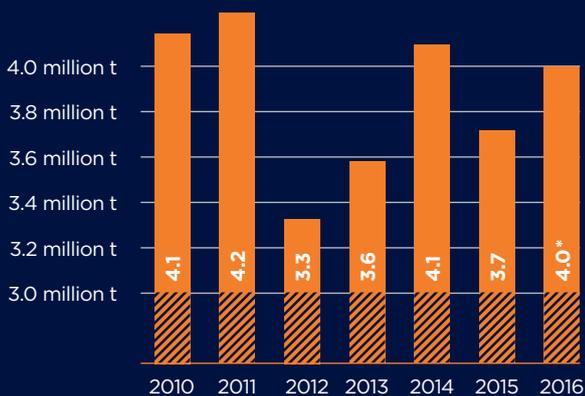
A 76 ton capacity electric arc furnace of N.T.S. Steel Group Public Company Ltd. is currently being modernized by Primetals Technologies at Chonburi. The furnace is being equipped with a new electrode control system, the Foaming Slag Manager and a Refining Combined Burner. The target of the furnace upgrade is to lower electricity consumption by 4% and electrode consumption by 17%. These improvements will contribute to a reduction of tapping times, increased furnace productivity and lower specific production costs.

Kobelco Millcon Bar Mill Upgrade

To increase the supply of special steel products, Kobelco Millcon Steel Co., Ltd. is modernizing a wire-rod mill in Rayong, Thailand with equipment supplied by Primetals Technologies. When completed in May 2017, the Thai mill will supply steel rods for automotive parts. Upgrades to the mill include a new mill-stand gear drives, water boxes, pinch rolls and laying heads, and the latest-design stepless reform. In addition, Primetals Technologies will install a Morgan Reducing Sizing Mill with a quick-change feature to produce thermomechanically rolled products and improve tolerances, mechanical properties and coil packages. Speed guarantees for the 480,000 t/a mill will be 110 m/s, with a maximum rolling rate of up to 120 t/h.

TABLE 6:

THAI CRUDE STEEL OUTPUT 2010–2016 (MILLION TONS)



Source: worldsteel

*2016 estimate based on first 8 months

Steelmaking in Thailand is by the electric arc furnace route, making the country a major scrap consumer.



China's desire to upgrade its manufacturing sector means lucrative business opportunities for multinationals.

REFLECTING ON CHINA

2016 saw China host the G20 meeting in September in Hargzhou city, the first time the country has hosted this prestigious event. Addressing the meeting, Chinese President Xi Jinping reassured the world's business leaders that China can achieve strong growth, would not backslide on structural reform, and would open up to business activities.

China's desire to upgrade its manufacturing sector means lucrative business opportunities for multinationals. As a consequence, foreign investment in high-tech services in China from January to June 2016 nearly doubled over the previous year.

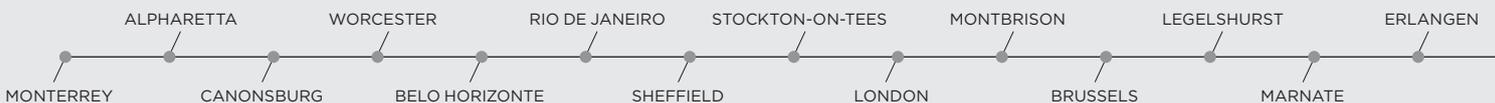
As an example of China's massive investment in infrastructure, in September 2016, a ceremony was held in Zhuhai to celebrate completion of the 55-km cross-sea route between Hong Kong and Zhuhai on the Chinese mainland. More than 400,000 tons of steel are used for the 6.7 km immersed tube tunnel and 29.6 km bridge, which links artificial islands. Construction began in December 2009 at Zhuhai. The bridge starts from Lantau Island in Hong Kong with branches to Zhuhai and Macau. Only road surfacing and related work remains to be completed. Before the project, the 36.48 km bridge across the mouth of the Jiaozhou Bay in eastern Shandong Province was considered to be the world's longest cross-sea bridge.

A UNIQUE LEGACY OF **CRAFTSMANSHIP**

**A PORTRAIT OF THE HIROSHIMA WORKSHOP OF PRIMETALS
TECHNOLOGIES, ITS PRODUCTS, AND ITS PEOPLE**



HIROSHIMA IS THE SPOTLIGHTED COMPANY LOCATION IN THIS ISSUE OF METALS MAGAZINE



Among the numerous locations of Primetals Technologies, Hiroshima holds a special significance. This is particularly true for the site workshop, which serves as a center of manufacturing for Japan and abroad. The workshop generates products of the highest quality for all customers, and its workflows are designed to ensure a constant refinement of everything it creates. *Metals Magazine* editor Dr. Thomas Widter visited the place to discover what makes this workshop – and its people – so very special.

"I bet you could easily eat off this spotless floor." – This is what we just can't help thinking as we step into the Hiroshima workshop of Primetals Technologies for the first time. And indeed, while the facility has certainly been designed for purposes other than dining, the level of cleanliness could hardly be higher. The workshop makes the best first impression possible, and the surroundings also contribute to an overall sense of restrained splendor.

It is a beautiful summer's day, complemented not only by a glaringly powerful sun, but also by the high humidity levels so typical for the region. When driving to the workshop, we had made our way through a large and complex area comprising not only the Hiroshima operations of Primetals Technologies, but also some of the buildings of the mother company Mitsubishi Heavy Industries. The roads are designed as wide-spaced alleys with trees on both sides. It is a beautiful look, calm and unpretentiously tasteful. Even though there is a slight feeling of "only two more weeks until the main summer vacation" in the air, the atmosphere is one of composed professionalism.

MEETING THE PEOPLE

There is, of course, a reason behind the high standard of tidiness and the sense of order on display in the workshop, as our guide and Senior Engineer Shuhei Aso points out to us. Actually, there are even two reasons: Firstly, the entire workshop is run in a way that ensures the highest safety standards possible for all personnel, and one factor that contributes to achieving this goal is keeping everything neatly organized and thoroughly clean. "We have not had an accident for 2,361 days," Aso says. Not only he, but the entire team is incredibly pleased with that fact. There is even a board counting the "Days

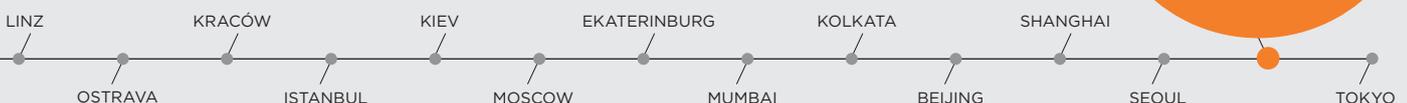
Since the Last Accident," which at the time of our visit had accumulated over six years' worth of operation time.

The second motivation for keeping the workshop a tightly run ship is the high standard of excellence that everybody strives for. This is not only evident in the outer manifestation of the workshop and the impression its looks create, but also the philosophy behind it. Anyone starting to work at the Hiroshima site of Primetals Technologies will learn to aspire to perfection, as Masakazu Yamamoto, manager of the Assembly Group, explains: "After one of our products gets delivered to the customer, I always make sure that everything is to their satisfaction. This kind of perfection corresponds to a value-set that I learned as a young trainee, and I feel it is important to pass these values on to my younger colleagues today, as it is the heritage of our Hiroshima workshop." Another impressive aspect of the Hiroshima operations is the great amount of consideration its employees have for one another, especially toward their subordinates. Everyone responsible for a smaller group of workers will ensure their growth in skill and expertise over many years of personal development. Masakazu Yamamoto is passionate about ensuring the best-possible training for his staff: "Properly educating the members of my team is very important to me. I like to pair a younger person with a more experienced one, so they can learn from one another. They will also be sent to external seminars together. After these sessions, the younger worker will receive a certificate issued by the Japanese government."

"It is vital that every single employee reaches an exceptional training level," emphasizes Toyoharu Yoshikawa, one of the on-site team leaders. "Great technical skill >>

HIROSHIMA

The Hiroshima location of Primetals Technologies features a workshop where a large variety of products for the steel industry is engineered and manufactured.





Our guide and senior engineer Shuhei Aso shows us the way through the workshop.



At the time of our visit, the facility had seen a full 2,361 days of accident-free operation.



Workshop manager Masakazu Yamamoto and team leader Toyoharu Yoshikawa

and know-how, but also a good personality and character are required, so that everyone can represent our company toward our customers. I will have in-depth talks with every person I am responsible for, and will provide them with detailed feedback on how they can improve their everyday work. This way, each worker learns to perform their job in the best possible way."

INSPECTING THE PRODUCTS

So what kinds of products are made at the Hiroshima workshop? As you might have guessed, they are quite diverse and cover almost the entire range of parts (both spare and new) that today's steel producers require. During our visit at the site, we picked out a few products that seemed particularly interesting (see below for an overview).

One product type that could be called a "specialty" of the workshop is the housings for hot-strip mills, which are not forged but welded. They feature an outstanding price-performance ratio. Crafting these housings requires extreme precision, because the surface must be absolutely even. For this reason, the Hiroshima workforce is distinctly proud of this product category. Other products constructed at the Hiroshima workshop include sizing press crank shafts and main gear boxes for width reduc-

tion, components for the main cylinders of cold-strip mills, and inner housings for HZ mills.

But whatever the product the team at the Hiroshima workshop will be working on, it will have two common characteristics: It will have been manufactured to the highest standards, and when the time for installation comes, it will be fine-tuned by expert hands. Should it be called for, workshop manager Masakazu Yamamoto tends to send a specialist from the Hiroshima Assembly Group to the customer's site to provide assistance. "Everything will be checked with great care, and any on-site findings will be thoroughly reported back to our group, taken into consideration and well discussed," Yamamoto details. "Creating this kind of feedback cycle ensures a constantly ongoing refinement of our product assembly and greatly contributes to overall customer satisfaction."

When asked about whether there is a motto that they live by, the workers will state that they adhere to a three-stage practice when encountering more complex challenges. The first step they will take is to go on-site where the issue can be directly examined. The second is to look for the facts "with honesty," thereby leaving any presupposed notions about what might be the case behind. The

PRODUCTS

At the time of our visit, a broad range of products had just been finished and was getting ready to be shipped to the customers' sites. As we can only present a selection of the total portfolio, we have picked some of the more visually striking products.



HOUSING OF A HOT-STRIP MILL THAT WAS CRAFTED FOR AN INDIAN CUSTOMER



SIZING PRESS CRANK SHAFT AND MAIN GEAR BOX FOR WIDTH REDUCTION

“ Every single product created in the Hiroshima workshop is manufactured to the highest standards, and when the time for installation comes, it will be fine-tuned by expert hands.”

third one is to then focus on the actual findings and to tackle the task at hand accordingly. This way, the best possible approach to improve the technology at work can be ensured. At the core of this method is the idea of constant refinement, with the goal of delivering products of ever-higher quality to the customer.

THE FABRIC OF HIROSHIMA

When talking to the workers in Hiroshima, one gets a sense of the fabric that the place is made of. It is a place rich in history. Not only is the city known for having had to endure the devastation caused by the atomic bomb during the Second World War, but also for its fast rebuilding, despite all obstacles it faced. Hiroshima is also rich in legacy, evident in both various cultural aspects of daily life and the craftsmanship to be found, for instance, at our workshop. Knowledge is passed down from one generation to the next with a strong sense of order and intergenerational harmony.

Of course, Hiroshima is also rich by virtue of the passions of its people. Two sources of personal pride you will often hear about are family and sports. Workshop team leader Toyoharu Yoshikawa will tell you about his three boys, who propel each other to become even more proficient swimmers. "Having children may be challenging at

times, but is also very fulfilling," he says. Masakazu Yamamoto informs us about the locals' enthusiasm about a certain kind of sport: "My personal passion is for the Carp, Hiroshima's professional baseball team. When I raise a toast, it will often be to the future success of the Carp. I like to cheer them at the stadium when they play. This year, the Carp made it to number one in Japan's Central League, which I am incredibly proud of."

During our revealing and extremely hospitable stay in Hiroshima, we have come to believe that it must have been the method of never-ending refinement that propelled the skills of the city's baseball team to the top. The players of the Carp must have trained with quiet professionalism. They must have played every single game with passion. And in doing so, they could not have made their entire home town more proud of its legacy. Staying on the site of the Hiroshima workshop, we got the feeling that the same was true for its workers, their craft, and their dedication to excellence. ●

The author wishes to thank Shinichi Yamashita, Michael Wöss and everyone mentioned in the text for their invaluable support in and around Hiroshima.



COMPONENTS FOR THE MAIN CYLINDERS OF COLD-STRIP MILLS (TO BE FINISHED)



SPARE PARTS FOR A SIZING PRESS, CREATED FOR A TAIWANESE CUSTOMER



INNER HOUSINGS OF AN HZ MILL, WILL BE PAINTED TO PREVENT OXIDATION



The most striking aspect of Hiroshima's Peace Memorial site is arguably the "Atomic Bomb Dome," intentionally left as a ruin.

HIROSHIMA PEACE MEMORIAL

At first sight, it might look like a ruin. And in a way, it is: The Genbaku Domu or "Atomic Bomb Dome," was the only building that remained standing close to the hypocenter where the atomic bomb hit Hiroshima on August 6, 1945. What you discover once you investigate the history of the building is that the remains have been intentionally left the way they survived the Second World War, if not completely without occasional controversy about a potential renovation. The building was originally designed by the Czech architect Jan Letzel as an exhibition hall and was completed in April 1915. The Dome's main use was that of arts and educational exhibitions, which, of course, was abruptly stopped by the bombing. In December of 1996, the Dome became part of the UNESCO World Heritage List on the Convention for the Protection of the World Cultural and Natural Heritage. The inclusion was made based on the fact that the building symbolized both the first use of nuclear weapons on a human population and the lasting peace that followed. Nowadays, the Dome is part of a large memorial site, entailing a dedicated exhibition building and an extensive park. In May 2016, the site of the Peace Memorial was visited by Barack Obama. He was the first U.S. President to officially come to Hiroshima since World War Two.

Hiroshima is rich in history and culture. The city's inhabitants have developed a dedication to perfection despite the hardships that they have had to endure.

HIROSHIMA TOYO CARP

The people of Hiroshima are incredibly proud of their city's well-known and well-respected baseball team. At the time of our visit to Hiroshima in the summer of 2016, the Carp had just made it to the Number One position within Japan's Central League for the first time in 25 years. The Carp had reached the top position several times before, with the first victory having taken place 30 years after World War Two had ended. But there had been years when the team had to endure a string of seasons with bad luck – a fact that makes the current success all the more satisfying. The team was established in 1949, with its identification colors being red and dark blue. The name stems from both the Hiroshima Castle, which is called "Carp Castle" in Japanese, and the hefty presence of carps in the Otagawa River that flows through Hiroshima. The team's primary owners comprise the Matsuda family with a 60% share and the carmaker Mazda with a 34% share. Between these two, a strong connection exists, as the Matsudas' ancestor Jujiro Matsuda was the entrepreneur who founded Mazda in 1920. Underlining this historic link, the Carp's full name to this day refers to the original name Mazda used until 1984, "Toyo Kogyo Company." While many employees of the Primetals Technologies workshop are among the team's most avid fans, its followers are generally spread all over Japan and innumerable. The high profile the Carp holds is richly illustrated in the ever-present merchandise one encounters when wandering through Hiroshima's shopping malls. Also, you will see many people in the streets of Hiroshima wearing Carp T-shirts. More information on the Hiroshima Carp can be found online at www.carp.co.jp/en/



The Hiroshima Carp's mascot is ever-present in Hiroshima. It can be found on countless merchandise items, posters and banners.

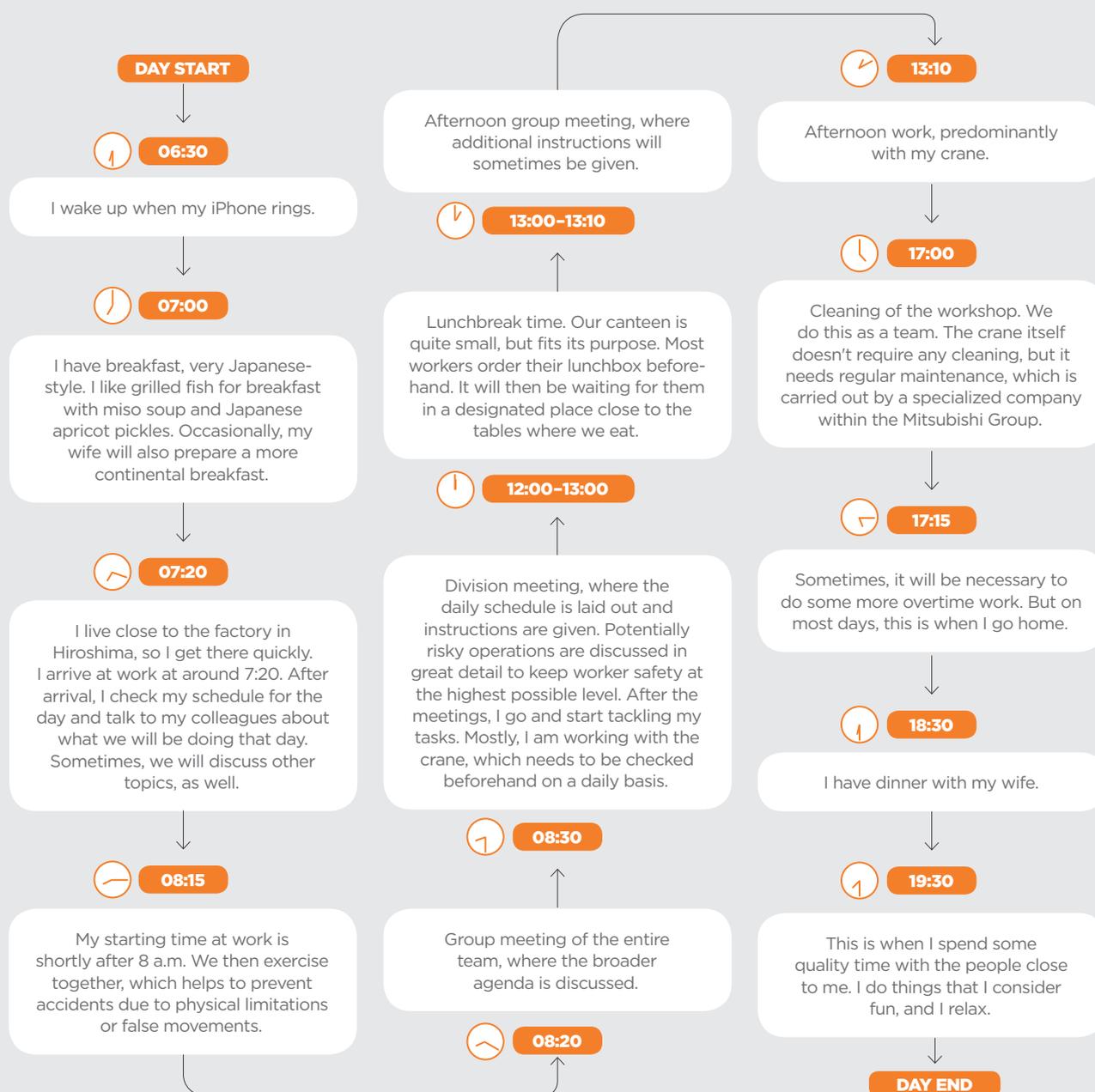


YUJI KAWABATA

As a crane operator at the Hiroshima workshop, Yuji Kawabata contributes to the assembling of many products.

A DAY IN THE LIFE OF YUJI KAWABATA

Metals Magazine has asked crane operator Yuji Kawabata to share with us what his typical work day looks like. He has been with Primetals Technologies (and its predecessor company) since 2008.



LEADING INNOVATION IN JAPAN

**INTERVIEW WITH DR. TAKEHIKO SAITO,
HEAD OF TECHNOLOGY AND INNOVATION
FOR COLD ROLLING AT PRIMETALS
TECHNOLOGIES JAPAN**

Dr. Takehiko Saito is one of the most distinguished inventors at Primetals Technologies. Over the last two decades, he has contributed to several dozen patent applications, chiefly in the area of cold rolling. He was part of the team responsible for the development of Cross Seam Welder technology, which is considered one of the major breakthrough welding solutions of recent years. We sat down with Dr. Saito to discuss his career, his innovations, and the nature of creativity.

DR. TAKEHIKO SAITO

Head of Technology and Innovation
for Cold Rolling, Primetals
Technologies Japan





“ I have come to believe that innovation is not so much country-specific, as it is dependent on the type of innovation that one wants to achieve.”

“ I think that ideas and innovations come together when there is a fusion of both a wide range of general knowledge and deep expert knowledge.”

How many patents or innovations have you been involved with during your career with Primetals Technologies and its predecessor companies?

Dr. Takehiko Saito: I have tried to count the patents that I have been involved with during my time at the predecessor companies of Primetals Technologies, namely Hitachi and Mitsubishi-Hitachi Metals Machinery. The number I got was a total of 44 patent applications over 20 years, of which 30 patents have been registered up until today. These patents are, of course, the achievement of not just myself, but the teams that worked on the various projects. In the case of one of my senior colleagues from the Technology & Innovation Department, the total I get is 80 patents in 35 years. And Dr. Hirai, the CTO of Primetals Technologies, has been involved with the patents for more than 130 items. So I think that I really should aim to engage in even more patents and innovations in the future.

What, in your opinion, was the most economically successful innovation for the company?

Saito: First, I should say that the technology I have been involved in has had a long history of innovation related to steelmaking machinery. While I have made certain contributions, there have been numerous areas that I was not directly engaged in. Having said that, I think that one of the most successful innovations is the Universal Crown Control Mill (UCM-Mill), including the High Crown Control Mill (HC-Mill), both of which I was not previously involved in, but today am so profoundly associated with. When I was looking for a job some 23 years ago, I visited Hitachi's Mechanical Research Laboratory and brought with me presentation materials from my academic background. I was aspiring to land a research position related to the rolling-machine business of Hitachi, because I was highly impressed with the innovations of the UCM-Mill and the HC-Mill. It was a true turning point in my life. I feel that there is a mission to continue to supply the brand and the

know-how that make up the UCM-Mill to the world, just as we inherited it from our predecessors, because the UCM-Mill is still the flagship technology of the cold-rolling mill.

Which innovation are you most proud of personally?

Saito: This would be the Hyper UCM-Mill and the Cross Seam Welder (CSW). These two products actually won the Technology Development Award from the Japan Society for Technology of Plasticity in 2011 and 2014. The Hyper UCM-Mill has dramatically improved the rolling performance of the standard UCM-Mill. It has the advantage of achieving a higher productivity while lowering the customer's capital expenditure. The CSW has substantially advanced the welding performance associated with more conventional mash seam welding machines. It allows for wider product specifications and has a larger market due to its very competitive price. I am particularly proud of the appreciation that the CSW has received. About a decade ago, a freshly founded team, consisting of Noriaki Tomi-naga, Shinichi Kaga, Mitsuru Onose and myself, conceived a new approach. It was called "Compact Continuous Cold-Rolling System," and the Cross Seam Welder was one of the central innovative components of the larger concept. There has, of course, been further research and refinement of the process around the CSW since its first inception. As of today, we have sold this technology twice and are expecting additional orders to come in soon.

Are most of your ideas and innovations the product of a persistent systematic approach, or do they generally occur as the result of chance or coincidence?

Saito: I think that ideas and innovations come together when there is a fusion of both a wide range of general knowledge and deep expert knowledge. This is necessary when someone tries to solve technical issues either continuously or intermittently. The question then becomes: how much time does it take to solve a problem? In »



“ I wrote down a quote from film director James Cameron in my notebook. It reads, ‘Failure is an option, but fear is not.’ This is a fantastic motto for innovators in my opinion.”

Japan, we have a saying that it takes the right “seeds” for certain “needs” to change into “wants.” If we apply this to the Cross Seam Welder, then its seeds were born during the first development steps of the Compact Continuous Cold-Rolling System. We then improved these seeds to fit the needs of our customers, and in doing so, we changed their needs into wants. Overall, this process took a decade, and I believe that having a continuous ten-year-long development process is important, particularly when the research process has different phases of varying intensity.

In your view, is creativity something that a person is born with, or is it something that can be fostered with proper training and education?

Saito: I would have to say “yes” to the second part of the question, as I believe that education plays a major role. The fusion of curiosity, creativity, basic knowledge and expertise leads to inspiration and concrete solutions. Dr. Clayton Christensen, a professor at Harvard Business School, lists in his work five essential skills that innovators have to have: associating, observing, questioning, experimenting and networking. Christensen suggests that it is possible to increase one’s abilities through active learning. Also, I think that it is an essential ability for creative people not to fear failure, but to seek new challenges instead. To remind myself of this, I wrote down a quote from film director James Cameron in my notebook. It reads, “Failure is an option, but fear is not.” In my opinion, this is a fantastic motto for innovators.

In many parts of the world, it is often just a single person or small group of people working together who generate innovative ideas – for example, Steve Jobs and Steve Wozniak, who assembled their first computers in a garage. Is it like this in Japan, or you do feel that Japanese ideas and innovations tend to be more consensus-driven and the result of a collective effort?

Saito: Again, I would turn to Dr. Christensen’s research to answer this question. In his work, he differentiates between two types of innovation, namely sustaining and disruptive innovation. Sustaining innovation is a business model in which the supplier provides continuously improved products to existing customers. If I apply the model of needs, seeds and wants again in this context, one could say that sustaining innovation requires the supplier to always strive to satisfy the needs of his higher-end customers. A collective consensus is then important, because it is necessary to satisfy the needs of existing customers by bringing together experience and knowledge. Disruptive innovation is a business model that sees the supplier providing a very affordable product that yields a high profit for new customers. So this would mean that these customers’ needs would have to be transformed into wants by the supplier’s seeds. One such disruptive innovation has been the minimill. This type of innovation is best attempted by small groups of people, as in your example of Apple, because there is an aspect that should not be judged by the existing sense of values. What I have taken away from Dr. Christensen’s work is that



DR. TAKEHIKO SAITO RESEARCHER AND INNOVATOR

Takehiko Saito was born in Fukushima Prefecture and raised in Yawata City, a comparably small town located in Kyoto Prefecture. Having acquired a Master's Degree in Mechanical Engineering at the Kyoto Institute of Technology, Saito started work at Hitachi, a predecessor company of Primetals Technologies, in 1994. Nine years later, Saito's department within Hitachi became part of Mitsubishi-Hitachi Metals Machinery (MHMM), where Saito investigated thickness and shape control methods in the ultra-low speed range, strip breakage initiated by a step around the welded part, and many other issues within the field of cold rolling. Importantly, Cross Seam Welder technology also originated at MHMM. Having become a specialist in the area of plastic deformation of metal and an expert in the rolling theory of cold rolling, Saito earned a Ph.D. from Nagoya University in 2014 for his studies on the application of a mash seam welder to continuous cold rolling. In 2015, both MHMM and Saito became parts of Primetals Technologies. Besides "all things cold rolling," Saito is passionate about recent developments in the area of virtual reality technology, which he would like to see become an integral part of the control pulpit of steel plants in the future.

innovation is not so much country-specific as it is dependent on the type of innovation that one wants to achieve.

Do you think that there are any aspects to Japanese innovation culture that are unique in the world?

Saito: I don't think so, and even if there was such a distinction, I would much rather attribute it to the idea of "diversity within a single world." However, I do think that "cool Japanese culture" is a unique trend in popular culture, and an innovative one at that.

Is there any singular inventor or scientist from the past that you particularly admire or who was been an inspiration to you?

Saito: To be honest, there is no one inventor who inspires me more than others. However, when I was a child, I was very aware of Thomas Edison's invention of the incandescent light bulb. This was because from 1880 to 1894, bamboo from my hometown of Yawata City was used for the filaments. It was said that these bulbs reached lifetimes of 1,000 hours and more.

What innovations or technical solutions are you working on right now that stand out from the rest?

Saito: I am trying to transform the Compact Continuous Cold-Rolling System into a disruptive innovation within the cold-rolling area. I cannot go into more detail here, but this development will come soon, once the needs change into wants on account of our new seeds. ●

QUALITY STARTS WITH THE ORE

**PRIMETALS TECHNOLOGIES OFFERS
A HOST OF BENEFICIATION SOLUTIONS
TO IDENTIFY THE MOST FEASIBLE
IRON- AND STEELMAKING
PRODUCTION ROUTE**

The efficiency of iron and steel production has always been decisive for producers to remain cost-competitive. It can be shown that the properties, cost and quality of iron ore are the most important factors that influence the overall efficiency of the subsequent iron- and steelmaking steps. Improving the quality of iron ore benefits the entire process chain. Primetals Technologies has therefore intensified its efforts and activities in the field of beneficiation to support producers to derive the maximum value from their ore. Practical simulation and calculation tools have been developed to assess the suitability of iron ore, and optimized beneficiation measures are proposed for more efficient iron and steel production.



The market is increasingly calling for detailed analyses and improvements at each step of the iron- and steel-making production chain. The drivers behind this development are the difficulties in ensuring profitability and the dwindling availability of high-grade raw materials at reasonable prices. In the past, the primary focus was placed on enhancing downstream production processes, however, upstream processes, in particular beneficiation, today offer many opportunities for profitable improvements. By enhancing the quality of lower-grade raw materials through beneficiation, downstream processes also become more viable.

Various production routes are available to transform iron ore into liquid steel, as shown in Figure 1. The selected route depends to a large extent on the quality of the iron ore, energy source and related costs. Assuming that these factors are equivalent for a certain region, the quality and properties of the available iron ore can usually be enhanced by applying the right technology, intensity and sequence of beneficiation steps. In general, iron ore beneficiation is done at the mining site. The concentrated

Improving the quality of iron ore benefits the entire process chain.

iron ore is subsequently sintered or pelletized, depending on the grain size distribution, before it is charged to an ironmaking plant. In cases where after the initial processing steps the iron ore fractions are of inferior quality (too fine or low iron content), the iron ore quality can be significantly improved by applying additional beneficiation measures. These may include comminution, classification, gravity separation, density separation, magnetic separation and/or flotation.

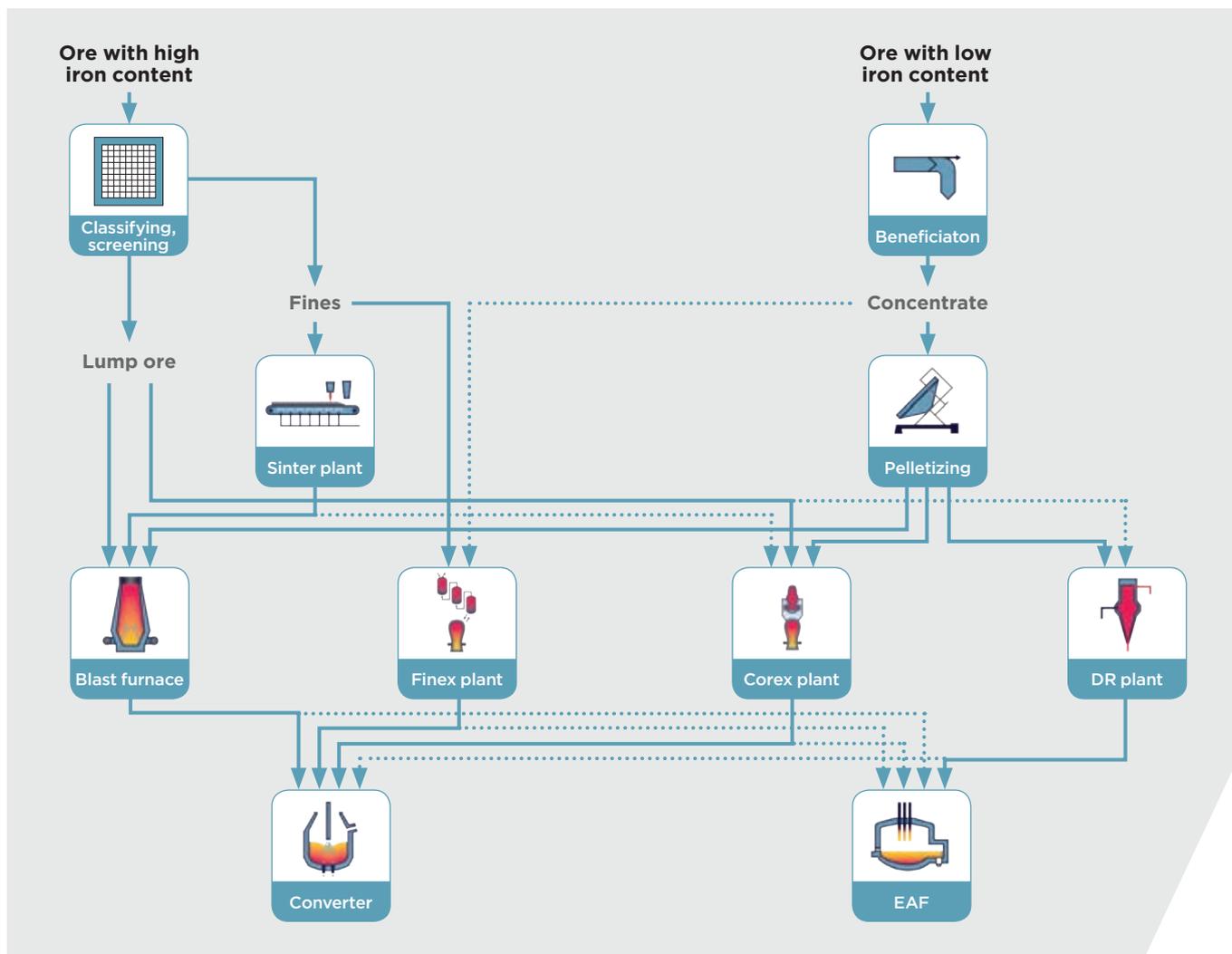


FIG. 1: Possible ore-based iron- and steelmaking process routes

At grain sizes below 100 μm , impurities such as silica and alumina are separated from the iron ore in a sequence of beneficiation steps, depending on the mineralogy of the iron ore. Removal of impurities from the iron ore is done prior to subsequent processing in pelletizing plants and direct-reduction plants. Otherwise, the impurities will simply pass on to the downstream production steps, resulting in higher energy requirements to melt the increased quantities of slag (where the impurities generally tend to concentrate). This may be in the blast furnace (thermal energy) or in the electric arc furnace (electrical energy). Especially in areas characterized by high costs for power, more attention is thus being focused on the benefits offered by iron ore beneficiation.

THE FUTURE IS ELECTRIC

The growing importance of using enhanced iron ores for steelmaking is exemplified by a recent trend in electric steelmaking. Most electric arc furnaces (EAF) are based on the use of scrap. However, with consideration to erratic scrap prices, particularly for high-quality scrap, many producers are considering using direct-reduced iron (DRI) as an additional or as the primary feed material for their EAFs. The DRI ironmaking route is also attracting the attention of many producers who already sell iron ore or pellets on the market and now want to increase the value of their products by selling hot-briquetted iron (HBI) as a merchant good. The use of high-grade ore to make high-grade DR pellets is a prerequisite for the production of high-quality DRI that is hot-compacted to HBI.

IDENTIFYING THE OPTIMUM ORE-BENEFICIATION PROCEDURES

Primetals Technologies has responded to the challenge of improving the quality of iron ore and has introduced a computer-based model that provides an initial analysis of the suitability of a particular iron ore for use in the steel-making process. The results of these analyses can be verified in practical tests with in-house testing facilities, or may be conducted elsewhere in the labs of customers, universities and research partners (Figures 2-3).

Testing facilities used by Primetals Technologies include lab- and pilot-scale beneficiation tests, as well as pellet pot and reduction tests. The tests are followed by a selection of the best overall process route, and the required beneficiation steps are defined. The goal is always to identify the most feasible route with consideration to the specific requirements of the customer.

BENEFIT FROM BENEFICIATION

Primetals Technologies supports its customers with detailed assessments of available ores and offers solutions to maximize ore value through beneficiation. As a highly experienced full-liner plant builder, Primetals Technologies integrates the complete production route from run-of-mine ore to liquid steel into a single entity with the highest efficiency and lowest-possible processing costs. »



FIG. 2: Hybrid Flotation testing rig of Primetals Technologies (ARP, Leoben, Austria)



FIG. 3: Agglomeration testing facility (ARP, Leoben, Austria)

By enhancing the quality of lower-grade raw materials through beneficiation, downstream processes also become more viable.

CASE STUDY NO. 1

Primetals Technologies proposed various upgrading measures to improve the efficiency of the beneficiation process at a Kazakh ironmaking plant. Existing equipment was utilized to the greatest extent possible. Improvement measures included the application of a clever slurry-handling and ore-treatment procedure, implementation of a more effective dewatering and filtering system, and the use of an innovative binding agent that reduced the quantity of required additives to produce ore pellets. These measures allowed the iron content of the iron ore concentrate and the resulting pellets to attain 69.2% and 66.5% respectively. All laboratory, pilot, and pelletizing test work was executed in the labs of Primetals Technologies in Austria.

CASE STUDY NO. 2

For an Indian customer with access to an untypical magnetite ore with an exceptionally high sulfur content, a feasible ore-processing route was identified that would allow iron ore pellets to be produced for use in the blast furnace. The study included solution measures for the beneficiation and pelletizing processes in order to reduce the sulfur content in the raw materials from up to 4% down to significantly less than 0.5% in the ore pellets.

The first induration trials conducted in pellet pot tests showed that the ore contains two different sulfur compounds, which are completely combusted at different temperature levels in the pellet bed. Due to the extremely high SO₂ load in both offgas ducts (hood exhaust and windbox exhaust), Primetals Technologies adopted a solution that combines thermal pretreatment in an early beneficiation stage to remove the "low-temperature" sulfur with an intelligent tailor-made process-gas routing for a circular traveling grate induration machine to remove "high-temperature" sulfur in a downstream DeSO_x plant.

CASE STUDY NO. 3

An Egyptian customer contracted Primetals Technologies to conduct a study related to the utilization of local low-grade iron ore for the production of direct-reduction-grade pellets. The ore is available at extremely favorable costs, however, its use for the production of direct-reduced iron (DRI) in a process route that includes beneficiation, pelletizing, DRI production and steelmaking still had to be carefully investigated in terms of technical and economic feasibility.

Ore samples sent to Primetals Technologies initially underwent physical, chemical and mineralogical analyses, which lead to the conclusion that beneficiation is mandatory due to the grain size distribution of the ore, low iron content and the high portion of undesirable elements. Following a series of beneficiation tests, it could be shown that the iron content in the final concentrate of the Egyptian iron ore would be significantly below 58%, which meant that the ore could only be sintered or pelletized for use in blast furnace ironmaking and that it



The goal is always to identify the most feasible route with consideration to the specific requirements of the customer.

could not be feasibly used in a direct-reduction process route. Furthermore, the exclusive use of local iron ore would have a negative impact on the operation and productivity of the blast furnace and downstream LD (BOF) steelmaking facility due to the unacceptably high percentage of phosphorous and manganese in the ore. Thus, blending of local iron ore concentrates with outside higher-grade iron ore concentrates containing a lower fraction of undesirable elements is required if the local iron ores are to be used.

CASE STUDY NO. 4

A Russian steel producer plans to install a pelletizing plant in order to substitute a portion of the sinter smelted in the blast furnaces with pellets. Currently, the beneficiation plant produces a magnetite concentrate that is

Use of high-quality pellets in ironmaking is a decisive factor for achieving outstanding ironmaking results and reducing environmental emissions



agglomerated in three older sinter plants, which are no longer capable of fulfilling the product quality requirements and environmental regulations.

Primetals Technologies was requested to determine the achievable pellet quality, the necessary design parameters of the induration machine and the waste gas emission rates based on the produced concentrate. Support was also provided to the customer for predicting the effects of a changing burden composition on blast furnace operation, as well as for feasibly coordinating the reduction in sinter capacity, modified beneficiation procedures and pellet capacity increase.

During the pelletizing pot tests, it could be shown that with minor adaptations in the beneficiation process, a

much higher pellet quality can be achieved. Based on the improved pellet quality parameters, the complete production route from beneficiation to hot metal could be visualized in the Integrated Steel Plant Optimization Tool of Primetals Technologies.* ●

*This tool allows different operational states to be reviewed and evaluated along the entire iron and steel production route, extending from plant construction and installation up to start-up and commissioning. Plant shutdowns as well as various project implementation scenarios can also be depicted.

Bernhard Hiebl, Process Engineer, Pelletizing

Jan Martens, Process Engineer, Beneficiation

Lukas Petzold, Process Engineer, Beneficiation

Reinhard Redl, Agglomeration, Sales

(All with Primetals Technologies Austria)

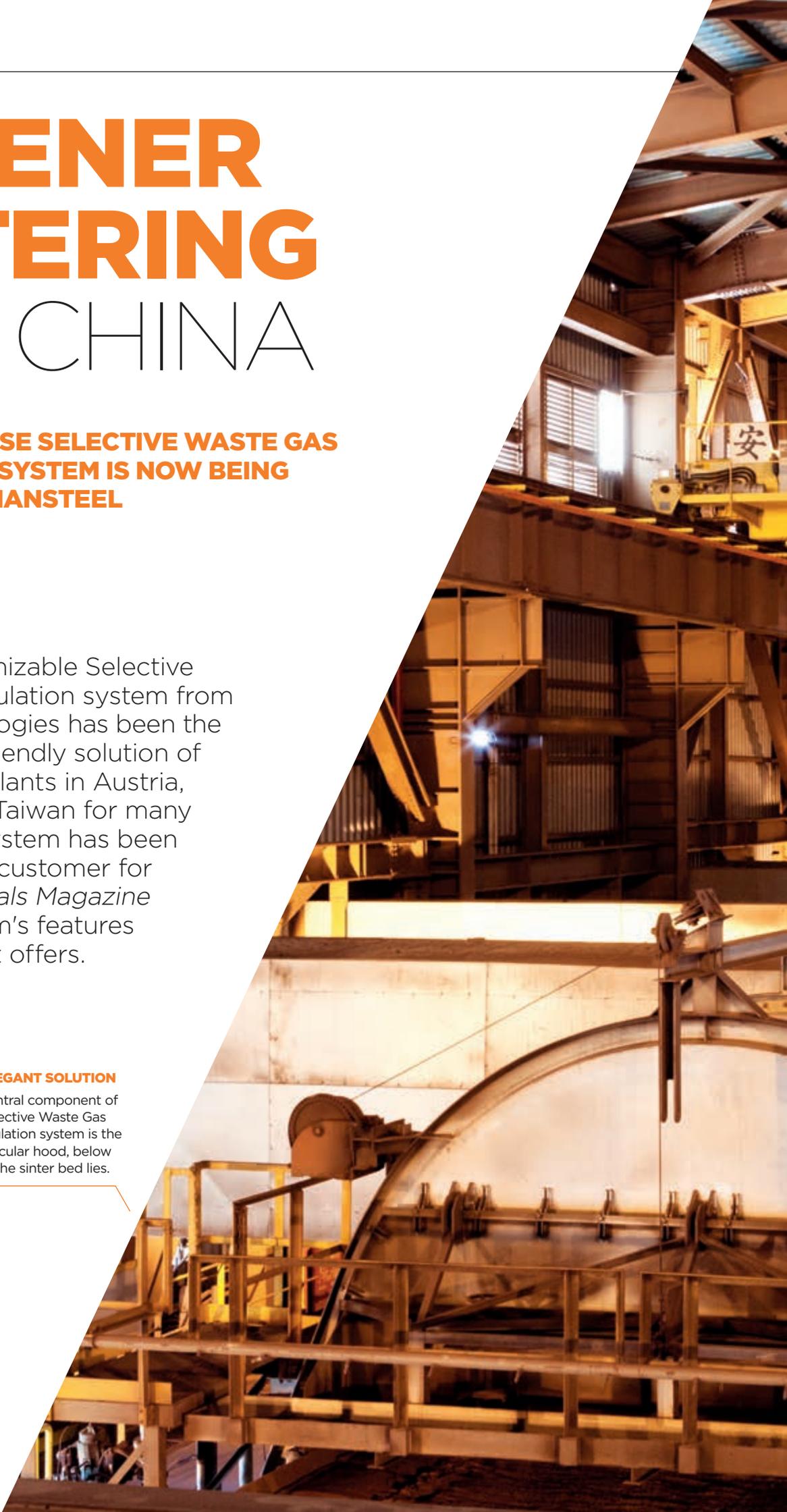
GREENER SINTERING FOR CHINA

**THE FIRST CHINESE SELECTIVE WASTE GAS
RECIRCULATION SYSTEM IS NOW BEING
INSTALLED AT SHANSTEEL**

This highly customizable Selective Waste Gas Recirculation system from Primetals Technologies has been the environmentally friendly solution of choice for sinter plants in Austria, South Korea and Taiwan for many years. Now, the system has been sold to a Chinese customer for the first time. *Metals Magazine* reviews the system's features and the benefits it offers.

AN ELEGANT SOLUTION

The central component of the Selective Waste Gas Recirculation system is the semicircular hood, below which the sinter bed lies.





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Chinese integrated steel producer Shandong Iron & Steel Corporation Limited (Shansteel) has recently ordered a Selective Waste Gas Recirculation (SWGR) system from Primetals Technologies for its new sinter plant in Rizhao, Shandong province. It is the first order that Primetals Technologies has received from the Chinese mainland for this well-proven environmental solution for sintering plants. Several units have already been installed in Austria, South Korea and Taiwan, which have successfully demonstrated the positive impact on environmental emissions and operational costs.

Shansteel is a state-owned company and listed as one of China's top ten steel producers. It manufactures and sells various kinds of steel products such as plates, hot-rolled coils, cold-rolled coils, H sections, high-quality steels, special steels, hot-rolled ribbed bars and many more. The company is headquartered in Jinan City, Shandong Province. Shansteel ordered the SWGR for its new Rizhao-based plant, which will largely be dedicated to serving some of the most demanding automotive companies. The strategic target behind the construction of this new steelmaking facility is to enable Shansteel to discontinue using several older production sites in Shandong province that no longer fully meet today's environmental standards.

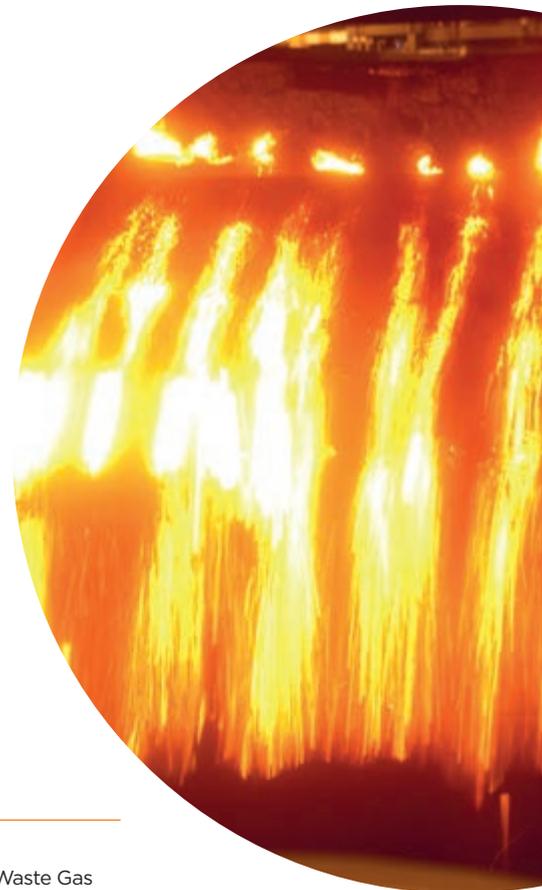
UP TO 40% RECIRCULATION RATE

The new sinter plant will consist of two 550 m² sinter strands, which will be installed in two construction phases. With a waste-gas recirculation rate of up to 40%, the SWGR reduces waste gas emissions to the atmosphere by 770,000 m³ per hour. Additionally, coke consumption stemming from the sintering process is decreased by approximately 5%. Due to the lower waste-gas flow rate, downstream gas-cleaning facilities can be designed with 30% less space requirements.

By choosing SWGR technology, Shansteel will be able to moderate its waste-gas emissions to the atmosphere and the CO₂ footprint of the overall plant thanks to a lower coke consumption. It will also be in a position to substantially trim capital expenditures for the downstream gas-cleaning facilities, as those can be designed with considerably smaller waste-gas capacities.

A HIGHLY ADAPTIVE SYSTEM

In the SWGR process, a significant portion of the primary sinter waste gas is recirculated back to the sinter strand. This is accomplished by means of an efficient ductwork, an electrostatic precipitator for pre-dedusting, a circulation fan and the recirculation hood, which distributes the recirculated waste gas onto the sinter strand while main-



OVERVIEW

The new Selective Waste Gas Recirculation System from Primetals Technologies installed at Shandong Iron & Steel

taining proper sealing to the atmosphere to avoid any gas leakage. The system is selective in that the waste gas from different wind boxes can be chosen for gas recirculation. The process design is specifically tailored to the customer's needs. A minor quantity of fresh air is added to the recirculation gas stream in order to maintain a certain minimum oxygen content in the recirculated gas, which is required for proper sintering performance.

The project will be executed by Primetals Technologies China Ltd. jointly with Shandong Province Metallurgical Engineering Co. Ltd. (SDM) as the main contractor for the sinter plant package (engineering, procurement and construction). Primetals Technologies will be responsible for engineering, the supply of key equipment and automation systems, as well as advisory services related to the erection and commissioning of the SWGR system. The new sinter plant is scheduled for start-up (initiation of Phase 1) in September 2017. ●

Dr. Michaela Böberl, Senior Key Expert, Sintering¹⁾

Edmund Fehring, Head of Technology, Agglomeration¹⁾

Stefan List, Lead Engineer, Sintering¹⁾

Peter Puschitz, Head of Iron & Steelmaking²⁾

¹⁾Primetals Technologies Austria

²⁾Primetals Technologies China

MAIN BENEFITS OF SWGR

A key advantage of the Selective Waste Gas Recirculation system is the reduced operational expenditures of the sinter plant due to a notable decrease in coke consumption. This is because of the CO portion contained in the waste gas recirculated to the sinter strand. A lower coke consumption also means fewer SO₂ emissions and a smaller CO₂ footprint of the sinter plant.

Another benefit is the lower utility and agent consumption in the downstream gas-cleaning facilities, which is due to a reduced waste-gas flow volume by approximately 30%. The lower gas flow rate also allows the downstream gas-cleaning facilities to be designed with smaller dimensions, which scales down investment expenditures. Thanks to the recirculation of sinter waste gas to the sinter strand, the specific concentrations of dusts, combustion products, SO_x, NO_x, VOCs and heavy metals released to the environment through the sinter stack are also decreased.



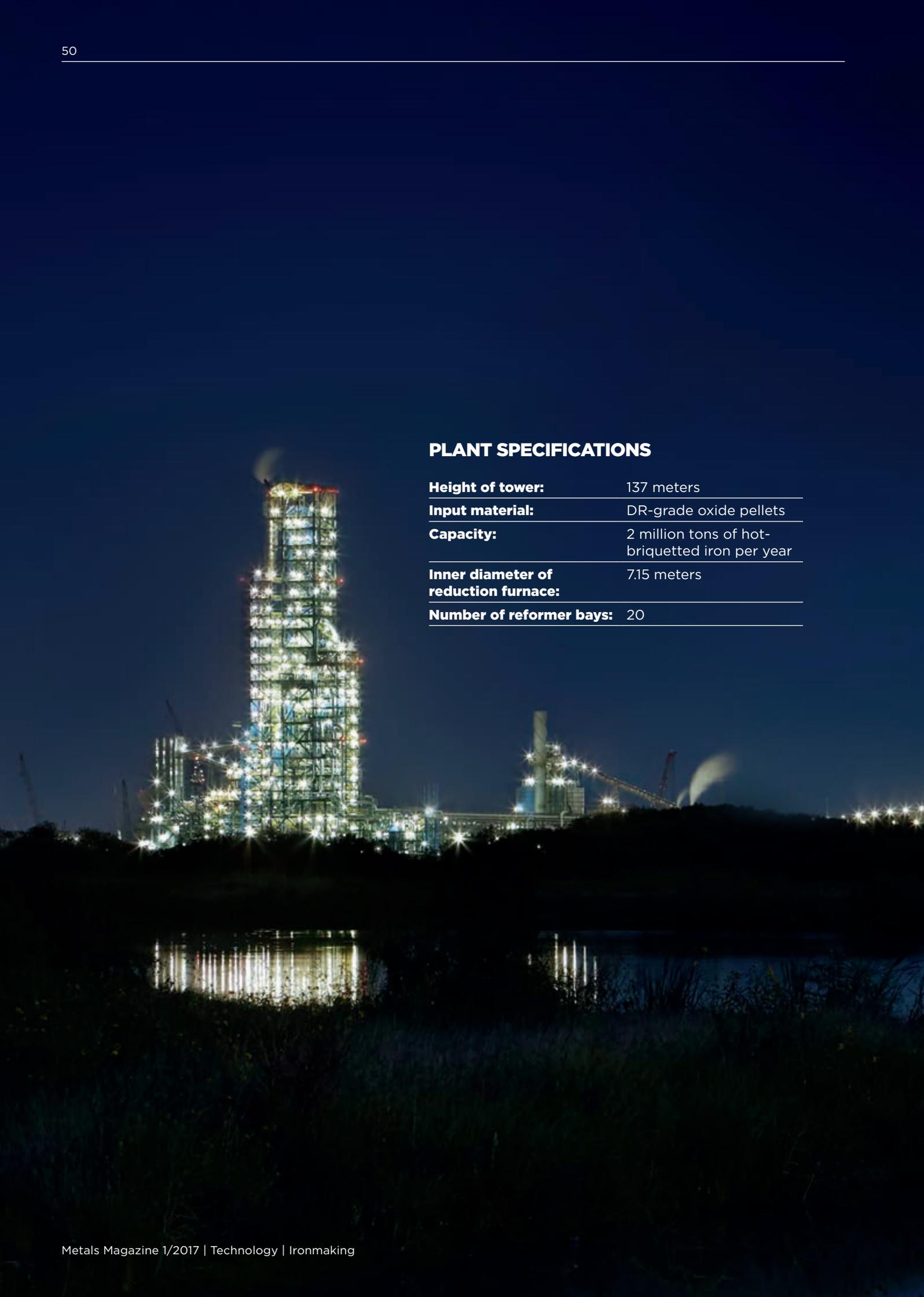
REFINED BY FIRE

The hot sinter cake drops off the sinter machine and is then broken up into smaller pieces by the star crusher.



ENVIRONMENTALLY FRIENDLY

This sinter was produced using less coke and with reduced waste-gas emissions to the environment.



PLANT SPECIFICATIONS

Height of tower:	137 meters
Input material:	DR-grade oxide pellets
Capacity:	2 million tons of hot-briquetted iron per year
Inner diameter of reduction furnace:	7.15 meters
Number of reformer bays:	20

TAKING A LARGE STEP INTO THE U.S.A.

VOESTALPINE CELEBRATES THE START-UP OF ITS PRESTIGIOUS TEXAS-BASED HOT-BRIQUETTED IRON DIRECT-REDUCTION PLANT

It is the largest investment that an Austrian company has ever made in the United States: voestalpine's new hot-briquetted iron direct-reduction plant in Corpus Christi, Texas, is a masterpiece of engineering and saw its official start-up on October 26, 2016, after a construction time of two and a half years. The plant will help reduce voestalpine's energy costs and CO₂ emissions, and is expected to make a major contribution to the future growth of voestalpine in the NAFTA region.

As the world's largest hot-briquetted iron direct-reduction plant, the new facility of voestalpine is capable of producing two million tons of hot-briquetted iron per year. There is a saying that "everything is bigger in Texas," and one aspect that really stands out about the plant is its 137-meter high reduction tower. This structure is the highest in southern Texas and as tall as St. Stephen's Cathedral in Vienna, Austria's capital. The use of natural gas as the main energy source contributes to a significant overall reduction in CO₂ emissions for the voestalpine Group, which helps to further future-proof the company.

60% of the total output will be sold to other steel producers in the form of hot-briquetted iron. The custom-designed nearby port will handle the receipt of ferrous raw materials and the shipping of produced goods. Hot-briquetted iron is highly desirable as a feedstock for steel production, as it is comparable to scrap of the high-

est quality, or to pig iron. When charged into electric arc furnaces, converters or blast furnaces, even highly demanding steel grades can be produced.

SIGNS OF TRUST

Design and engineering of the core direct-reduction plant was executed by Primetals Technologies and U.S.-based Midrex Technologies in a consortium. The two companies were also responsible for the supply of all mechanical and electrical equipment for the core area of the facility in addition to providing comprehensive advisory services. "For me, voestalpine's decision to choose Primetals Technologies as a key project partner was one of the most rewarding experiences of my professional life," says Martin Schmidt, Head of Project Management of the Ironmaking Department of Primetals Technologies. "Also, getting nominated as Project Manager by my company was highly gratifying. It was such a huge undertaking, and a great sign of trust." »



FIG. 1: Instrumental in making voestalpine's Corpus Christi plant a reality (from left to right): Angelika Leitner (Primetals Technologies), Erich Pizzera (voestalpine), Martin Schmidt (Primetals Technologies) and Bernhard Schlattl (voestalpine)

THE LARGEST GREENFIELD PROJECT OF VOESTALPINE TO DATE

"It was the biggest project for voestalpine abroad," adds Erich Pizzera, CTO of voestalpine Texas, "and it was also the biggest greenfield project for Austria." The teams of both voestalpine and Primetals Technologies were happy to join forces to embark on a common mission, as Bernhard Schlattl, CEO of voestalpine Texas, explains: "It was fantastic to do this project with our neighbors. We share a common heritage with the Linz location of Primetals Technologies, which has its roots in VAI and was once 'under the same roof' as us. Things like the Linz-Donawitz process and the continuous casting process come to mind, and our mutual history provides us with a shortcut for working together."

PARTNERING WITH THE CUSTOMER

Building trust with the customer is of paramount importance for the staff of Primetals Technologies, even in the case of "neighbor" voestalpine. Bernhard Schlattl emphasizes that "you have to do your best, and to perform exceptionally. Nothing else will contribute more to a trust-based partnership." Martin Schmidt fully agrees: "It has never seemed more crucial to me to build good and solid personal relationships than with this extensive project, and also to offer leadership where required. We provided high-quality engineering as well as the necessary equipment. Together with voestalpine, we also carefully guided the local workforce. I am also happy about the relationships we were able to build with the local workers, as we shared our knowledge with them and helped them out in difficult situations. In my opinion, this was ultimately the key to the project's success." ●

WHAT ARE YOUR TOP 3 MEASURES TO ENSURE PROJECT SUCCESS?

MARTIN SCHMIDT

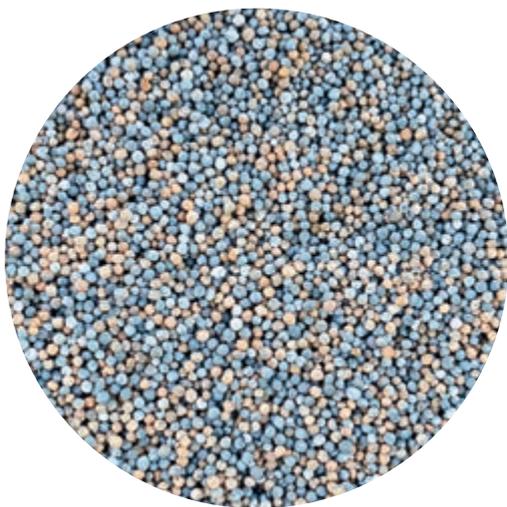
Head of Project Management, Ironmaking, Primetals Technologies Austria

- "Recruit an experienced team for project execution, engineering, site, commissioning and contract management."
- "Invest time and money into engineering and avoid shortcuts. Every error in a drawing and every wrong instruction costs money."
- "Have every little detail documented, and give instructions in writing to avoid misunderstandings."

ANGELIKA LEITNER

Commercial Project Manager & Joint Project Controller, Sales, Primetals Technologies Austria

- "Find the best people for the job, and then never change the team."
- "Maintain a professional conduct and keep using an appropriate language under all circumstances."
- "Stick to the contract, but never forget that the wording of any contract leaves room for interpretation."



INPUT MATERIAL

These DR-grade oxide pellets were made from high-quality iron ore and are the basis for the production of hot-briquetted direct-reduced iron.



HOT-BRIQUETTED IRON

This is the output of voestalpine's Corpus Christi plant. When used as a feedstock for steel production, it is on par with scrap of the highest quality or pig iron.



FOR FURTHER READING

Would you like to learn more about voestalpine's hot-briquetting plant in Corpus Christi? Simply scan the QR code – or follow the link below using your web browser – to read an article taken from *Metals Magazine* Issue 3/2014.



primetals.com/gowest-article

VIRTUAL REALITY EXPERIENCE

Primetals Technologies has developed an app for iOS and Android devices with which you can inspect the Corpus Christi plant in a three-dimensional environment. For the full experience, please use the app with Google Cardboard glasses or a comparable 3D viewer.



primetals.com/vr

THE FURNACE

AT YOUR FINGERTIPS

ELECTRODE CONTROL SYSTEM, NOW WITH "INDUSTRY 4.0"-INSPIRED UNIVERSAL ACCESSIBILITY

Melt Expert is the solution of choice from Primetals Technologies to monitor and control the melting process of electric arc furnaces. It retrieves information from a vast array of components, and uses this data to conduct a real-time analysis of the current state of the melting process. Melt Expert continuously regulates the furnace parameters with the highest degree of reliability, and displays all relevant data by means of an easy-to-use interface. The application of the sophisticated algorithms of Melt Expert helps to save energy and results in many other substantial benefits.

The user-friendly interface is both highly detailed and evenly structured, allowing for a streamlined evaluation process of all ongoing furnace activities.

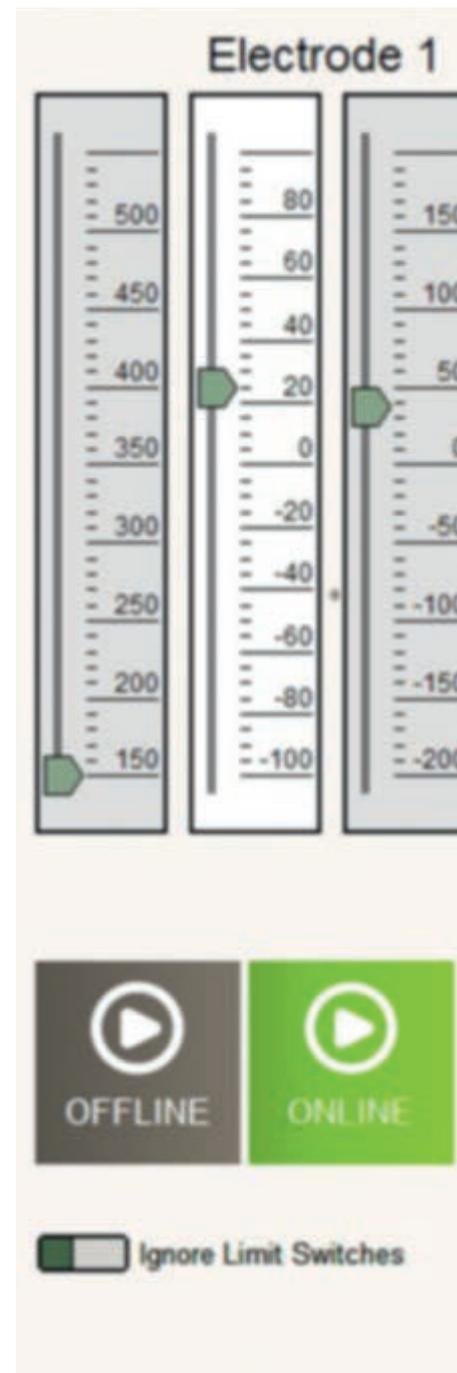
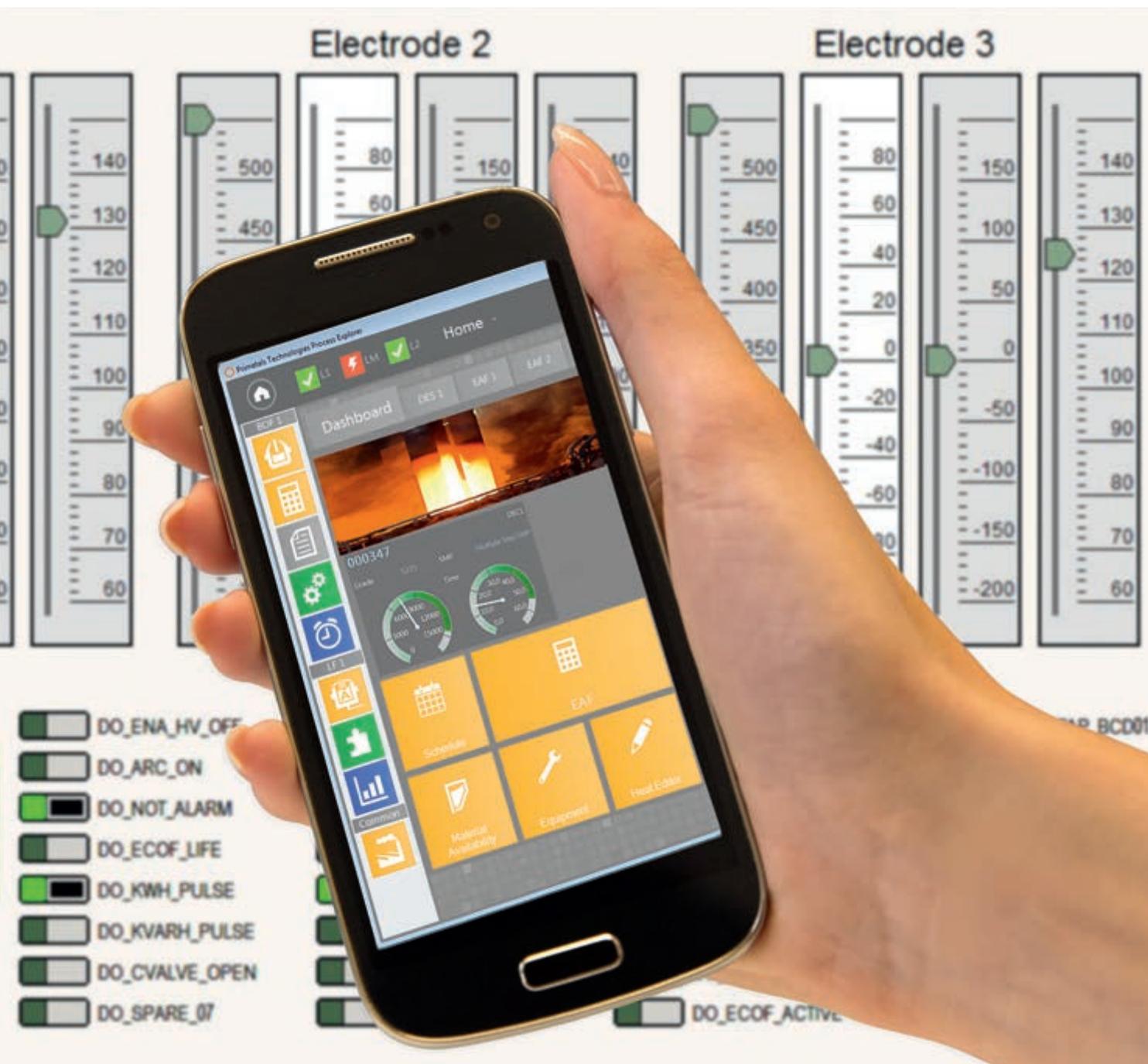


FIG. 1: Melt Expert features a universally accessible furnace control interface.



Melt Expert is one of the most essential tools Primetals Technologies has to offer for steel plants that are based on electric arc furnaces. It is a sophisticated control system that regulates the position of the electrodes so that they will always operate with an optimal arc length. Additionally and importantly, the system provides detailed information about the furnace and makes its findings easily accessible. It employs characteristics of "Industry 4.0" technology, meaning that it systematically accumulates and evaluates large amounts of data that stem from the processes taking place in and around the electric arc furnace. Melt Expert then does its calculations, makes adjustments to the furnace parameters, and presents all data through an easy-to-understand interface.

UNIVERSAL ACCESSIBILITY

The user-friendly interface is indeed one of the important strengths of Melt Expert. It is both highly detailed and evenly structured, allowing for a streamlined evaluation process of all ongoing furnace activities. This is essential because it ensures that the personnel in charge of maintaining proper furnace operation can quickly identify the functions they require for a given task. All information displays are clearly labeled, and the interface follows intuitive design principles.

The engineers at Primetals Technologies who developed the Melt Expert technology are particularly proud of the smartphone app that they recently finalized. It is »

scheduled for release in the spring of 2017. With this app, all of the essential information that Melt Expert collects and evaluates is immediately accessible, utilizing the touchscreen of your smartphone to display data and collect user input. It has certainly never been more straightforward to monitor an electric arc furnace.

INNOVATION, BACKED BY EXPERIENCE

Work by the development team took about three years to design, test and prove Melt Expert technology in its current form. However, it is also true that the underlying components are the results of decades of research, and are based on two highly successful predecessor solutions: Melt Expert combines the benefits of both the Arcos and Simelt electrode control systems, and bundles all of their respective features into one comprehensive control package.

The fact that Melt Expert makes use of the rich technological legacy of Primetals Technologies has several positive effects. One of them is that it is relatively easy to upgrade an existing Arcos or Simelt installation to an up-to-date Melt Expert system. The requirements will, of course, vary from plant to plant, but the compatibility with older equipment is generally very high. Another positive aspect is that the core components of Melt Expert and the underlying technological concepts are extremely well-tested and refined. Arcos originated in 1991, and Simelt was first introduced in 1980. Together, the two have acquired an impressive reference base of approximately 500 EAF and ladle furnace installations.

CONSTANT MONITORING AND ANALYSIS

So what exactly does Melt Expert do? The system communicates with all equipment connected to the electric arc furnace. Thereby, it acquires substantial amounts of



FIG. 2: This is a screenshot of one of the many control-surface pages that the Melt Expert system makes available.

data about the ongoing melting process and the relevant support procedures. It then analyzes and interprets the acquired information and passes on its findings to superordinate systems of the furnace. This guarantees an optimal adjustment of the furnace electrodes, and is the basis for a multitude of benefits reaching from energy savings to an extension of the electrode lifespans.

The core idea is that Melt Expert acts like a "point of service" for both humans and machines, meaning that it functions as an information hub and a guidance center that indicates what the necessary course of action should be. This is true especially in scenarios where the furnace is operating in a less-than-optimal mode or is steering into potential problems. Melt Expert proactively helps to prevent accidents and ensures that any plant-shutdown



FIG. 3: Typical A.C. electric arc furnace

times due to unforeseen occurrences are avoided. Also, unnecessary wear of furnace components is averted. For instance, Melt Expert can reduce electrode consumption by about 3%.

PREVENTIVE MAINTENANCE

The electrode control system not only acts as an instruction system and as an information server, but also offers special services for maintenance purposes. In this role, Melt Expert makes use of very unique design aspects to fulfill the requirements of the maintenance crew, assisting them in the examination of the condition of the electrical and mechanical systems during maintenance shutdowns. Fully automatic diagnostic tests of the equipment can detect faults in high-current busbars, hydraulic valves and pumps, current and voltage levels, and the rolls of the electrode-lifting column. Detailed reports show the results of all measured parameters, including evaluations and specific advice for repair measures that should be taken. This reduces the need for human interpretation of the readings. Even in scenarios where Melt Expert itself is not in charge of making any major decisions, it supports the superordinate systems by providing well-founded recommendations. Interactions with surrounding facilities enable further optimization of the system.

HIGHER EFFICIENCY AND RELIABILITY

Melt Expert introduces several key benefits. Besides the longer lifetime of the furnace electrodes, energy savings of about 2% can be expected. Due to the more precise furnace-control possibilities, the power-on and shutdown times can be kept 3% shorter. This increases overall productivity. The sophisticated Melt Expert algorithms drastically improve operational stability and make the melting process much more transparent. The system reduces the need for maintenance considerably, and increases the long-term reliability of the furnace through integrated system health checks.

FURNACE CONTROL MADE EASY

A key benefit that should not be underestimated is that the Melt Expert system itself does not require any maintenance. Its dependability, as well as its ease of use and high efficiency, originates from the decades of experience that Primetals Technologies has gained from the earlier Arcos and Simelt furnace control solutions. With Melt Expert, users get the most competent electrode control system on the market: It is the one with the highest effectiveness, the one with the best user interface, and, particularly when put into historical context, certainly the one that has proven its reliability in hundreds of installations. ●

Christoph Sedivy, Product Manager, Mechatronics Solutions

Dr. Thomas Widter, Deputy Managing Editor, Metals Magazine

(Both with Primetals Technologies Austria)

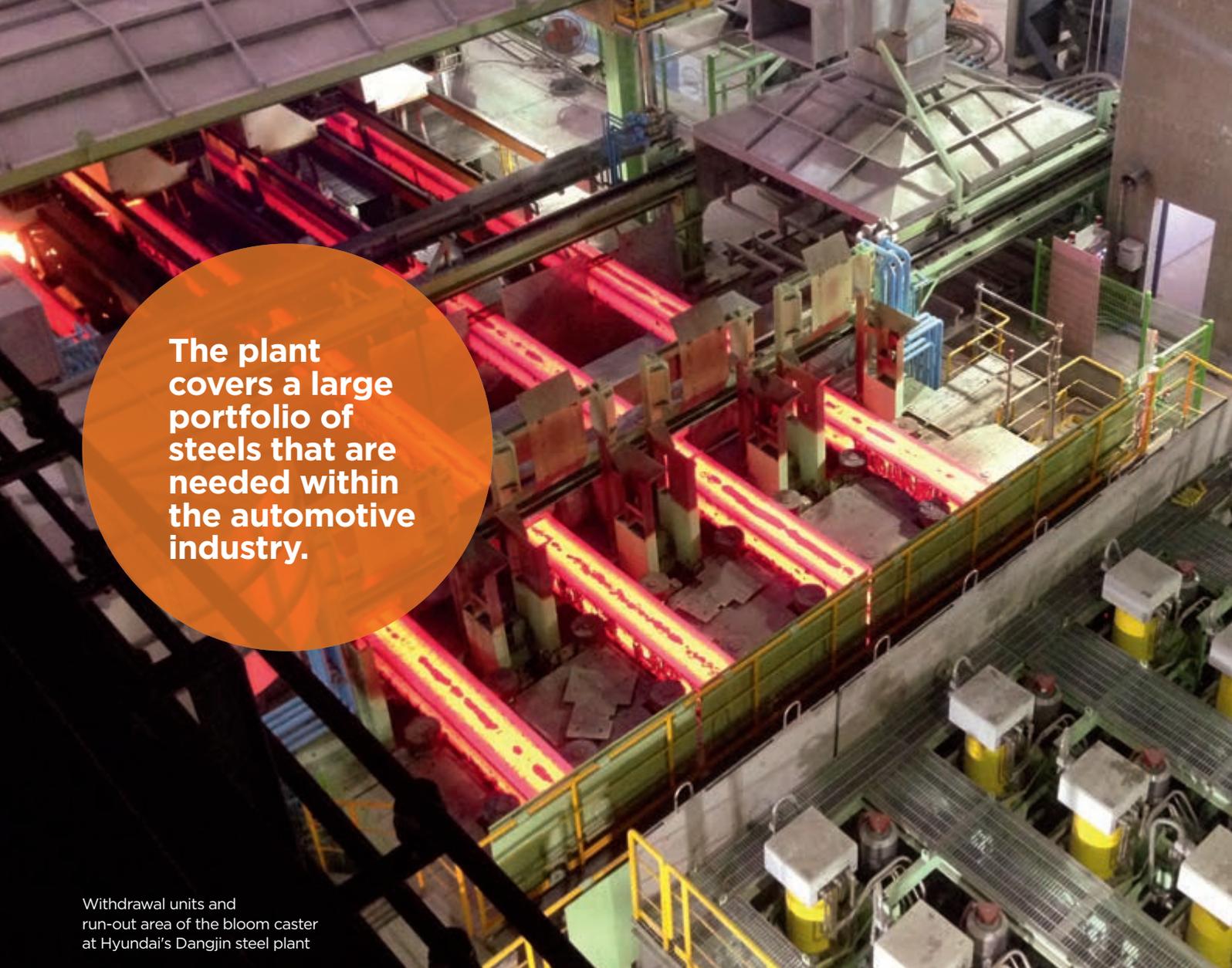
The Melt Expert algorithms improve operational stability and make the melting process much more transparent.

A TRUE INFORMATION HUB

Melt Expert unites many different sources of information, which results in numerous very tangible advantages – and a few additional ones that usually remain in the background but are just as important.

The system interface provides simple and fast access to all process-relevant data, and includes benchmark reporting (e.g., power-on time, energy input, active power input, flicker, arc stability and heating rate). It can be used to compare new readings with historical ones, offering users an even better idea of the current state of the steelmaking process. Since the interface is accessible through a variety of devices, including smartphones, keeping an eye on furnace activity could not be more simple.

Equally relevant are the less obvious preventive-maintenance functions. Melt Expert permanently monitors many hydraulic, mechanical and electrical components, and conducts a real-time analysis based on these readings. Additional long-term analyses ensure that creeping malfunctions are identified early on. Melt Expert also registers less-than-optimal furnace operation due to short electrodes and manual intervention. Automatic self-diagnostic checks, an early-stage alarm system, and built-in suggestions ensure that unplanned downtimes can be proactively avoided.



The plant covers a large portfolio of steels that are needed within the automotive industry.

Withdrawal units and run-out area of the bloom caster at Hyundai's Dangjin steel plant

EMINENT QUALITY **FOR AUTOMOTIVE APPLICATIONS**

**HYUNDAI'S NEW BENCHMARK 4-STRAND BLOOM CASTER
AT ITS DANGJIN PLANT IN KOREA**



Primetals Technologies supplied Hyundai's Dangjin steelmaking plant with a new 4-strand bloom caster designed to facilitate the production of a vast array of automotive parts. The plant serves Hyundai's large car-manufacturing infrastructure and specializes in high-end applications such as ultra-high carbon steels, special forgings, ball bearings, axles, springs and gearbox parts. The caster provided by Primetals Technologies features a uniquely customized set of technological packages and was installed so efficiently that the initial start-up could be executed almost one month ahead of schedule.

Hyundai's Dangjin steelmaking plant has the main objective of producing the highest-quality steel for Hyundai Motor Group. As it targets very distinct steel grades, the overall plant setup is highly customized and designed to fit Hyundai's needs. This trickles down to the individual facilities within the plant, which each demonstrate the same degree of specificity and adhere to strict quality control guidelines in order to meet Hyundai's internal ISIR certification program throughout the entire steel production complex.

STEELS FOR THE AUTOMOTIVE SECTOR

Overall, the Dangjin plant within Hyundai covers the complete portfolio of steels necessary for the automotive industry. The facility in which the new bloom caster was installed is dedicated to unexposed car parts. Its capabilities therefore entail the manufacture of bearings, axles, engine parts such as pistons and many other components. It is clear that the production requirements for these types of high-end applications demand the use of state-of-the-art technologies, and that very strict production parameters have to be reliably kept and enforced.

Also, great care must be taken in both the design and construction of all plant equipment.

A BENCHMARK BLOOM CASTER

Primetals Technologies supplied Hyundai with a new 4-strand bloom caster that is equipped with the latest mold-level control system and an instrumented mold with breakout prediction. The provided equipment for the heavy-section bow-type caster is capable of precisely producing the crucial steel grades required for engine and gearbox parts. Hyundai can manufacture ultra-high carbon wire as well as special forgings and ball bearings from these blooms. Even large-size car components, such as axles, crankshafts and springs, are possible. The capacity of the caster is 1.1 million tons of super-quality blooms per year.

HIGHLY SPECIFIC REQUIREMENTS

When Hyundai approached Primetals Technologies about the bloom caster project, the requirements were extremely specific. To guarantee an outstanding quality in the final product, engineers at Primetals Technologies »



FIG. 1: Blooms produced with DynaTac dry-casting

DYNATAC DRY-CASTING

For the production of automotive steel grades, DynaTac dry-casting technology offers decisive benefits. Automotive grades are often alloyed with niobium, vanadium, titanium and boron, which makes them prone to the formation of high-temperature soluble precipitates (carbides and nitrides). These precipitates often arise at the grain boundaries and may cause steel embrittlement and intergranular surface cracks to form during the unbending process. For this reason, it may be necessary to completely turn off the secondary cooling water for the production of certain critical steel grades in order to remain above a critical temperature before unbending takes place. Another advantage is that when hot-charging practices are applied, higher strand exit temperatures are achieved with DynaTac dry-casting, which saves time and costs at the reheating furnace before the blooms are charged to the rolling mill. As the complete strand guide is designed for dry casting, the lifetime of the equipment is much higher, resulting in the lowest cost per ton of cast steel. For all of these reasons, Hyundai chose DynaTac dry-casting technology to be installed in its bloom caster.

– in close cooperation with Hyundai’s experts – elected to bundle a selection of powerful and well-proven solutions to develop a new caster configuration that would be unique in the industry.

In combination with air-mist spray cooling and internally cooled rollers in the strand-guidance system, a custom-tailored set of innovative technology packages was chosen and fine-tuned to ensure reliable and uniform bloom production. One of the core design aspects was that the blooms would be fed into the bar line for direct rolling when still hot. This would save energy during reheating and improve operating safety, as there would be no need to transfer the blooms with the use of cranes. To support the production of special steel grades, an inline bloom-quenching facility was provided.

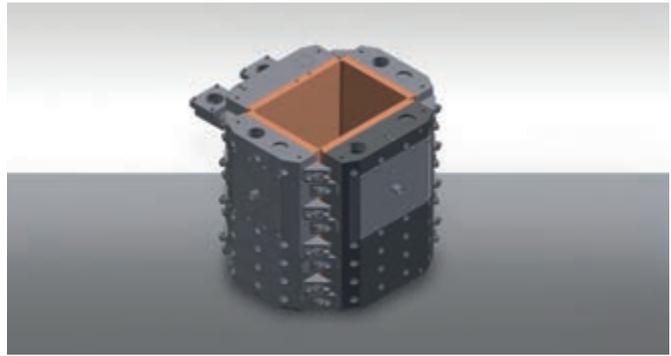


FIG. 2: Bloom mold with testing plate for thermocouples

MOLD EXPERT

The new 4-strand bloom caster section at Hyundai’s Dangjin plant features the 200th installation of the Mold Expert monitoring system, which is the central information system of the mold. However, the current version stands out from previous ones, as it is one of the first systems to be applied in a bloom caster instead of a slab caster. The basic function of Mold Expert is sticker detection and breakout prevention, but it also offers friction calculations as well as heat-flux and mold-level analyses. The mold is constructed with a specific distribution of thermocouples on its inner surface to ensure the reliable and accurate detection of stickers as well as comprehensive data acquisition. This supports the optimization of the casting process.

ADDITIONAL TECHNOLOGIES

The technologies Dynacs 3D, DynaGap 3D, and DynaPhase were also employed at this plant and are discussed on pages 62–67.

FUTURE-PROOF BY DESIGN

Primetals Technologies implemented the carefully designed Dangjin bloom caster for Hyundai with great success, smoothly achieving the targeted completion date. In fact, the caster could be started up almost a full month ahead of schedule. Hyundai’s new 4-strand bloom caster will not only be able to meet the current demands of Hyundai Motor Group, but offers the flexibility to respond to future developments and changing needs as well. This is due to the adaptability of the technological packages of Primetals Technologies, which are discussed in more detail above and on pages 62–67. ●

Dr. Denijel Burzic, Metallurgist for Continuous Casting Machines

Dr. Thomas Widter, Deputy Managing Editor, Metals Magazine
(Both with Primetals Technologies Austria)

MEET THE EXPERT

INTERVIEW WITH DR. DENIJEL BURZIC

Partnering with the customer will achieve the best-possible results.



When Hyundai Group first approached you about this bloom caster project, what was the main goal that had to be met?

Dr. Denijel Burzic: We had to design a machine that would be capable of casting not only those steel grades that Hyundai Motor Group is using today, but also future ones. The automotive industry is developing fast, and the new caster had to be able to keep up with the future trends. Hyundai Steel has chosen as their motto "Leading the New Era of Steel." Their expectations for the new caster were according to this motto and extremely high.

Were there any unexpected challenges that arose during the development phase of the project?

Burzic: As this caster was a custom design, many things had to be accomplished for the first time. Our biggest challenge was to keep the duration of the whole project as short as possible. Despite all challenges, we successfully managed to start the machine one month ahead of schedule and achieve stable operation in very little time. This makes me very proud of the entire project team.

What can you tell us about the project-execution stage?

Burzic: During the whole project, we were closely working together with our client, especially with Hyundai Steel's

R&D department. Our relationship was very open from the beginning, which helped us to meet all the challenges we were facing. The project teams on both sides were highly experienced and had already designed and commissioned five slab casters together. So everything went extremely smoothly.

Which factors contributed to the smooth installation?

Burzic: We held regular progress meetings, and over certain periods we would even be in daily contact with Hyundai. That way, potential problems were both identified and solved at a very early stage. This close cooperation was one of the key factors why this project went so well.

Is there anything about this project that you personally particularly enjoyed?

Burzic: This bloom caster had to be designed to produce a vast number of steel grades, many more than most plants in the world are capable of delivering. Therefore, it required more special features than any other caster I know of. That gave me, as a metallurgist, so many possibilities. We did many tests together with Hyundai Steel's R&D department, and sometimes we felt like kids playing with a new toy. This yielded great results, and I enjoyed it very much. ●



FIG. 1: Project team members from Primetals Technologies are celebrating the first heat with Hyundai representatives.

The model suite
takes cooling
precision and
control possibilities
to a new dimension
of excellence.





CAST TO PERFECTION

**RECENT INNOVATIONS AND
DEVELOPMENTS IN CONTINUOUS
CASTING AUTOMATION**

Use of sophisticated process models is decisive for outstanding caster performance.

Advanced automation packages are decisive for casting products that meet the highest quality demands at maximum levels of productivity and yield. New challenges that arise from ever-increasing market requirements and the need to enhance the continuous casting process to enable the production of new and special steel grades can be met with proven and exciting automation solutions from Primetals Technologies.

Ensuring optimum steel quality requires the right equipment and process control combined with experience, metallurgical know-how and precision. On the basis of the knowledge acquired from hundreds of slab, billet and bloom caster references that Primetals Technologies has successfully implemented since the introduction of slab-casting technology at voestalpine in Linz in 1968, steel producers have at their side a partner with vast automation know-how to enhance and optimize their existing casting operations. This is exemplified by an advanced secondary cooling and soft-reduction model suite that comprises DynaPhase, Dynacs 3D and DynaGap Soft Reduction 3D, which works in conjunction with Nozzle Expert and Speed Expert (Figure 1). The model suite takes cooling precision and control possibilities to a new dimension of excellence. With its modular setup, the solution package can be installed on existing caster equipment and even integrated with basic automation systems from other suppliers. All process models can then be ideally adapted to the specific customer requirements in the Maintenance and Setup System (MSS) tool of Primetals Technologies.

NOZZLE TESTING AND EVALUATION RESULTS

When setting up an advanced secondary cooling system for a caster, it is of utmost importance that all parameters are taken into consideration that can have an impact on the calculation of the 3D temperature profile of the cast

strand. This includes the evaluation results when testing the spray-water distribution of different nozzle types at the nozzle testing stand (Figures 2–4). The derived information, including the exact position of the nozzles in the cooling zones of a caster, is entered into the MSS of the Dynacs 3D model for the online calculation of the 3D thermal profile of the strand.

The MSS allows all cooling-relevant settings to be configured in such a way that the spray-water distribution in the various cooling zones and the application of defined cooling strategies can be optimized for slab, bloom and billet casting machines. Acquired metallurgical know-how can also be easily incorporated into the Dynacs 3D automation setup. A built-in offline simulation system enables comprehensive testing of new parameter settings prior to their application in the production process.

DYNAPHASE – ONLINE CALCULATION OF MATERIAL PROPERTIES

Knowledge of the thermodynamic properties of steel (enthalpy, density and conductivity) as a function of the steel temperature is vitally important for the calculation of the 3D temperature profile of a strand. Traditionally, steel grades are grouped together and an average chemical analysis is made for each steel group. The respective material properties of the group are then experimentally determined. This information is manually entered into the

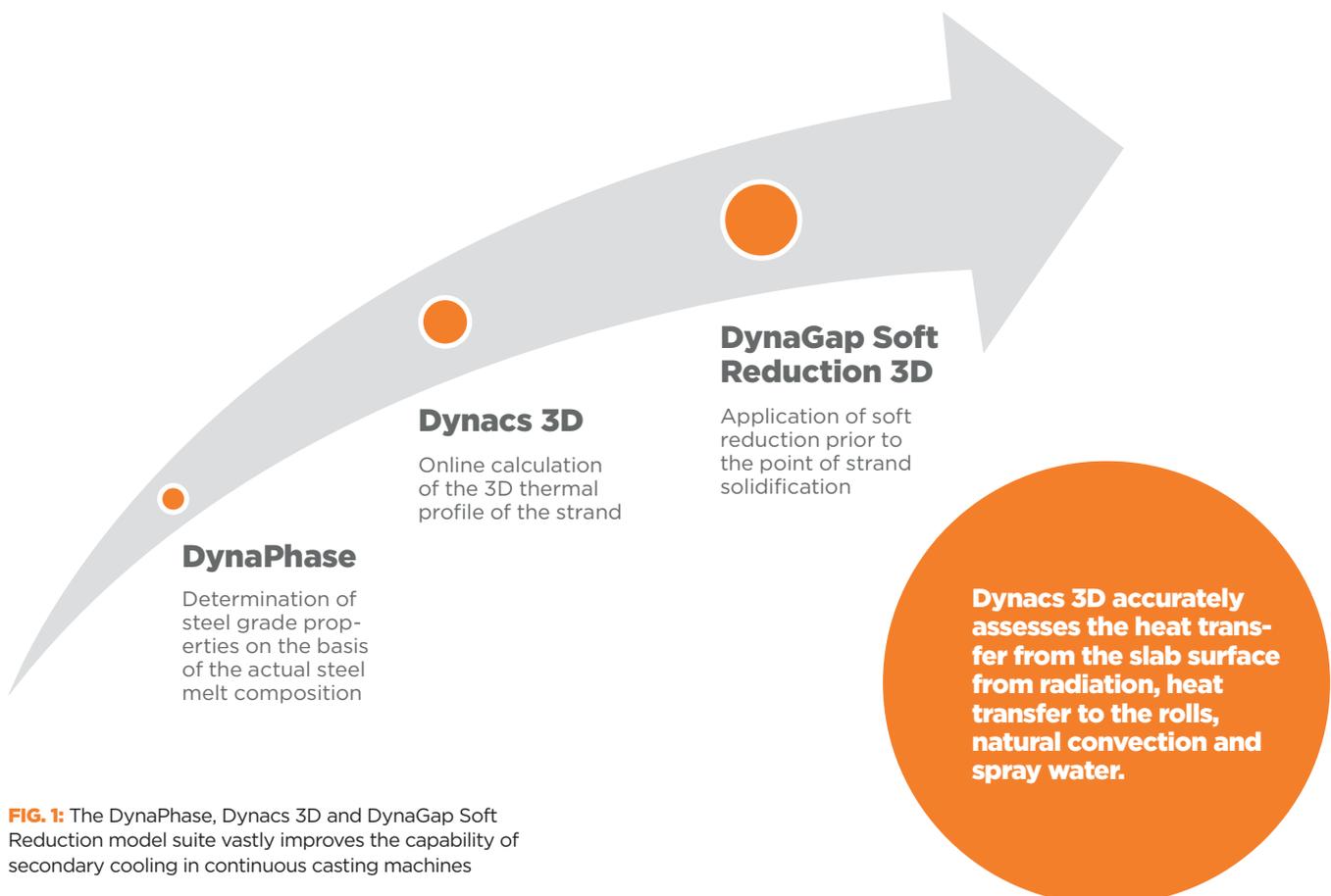


FIG. 1: The DynaPhase, Dynacs 3D and DynaGap Soft Reduction model suite vastly improves the capability of secondary cooling in continuous casting machines



FIG. 2:
Evaluation of the spray-water distribution at the nozzle testing stand

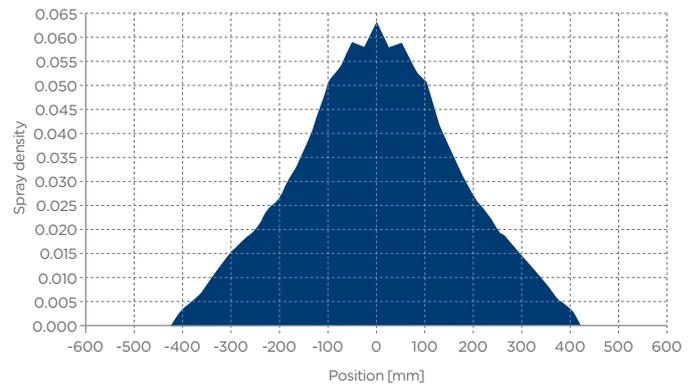


FIG. 3: Example of the spray-water distribution of a single nozzle

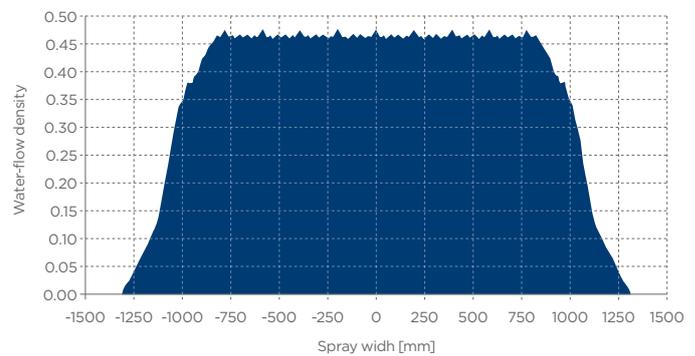


FIG. 4: Example of the spray-water distribution of a nozzle row

MSS by the metallurgist, which is a time-consuming procedure. However, casting operations show that there can be a difference in the point of final strand solidification by half a meter and even more when casting different steel grades within a particular steel group. This fact thus underlines the need for the online calculation of the actual steel grade properties.

With the DynaPhase software model, thermodynamic properties of each individual steel grade can be calculated online on the basis of the relative proportions of coexisting steel phases at a particular temperature and with consideration to minimizing the Gibbs free energy quantity. This information is also entered into the Dynacs 3D system for calculating a 3D strand-temperature profile. The interplay of the DynaPhase and Dynacs 3D process models to do this is unique in the industry.

Number of references: 11 since the introduction of this process model in 2013; four additional projects will be implemented between 2017 and 2019

DYNACS 3D – ADVANCED SECONDARY COOLING SYSTEM

Continuous improvements in computer performance have made it possible to calculate the temperature at any point within a strand in real time, which allows detailed 3D temperature profiles to be generated with the Dynacs

3D process model from Primetals Technologies. The model is based on an explicit finite-volume approximation that solves the heat-transfer equation and takes into consideration temperature-dependent steel density as well as the slab thickness and width at a specific position. Dynacs 3D accurately assesses the heat transfer from the slab surface from radiation, heat transfer to the rolls, natural convection and spray water (Figure 5). Furthermore, Dynacs 3D can be applied for both spray-water cooling and air-mist cooling, and it takes into account the spray-distribution pattern of the nozzles and the actual spray-water temperature. This allows an even more precise determination of the strand surface-temperature profile and the final point of strand solidification.

With these precise temperature calculations, even individual control of the water flow rates and precise positioning of each cooling nozzle by means of moveable 3D spray nozzles is possible. The control algorithms of Dynacs 3D calculate the water-flow setpoints to reliably obtain the targeted strand-surface temperature values. This is the basis for homogeneous cooling of the strand surface and thus excellent surface quality.

Knowledge of the exact point of complete strand solidification then allows precise soft reduction to be applied beforehand to eliminate center-strand porosity. Another advantage of the described DynaPhase and Dynacs »

Knowledge of the thermodynamic properties of steel as a function of the steel temperature is vitally important for the calculation of the 3D temperature profile of a strand.

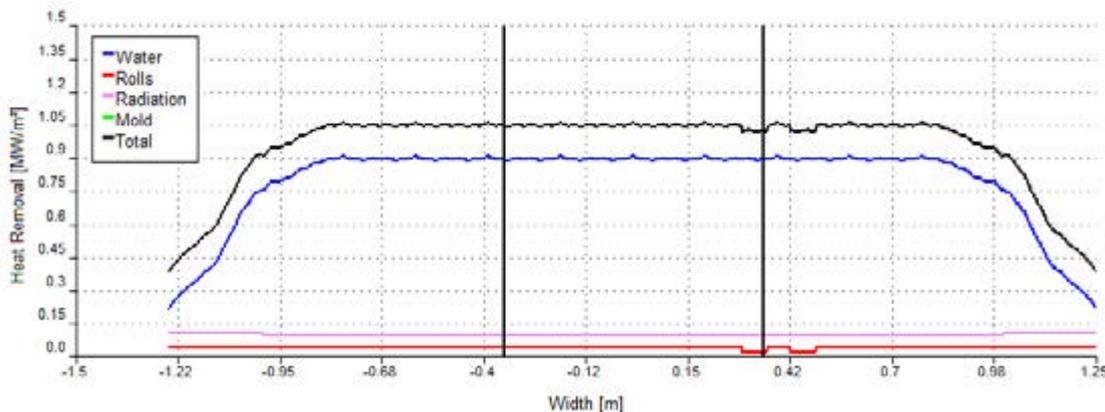


FIG. 5: Distribution of heat transfer within a cooling zone (black: total heat removal; blue: heat removal by the spray water; pink: heat radiation; red: heat removal by rolls)

3D process models is that they can serve as powerful off-line simulation tools for creating the cooling strategies for new steel grades.

DYNAGAP SOFT REDUCTION 3D

DynaGap Soft Reduction 3D features the dynamic adjustment of the roll gap for strand-thickness changes. It also minimizes or eliminates centerline segregation for improved internal strand quality. This is made possible with the use of specially designed strand-guide segments where the roll gap is remotely adjusted.

On the basis of the online information provided by the Dynacs 3D thermal tracking model, the required roll-gap setpoints are dynamically calculated by the DynaGap Soft Reduction 3D model. Supervision of the roll engagement, depending on the actual state of solidification (liquid, mushy or solid) and the calculated strand-thickness profile, are decisive for ensuring precise roll-gap adjustments and thus superior product quality. An optimized roll engagement also reduces excessive forces on the strand and minimizes roll wear.

DynaGap Soft Reduction 3D also makes it possible to freely define scenarios for start-up, tundish change and tailout strategies based on the thickness of the strand and the steel grade being cast.

Number of references: more than 45 since the introduction of this process model in 2011

NOZZLE EXPERT - EARLY DETECTION OF NOZZLE CLOGGING

Nozzle Expert helps to detect clogged nozzles and broken hoses in continuous casting machines and consequently ensures that the strand is uniformly cooled for high-quality steel production. The model automatically monitors the condition of the nozzles during the casting process, and it can also be used to check nozzle status following maintenance work or segment changes. This allows nozzles to be immediately repaired before re-starting the casting process. Nozzle Expert takes into consideration parameters such as nozzle type, water pressure, pipe lengths, pipe diameters and nozzle positions.

Nozzle Expert is based on statistical models and indicates the clogging ratio of all nozzles in each cooling zone. Operators only need to inspect those zones where an alarm is generated. Calculations begin automatically with the start of casting, and the condition of the nozzles is monitored throughout the casting process.

Customer feedback confirms the accuracy of detecting nozzle failures in the secondary cooling system. In several

cases, alarms have helped to detect leakages, clogged nozzles and even falsely installed nozzles on a segment.

Number of references: 20 since the introduction of this process model in 2013; seven additional projects will be implemented between 2017 and 2019

SPEED EXPERT - OPTIMUM CASTING SPEED IN ANY CASTING SITUATION

Selecting the proper casting speed is especially important in continuous casting and it depends on numerous factors that include minimum/targeted/maximum speed for a particular steel grade, superheat, Mn/S ratio, low weight of steel in the tundish, the casting velocity for optimum soft reduction, machine-protection limits and other production requirements. These different factors are often contradictory. For example, increased production calls for a high casting speed, whereas safety requirements place limits on this.

Calculation of the optimum casting rate is based on different rules that take different aspects into account. Each rule defines a range that satisfies the requirements. Speed Expert first determines the intersection of suitable speed ranges. It then makes a selection that depends on the predefined strategy, which may be "max. speed" (maximum speed of intersection), "aim speed" (targeted speed for a particular production practice within an intersection), or "keep constant" (avoidance of speed changes as long as the actual figures are within the acceptable range).

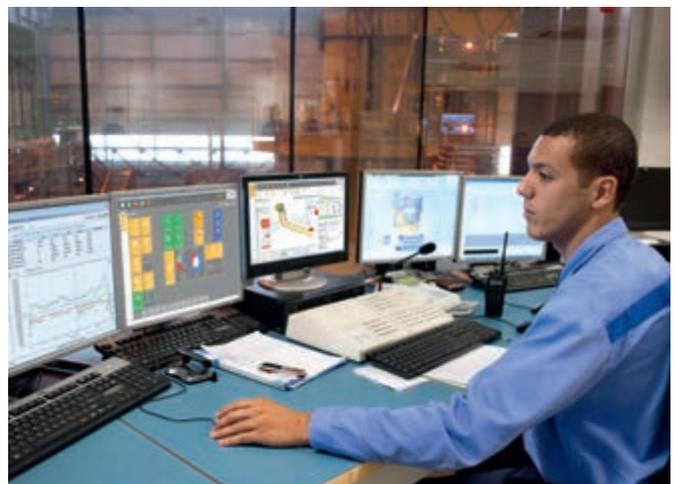
Customers frequently have their own software solutions to calculate the ideal casting rate with consideration to various factors. Speed Expert covers most of these factors and is integrated within the MSS tool that allows the required settings to be adapted to individual needs. On the online HMI (human-machine interface), the operator can view the speed ranges (green bars) of all rules and the derived ideal figure (Figure 6). The operator can change the priorities of the different rules, and speed setpoints are automatically sent to the Level 1 automation system.

In continuous casting machines where soft reduction is applied, a series of moveable segments are installed at the end of the caster strand prior to strand solidification. Depending on the current casting situation (superheat, mold format, cooling practice), Speed Expert determines the ideal casting speed to ensure that the soft reduction process is completed exactly at the end of a particular segment. Speed Expert is distinguished by the fact that the required casting speed to achieve this can be determined online during a casting sequence.

Number of references: five since the introduction of this process model in 2015; three additional projects will be commissioned by 2017



FIG. 6: Example of a Speed Expert HMI



Primetals Technologies-supplied automation systems at ThyssenKrupp CSA, Brazil

SUMMARIZING REMARKS

Primetals Technologies employs the largest in-house team of automation and mechatronics specialists dedicated to the metals industry. In the field of continuous casting, a vast suite of automation solutions and process-optimization models is available to customers to optimize their production performance and maximize product quality. This article summarizes the highlights of the sophisticated process models that are a part of the secondary cooling and soft-reduction model suite. ●

Dr. Kurt Dittenberger, Senior Expert, Continuous Casting Automation

Reinhold Leitner, Product Manager, Continuous Casting Automation

Wolfgang Oberaigner, Head of Process Automation, Continuous Casting

(All with Primetals Technologies Austria)

MEETING MARKET DEMAND **WITH ARVEDI ESP**

RIZHAO STEEL'S NEW ARVEDI ESP LINES HAVE JUST RAISED THE BAR OF EXCELLENCE WITH SEVERAL PRODUCTION RECORDS AND A STRONG, MARKET-ORIENTED BUSINESS STRATEGY



FIG. 1: Overview of the three currently operating Arvedi ESP lines at Rizhao Steel's plant.

While China's economy and its steel industry are dealing with saturated markets, steel producer Rizhao Steel, based in eastern China, has redirected its production to high-quality, thin-gauge, hot-rolled strip using Arvedi Endless Strip Production (ESP) technology – and to much success.

Having seen the benefits of Arvedi ESP technology first-hand in Cremona, Italy, China-based Rizhao Steel chose to invest in five Arvedi ESP production lines with a total annual capacity of 11 million tons of strip rolled to a minimal thickness of 0.8 mm. Primetals Technologies was responsible for the complete supply of all plant systems and equipment.

FINAL ACCEPTANCE AFTER 22 MONTHS

For all three currently active lines, the time from project start to the issuing of the final acceptance certificate could be kept to an impressively short 22 months. Over

the course of the first two years of operation that included the respective start-up periods, the first three lines yielded 8 million tons of ultra-thin high-quality steel that was highly sought after on the market.

PREMIUM-QUALITY PRODUCTS

With its new Arvedi ESP lines, Rizhao Steel produces a wide variety of premium steel grades for a broad spectrum of steel products that serve many different industrial sectors. From a quality point of view, the final products are characterized by superior geometrical strip quality and flatness. The outstanding surface quality was

confirmed by a major European automotive supplier that tested ESP material on its cold-rolling mill. Very high strip homogeneity along its entire length could be repeatedly demonstrated. This is because in endless operation no strip head or tail end pass through the line.

PRODUCTION RECORDS

Even over the course of the early start-up phase, several production records were set. The rolling of 0.8 mm thick strip was achieved in the shortest period to date. Also, extra-long sequences that exceeded 3,000 tons were carried out, work-roll lifetime was extended to more than 170 km, and production sequences were directly started in endless mode for increased yields.

After only four months of operation, the first final products reached the market. A large order of more than 100,000 tons of 1 mm strip followed almost immediately. The percentage of ultra-thin production down to 0.8 mm was quickly maximized to meet the high demand on the Chinese and overseas markets. Sequences were executed where 57% of the total production consisted of strip with thicknesses of less than 1.2 mm (see Figure 2), solely relying on Arvedi ESP technology and without any additional cold rolling being performed.

A STRATEGY TO SATISFY THE MARKET

Even this early after start-up, Arvedi ESP technology has proven to be the perfect choice for Rizhao Steel, especially considering the current tight market conditions.

Coils with thicknesses below 1.2 mm achieve a price advantage of up to 40% compared to thicker gauges. In this way, Rizhao Steel can operate profitably even at lowest coil-price levels. The company's new facilities will provide it with the basis to spearhead state-of-the-art hot-rolled coil production in East Asia and to excel on the steel market, particularly when it comes to quality, consistency, and fully meeting actual market demands. ●

Andreas Jungbauer, General Sales Manager, Endless Strip Production

Bernd Linzer, Head of Technology, Endless Strip Production

(Both with Primetals Technologies Austria)

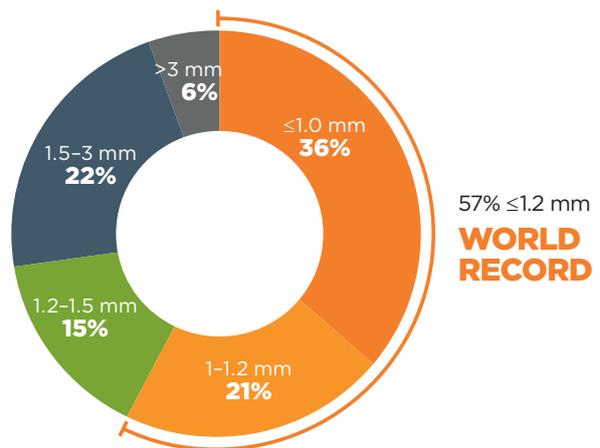
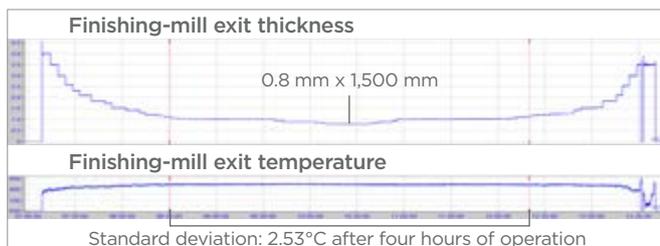
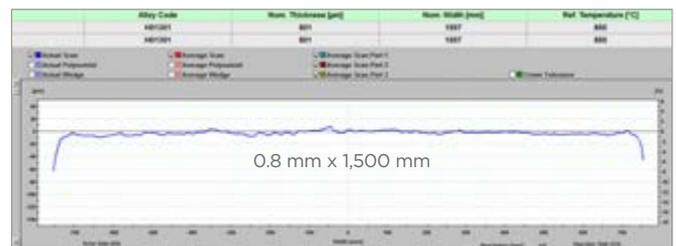


FIG. 2: Rizhao Steel has achieved production sequences with a 57% share of strip below 1.2 mm.



HIGHLY STABLE PRODUCTION

The exemplary sequence depicted here shows four hours' worth of production below 1 mm. During this period, the standard temperature deviation at the finishing-mill exit amounted to only 2.5°C (see illustration). Both the contour and crown are stable, allowing for the manufacture of large volumes of thin and ultra-thin gauges. As Rizhao Steel focuses on ultra-thin gauges, most of the sequences do not start with thicker batch coils. Instead, they directly start in endless mode with thicknesses below 4 mm. On average, a total yield of 98% from liquid steel to coil could be achieved after the first year of production.



ADJUSTABLE CROWN SHAPE

In an Arvedi ESP line, crown and wedge shaping start early – namely, in the high-reduction mill right after the caster where the core of the strand is hotter than its surface. This approach is vastly different from conventional hot-rolling processes because the strand is rolled in a more easily formable state. It gives the operator greater freedom to adjust the final profile of the strip, which can be shaped to be completely flat or exhibit a crown value of 1% or more. This allows slitting to narrow final cold-band substitute products, while keeping good symmetric crown values and avoiding wedge-related issues at downstream facilities.

PROMOTING TRANSFORMATION

INTERVIEW WITH MENG LING XUE, VICE PRESIDENT OF RIZHAO STEEL

Meng Ling Xue, Vice President of Rizhao Steel Holding Group Co., Ltd., joined Rizhao Steel in 2006. His career in the metallurgical industry goes back more than 30 years. In this interview, he comments in a straightforward manner on the current situation of the industry, the challenges it faces, and the responses that need to be made.

What are the reasons that Rizhao Steel chose Primetals Technologies as its main partner?

Meng Ling Xue: In recent years, Rizhao Steel has been developing rapidly and has built many new facilities. For these new projects, we need to apply state-of-the-art technologies, including steelmaking, hot continuous rolling, and cold rolling. Primetals Technologies offers well-proven and unique processes and solutions, and has a very good reputation and a high market share in the international metallurgical industry. Logically, it became our preferred partner.

Rizhao Steel ordered five new Arvedi Endless Strip Production (ESP) lines in 2013 and 2014. What were the main reasons behind this decision?

Meng Ling Xue: Rizhao Steel is a relatively young enterprise, and after a development time of more than one decade, its annual capacity has exceeded 10 million tons. The rapid growth of Rizhao Steel is in line with the ramp-up of the Chinese steel industry as a whole. However, in recent years, the metallurgical industry remains in a downturn with huge overcapacity. Especially since the financial crisis in 2008, the Chinese steel industry has been impacted quite negatively. Under such circumstances, the major state-owned companies responded properly by swiftly transforming the growth mode. On the other hand, the small- and medium-sized companies, especially the late-coming private ones, were inefficient in reacting to the crisis. Due to a lack in manpower and technical capabilities, they were unable to transform as intended and could only try to cut their costs. Rizhao Steel knows its own limitations very well. Although we have a large capacity, our product mix is similar to that of

a smaller company. We are in an inferior position in manpower compared to state-owned companies, and also in terms of costs compared to private ones. In order to respond to market competition through structural adjustments and the promotion of transformation, we must determine the products and the development directions that fit us. After the on-site visit to Arvedi in 2013, we became convinced that the ESP process is advantageous for the production of thin-gauge and high-strength steel strip. Therefore, we signed the commercial contract with Primetals Technologies in the same year for the supply of two new ESP lines. In 2014, we signed another contract for three more lines.

Are the ESP lines from Primetals Technologies meeting your requirements for operational reliability and flexibility?

Meng Ling Xue: Rizhao Steel ordered the equipment from Primetals Technologies with know-how from Arvedi. The first three lines were commissioned within one year and their stability and reliability are all excellent.

What were the major challenges that Rizhao Steel faced during the execution of the ESP project?

Meng Ling Xue: It is true that we had to overcome many challenges. One was the tight project schedule. Normally, it would take two to three years, but our aim was only 18 months. Even under such pressure, each party worked closely with the other one, settled many difficult issues, and managed to stay on schedule. Also, profile defects and equipment failures occurred during commissioning. As a brand new process, ESP lines do not have much experience in operating plants and this gave us some



MENG LING XUE

The Vice President of Rizhao Steel Holding Group has been in the industry for more than 30 years.

initial problems. Fortunately, the experts from Primetals Technologies and Arvedi were available on site and supported us greatly. They worked together with our own personnel to analyze, explore and fine-tune the temperature setpoints, utilities parameters and Level 2 models. Because of that, we eventually met our requirements within a short period.

Considering the situation that the steel industry is currently in, what strategies will be adopted by Rizhao Steel to deal with the challenges at hand?

Meng Ling Xue: The competition on the market is unavoidable. Companies must meet challenges to ensure their survival. Rizhao Steel will take full advantage of its ESP lines to focus on the development of new products. Also, Rizhao Steel will pay much attention to recruiting qualified technicians because business competition actually directly leads to a competition for human resources. Rizhao Steel will combine the short-term market demands with long-term product R&D to be well-prepared for any future market fluctuations.

In which areas will Rizhao Steel focus on R&D in order to improve production operations, reduce costs, and find further market opportunities?

Meng Ling Xue: Today, the steel used for automotive structures is profitable in both domestic and overseas markets. These steel grades are perfectly suitable for ESP lines, the product dimensions of which fit the requirements of automotive structures. Furthermore, the ESP lines feature the production of high-strength steels, and this most certainly will be one of our R&D focus areas. We also discussed the steels for small electromechanical

devices with Primetals Technologies, and this will be a future direction that Rizhao Steel will take as well.

How does Rizhao Steel meet the increasingly stringent environmental requirements?

Meng Ling Xue: With shorter line lengths and lower energy consumption, ESP can reduce emissions significantly. In 2014, Rizhao Steel designed a two-year plan for the improvement of environmental factors, mainly for the control of fumes, dust, wastewater and solid-waste discharge. We have constructed a large wastewater treatment plant and two solid-waste treatment facilities, and the flue gas desulfurization and denitrification systems will be put into operation soon. It is expected that Rizhao Steel will make great progress in environmental improvements by the end of this year or the first half of next year.

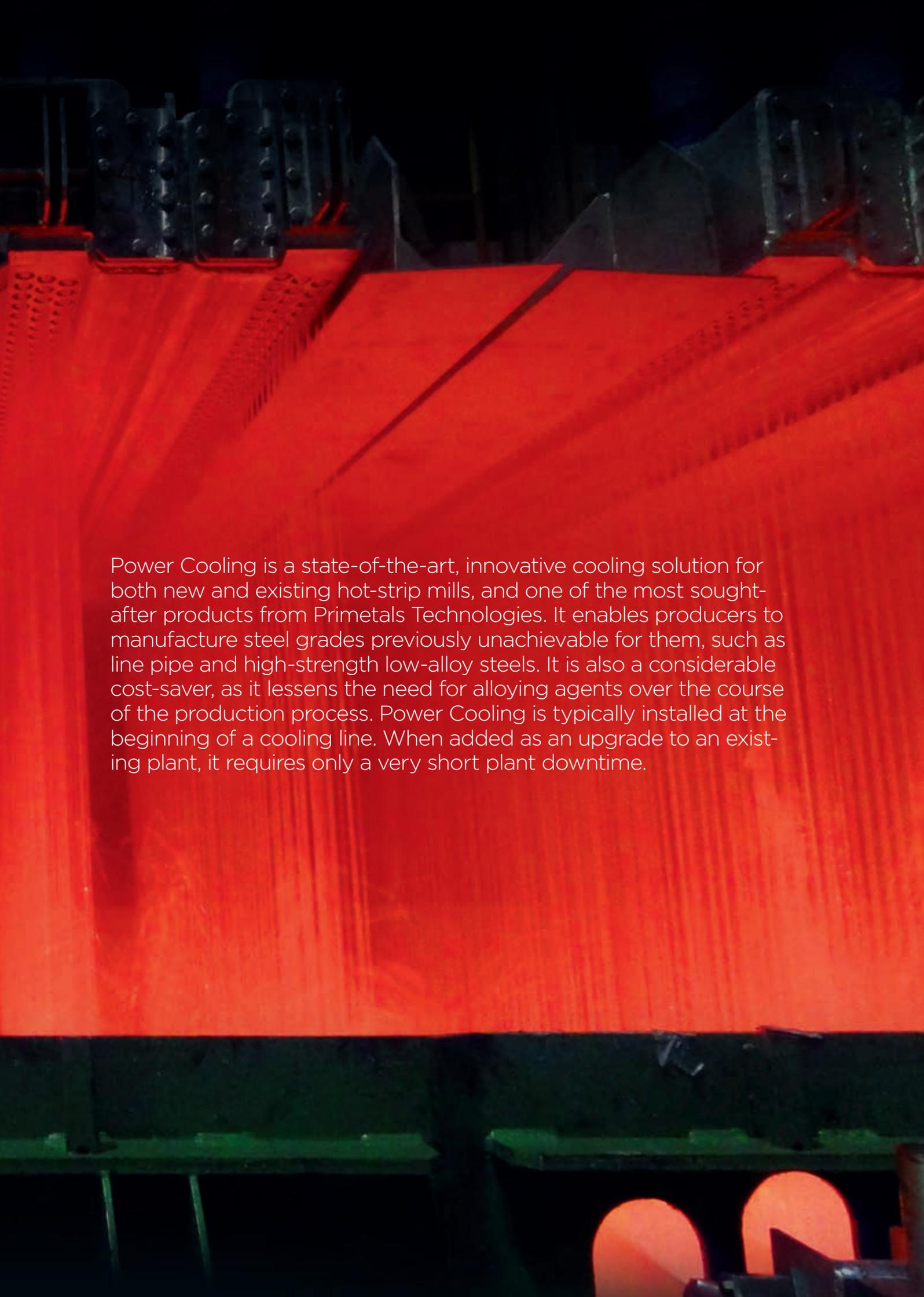
What are the main criteria that Rizhao Steel considers when selecting technology suppliers? And which aspects do you care about most when working with business partners?

Meng Ling Xue: First of all, the supplier must have convincing references and well-proven technologies. Also, the spirit of cooperation is certainly critical. Not only should a supplier provide equipment and technology, but it should also guarantee that our production lines will run properly and the resulting products will be sellable and profitable. Primetals Technologies possesses proven technologies and has an outstanding team. Since the contract signing in 2013, both parties have been working together closely, efficiently and very pleasantly. ●

Wang Shi Yi, Communication Specialist, Primetals Technologies China



UNLEASH
THE WATER

The image shows a large-scale industrial hot-rolling mill. Multiple wide, glowing red steel strips are being processed by a series of large, dark metal rollers. The scene is dimly lit, with the primary light source being the intense heat of the steel, which glows a vibrant orange-red. The rollers are arranged in a line, and the strips are being fed through them from the background towards the foreground. The overall atmosphere is one of intense industrial activity and high temperature.

Power Cooling is a state-of-the-art, innovative cooling solution for both new and existing hot-strip mills, and one of the most sought-after products from Primetals Technologies. It enables producers to manufacture steel grades previously unachievable for them, such as line pipe and high-strength low-alloy steels. It is also a considerable cost-saver, as it lessens the need for alloying agents over the course of the production process. Power Cooling is typically installed at the beginning of a cooling line. When added as an upgrade to an existing plant, it requires only a very short plant downtime.

When China's Wuhan Iron and Steel Co. approached Primetals Technologies for what would become an exemplary installation of Power Cooling, the steel producer's objective was clear: Wuhan's goal was to upgrade the existing laminar-cooling line in its 2,250 mm hot-strip mill so that the product mix could be shifted closer toward high-end steel grades such as high-strength low-alloy, dual-phase and line-pipe steels. Instrumental to this advancement was that the plant's cooling intensity in both the early and the late cooling phases would be significantly increased.

A CUSTOM-TAILORED SETUP

During the planning stage, Primetals Technologies proposed to install additional high-capacity "turbo-laminar" cooling headers in the rear section of the cooling line, which would allow the cost-efficient production of as-hot-rolled, multi-phase steel grades. Furthermore, a laser-type speed gauge was added to the cooling line so that the speed control accuracy could be increased. This measure was expected to especially have a positive effect on the temperature accuracy of those strips that are shorter than the distance between the last finishing mill stand and the downcoiler.

To facilitate an accurate tuning of the new cooling process model, intermediate temperature measurements proved necessary, especially in those instances where

the mill produced strip through the application of an interrupted-cooling strategy. Together with the customer, the project team of Primetals Technologies decided to remove eight of the existing top headers and 24 bottom headers to create the gap required for making these measurements.

POWER COOLING COMES ALIVE

The first 16 laminar-cooling header sets, with each set comprising one top and three bottom headers, were replaced by 18 sets of the far more effective Power Cooling headers. Each of these header sets consists of two top headers and two bottom headers. After the upgrade, the complete Power Cooling zone featured a total maximum flow rate of approximately 14,000 m³/h. This enabled extremely high cooling rates during the early cooling phase to be achieved in order to meet the demanding requirements of the production process when the most advanced high-strength steel grades are manufactured.

The flow rate of the new Power Cooling headers is widely adjustable, which thus permits an exceptionally broad range of cooling rates to be applied for the production of the desired steel grade. Applicable cooling rates can extend from mild up to intensive, depending on the steel grade specifications and quality and gauge parameters. For certain standard products that command a very spe-



NEW OVERHEAD TANK

This new tank is located outside of the mill building adjacent to the cooling section. Next to the overhead tank, a new pumphouse was erected. The building contains the booster pumps for the Power Cooling section as well as those for the Power Cooling cross sprays and water knives (for blowing excess water off the strip). Both the new and the pre-existing laminar-cooling headers are fed directly from the tank. Importantly, this is also true for the new Power Cooling headers. In those cases where the water pressure level of the tank is not sufficient, a valve in the supply line can be closed so that the water will flow via the pumps in the pump house to the Power Cooling section.



PRE-ASSEMBLED NEW EQUIPMENT

The installation of the Power Cooling equipment was greatly facilitated by pre-assembling the new components into larger units, which could then be easily and quickly moved into place using an overhead crane. This approach contributed greatly to the short installation time of 15 days, which will be improved even more future projects.

cific cooling strategy, the previously existing laminar-cooling headers can be used in parallel with the new Power Cooling setup.

A COMPREHENSIVE UPGRADE

As part of the upgrade, a new overhead water tank was installed. It was designed to supply water to the Power Cooling headers, which can be operated similarly to standard laminar-cooling headers that rely on gravity to build up the necessary pressure. When higher flow rates are called for, the water is pressurized by frequency-controlled booster pumps. This operational concept combines the most advanced high-capacity cooling technology with the most economic production costs. To ensure the most efficient cooling possible in all situations, the cooling system offers an additional operation mode called "quasi-laminar" cooling. In this mode, the pumps run at very low speeds so that a switchover to "pressure-cooling mode" can be facilitated within less than a second.

In order to increase the maximum cooling rate during the second stage of cooling of "as-hot-rolled multi-phase steel grades," a number of turbo-laminar-cooling headers were installed in front of the existing trimming zone. These headers work like standard laminar-cooling headers and are fed from the new overhead tank, but can provide significantly higher flow rates due to their special

design. In order to offer maximum flexibility in terms of cooling rates, as required for different products, all top headers and each corresponding group of three bottom headers are flow-controlled.

STREAMLINED INSTALLATION

To minimize the shutdown time that would be imposed by the installation, all new equipment was preassembled on site and into units that could be lifted and moved into position using an overhead crane. This was done directly after the existing equipment had been removed. The upgrade also entailed the replacement of the roller table section in the Power Cooling area to ensure a proper drainage of the water on both the top and the bottom side of the strip. The Power Cooling headers were pre-tested at the manufacturer's site to verify that all requirements would be fully met immediately after the start-up of the cooling line. Due to the highly detailed planning and streamlined execution that Primetals Technologies provided over the duration of the installation, the total plant downtime was kept to just 15 days. Future installations of Power Cooling are expected to be completed in an even shorter timeframe. ●

Dr. Lukas Pichler, Product-Lifecycle Manager, Hot Rolling

Alois Seilinger, Senior Expert, Hot Rolling

Erich Opitz, Technologist, Hot Rolling

(All with Primetals Technologies Austria)



FOR STEEL PLANTS OLD AND NEW

Power Cooling can be implemented in existing plants in a straightforward fashion, using available water-treatment plants, piping infrastructure and sufficiently large water tanks. The Power Cooling units are then supplied with water via a booster pump that generates the required operational pressure. Optionally, the pump can be bypassed, in which case the Power Cooling headers are supplied directly from the overhead tank for an operation in laminar-cooling mode. Thus, the full operational spectrum and even applications that require a "quasi-laminar" cooling level to be maintained over the full length of the cooling line can be achieved after the installation of Power Cooling.



ADDITIONAL REFERENCE PLANTS

Besides the Wuhan Iron and Steel plant portrayed in this article, two further reference plants that utilize Power Cooling technology exist today. They are both operated by Thyssenkrupp and located in Bruckhausen and Beeckerwerth (above photo), Germany. Their respective production capacities are around 3 and 5 million tons of steel per year.

CONSTANT REFINEMENT

**INTERVIEW WITH YOICHI KIRA,
GLOBAL HEAD OF THE HOT MILL BUSINESS
SEGMENT AND SENIOR VICE PRESIDENT OF
PRIMETALS TECHNOLOGIES JAPAN**

What are today's challenges in the hot-rolling area? What kind of technological progress can realistically be expected? How will Primetals Technologies make the most of its multinational structure with locations all around the world? In this interview, Yoichi Kira, Global Head of the Hot Mill Business Segment and Senior Vice President of Primetals Technologies Japan, answers these questions – and lets us in on how the company's Japan-based operations fit into the larger scheme of things.

Over the last ten years alone, Primetals Technologies can refer to more than 40 references for new flat-product hot-rolling mill start-ups. This comprises 16 references for hot-strip steel mills, 18 references for plate and plate-Steckel mills, and ten for aluminum mills. What has convinced so many customers to choose our company? What steps will be taken to ensure the continuation of business success in the future?

Yoichi Kira: We have a long history of successful projects with our legacy companies. This includes providing the best products and solutions over decades. Our in-house resources are vast and diverse and cover engineering, design, and manufacturing with great creativity and innovation to fulfill our customers' requirements. Also very important is our relationship with our business partners, which means our suppliers and consortium partners.

Finally, when we commission the ordered equipment to our customers, we ensure an optimal handing over of the supplied products so that our customers feel supported all the way through the complex start-up procedures. This should be viewed as a cycle, where after the completion of an order, a new cycle starts – and the customer can count on us to be a reliable partner all the way.

How does the technological competence and expertise of Primetals Technologies differ from that of its competitors in your area of expertise?

Kira: At Primetals Technologies, we are a total solution provider. From a portfolio point of view, my segment supplies the mechanical equipment, and our own competent Electrics & Automation Business Segment provides their respective solutions to ideally fulfill the customers' require-



“ At Primetals Technologies, we are a total solution provider.”

YOICHI KIRA
Global Head of the Hot Mill Segment and Senior Vice President of Primetals Technologies Japan

ments. We can provide what we call “Through-Process Know-How,” meaning that we know the entire production process from start to end in an extraordinarily detailed way. The unique combination of these three areas of competence within our company is a decisive benefit to our customers and a true differentiator on the market. Another advantage of ours is the close connection between equipment design and manufacturing. This gives us the opportunity to not only use the expertise of our manufacturing team to provide feedback to our design team and contribute to the refinement of the design, but also to test new design concepts in our own workshop.

In which direction are technological developments going in the hot-rolling area? Are these developments more of an evolutionary or a revolutionary nature?

Kira: In terms of technological development, our mission is to support our customers to achieve their target and their vision. Basically, there are two different scenarios in this context: Firstly, if a customer wants to enter the flat-rolling market, we can provide them with the necessary technology. Secondly, if the customer already has existing flat-rolling equipment, we can offer them various options to upgrade their plant and to differentiate themselves even further from their competitors. In order for Primetals Technologies to be able to fulfill the requirements in both of these scenarios, it is essential to implement a constant development of our portfolio. This allows us to provide robust and reliable equipment that is easy to use and maintain. Even though our components are already highly specialized and advanced, they will undergo additional refinement in the future. Improving our core technolo- »

“A key goal of our customers will be to maintain a very high product tolerance, achieve the specified mechanical properties, and reach an exceptional surface quality while enlarging the product range.”

gies is really a never-ending story. Overall, the technological development might be both evolutionary and revolutionary. Even though I would expect the near-term advances in hot rolling to be more of an evolutionary nature, they might seem like they actually were quite revolutionary when looked back upon in a few decades' time.

What is left to improve in rolling? More exact tolerances or even flatter strip? With the technology already being so mature, do you think that any major improvements can still be expected?

Kira: In hot rolling, customers are always looking for ways to achieve thinner and stronger steels for high-end applications such as for the automotive industry. Also, certain customers are seeking to produce thicker plates, for instance, for the manufacture of pipes. And yet another expanding customer group is that of the aluminum producers. These are the areas where I would expect future improvements to be made. A key goal of our customers will be to maintain a very high product tolerance, achieve the specified mechanical properties, and reach an exceptional surface quality while enlarging the product range. This will make continuous enhancements necessary.

In which market regions around the world do you see growth potential for the hot-rolling Business Segment?

Kira: Our market will be wherever metals will be consumed. We see very limited opportunities for new green-field projects. But I would expect more modernization projects everywhere. As of 2016, around 400 hot-rolling mills have been built worldwide, and we are ready to offer upgrades to these producers, should they require them.

What are the main company locations, how do they serve the global market, and how is this coordinated?

Kira: Our locations in Japan and Europe have outstanding competence in hot rolling. Every new project is assigned to the location best fit to serve the respective customer. There are several factors influencing the decision about

which location will execute the project. Sometimes, the customer already has a long-standing relationship with a certain location, and this relationship is definitely maintained. Also, geographical aspects play an important role. I always take all this into consideration whenever I assign a project to any one of our locations. Our customers can be absolutely confident that no matter where in the world they are located, they will receive the very best solution Primetals Technologies has to offer. Our newly established Sales & Marketing department and my segment have started an extensive cooperation with the goal of increasing efficiency when presenting our customers with the remarkable technologies that we can provide them with.

Is there anything unique about the Japan-based operations of Primetals Technologies? Can you think of any cultural idiosyncrasies that shine through in the way that technology is handled?

Kira: In Japan, our company has a long legacy of refining its products by relying on a combination of the efforts of the design department and the manufacturing team. We have always used this setup to ensure the quality and a prompt delivery schedule, and to guarantee future technical improvements. We actually call our Hiroshima workshop our "mother workshop" for that very reason.

Do you think the "collective character traits" of Japan and Japanese companies have a positive influence when customers make the choice to use solutions from Primetals Technologies?

Kira: No, because in my opinion no single cultural background that our company entails should be a significant factor in the decisionmaking of our customers. Rather, our strength comes from the unique combination of several countries and cultures. We work unitedly to serve our customers with an extremely wide product portfolio. Our customers should rely solely on our technologies and not base their choice on our cultural heritage, even though it clearly enriches our company.

What synergy benefits have resulted in the hot-rolling area as a result of being part of an organization with such a large product portfolio and such a rich, multi-cultural background?

Kira: Our large portfolio means that we encompass a very broad range of activities from which we have generated enormous know-how. As I mentioned, the Hot Mill Business Segment will come together with Electrics & Automation and Through-Process Know-How to deliver outstanding solutions to our customers. I appreciate the presence of our global Metallurgical Services Business Segment, which spreads over several continents. Knowing their activities will help us recognize the situation that our customers are currently in. We would like to understand the issues our customers are dealing with as well as possible, and the Services Business Segment can provide us with a lot of insight in this regard. Using such information, we can offer customers distinct solutions from the Hot Mill Business Segment. By collaborating with our global Sales & Marketing operations and our local entities, such as at the U.S., China and India locations, we can approach our customers very effectively and be a true lifecycle partner to them. ●

“As of 2016, around 400 hot-rolling mills have been built worldwide, and we are ready to offer upgrades to these producers, should they require them.”



YOICHI KIRA

A LONG CAREER WITHIN THE METALS BUSINESS

Yoichi Kira has been passionate about the metals industry for a long time, particularly about hot-rolling technology: “Shortly before I graduated, I visited four workshops in Japan: In a shipyard, at a camera manufacturer, at a chemical plant, and, the one that really stood out to me, a hot-rolling workshop. From then on, I was adamant to contribute to the rolling side of the steel industry myself.” In 1983, Kira joined IHI Corporation, a predecessor company of Primetals Technologies, just after earning his Master’s Degree in Engineering from Keio University, Japan. He first worked as a design engineer in rolling technologies (steel and aluminum), where he was responsible for a large array of tasks, including automation programming and equipment start-ups at customers’ sites. In October of 2013, when IHI’s daughter company IHI Metaltech merged with Mitsubishi-Hitachi Metals Machinery (MHMM), Kira acquired the position of Executive Managing Director of MHMM, which he kept after MHMM became part of Primetals Technologies in January 2015.

As Global Head of the Hot Mill Business Segment and Senior Vice President of Primetals Technologies Japan, Kira currently holds two of the most distinguished positions within the company. One of his ambitions is to always take both a specialist’s and a generalist’s point of view when dealing with complex subject matter so that a good balance between detail orientation and pragmatism can be reached. Privately, Yoichi Kira is a keen admirer of classical music. He plays the piano and tries to attend classical concerts when time and opportunity allow for it.

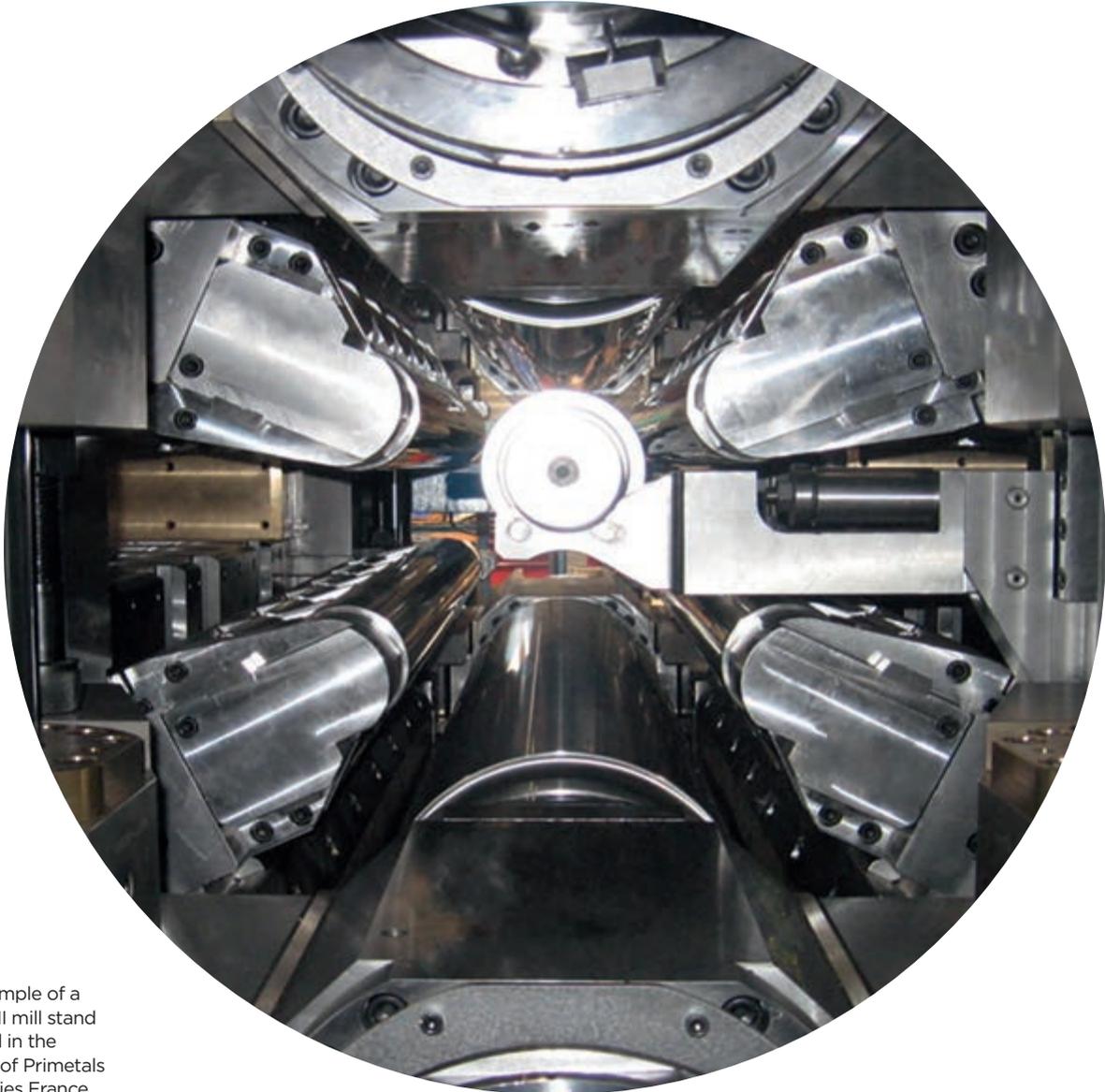


FIG. 1: Example of a Power X-HI mill stand assembled in the workshop of Primetals Technologies France

A BETTER WAY TO PRODUCE **STAINLESS STEEL STRIP**

BACKGROUND AND BENEFITS OF THE POWER X-HI MILL

The price factor is a real challenge in the stainless steel market. With the installation of high-capacity Power X-HI rolling stands in a continuous rolling configuration, rolling times can be considerably shortened, output increased and profit margins improved compared to the 20-high reversing-mill process for rolling stainless steel (Figure 1). In addition to a review of the Power X-HI rolling concept, this topic outlines the most recent stainless steel projects implemented by Primetals Technologies in China.

Primetals Technologies is a key supplier of continuous in-line stainless steel rolling mills. As early as 1999, the company provided mill equipment for a stainless steel production line at Isbergues, France, for Ugine S.A. – the Stainless Steel and Special Alloys Division of French steel giant Usinor S.A. This was followed by the installation of automation and drive systems in the integrated stainless steel production line of Outokumpu Stainless Oy in Tornio, Finland. Additional references include the supply of main equipment for the direct-rolling, annealing and pickling (DRAP) line at Lianzhong Stainless Steel Corporation (LISCO), Guangzhou province, China; and the start-up of a 4-stand Power X-HI mill in February 2015 at the integrated annealing, pickling and rolling facility of Baosteel Desheng Stainless Steel Co., Ltd. in Fujian province, China.

In its most recently executed stainless steel project, Primetals Technologies supplied a 5-stand Power X-HI continuous rolling line to Beihai Chengde Stainless Steel Co., Ltd. (Beihai Chengde) in Guangxi Province, China. Following completion of equipment installation, cold testing was carried out within 17 days, and the first coil was successfully rolled within three months in late December 2015. With a rolling speed of 400 m/min and a rolling capacity of 600,000 tons per year, this mill features the fastest rolling speed for the production of stainless steel in China. The layout of the mill is depicted in Figure 2, and a view of the completed Power X-HI tandem mill stand is shown in Figure 3. Additional technical details and process parameters of the line supplied to Beihai Chengde are listed in the box. »

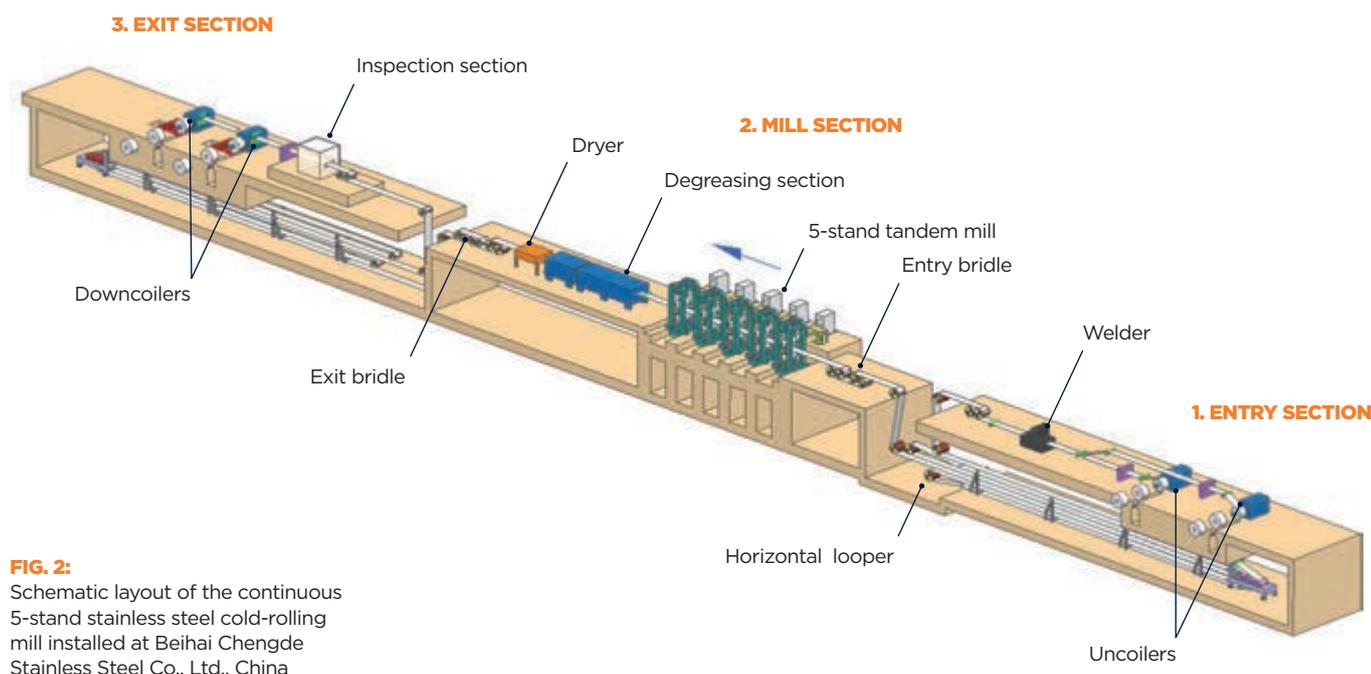


FIG. 2: Schematic layout of the continuous 5-stand stainless steel cold-rolling mill installed at Beihai Chengde Stainless Steel Co., Ltd., China

With a rolling speed of 400 m/min and a rolling output capacity of 600,000 tons per year, this mill features the fastest rolling speed for the production of stainless steel in China.



FIG. 3: Power X-HI rolling mill installed at Beihai Chengde Stainless Steel



FIG. 4: The LW21H heavy laser welder in the workshop of Primetals Technologies France

DEVELOPMENT OF THE POWER X-HI ROLLING PROCESS

In standard stainless steel processing routes, the hot-rolled material is first annealed and pickled, followed by cold rolling in a 20-high reversing mill down to the desired thickness. Final annealing, pickling and skin passing are then carried out. In some cases, particularly for thinnest strip gauges, intermediate annealing and pickling is required, which means that a second passage through the mill facility is necessary. Although the technology is mature, classical reverse rolling in a 20-high mill stand still has a number of drawbacks. Among others, these include high yield losses resulting from the strip head and tail ends that are not rolled, time-consuming strip threading into the roll gap, output limitations due to the inherent nature of the reversing process and suboptimal cooling efficiency.

The Power X-HI rolling mill solution was therefore developed by Primetals Technologies to address these problems as well as to enhance mill performance and operational efficiency for the rolling of stainless steel. A key focus was placed on improving product yield, increasing operational and energy efficiency, and applying accessible technology to facilitate local maintenance work. At Beihai Chengde, it was not possible to implement a completely integrated stainless steel processing line due to the need to allow for two separate pickling and annealing steps to ensure the flexibility required for rolling different products.

LINE EQUIPMENT

1. Entry section

To safeguard that a Power X-HI mill can be endlessly fed with strip, the entry section is equipped with double pay-off reels, a heavy laser-type welder and a 6-strand looper. A LW21H heavy laser welding machine that was designed and manufactured at the workshop of Primetals Technologies in France was installed in the Power X-HI line supplied to Beihai Chengde (Figure 4). The welder, which is able to weld strip with thicknesses between 1 mm and 5 mm, features an 8 kW laser source, including an inline welding-seam annealing and quality-control system. Strip tension prior to entry into the rolling mill is controlled by a 4-roll tension bridle.

2. Mill section

The design of a standard 18-high mill stand was reengineered to the patented Power X-HI mill stand. The main features of this new mill-stand generation are as follows:

- The intermediate rolls are mounted within a sturdy shifting-chock assembly. The stabilizing side-support rolls are in a modular design arrangement and are characterized by a highly reproducible and accurate positioning system.
- The roll set geometry was adapted to allow a slightly increased work-roll diameter range to be applied, which means a larger work-roll surface, reduced generation of

TABLE 1:

KEY DATA OF THE POWER X-HI MILL SUPPLIED TO BEIHAI CHENGDE STAINLESS STEEL

Number of mill stands	5
Installed power	22,000 kW
Material to be processed	Hot-rolled annealed and pickled stainless steel
Product grades	AISI 200 and 300 series
Capacity	600,000 t/a
Welder type	LW21H laser welder (Primetals Technologies)
Entry section speed	max. 400 m/min
Mill section exit speed	max. 400 m/min
Exit section speed	550 m/min
Entry strip thickness	1.0 mm to 5.0 mm
Exit strip thickness	0.3 mm to 3.0 mm
Strip width	800 mm to 1,300 mm

heat in the roll bite, lower roll wear, fewer work-roll-changes and longer roll lifetimes.

- Roll change is performed independently and fully automatically for each roll type (work rolls, intermediate rolls and side-support rolls) to improve the efficiency of regrinding works. The rolling stands are also designed to enable a flying roll change with the mill in rolling operation so that production will not be interrupted during roll change. This increases productivity and reduces output losses.

An emulsion-based cooling media was chosen as a roll coolant for Power X-HI. This considerably increases the cooling effect compared to using pure oil. Another advantage is that fire risk is reduced to nearly zero. The specific design of the emulsion spray system, which is embedded within the lateral stabilization roll (patented), allows the media to be directly applied at the roll bite for an improved cooling and lubrication effect.

A cleaning section, positioned just after the mill, removes oil residue from the strip using a combination of high-pressure hot water, steam and a brush scrubber. With this setup, cleaning with an alkali solution is no longer needed. A 6-roll bridge and exit looper are installed after the cleaning section to serve as a strip buffer between the rolling-cleaning exit section and the coilers. This also enables the strip surface to be intermediately inspected during continuous rolling operations, which reduces strip losses.

3. Exit section

The exit section includes an exit bridge, inspection station, rotary shear, a scrap and sample cutter, twin coilers, a belt wrapper, paper un-winder equipment and a coil-unloading car with the associated coil banding and storage facilities. The strip looper, positioned between the mill section and the exit section, decouples the rolling process from the downstream activities. This allows the strip surface to be intermediately inspected during continuous rolling operations. With these measures, there are thus no longer any limiting factors on mill throughput.

A POWERFUL AND PROVEN SOLUTION

To date, Primetals Technologies has supplied two Power X-HI mills to China. These mills are characterized by their reliability, increased yields, high output rates and lower operational costs compared to a reversing cold-rolling mill. All of these factors, of course, are essential to succeed in today's highly competitive market for stainless steel flat products. ●

Deng Wei Jian, General Manager¹⁾

Zhang Shijun, Vice General Manager, Cold Rolling Factory Director¹⁾

Gaël Imbert, Head of Technical Proposals for Cold Band Lines²⁾

Olivier Lietar, Project Management²⁾

¹⁾ Chengde Beihai Stainless Steel Plant

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INCREDIBLE STRIP QUALITY

DESIGN HIGHLIGHTS OF TWO CHINESE PL-TCM FACILITIES FOR THE PRODUCTION OF STEEL STRIP FOR TINPLATE APPLICATIONS

Cold rolling of steel to produce tinplate places special demands on the rolling speed and thickness reduction. The high rolling speeds and thin gauges required, however, are often associated with problems related to unstable threading, poor strip shape and thermal scratching, all of which must be avoided or minimized. Primetals Technologies addresses these problems with an innovative continuous pickling line and tandem cold mill, which is already in operation with impressive results at the steelworks of two Chinese customers.



FIG. 1: Tandem cold mill section; left: Shougang Jingtang United Iron & Steel Co., China, right: Wisco-Nippon Steel Tinplate Co., China

The most advanced rolling technology is installed to enable faster and stable rolling of harder and thinner steel strip that fulfills the product demands for excellent shape, precise gauge control and thermal crown compensation.

TABLE 1:

MAIN SPECIFICATIONS OF THE PL-TCM LINE

Item	Typical Specification	
Material	Material	T1 to T5
	Entry thickness	1.5 mm to 4.0 mm
	Delivery thickness	0.15 mm to 1.0 mm
	Width	700 mm to 1,300 mm
	Coil weight	28 tons
Capacity	850,000 t/a	
Speed	Pickling speed	200 m/min
	Rolling speed	1,800 m/min to 2,000 m/min
	Strip dividing speed	300 m/min
Welder type	Laser-based	
Pickling type	Jet pulse	
Mill type	6-high UCM-Mill	

To meet the surging demand for canning material in China, Primetals Technologies supplied an advanced continuous pickling line and tandem cold mill (PL-TCM) for tinplate applications to Shougang Jingtang United Iron & Steel Co., Ltd. (SGJT) and Wisco-Nippon Steel Tinplate Co., Ltd. (WINSteel) – Figure 1. The most advanced rolling technology is installed to enable faster and stable rolling of harder and thinner steel strip that fulfills the product demands for excellent shape, precise gauge control and thermal crown compensation. The

5-stand tandem cold mill features 6-high Universal Crown Control Mill (UCM-Mill) technology and the newly designed jet-pickling tank from Primetals Technologies. Steel is rolled to thicknesses down to 0.15 mm at rolling speeds of more than 1,800 m/min.

PL-TCM LINE LAYOUT

A general overview of the directly linked PL-TCM line configuration is depicted in Figure 2. Table 1 shows the main specifications of the line. »

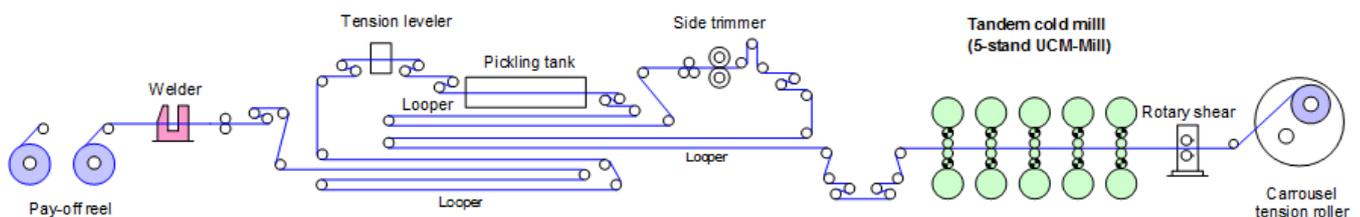


FIG. 2: Outline of the PL-TCM line configuration

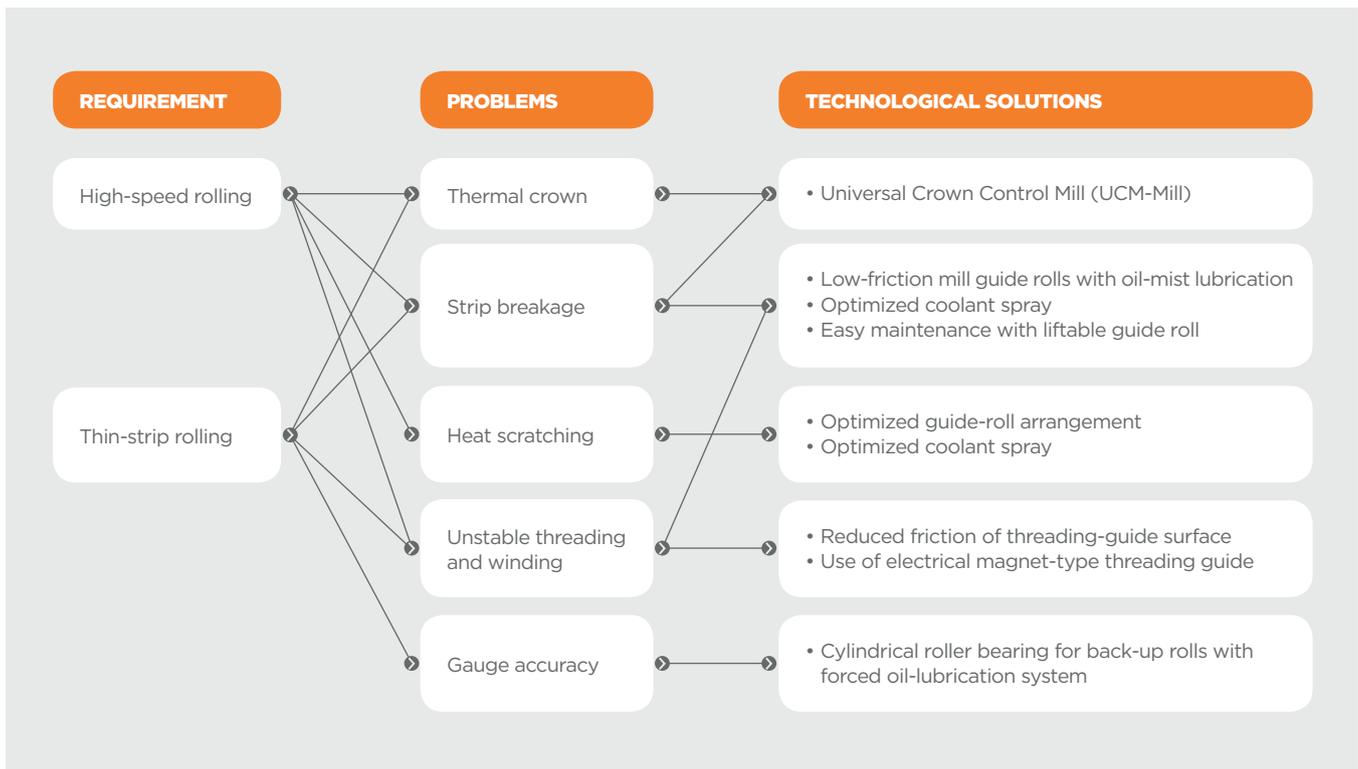


FIG. 3:
Requirements and technologies for rolling steel for tinplate applications

ENTRY AND PICKLING SECTION

A dual pay-off reel system is installed in the pickling line entry section to ensure uninterrupted pickling and rolling operations. With consideration to the thin strip gauges rolled in the cold-rolling mill, the coil-handling equipment, which includes coil opening and threading to the welder, supplies steel strip to the line in a reliable and controlled manner with a high degree of centering accuracy. Jet pickling is then performed at high speeds without over- or under-pickling. Following precise strip trimming, the strip is fed to the cold-rolling mill within specified speeds and also with high centering accuracy.

TANDEM COLD MILL SECTION

The 5-stand tandem cold mill (TCM) with 6-high UCM-Mill technology meets the requirements for harder, thinner, faster and more stable strip rolling. Steel is rolled to a minimum gauge of 0.15 mm at strip widths of up to 1,300 mm for the production of T2.5 to T5 tinplate. Maximum rolling speeds of more than 1,800 m/min have been achieved, making it one of the fastest rolling mills in the world. UCM-Mill technology, optimization of the mill guide arrangement and the configuration of the coolant system are decisive for preventing heat scratches on the strip surface – even at these high rolling speeds.

REQUIRED TECHNOLOGIES TO ROLL STEEL FOR TINPLATE APPLICATIONS

High-speed, heavy-reduction rolling with utmost gauge accuracy is required for the production of thin strip for

tinplate applications at high productivity levels. Insufficient roll cooling can cause strip shape variations due to a growing thermal crown as well as potential heat scratching, which adversely affects strip surface quality and may also result in rolling-speed limitations. Furthermore, poor strip shape increases the frequency of strip breakage during strip width changes and may also result in unstable strip winding in the carousel tension reel following shear cutting. Technical countermeasures for these issues are addressed in Figure 3.

UNIVERSAL CROWN CONTROL MILL

The UCM-Mill combines the advantages of excellent strip-shape-control performance and self-stabilization of the strip shape. Figure 4 shows the function principle of a UCM-Mill stand. The mill features axially shiftable intermediate rolls inserted between the work rolls and backup rolls. The intermediate rolls are shifted in conformity to the width of the strip to eliminate undesirable contact areas. Furthermore, this roll arrangement makes it possible to use smaller roll diameters and straight (without initial crown) work rolls for rolling all steel grades. The mill stand is also equipped with work-roll and intermediate roll-bending functions.

MILL GUIDE SYSTEM

Heat scratches caused by insufficient lubrication and cooling place limits on rolling capability with respect to rolling speed and strip-thickness reductions, yet high rolling speeds and heavy-gauge reductions are a prereq-

uisite for steel produced for tinplate application. Thin-gauge rolling also increases the frequency of strip breakage. High-speed stable rolling with high-quality rolling results is achieved by optimizing the roll-coolant flow rate at each stand and for each strip-cooling zone. Oil-mist lubrication is also applied instead of grease-packed mill guide-roller bearings in order to reduce bearing friction. Accordingly, a secured and stable roll rotation during rolling-speed acceleration and deceleration with reduced strip tension prevents scratches between roll and strip surfaces. Lifiable mill guide rolls are also installed to shorten handling time in case of strip breakage.

THIN-STRIP THREADING

Stable strip threading and winding into the carousel tension reel (Figure 5) is required for continuous rolling. However, strip shape sometimes deteriorates during strip width changes when rolling thin strip. For strip thicknesses less than 0.2 mm, unstable threading and winding into the carousel tension reel after strip cutting at the rotary shear often occurs due to strip buckling. To correct this problem, a lower-friction threading-guide structure is installed as well as air blowing to reduce the friction between the guide and strip surface. These improvements result in stable strip threading and winding. Furthermore, an electrical magnet threading guide is applied to prevent buckling of the strip tail end after strip cutting and winding speed deceleration. This threading guide consists of four magnet sections. The magnets are independently energized to attract the strip upward, depending on the position of the strip tail end.

SUCCESSFUL START-UP AND COMMERCIAL OPERATION

The described PL-TCM facilities for the rolling of steel for downstream tinplate applications entered commercial production at SGJT and WINSteel in 2013 and 2014 respectively. The production of high-quality steel strip at thicknesses of only 0.15 mm and at rolling speeds exceeding 1,800 m/min was made possible with the use of UCM mill technology and by optimizing the mill guides and the coolant system. ●

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²⁾Hitachi, Ltd. Services & Platforms Business Unit

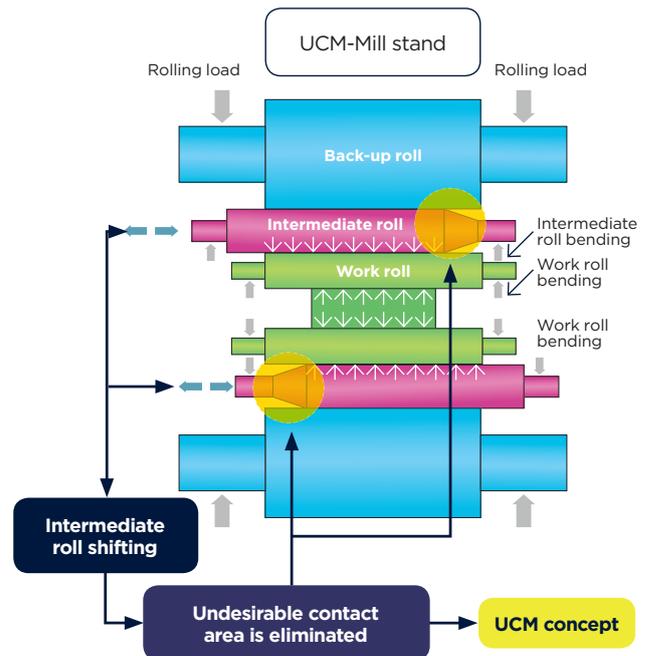


FIG. 4: Function principle of a mill stand equipped with UCM-Mill technology

Maximum rolling speeds of more than 1,800 m/min have been achieved, making it one of the fastest rolling mills in the world.

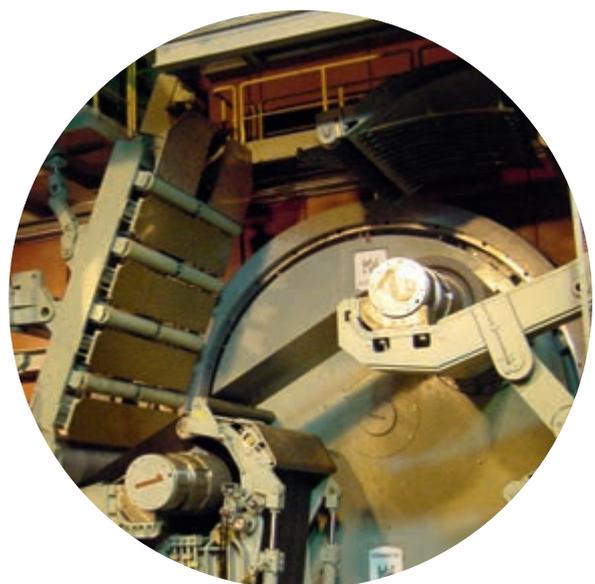


FIG. 5: Carousel tension reel with electrical magnet threading guide

COMBINING COMPETENCES

INTERVIEW WITH SHUNSAKU KASAI, GLOBAL HEAD OF THE COLD ROLLING & PROCESSING LINE BUSINESS SEGMENT AND EXECUTIVE VICE PRESIDENT OF PRIMETALS TECHNOLOGIES JAPAN

Recognizing new market opportunities and devising a strategy to surpass an already high level of success in the Cold Rolling & Processing Line Business Segment of Primetals Technologies is only part of Shunsaku Kasai's responsibility. He also serves as Executive Vice President of the company's Japan operations. Dr. Thomas Widter asked Mr. Kasai in what direction the steel business will be going, what developments are to be expected in cold rolling, and how the company's global setup will lead to decisive customer benefits.

Primetals Technologies and its predecessor companies have gathered an impressive number of references over time. For the supply of continuous tandem cold-rolling mills alone, the company counts 55 references so far. What do you think has convinced so many customers to choose our company for technological solutions?

Shunsaku Kasai: This has to do with the innovative nature of our products, many of which our customers could not get elsewhere at this performance level. For instance, we were the first to develop 6-high rolling technology. Cascading six rolls on top of one another allows higher strip-thickness reduction levels to be applied, enabling our customers to produce flat strip of very high quality. When it comes to continuous tandem cold mills, we currently have an approximate 70% share of the total number of green-field projects that have been implemented worldwide. This impressive number demonstrates our competence to our customers and assures them of the outstanding quality of our solutions. We also continue to improve our portfolio

by the application of new findings stemming from our in-depth research in order to prepare our customers for the future market. Another key factor for our success is that we are able to provide both mechanical and electrical equipment as a single-source supplier.

How does the downstream technological competence and expertise of Primetals Technologies differ from that of its competitors?

Kasai: Our R&D department is very strong. We are in constant communication with our customers and are actively looking for new solutions. We have the opportunity to test out new approaches and new components in our Hiroshima workshop before supplying the finalized product to the customers. This ensures that the performance of all equipment will hit the expected mark when it gets delivered. Some of the more complex orders we receive really benefit from our multi-national structure with many centers of competence. We can accumulate the technologies



“ New developments stem from decades of rich experience.”

SHUNSAKU KASAI

Global Head of the Cold Rolling & Processing Line Segment and Executive Vice President of Primetals Technologies Japan

that perfectly match our customers' requirements, making use of the expertise and resources of our company's worldwide span.

In which direction are technological developments going within your respective areas of responsibility? Are these developments more of an evolutionary or a revolutionary nature?

Kasai: It is clearly evolutionary. Our technology is developed based on the widely-known fundamental concepts that make up cold-rolling technology. However, we have been constantly enhancing the core processes and have made significant improvements to individual components for a very long time. So new developments stem from decades of rich experience. In that sense, the cold-rolling process is changing all the time, but a dramatic and sudden change is not to be expected in this field. If I were to describe the situation with a bit of humor, I would say that "rolling without the rolls" is just not a likely scenario. We

are building on past findings and refining our technologies constantly to further improve our already high standard of excellence.

What is left to improve in rolling? More exact tolerances or even flatter strip? With the technology already being so mature, do you think that any major improvements can still be expected?

Kasai: Increasing productivity is still an ongoing goal. This is particularly true for the production of advanced high-strength steels. Flatness and thickness tolerances, for instance, are still aspects that will see future improvements. Looking forward, another issue that needs to be addressed even more effectively is that of yield loss.

In which market regions of the world do you see growth potential for your respective areas of responsibility?

Kasai: Mexico and India are both very hot markets right now. Aluminum cold rolling is a highly attractive and »



SHUNSAKU KASAI AN EXPERT IN METALLURGY

Shunsaku Kasai majored in mechanical engineering and graduated from Osaka University in 1980. Osaka University is one of the most highly ranked educational institutions in Japan and one of the most well-renowned for its strength in the field of metals and metallurgy. After his graduation, Kasai entered Primetals Technologies' predecessor company Hitachi, where he played an important role in the design and improvement of cold-rolling mill technology. He then worked as Project Manager for Cold-Rolling from 1989 to 2001 and became the department's General Manager at the end of this career stage. Three years later, after Hitachi had merged with Mitsubishi to form Mitsubishi-Hitachi Metals Machinery, Kasai advanced to General Manager of the Processing Line Division. From 2011 to 2014, he lived and worked in the United States as President of Mitsubishi-Hitachi Metals Machinery U.S.A. Since 2016, he has the dual responsibility of serving as Executive Vice President of Primetals Technologies Japan and as Global Business Segment Head of Cold-Rolling & Processing Line.

important field in the U.S., and it is also an area with great future potential in Asia.

How do your main company locations serve the global market, and in what way is this coordinated?

Kasai: In general, we have certain primary customers and it is quite clear which location takes care of them. But all of our locations are in constant contact with one another, and if a customer requires something new, we will try to find the best location to cater to the specific needs this customer has. We gather information on what our customer is looking for on a worldwide scale, have a deep discussion on what the best solution would be, and make sure that the location best fit to serve that specific customer is picked to lead the project. Since each of our locations has its own strengths, we can combine all of their expertise to offer highly specialized, complete packages.

Is there anything unique about the Japan-based operations of Primetals Technologies? Can you think of any cultural idiosyncrasies that shine through in the way technology is handled?

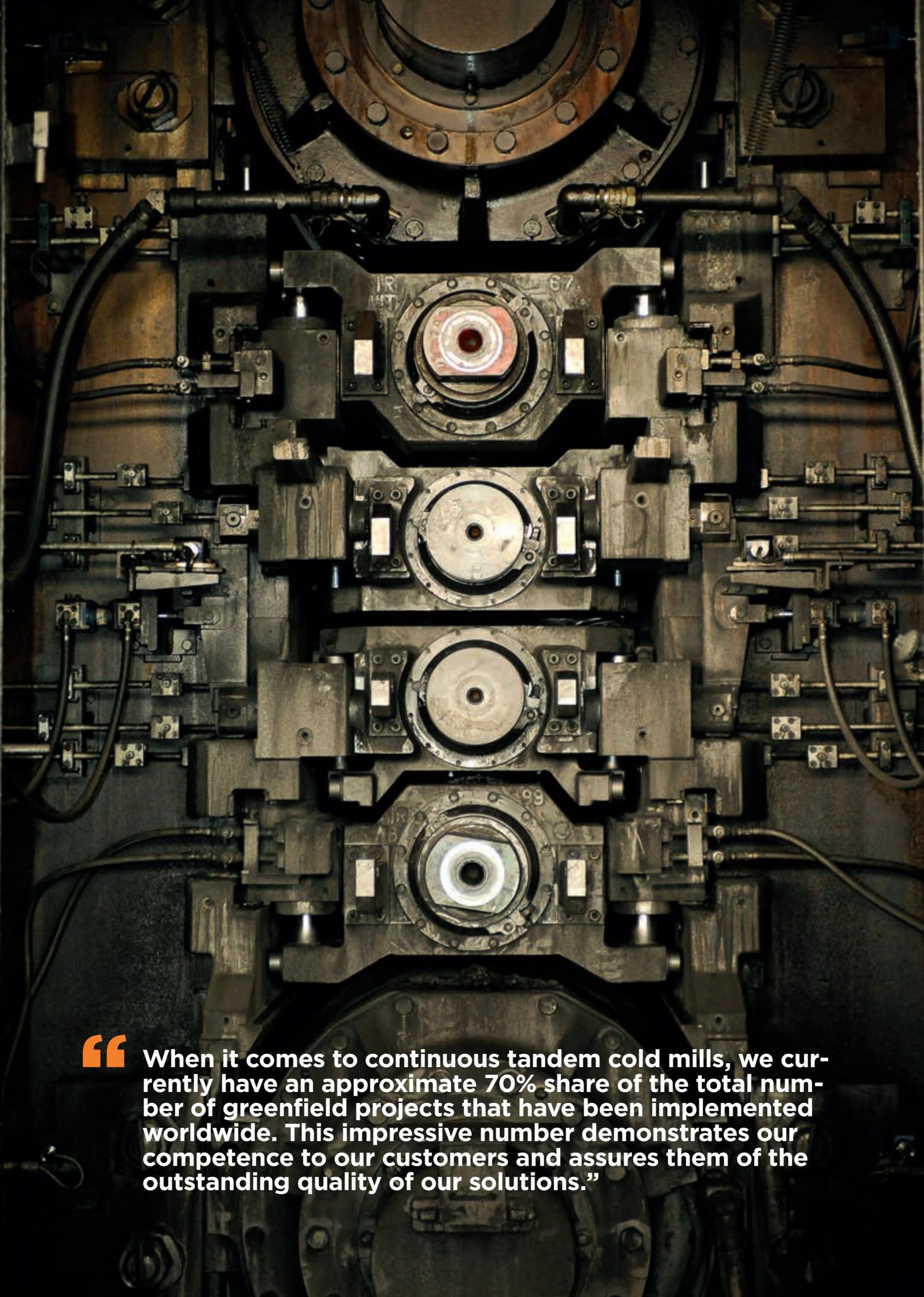
Kasai: No. When a customer tells us their requirements, each technology is evaluated, and one of the locations of Primetals Technologies is then chosen to lead the specific project.

Do you think that sometimes certain "collective character traits" of Japan and Japanese companies have had a positive impact when customers make the choice to use solutions from Primetals Technologies?

Kasai: Well, maybe sometimes. To give you an example, some customers may prefer the typical Japanese diligence that characterizes the way we approach our challenges. Japanese teams by and large can be trusted to keep the previously determined schedule and deliver a solid performance. However, there is also a downside to "the Japanese way" of doing things. We might not always be as communicative as people from other nations. So, like every culture, the Japanese one has its strong suits and minor deficiencies. But I do not think that all of this has a major influence on our customers' decision-making process before entrusting us with an order.

What synergy benefits have resulted in your respective areas of responsibility as a result of being part of an organization with such a large product portfolio and such a rich, multi-cultural background?

Kasai: Our locations complement one another, and there is comprehensive technical exchange between our centers of competence. Therefore, we are able to carry out any cold-rolling project you could imagine, no matter how complex it might be. We have task force teams that discuss their latest innovations, projects and future ambitions. For example, our laser welder technology is a combined research effort of our French and Japanese operations; our French colleagues are the specialists in the field of laser welding technology, while our Japanese experts are at the forefront when it comes to high-precision cutting technology. As Primetals Technologies, we always make sure that our customers distinctly benefit from the vast competence that we have as a company acting on a global scale. ●



“

When it comes to continuous tandem cold mills, we currently have an approximate 70% share of the total number of greenfield projects that have been implemented worldwide. This impressive number demonstrates our competence to our customers and assures them of the outstanding quality of our solutions.”



WELDING

The highly efficient welding operation of the LW21 technology saves up to 50% of the energy needed with other laser welders.

DRIVEN BY THE **POWER OF LIGHT**

EXCELLENT CUSTOMER FEEDBACK UNDERLINES THE COMPETENCE OF THE LASER-WELDING SOLUTIONS DEVELOPED BY PRIMETALS TECHNOLOGIES

Solid-state welding solutions from Primetals Technologies have proven themselves many times over, and in many different production setups. After analyzing six years' worth of industrial feedback, the results show a demand for high performance and reliability in a broad range of products: silicon, high-strength, dual-phase, and high-strength transformation-induced plasticity steels.

SHORT FINE-TUNING PERIOD

After preliminary acceptance, the rates for both rewelding and breakage are typically brought down to exceptional levels after a comparably short period. These impressive values are reachable thanks to the consistently high cutting quality from one coil to the next and the reliability of the welding process when using solid-state (fiber-based) lasers. Additionally, proper supervision and the use of a good quality-control system contribute to ensuring that 100% of the welds are executed correctly.



STAMPING TEST

TENSILE TEST

MICROGRAPH TEST



EXCEPTIONAL WELDING QUALITY

The impressive welding quality achieved with solid-state laser technology has been verified on a wide range of products, including carbon, high-strength, silicon and stainless steels. Primetals Technologies has performed

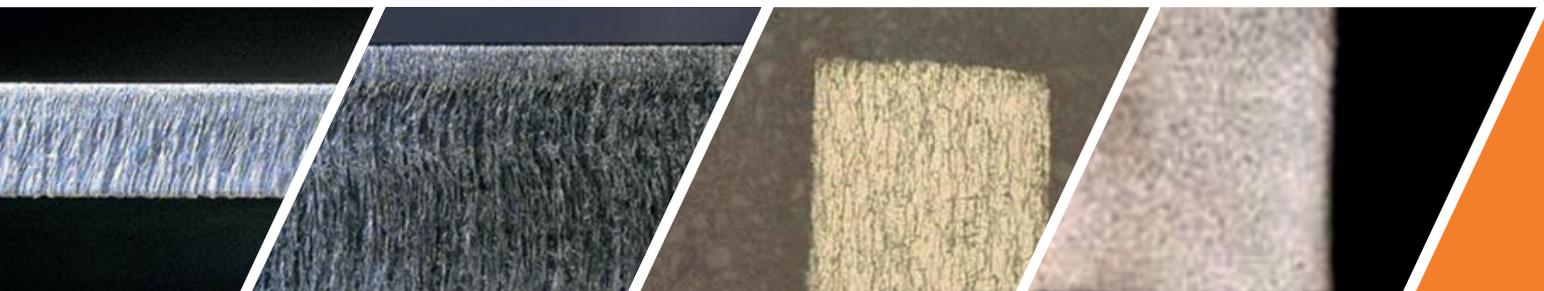
a variety of tests to qualify the welding parameters, such as stamping tests (ball tests), tensile tests (for high-strength steels) and micrograph tests. All test results underline the competence of this innovative welding solution.

2 MM CUTTING FACE

6 MM CUTTING FACE

0.5 MM CUTTING EDGE

2 MM CUTTING EDGE



HIGHLY PROFICIENT CUTTING

With Primetals Technologies' solid-state laser technology, the cutting quality is precise and consistent with no deformation of the strip that can be induced by mechanical shearing. There are no limitations in cutting capacity based on the strength of the steel. Both the quality and

reliability in cutting have been verified across the entire range of steel thicknesses for two applications, namely LW21L (continuous galvanizing, continuous annealing, recoiling and inspection lines) and LW21H (pickling lines, coupled-pickling lines and tandem cold mills).

In recent years, steel grades have changed drastically and are now characterized by high yield strength and elevated elongation levels. They include more added elements such as silicone, manganese, aluminum and more. When manufacturing dual-phase, transformation-induced plasticity, twinning-induced plasticity, boron, silicon, stainless and specialty steels, production lines are able to process steel grades at up to 1,000/1,400 MPa and reach a tensile strength of up to 2,000 MPa.

In terms of welding capacity, the thickness range has been expanded to support even thinner gauges. The minimum thickness required for welders is now less than 1.00 mm for pickling lines and tandem mills, and less than 0.30 mm for galvanizing, continuous annealing and finishing lines.

At the same time, the level of performance required from welders has improved significantly. Availability, welding quality, weld-over thickness and cycle times have reached levels never before achieved. Automatic welding-quality-control systems are now mandatory for customers, preventing human intervention and providing clear welding-quality documentation in accordance with a customer's request.

THE ADVANTAGES OF SOLID-STATE TECHNOLOGY

The full-laser-welding approach integrates solid-state components in its laser source, thus replacing the CO₂ resonator. Solid-state technology is already used in certain sectors such as in the automotive industry and tailor-blank welding, as it leads to different and significant advantages compared to the CO₂ solution. It offers the ability to transmit a beam from the laser source to the cutting and welding heads through optic fiber instead of using mirrors, and without the necessity for a beam switch.

HIGHER EFFICIENCY AND LOWER MAINTENANCE

This technology offers many benefits for steel producers, including higher efficiency, lower energy consumption and higher processing speeds for cutting and welding. For example, the electrical power needed for the chiller and laser source is reduced by 50% when a solid-state solution is used at the same laser-power level as applicable with conventional laser-welding methods.

Also, maintenance is both easier and needed less frequently due to the mirror-free operation, the fact that

EXCELLENT INDUSTRIAL RESULTS

With eight installations active and working in industrial conditions for more than three years, it was shown that all laser welders demonstrated great robustness and easy operation even in the most complex processing scenarios (e.g., production of electrical steels with a silicon content of up to 3.5%, and continuous galvanizing lines processing dual-phase steels up to 1,200 MPa).

With the latest laser welder installed in China, it took less than three months after the hot test to achieve an acceptable level of performance with respect to weld-breakage, re-welding rates and cycle times. With the most recent machine being brought into production in Korea (as part of a revamp), the production ramp-up started before the contractual milestone. All examples shown here represent high-end processing lines based on LW21L solid-state laser technology.

Type	EXAMPLE 1 Continuous Annealing Line	EXAMPLE 2 Continuous Galvanizing Line	EXAMPLE 3 Continuous Galvanizing Line
Location	China	China	Korea
Line supplier	Other	Primetals Technologies	Other (revamping)
Thickness (mm)	0.5 to 2.5	0.5 to 3.0	0.4 to 2.5
Width (mm)	1,875	1,650	1,610
Capacity (t/a)	900,000	450,000	936,000
Product	Commercial quality to extra-deep-drawing, high-strength, and boron steels		Deep-drawing quality; extra-deep-drawing quality; hot-formed, high-strength, dual phase; transf.-induced plasticity; and twinning-induced plasticity steels



CUTTING

When used for cutting, the quality of the laser beam allows for remarkably high cutting speeds with very low wear.

no overpressure system is required, and because no internal parts are used that would command regular attention. The technology relies on contact-free operation, which has the main benefit of almost zero wear on the cutting tools. This is in stark contrast to mechanical shears and their elaborate maintenance needs that require blade changes and regular grinding treatment. Using laser welders, stable welding quality can be expected at all times between maintenance intervals. Overall, at the same laser-power level, solid-state technology means 50% lower maintenance effort compared to CO₂ technology.

SUPERIOR WELDER PERFORMANCE

The use of highly efficient laser welders results in increased welding and cutting speeds with a gain of 20% to 50% for welding and 20% to 100% for cutting (depending on strip thickness). Not only is cutting-tool wear effectively eliminated by using laser welders, but the strip is also perfectly processed without deformation for subsequent welding operations. Customers can also be assured of reduced strip breakage during operation.

PROVEN AND EASY TO INSTALL

Connecting the laser cutter to its power sources is extremely easy. Only one connection per energy source

is required. The interconnecting piping and cabling has been reduced to a minimum for fast welder installation. Before assembly at the customer's site, new welders, including all peripherals, are fully tested in the workshop of Primetals Technologies to ensure maximum reliability in a demanding production environment and to optimize line-stoppage time. The process is therefore adaptable to any application, particularly for revamping projects.

ENHANCING VALUE FOR CUSTOMERS

Primetals Technologies is dedicated to providing the latest solutions to customers on the basis of extensive R&D efforts. Close cooperation with the customer during all project phases is a key factor for the successful implementation and operation of welding machines. Improvements are continually made in the design of laser welders, and also to extend the scope of their applications. Long-term service agreements can be concluded to ensure optimum welder performance over the long term. All equipment supplied by Primetals Technologies, such as the laser welder solution, focuses on enhancing value for customers. ●

Thomas Vallée, Product Manager, Welders

Stanislas Mauuary, Head of Technical Proposal, Cold-Band Products
(Both with Primetals Technologies France)

REASON FOR OPTIMISM

INTERVIEW WITH TAN WENZHEN, VICE PRESIDENT OF TANGSHAN IRON AND STEEL GROUP, CHINA

Tan Wenzhen, Vice President of Tangshan Iron and Steel Group Co. Ltd., has been working at the company for nearly 30 years since he graduated from the University of Science and Technology Beijing in 1988. With his expertise and deep understanding of cold-rolling technologies, Tan Wenzhen speaks about his experience with Primetals Technologies.

What are the main criteria when you select a technology supplier, and how would you evaluate the cooperation between Tanggang and Primetals Technologies?

Tan Wenzhen: When choosing a supplier, we consider its technological competencies first, followed by services and price. There is no doubt that the cooperation with Primetals Technologies is contributing greatly to the development of Tanggang. Primetals Technologies always focuses on a customer's demands both in terms of technology and equipment supply. For new projects, they follow up the progress and respond to our requirements. During project execution, their know-how team is highly dedicated to Tanggang and provides us with their full support. The experts they introduce – both from Primetals Technologies and from external resources – really pursue excellence with a professional spirit. We gained a lot from them; not only encouragement and inspiration, but also

confidence and support. Also, the prices offered by Primetals Technologies were reasonable. To Tanggang, Primetals Technologies is a trustworthy partner and I believe that there might be further cooperation in the future, based on the current relationship between us.

Are both the equipment and the technical solutions from Primetals Technologies meeting your requirements?

Tan Wenzhen: After the installation of new equipment, our product development gained high attention from other domestic steel producers, which I think is a good sign. It is worth mentioning that with joint efforts from both parties, the pickling line with tandem cold mill as well as the continuous annealing line were started up just 21 months after the contract was signed, which broke a world record. Furthermore, the continuous galvanizing line successfully

A DEPENDABLE RELATIONSHIP

Tangshan Iron and Steel Group Co. Ltd. (Tanggang) has developed a close relationship with Primetals Technologies over the years. In 2013, Tanggang signed a contract for the supply of a new cold-rolling mill complex, including a pickling line coupled with a tandem mill, a continuous annealing line, and a continuous galvanizing line. In 2015, another order was placed for two additional galvanizing lines (No. 5 and No. 6).



processed high-strength steel with a tensile strength of up to 980 MPa.

Environmental regulations have become stricter than ever before. What countermeasures have been or will be taken by Tanggang?

Tan Wenzhen: Tanggang pays much attention to protecting the environment. As one of the premiere enterprises for green and intelligent manufacturing in China, Tanggang is fully committed to energy savings and environmental responsibility. I hope to have the opportunity to discuss and cooperate further with Primetals Technologies in this respect.

In the current situation of the metallurgical industry, with overcapacity and intense competition being undeniable factors, how do you see the future development

of your company, especially the cold-rolling and processing technologies?

Tan Wenzhen: It is true that the steel industry currently faces a tough situation whereby production capacity exceeds actual market demands. But I personally do not think it is a "sunset industry." In the past decades, there have been two boom periods, and now it is just in the trough. The reason is that the steel industry grows much faster than the overall economy. The industry will have a new round of rapid growth when the economy develops to a certain level. By then, the steel industry may have a qualitative improvement instead of a quantitative increase. Therefore, I am optimistic about the steel market and believe that the current downturn is temporary and the future of the industry will be getting better and better. ●

Wang Shi Yi, Communication Specialist, Primetals Technologies China



The "smart" steel plant of the future will consist of components that communicate with one another.

INTRODUCING **METALS ORCHESTRA**

PRIMETALS TECHNOLOGIES HAS DEVELOPED A SPECIFIC APPROACH FOR THE FUTURE-ORIENTED IMPLEMENTATION OF THE "INDUSTRY 4.0" CONCEPT IN THE CONTEXT OF TODAY'S STEEL PRODUCTION

Imagine your steel plant as an orchestra where all components work in harmony to manufacture products of the highest quality. The "smart" plants of the future will contain equipment that is interconnected and can be orchestrated with ease to deliver unparalleled efficiency and reliability.

"Instruments for the digital era of steel" is the slogan that Primetals Technologies has created to mirror the concept behind its new and future-proof equipment-integration approach. It is based on the concept that all components need to be ready to meet future challenges, and it is driven by three goals: First, the production quality of a steel plant should be as reliable and consistent as possible. Second, the production chain should be adaptable to respond to specific customer requests, changes in raw materials, and other factors. And third, it tends to be on the wish list of literally any steel producer worldwide to lower production costs and increase output.

HOW FUTURE-PROOF ARE YOU?

The questions that are relevant here are: How capable are the individual plants of a metallurgical facility? Do they need to be improved or replaced to accommodate impending portfolio changes? How well are they directed and synchronized throughout the whole production chain? The concept of "Metals Orchestra" ties into all of these questions and proposes a distinctive approach for how to answer them in a concise way.

THE PLAYERS OF THE ORCHESTRA ...

All plant components can be thought of as "players of the orchestra," which need to be enabled to inter-operate with one another in several ways. So-called "smart" sensors are constantly providing information where necessary. Sophisticated process optimization provides adaptable control of all local processes, and automatic functions lessen the overall workload. Condition monitoring provides transparency and minimizes the maintenance efforts, and advanced connectivity features lead to a highly efficient use of the information available within the separate plant facilities. All together, these technologies make the lives of plant personnel significantly easier and allow for everyday work to become "smarter," thanks to the support of the Metals Orchestra system.

... AND ITS CONDUCTORS

The orchestration of the plant components is performed by three "conductors" who form an interdependent unity: a production management system, a computerized maintenance management system, and a process-quality optimization package that Primetals Technologies calls "Through-Process Optimization." The latter uniquely provides know-how-based identification of nonconformities, identifies the root cause, and provides corrective and compensational actions that cover the full production chain. These "conductors" ensure that all facilities are properly synchronized and achieve their full potential.

MORE TO FOLLOW SOON

Over the course of the coming months, Primetals Technologies will release more information about the Metals Orchestra concept. While the total complexity is high, the core idea is simple: Any equipment obtained from Primetals Technologies that carries the "Metals Orchestra" label will be capable of being integrated into future setups where it will be a "player" within a

THROUGH-PROCESS OPTIMIZATION AT WORK

A recent, exemplary installation that featured a component in alignment with the Metals Orchestra concept was completed for a major Chinese steel producer. Primetals Technologies introduced Through-Process Optimization (TPO), which is a software package capable of dealing with the large amounts of complexity that arise within a steel plant.

Two new functionality additions to TPO are rule-based surface-quality grading and statistical process control (SPC). The first of these innovations automatically evaluates freshly detected defects on the strip surface, and also determines an overall surface quality rating for the respective coil. This reduces the workload for all involved quality engineers and inspectors. The second solution, SPC, is used to monitor process data in order to ensure stable production without process-related quality issues. Compared to former SPC applications, the respective function within TPO acts as a centralized and consistent data source for SPC evaluations without having to collect the required process data from different locations. This greatly reduces the overall work effort.

These new functionalities demonstrate both the capability of the TPO solution and the underlying idea of Metals Orchestra, where all facilities of the plant perform in perfect synergy.



FIG. 1: Through-Process Optimization helps to achieve a consistently high-quality final product.

well-conducted "orchestra of steel." Thus, you as a customer can be assured that your investment in new equipment will be profitable over a very long time period due to the future-oriented nature of the equipment. ●

Kurt Herzog, Head of Industry 4.0, Electrics & Automation
Dr. Thomas Widter, Deputy Managing Editor, Metals Magazine
 (Both with Primetals Technologies Austria)

FAIRS AND EVENTS



Participants at the Cilegon Symposium on November 22, 2016

PRIMETALS TECHNOLOGIES SYMPOSIUM 2016 INDONESIA

On November 22 and 24, 2016, Primetals Technologies sponsored two symposiums that respectively took place in Cilegon and Surabaya for nearly 200 participants from the Indonesian steel industry. A selection of advanced technologies was presented for improved plant performance, cost savings and environmental protection.

The importance of the symposium for the local steel industry was underlined by the presence of distinguished guests and visitors. Hilman Hasyim, Director of Production and Technology of Primetals Technologies Krakatau Steel (Persero) Tbk, said: "The challenge for the Indonesian Steel Industry is to increase its competitiveness, adopt new technologies, shift to high-value end products and maximize the utilization of local resources." Setiawan Surakusumah, Chief of the Strategic and Technical Committee of the Indonesia Iron and Steel Industry Association, predicted an increase in steel consumption in Indonesia over the course of the next few years and the need to switch to state-of-the-art technology to meet the increased demand

for steel. Intensive technical discussions accompanied the symposium, which were followed by one-on-one talks to explore various project-implementation scenarios. ●

FEATURED TECHNOLOGIES

- Flat-rolling technology
- Long-rolling technology
- EAF Quantum steelmaking (shaft-type electric arc furnace to preheat scrap)
- Arvedi ESP (endless strip production from liquid steel to hot-rolled coils)
- WinLink (endless production of long products)
- Modernization and upgrade measures
- Automation and mechatronics packages



Felice Galati introducing the main conference speakers from Primetals Technologies

MIDDLE EAST IRON AND STEEL CONFERENCE UNITED ARAB EMIRATES

On December 12-14, 2016, Primetals Technologies hosted a half-day-long pre-conference workshop at the Middle East Iron and Steel Conference in Dubai. Around 100 attendees were present at the workshop and learned about the solutions offered by Primetals Technologies in the areas of cold briquetting, steelmaking, long rolling and service. Employees from Primetals Technologies additionally answered questions at a conference booth, moderated a technology panel that focused on the MENA region, and presented innovative ECO solutions. ●

A large number of technical sessions gave attendees valuable insight into recent research efforts and new trends within the metals industry.

ABM WEEK 2016 BRAZIL

ABM Week is the most important annual event for the Latin American steel industry. It is hosted by Associação Brasileira de Metalurgia, Materiais e Mineração (ABM) – the Brazilian trade organization for metallurgy, materials and mining. The second such event took place in Rio de Janeiro on September 26–30, 2016, and was attended by 1,200 people.

ABM Week included plenary sessions where the main industry topics were discussed, and a large number of technical sessions gave attendees valuable insight into recent research efforts and new trends within the metals industry. The Mill360° virtual reality experience at the booth of Primetals Technologies attracted a lot of interest, allowing visitors to see 360-degree views of the EAF Quantum furnace, a combination rod and bar mill, and several other technologies. Large overhead monitors displayed what the Mill360° users were seeing, which attracted even more attention. ●



Conference visitors immersing themselves in the innovative Mill360° virtual reality environment

PRIMETALS TECHNOLOGIES CUSTOMER DAY FRANCE

On December 8, 2016, Primetals Technologies France organized a Customer Day at its workshop in Savigneux, France. More than 30 customers from 18 companies and eight countries participated and discussed a wide range of topics with the experts on site. Keynote speeches focused on technologies and process-modernization packages for carbon and stainless steel processing lines, the benefits of the most recent mechatronics products, and new measures to improve efficiency in steel production. Four booths provided information on the wide technological spectrum covered by Primetals Technologies France. ●



More than 30 customers from 18 companies at the Customer Day in Savigneux

IRON & STEEL CONFERENCE IRAN

Primetals Technologies was a Silver Sponsor at the 2nd Iranian Iron & Steel Conference on September 26–28, 2016. Conference attendees received personal consultation at a dedicated information booth. Primetals Technologies employees held two very well-attended presentations on advanced agglomeration technologies and the most recent achievements made with Arvedi Endless Strip Production. ●



Primetals Technologies employees informing visitors about the latest achievements made with Arvedi ESP technology



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 will include the most recent issues of the customer magazine as well as interactive presentations of groundbreaking technologies.



Please search for "Primetals" in the App Store of your choice to download the new app.

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 PELLETIZING 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

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Cover page photo: A preheated steel ladle, ready for converter tapping

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STEEL IN EAST ASIA



THE SPIRIT OF CRAFTSMANSHIP

In East Asia, many steel workers subscribe to the ideal that knowledge should be passed on from generation to generation over the course of their everyday work routine. At the same time, every process is continually fine-tuned until efficiency reaches its maximum. This leads to a definition of "craftsmanship" that can not be found in other regions of the world. The "spirit of the craftsman" is therefore a theme that this issue of *Metals Magazine* tries to capture in detail.