SIEMENS VAI

Issue 03 | November 2014

Metals Magazine

Innovation and technology for the metals industry

Tapping the Hearth Of Innovation

World's Largest HBI Plant under Construction in Texas

Five Arvedi ESP Lines for China

Mechatronics – A Key Factor for Optimized Plant Performance

Innovation

The real challenge is not to create something new, but to create something extraordinary.

Laser torch used for cutting steel strip

Dr. Lawrence Gould

Dear Reader,

Apart from recognizing how to ignite and utilize fire, perhaps one of the greatest discoveries of ancient times was when man learned how to make

hay. This is because by properly drying moist grass, the resulting product known as hay can be kept and stored throughout the winter months to feed domestic animals. This changed the course of history because it allowed vast areas of the northern hemisphere to be settled, which otherwise would have remained the sole domain of hunters and gatherers.

Innovation, particularly in the metals industry, is the result of systematic, scientific and tedious incremental steps that usually lead to a eureka moment, that is, the manifestation of a new idea that can be further developed and applied to become a marketable commodity. More often, however, innovation is the product of serendipity – a totally unexpected revelation or event that sometimes leads to an extraordinary innovation with global implications.

The discovery of stainless steel, for example, was by accident. In 1912, during attempts by Harry Brearly to find a suitable steel alloy that could be used to increase the wear resistance of rifle barrels, he noticed that when 12% chromium was included in the alloy mixture, the steel samples maintained their luster and did not rust. The steel reacted with oxygen and formed a thin protective film, even when it was scratched. This was the birth of stainless steel.

Unplanned incidents outside of the metals industry also underline the importance of luck in research activities. Alexander Fleming's discovery of penicillin in 1928 is such an example. John Pemberton's search for a headache cure and his accidental mixing of coca leaves and cola nuts in carbonated water resulted in the world's first Coca-Cola. The idea for the microwave oven arose when someone's chocolate bar melted in his pocket as he passed by a large laboratory vacuum tube that emitted microwaves. And, of course, everyone knows the story about the proverbial apple that fell on Isaac Newton's head, which eventually led to his monumental theory of gravitation.

The serendipitous nature of innovation is frequently underrated in the industry. Emphasis is usually placed on collecting and processing Big Data rather than on enhancing the perceptive skills of people. Decisive, however, for initiating the concatenation of steps that may lead to an invention and subsequent innovation is the awareness and capability of individuals to link together knowledge, facts and circumstance. This must be done with a sagacious mindset and in such a way that when a favorable chance event does occur, its potential is recognized and acted upon. In the words of Louis Pasteur, the famous French chemist and microbiologist, "Chance favors the prepared mind."

Innovation is thus the product of a systematic approach and serendipity – backed, of course, by painstaking hard work. The real challenge, however, is not to create something new but to create something extraordinary. This is ultimately the foundation for all progress in history and in our society today.

Readers of this magazine are well aware of the impact that technological innovations have had on advances in the iron and steel industry. Many of these were introduced by the researchers and engineers of Siemens VAI, who, in response to the requirements of producers, combined methodology and brilliant insight to achieve milestone accomplishments.

This edition of Metals Magazine is therefore devoted to innovation. Various examples of Siemens VAI technological developments are presented that noticeably contribute to more efficient production processes, improved quality, greater energy efficiency and, most importantly, to the benefit of our customers.

Yours sincerely,

Dr. Lawrence Gould
Managing Editor
Siemens VAI Metals Technologies GmbH

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Metals Magazine is also available on the iPad

For selected magazine topics readers can access additional content with the new iPad magazine application. The app, an interactive alternative to the print version of Metals Magazine, can be downloaded at the Siemens magazine newsstand.

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As an example of an energy-saving innovation, the Simetal EAF Quantum allows steel producers to reduce their electric energy consumption by 20% through the preheating of scrap in a shaft. Other striking examples of groundbreaking innovations for each step of the iron and steel production route are presented in this issue. Producers benefit not only from improved process efficiency and environmental compatibility, but also from impressive cost savings.

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Siemens and Mitsubishi Heavy Industries are forming a joint-venture company for the metals industry

Ready for Takeoff

The new Mitsubishi Regional Jet (MRJ) is scheduled to fly its maiden flight in 2015 (3-D rendering, courtesy of Mitsubishi Aircraft Corporation)

As announced in May of this year, Siemens and Mitsubishi Heavy Industries (MHI) are forming a globally operating company that will be a high-end provider for technologies, plants, products and services for the iron, steel and nonferrous industries. According to Siemens VAI Metals Technologies CEO Albrecht Neumann, good progress is being made to reach the targeted starting date of January 2015.

Albrecht Neumann,
CEO of Siemens VAI

"The combination of competencies will result in a high-performing and competitive business that is better able to meet our customer's requirements."

Responding to the challenging market environment and high price pressure, two strong partners in the metals business are merging their individual, mostly complementary strengths and are establishing a globally well-positioned joint venture company (JV) with a world-class portfolio. Under the terms of the agreement signed on May 7, 2014, Mitsubishi-Hitachi Metals Machinery, Inc. (MHMM), a majority-owned subsidiary of MHI, will hold a 51% stake and Siemens a 49% stake in the new company. Subject to approval by the relevant authorities, operations are scheduled to start in January 2015. Under the current plan, the company's headquarters will be based near London.

"Dedicated integration planning teams from both sides have been working very hard to ensure that we have everything in place to start business operations on time," says Albrecht Neumann, CEO of Siemens VAI Metals Technologies. "Good progress has been made and a total of 26 individual workstreams from both sides are now finalizing the details in order to be ready for the start of the joint venture company," adds Neumann.

A perfect combination

The portfolios of the two partners ideally complement one another. While the technology strengths of Siemens VAI Metals Technologies lie in particular in iron and steel production, continuous casting, electrical engineering, metallurgical plant building, environmental technologies and life-cycle services, MHMM's technology competence is primarily focused on hot and cold rolling, processing and manufacturing expertise. By combining both portfolios, the joint venture can offer its customers the entire value chain in iron and steel production, from technologies for processing raw materials to surface finishing at the end of the production process, including the related life-cycle services.

The joint venture also comes at a time as the steel industry has experienced a strong regional shift to Asia. Over 50% of the world's steel production now takes place in China, with growing competition from local technology providers. "By drawing on the centers of competence of the JV partners in Asia, Europe and the United States, the new company will be equipped with a very solid regional setup," notes Neumann. "The combination of competencies will result in a high-performing and competitive business that is better able to meet our customer's requirements."

With approximately 9,000 employees, the company will be characterized by lean structures tailored to flexibly respond to a changing market environment. "With the complementary strengths of MHI and Siemens in the metals field and the good setup of the new joint venture, it will be a much stronger player on a global basis than if both companies were on a stand-alone basis," emphasizes Neumann. "We are very optimistic that we can keep the January starting date, and we are all eager now to get the JV to the runway and 'ready for takeoff.'"

Examples of the Latest Siemens VAI

Project Activities Worldwide

1. Linz, Austria
2. Baku, Azerbaijan
3. Ghent, Belgium
4. Ningbo, China
5. Liaocheng, China
6. Maanshan, China
7. Tangshan, China
8. Loudi, China
9. South Korea
10. Jamshedpur, India
11. Monclova, Mexico
12. Avilés, Spain
13. Kaohsiung, Taiwan
14. Rayong, Thailand
15. Bartonville, Illinois, U.S.A

1. Austria

VOD plant launched at voestalpine Giesserei Linz

A Siemens VAI-supplied vacuum oxygen decarburization (VOD) plant with a capacity of 50 tons commenced operation at voestalpine Giesserei Linz GmbH in Austria. This secondary metallurgical facility allows steel to be treated for the production of steel castings that are used in sophisticated applications in the energy and machine-manufacturing industries. The plant features electrically driven mechanical vacuum pumps instead of steam injectors and therefore does not require a steam generator.

For this project Siemens VAI supplied all of the core components, including a special ladle hood made of copper-plated sheet to minimize the occurrence of baked slag on the ladle and vacuum lid. The supply scope also comprised the vacuum lid, an oxygen-blowing lance system, a gas cooler and filter system, mechanical vacuum pumps and the hydraulic system. Furthermore, a water-management system, automation and instrumentation were provided.

EAF in operation at Baku Steel in Azerbaijan (Courtesy of Baku Steel Company Ltd.)

2. Azerbaijan

EAF with offgas cleaning system goes into operation at Baku Steel

Azerbaijani steel producer Baku Steel Company LLC (Baku Steel) has put into operation a new electric arc furnace (EAF) supplied by Siemens VAI. The plant is part of an expansion project to boost the producer's annual production capacity to around 1.1 million tons of steel. An offgas cleaning system was also provided that consists of a primary dedusting system for the EAF and the existing 50-ton ladle furnace, as well as a secondary dedusting system for the steel bay. With an overall exhaust capacity of approximately 950,000 Nm³/h, the system is designed to limit dust emissions to a maximum of 10 mg/Nm³, which corresponds to European environmental standards.

The plant is part of an expansion project to boost the producer's annual production capacity to around 1.1 million tons of steel.

3. Belgium

Siemens VAI to supply ArcelorMittal Gent with LiquiRob robotic system

Belgian steel producer ArcelorMittal Gent ordered a LiquiRob robotic system from Siemens VAI that was installed on the casting platform of its Slab Caster CC2. LiquiRob automatically performs a variety of tasks in dangerous working zones that are normally carried out by the plant personnel. This includes sample taking, measurements of the temperature and hydrogen levels in the tundish, and ladle lancing. Overall work safety is considerably improved, and measurements are carried out far more quickly, efficiently and reproducibly. In the future, the ladle shroud will also be manipulated with the aid of the LiquiRob robotic system.

LiquiRob at work on the casting platform

4. China

Siemens VAI and Baosteel cooperate in slag-granulation solutions

Siemens VAI and Baosteel Engineering & Technology Group Co. Ltd., a subsidiary of the Baosteel group, will cooperate in the future in the granulation of slag produced by LD (BOF) converters and EAFs. This collaboration focuses on the joint marketing and implementation of the Baosteel Slag Short Flow (BSSF) technology in steel mills worldwide. BSSF plants are already installed in China, South Korea and India.

In the BSSF granulation process, liquid slag is transferred to a granulation drum into which water is injected. The slag has a dwell time of between three and five minutes in the drum, which considerably reduces the amount of unreacted free lime. A high level of slag and crude steel separation is achieved, in addition to uniformly granulated, high-quality end products.

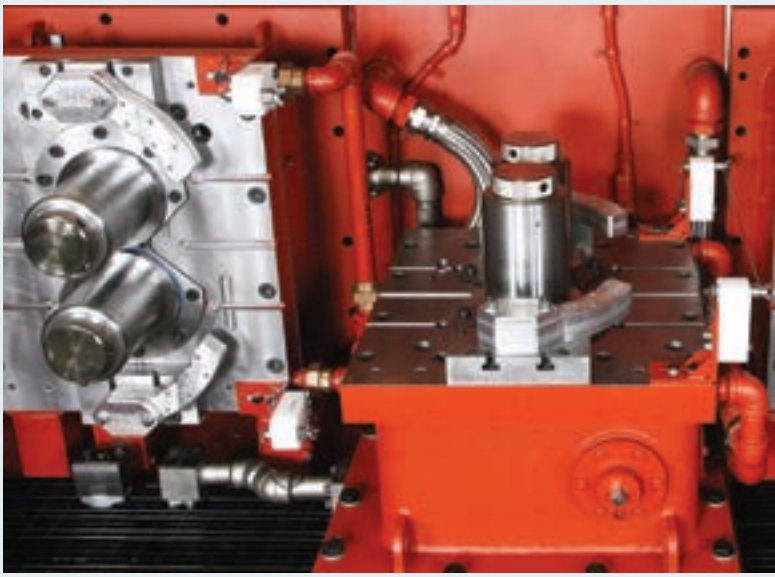
The new mill is designed to produce 230,000 tons of copper rod per year.

5. China

Southwire copper rod mill for end user Guangqing Copper

Siemens VAI received an order from Southwire Company of Carrollton, Georgia, U.S.A., to supply a copper rod mill to Guangqing Copper Co., Ltd. in Liaocheng, Shandong province. The project scope comprises engineering, manufacturing and commissioning of the rolling mill and coiler equipment. A total of 11 independently driven roll stands will be supplied. Coil weights will range from two to four tons. The contract also includes a rotary shear and table, an intermediate shear and downlooper, delivery and pickling system, pinch roll, orbital/laid coiler as well as a coil-handling system.

The new mill is designed to produce 230,000 tons of copper rod per year. Plant commissioning is expected in late 2015.



Copper rod rolling mill stands from Siemens VAI

Siemens VAI-supplied slab caster in operation at Maanshan, China

6. China

Completion of slab caster project at Maanshan

The Chinese steel producer Maanshan Iron & Steel Corporation (Maanshan) issued the final acceptance certificate to Siemens VAI for the successful completion of a slab caster project. The 2-strand caster (CCM 3) was installed in the company's LD (BOF) plant in Maanshan, Anhui province. It has an annual casting capacity of 2.4 million tons of slabs per year and is capable of casting a wide range of different steel grades for various applications in the construction, automotive and energy sectors. The steel grades include ultra-low- to medium-carbon steels; structural, silicon, micro-alloyed and peritectic steels; and also high-strength, low-alloyed pipeline and tinplate grades. Slabs are cast with widths between 950 mm and 1,600 mm at a thickness of 230 mm. The caster is equipped with the latest technological packages and process-optimization systems from Siemens VAI to ensure maximum casting flexibility, reliable operations and a high output of slabs with excellent internal and surface quality.

7. China

DeP converter commences operation at Tangshan

A dephosphorization (DeP) converter from Siemens VAI commenced operation at the Chinese steel producer Tangshan Stainless Steel Co. Ltd., a subsidiary of Tangshan Iron & Steel Group Co. Ltd. The phosphorus content of the crude steel is reduced in the converter to produce high-grade carbon steels. These steels are further processed to high-strength automotive steels at a newly constructed cold-rolling complex that was also supplied by Siemens VAI.

Siemens VAI converted an existing AOD converter to the DeP converter with a tapping weight of 110 tons. Dephosphorization takes place by means of a two-stage process: In the first step, oxygen is blown into the converter to oxidize the phosphorus. In a second step, the oxidized phosphorus is bonded with lime and removed from the steel with the slag. Six bottom blowers support and accelerate the chemical reactions. Removal of phosphorous from the steel is necessary to minimize steel brittleness as required for high-end steel applications.

8. China

Coupled pickling line and tandem cold mill enters service at VAMA

A coupled pickling line and tandem cold mill (PLTCM) was recently commissioned by Siemens VAI for Valin ArcelorMittal Automotive Steel Co., Ltd. (VAMA). The line is part of a new cold-rolling complex in Loudi, Hunan province, that is capable of producing 1.5 million tons of cold strip per annum, including high-strength steel grades for automotive applications.

Siemens VAI provided all of the mechanical, electrical and hydraulic equipment for the PLTCM in addition to basic automation and process-optimization systems. The tandem mill consists of four 6-high rolling stands that roll high-strength steels to within the tightest tolerances. Strip can be produced with thicknesses between 0.5 mm and 2.5 mm and at widths ranging from 900 mm to 1,890 mm. A full range of standard and special steel grades can be rolled, including highest-strength steels with a tensile strength of 1,200 N/mm².

A full range of standard and special steel grades can be rolled, including highest-strength steels.

9. South Korea

Installation of sixth Siroll ChatterBlock Monitoring system in South Korea

For several years now, the ChatterBlock Monitoring system has contributed to a safer rolling process at two mills operated by a Korean steel producer. The system monitors vibration levels at each mill stand and, in the event of excessive or abnormal vibrations that could lead to strip breakage or defects – and even to equipment damage – the control system is signaled and the line speed reduced. Satisfied with the product's performance, the customer has ordered four additional monitoring systems of this type since September 2013. The last installation was carried out in June 2014, less than one month after receiving the order. In total, Siemens VAI has already installed the ChatterBlock Monitoring system at over 25 steel and aluminum rolling mills worldwide.

Secondary dedusting system from Siemens VAI

10. India

Modernization of offgas-cleaning system at Tata Steel's converter steel plant

Tata Steel contracted Siemens VAI to modernize the secondary dedusting system of its LD2 shop in Jamshedpur, India. Dust levels within the steel mill will be reduced to less than 4 mg/Nm³, and will not exceed 30 mg/Nm³ at the stack. The project, which is scheduled to be completed in late 2016, is part of Tata Steel's campaign to reduce environmental emissions.

The project includes the supply of induced draft fans, electrostatic precipitators, systems to handle and transport the filtered dust, as well as the associated electric motors, drives and automation systems. Siemens VAI will also modernize two existing electrostatic precipitators and modify the duct system and the converter housings.

11. Mexico

Altos Hornos de Mexico orders new RH plant

Siemens VAI has won an order from Altos Hornos de Mexico, S.A.B. de C.V. (AHMSA) to supply a 150-ton, twin-ladle RH (Ruhrstahl-Heraeus) vacuum-degassing plant for its Converter Steel Works No. 2 in Monclova, Mexico. The project supply includes the vessel, mechanical vacuum pumps, structural-steel work and a combined vessel ladle-lifting system (CVL). This highly compact unit requires little space and allows vessels to be lifted in places inaccessible to cranes. The new plant will support AHMSA to produce steels with an ultra-low hydrogen content as required for the oil and gas industry. The RH plant is scheduled for start-up in October 2015.

For the same site Siemens VAI received an additional order to expand the annual capacity of the planned normalizing line to 300,000 tons of plates. The line will process carbon steel plates produced in a Steckel rolling mill that was previously installed by Siemens VAI.

The project scope comprises engineering and the supply of key components. The complete electrical equipment, energy distribution system, basic automation (Level 1) and process optimization (Level 2) constitute part of the order. The normalizing line is scheduled to become operational in the third quarter of 2015.

12. Spain

Pickling line to be modernized at ArcelorMittal Asturias

Spanish steel producer ArcelorMittal Asturias awarded Siemens VAI an order to completely modernize the pickling line at its Avilés plant. The line throughput capacity is to be increased from 1.5 to 1.8 million tons per annum, and working safety will also be improved. Siemens VAI is responsible for the complete basic and detail engineering of the mechanical components. New charging, strip-preparation and entry sections will be supplied, and the storage capacity of the strip accumulators will be increased. The existing skin-pass mill is also to be replaced with a new scale breaker. Upgrading work will be performed during short planned downtimes and the project is scheduled to be completed by late 2015.

Exit section of the pickling line of ArcelorMittal Asturias in Avilés, Spain (Courtesy of ArcelorMittal)

Mulpic intensive plate-cooling system

13. Taiwan

China Steel orders Mulpic intensive plate-cooling system

The Taiwanese steel producer China Steel Corporation (CSC) placed an order with Siemens VAI for the installation of a Mulpic (multi-purpose interrupted cooling) system in its plate-rolling mill in Kaohsiung, Taiwan. The intensive-cooling unit allows not only faster cooling during thermo-mechanical rolling but also direct quenching of plates. The system is designed to ensure uniform properties of the plates along their entire length and width, and to minimize the need for subsequent processing.

Following the Mulpic start-up scheduled to take place in June 2015, CSC will be able to widen its product mix to include highly wear-resistant plates for offshore, shipbuilding and pressure-vessel applications. This order from CSC will be the 21st Mulpic system installed by Siemens VAI since 2001.

14. Thailand

Thai Steel Profile Co. signs loan agreement for bar mill project

An order was recently placed by Thai Steel Profile Co. Ltd. (TSC) for the installation of a new bar-rolling mill at the company's plant in Rayong, Thailand. The mill is being supplied by Siemens VAI and will be capable of producing around 500,000 tons of reinforcing steel (rebars) per annum with diameters ranging from 9 mm to 40 mm. Diameters up to 14 mm will be rolled in the multi-slit mode. Plant commissioning is scheduled to take place during the second half of 2015.

On June 18, 2014, TSC signed a loan agreement with Kasikorn Bank for the financing of the bar mill project. The agreement was signed by Wiroj Rattanasirivilai, Chairman of TSC, and by Vasin Wanichworanant, Deputy Managing Director of Kasikorn Bank. The signing ceremony took place in the presence of numerous executives and representatives from TSC, Kasikorn Bank and Siemens VAI.

Signing ceremony of the bank loan agreement between TSC and Kasikorn Bank (1st from left: Narong Limastian, Siemens MT Country Head; 4th from left: Klaus Stefanc, Siemens MT Regional Head; 5th from left.: Visit Rattanasirivilai, TSC Plant Manager; 6th from left: Wichit Rattanasirivilai, TSC Managing Director; 7th from left: Wiroj Rattanasirivilai, TSC Chairman; 8th from left: Vasin Wanichworanant, Kasikorn Bank Deputy Managing Director)

15. U.S.A.

Wire-rod mill modernization at Keystone

U.S. producer Keystone Steel and Wire Co. placed an order with Siemens VAI to upgrade the cooling conveyors of a two-strand wire rod mill located in Bartonville, Illinois. The project includes the supply of new blowers, auxiliary systems, and electric and automation equipment. When the upgraded mill is put into operation in late 2014, Keystone will be able to extend its product range, produce steel grades with higher tensile strengths, and improve the quality of its rolled steel products. With an annual steel capacity of more than 700,000 tons, Keystone operates one of the largest wire mills in the world. The current project is part of an ongoing modernization campaign being implemented by Keystone to expand into markets for higher value-added products.

With an annual steel capacity of more than 700,000 tons, Keystone operates one of the largest wire mills in the world.

News Flashes

Acciaierie Venete S.p.A. — Italy

In October 2014, the hot test phase began on the new blooming stand designed and supplied by Siemens VAI. The blooming stand is capable of rolling 110 tons of blooms per hour with a weight of up to ten tons and with diameters between 350 mm and 600 mm.

Companhia Siderúrgica Nacional (CSN) — Brazil

An order was received for the modernization of a process-optimization system of the continuous casting machine CCM 4.

Dragon Steel Corporation — Taiwan

Three ladle turrets will be outfitted with ladle lid manipulators that will automatically place lids on the steel-filled ladles for improved heat retention and greater personnel safety.

Gerdau S.A. — Brazil

The performance tests were successfully carried out for the unpacking device for flat bars at Gerdau's steel mill in Mogi das Cruzes in the state of São Paulo. This device, installed in the cooling bed section, allows the bars to be separated in an orderly manner following the completion of retarded cooling to achieve the desired metallurgical properties.

Ilva S.p.A. — Italy

The FAC* was received for the modernization of two sinter coolers that Siemens VAI carried out at the Ilva steelworks in Taranto, which is the largest steelworks in Europe and manufactures some 30% of the steel used in Italy. The sinter plants can produce up to 11 million tons of sinter per year.

Jindal Stainless Limited — India

Siemens VAI will modernize the existing EAF automation and the third-party-supplied electrode control system with the latest Simetal Simelt AC, MDC (Melt Down Control) and EAF automation solutions at the Hisar plant near New Delhi.

JSW Steel Ltd. — India

The new direct-reduction (DR) plant with an annual capacity of 1.176 million tons was started up at Vijayanagar, Toranagallu. Direct reduction is based on the use of export gas from two existing Corex C-2000 modules that have been successfully operating at the steelworks since 1999. The hot direct-reduced iron (DRI) will be transferred directly to a new adjacent EAF melt shop by means of the Hot DRI transport system, which was developed by Siemens VAI and Midrex Technologies.

JSW Steel Ltd. — India

Level 2 automation systems were started up at the same site at more than 20 plant units in the SMS-1 and SMS-2 steel mills. A new order was also received for the installation of Siemens furnace switchgear Sivac-X at Ladle Furnace No. 1, following the successful start-up of the supplied furnace switchgear Sivac-X at Ladle Furnace No. 3.

Lotte Aluminium Co., Ltd. — South Korea

A contract was awarded to Siemens VAI to revamp the existing control system of a 4-high non-reversing aluminum foil mill in Seoul with the latest version of Siroll ALU TCS.

Mahindra Sanyo Special Steel Pvt. Ltd. — India

The existing third-party-supplied electrode control system will be replaced by Siemens VAI with Simetal Simelt AC and MDC systems at the Khopoli electric steel mill near Mumbai.

North American Höganäs, Inc. — U.S.A.

An order was received for the upgrading of a Simetal Simelt AC and MDC electrode control system with the new Simetal CMS (Condition Monitoring System) package at the Hollsopple plant in Pennsylvania.

Ternium Siderar — Argentina

Siemens VAI received an order to replace a 200-ton LD converter at the customer's San Nicolas plant.

Visakhapatnam Steel Plant (Vizag Steel) — India

Vizag Steel's Blast Furnace No. 1 was successfully blown in on July 30, 2014, and a production output of more than 5,000 t/d has been achieved. Rebuilding work on Blast Furnace No. 2 with five stoves has already commenced.

Wei Chih Steel Industrial Company Ltd. — Taiwan

Siemens VAI received the FAC* following completion of the rolling mill modernization at the Tainan steelworks. The original mill was installed in 1994 and in 2010 precision rolling equipment was added in a modernization project.

The latest project comprised the installation of a new bar-in-coil line for an annual production of 500,000 tons of rounds in carbon- and quality-steel grades. The maximum bar diameter is 42 mm and the maximum coil weight is 2.1 tons.

*FAC = final acceptance certificate

Siemens VAI offers a broad range of solutions to lower energy demand and environmental emissions in steel mills

Tapping the Hearth Of Innovation

Simetal EAF Quantum
shaft-type electric arc furnace,
Tyasa, Mexico

1 Fully automatic, elevator-type scrap-charging system

2 "The reign of fire" – scrap preheating in the EAF Quantum shaft

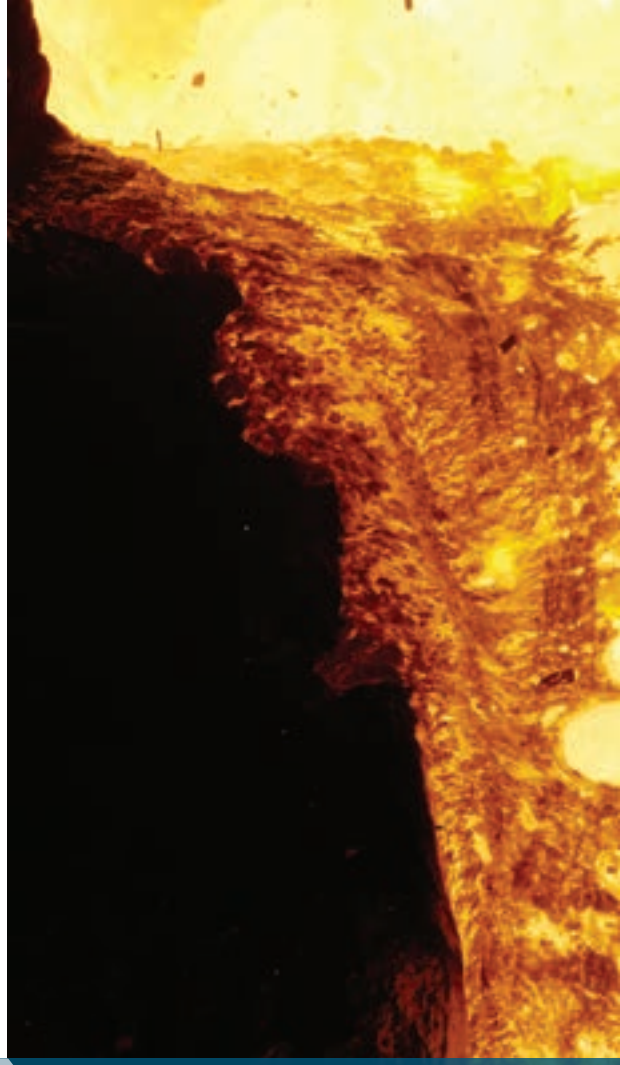
New technologies from Siemens VAI are helping to improve process efficiency and reduce energy consumption throughout the entire iron- and steelmaking production route, whether in scrap recycling, classic blast-furnace ironmaking or in casting-rolling operations. The result: lower resource demand, fewer emissions and an impressive reduction in overall costs. A number of future-oriented solutions are outlined in this article.

Fig. 1: Sequence of steel production steps in the EAF Quantum – from scrap charging to steel tapping (1 to 5)

A storm is raging in a powerful electric arc furnace (EAF). Every few seconds, there are deafening blasts and hissing noises. A red-hot mixture swirls in the furnace like lava in a volcano. The infernally hot blaze is fed by high voltage from graphite electrodes as thick as manhole covers, and it melts scrap into liquid steel at temperatures over 1,540°C. An electric furnace of this kind often devours more power than a small town. But the traditional iron and steel production route, where iron ores are smelted in conventional blast furnaces, is also an energy-intensive business. Operating at temperatures over 1,400°C, such plants, which are typically taller than the Statue of Liberty (93 m from the ground to the top of the torch), use iron ore and coal to produce hot metal that is then refined into steel in a converter.

It is thus not surprising that the steel industry – in creating the vital materials for ships, cars, railways and bridges – also produces a large amount of CO_2 because of its demand for energy and coal. "Steel mills account for over 6% of global CO_2 emissions," says Dr. Alexander Fleischanderl, Head of Technology and Innovation Management for Steelmaking, Long Rolling and ECO Solutions at Siemens VAI in Linz, Austria. He doesn't consider steel mills enemies of the environment, however, because products made of steel are also indispensable tools for saving energy; they are essential parts of wind turbines, solar energy systems and highly efficient gas turbines, for example. Furthermore, in recent decades steel manufacturers have been able to reduce energy input and thus CO_2 emissions dramatically. "Some 50 years ago, about 30 GJ were used for every ton of finished product in

3 Furnace power-on



4 Steel deslagging during power-on time

Europe; in 1990 it was 24 GJ; and today it's less than 20 GJ per ton of finished product," says Fleischanderl. "A typical integrated steel mill with a production capacity of 5 million tons of end products now emits approximately 8 million tons of CO_2, or 37% less than in 1960."

A quantum leap in electric steelmaking

In nearly all electric arc furnaces, the waste heat from scrap melting remains largely unused. "Almost a third of the energy consumed in EAF steelmaking is lost in the form of waste gas, which has a temperature of approximately 1,400°C," says Dr. Markus Dorndorf, Head of Research and Development for Electric Steelmaking at Siemens VAI. "However, energy consumption and CO_2 emissions can be sharply reduced in an electric arc furnace if scrap is preheated with process waste gases." This is the technique now applied by the new Simetal EAF Quantum furnace from Siemens VAI. The first high-performance furnace of this type with a tapping weight of 100 tons of liquid steel was recently started up for the Mexican steel producer Talleres y Aceros (Tyasa). The EAF Quantum furnace uses 20% less power than conventional electric steelmaking solutions, and it also offers a host of other benefits – including higher process speed, longer life for the melting electrodes, a more rapid amortization and a major reduction in CO_2 emissions. Figure 1 shows a sequence of production steps in the EAF Quantum.

"But if this heat is used to drive a steam turbine, 10% of the electricity input can be recovered," says Dorndorf. With this in mind, Stahlwerk Thüringen GmbH, a German producer of electric steel, turned to Siemens VAI, which designed and supplied an energy-recovery pilot system based on the use of molten-salt storage tanks positioned between the heat source and the steam turbine, thus ensuring a steady flow of energy for the turbine (Figure 2).

Profitable recycling of sinter waste gas

Greenhouse-gas emissions can also be cut substantially when hot metal is produced from iron ore in the blast furnace process. The potential for reduction starts with sintering. "A typical sinter plant produces more than a million cubic meters of waste gas per hour, and the gas contains incompletely combusted carbon monoxide, among other things," says Fleischanderl. But with Siemens VAI's Selective Waste Gas Recirculation (SWGR) technology, up to 50% of the waste gas can be fed back to the sintering process. The carbon monoxide then serves as a fuel and thus reduces

5 Tapping of steel into ladle

The EAF Quantum furnace uses 20% less power than conventional electric steelmaking solutions, and it also offers a host of other benefits.

Dr. Markus Dorndorf, Head of Research and Development for Electric Steelmaking

the coke demand and CO_2 emissions by approximately 10%. And the lower volume of waste gas results in lower costs for waste-gas purification too. SWGR technology has been successfully operating for a number of years at the sintering plants of steel producers in Austria, South Korea and Taiwan (Figure 3).

Furthermore, SWGR in combination with Meros gas-cleaning technology removes up to 99% of the pollutants contained in the sinter waste-gas stream – including sulfur oxides, nitrogen oxides, heavy metals and organic compounds such as dioxins (Figure 4). In the Meros process calcium hydroxide and other materials are used to convert SO_2 to harmless gypsum, and heavy metals and dioxins are trapped in dry adsorbents such as activated coke. The required additives are blown into the waste-gas stream at a high speed. Then the mixture of additives and waste gas is sprayed with water to cool it down to about 90°C. "This accelerates the desired chemical reactions," says Fleischanderl. "The particulate matter is separated, and since it still contains active additives, it can be recirculated into the waste-gas stream multiple times." Siemens VAI has already built three Meros plants in Austria and China, and five additional orders were received from steel producers in Turkey (one from Kardemir) and Italy (four from Ilva).

Fig. 2: Intermediate storage of waste heat from the EAF in a molten-salt storage tank (pilot plant)

Fig. 3: Selective Waste Gas Recirculation system installed at a sinter plant of voestalpine, Austria

Fig. 4: Meros plant installed at voestalpine, Austria

Where biology meets metallurgy

Large quantities of carbon monoxide are produced in the blast furnace during the smelting of iron ore with coke. The CO that exits the furnace is usually combusted in gas-fired power plants to generate electricity at an efficiency rate of only 40%. However, this efficiency rate can be substantially increased. "With bio-fermentation, microbes can be used to convert carbon monoxide into bioethanol and other valuable industrial chemicals," explains Dr. Fleischanderl. With this in mind, Siemens VAI signed a ten-year cooperation agreement with LanzaTech, an American gas-fermentation company, to develop, optimize and market this technology. The groundbreaking fermentation process developed by LanzaTech will be utilized to transform carbon-rich offgas generated by the steel industry into low-carbon bioethanol and other platform chemicals. Figure 5 shows a flow sheet of the LanzaTech process. In 2012, the process was successfully demonstrated in pre-commercial plants located in China at the steelworks of Baosteel and Shougang. A total of 300 tons of ethanol can be produced per year at each plant (Figure 6). Bioethanol production from combustible process gases has an efficiency rate of 65% and does not compete with the cultivation of crops. "Using biology, the LanzaTech process thus helps producers to notably increase their profit margin," comments Fleischanderl. "Processing waste gases with this technology provides a better internal rate of return (IRR) than when CO gas is fired in conventional power plants."

"Using biology, the LanzaTech process thus helps producers to notably increase their profit margin."

Dr. Alexander Fleischanderl

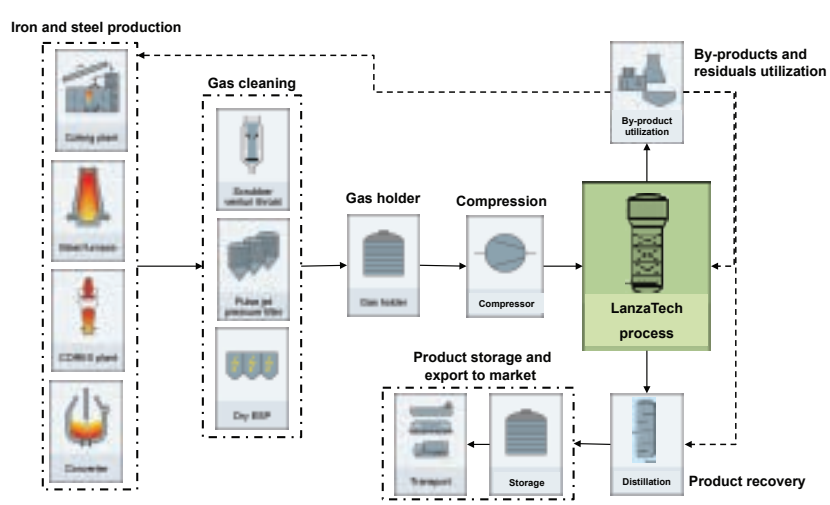


Fig. 5: Flow sheet of LanzaTech's bio-fermentation process to convert CO gas from metallurgical plants into ethanol and other products

Fig. 6: Pre-commercial LanzaTech bio-fermentation plant at Baosteel, China (Courtesy of LanzaTech)

Bioethanol production from combustible process gases has an efficiency rate of 65% and doesn't compete with the cultivation of crops.

Dr. Alexander Fleischanderl, Head of Technology and Innovation for Steelmaking, Long Rolling and ECO Solutions

Fig. 7: Dry Slag Granulation pilot plant at the University of Leoben, Austria

An electrifying solution for slag

Even slag, a by-product of blast furnace production, has plenty of potential that can still be tapped. Worldwide, almost 400 million tons of it are generated each year. In conventional processes, when it is still sizzling at approximately 1,500°C, the slag is separated and quenched with cold water. This results in the formation of a granular material that serves as a replacement for clinker in cement production. "But with a new Dry Slag Granulation (DSG) process, the molten slag can be granulated without water, making it possible to recover vast amounts of its inherent heat, explains Andreas Flick, CTO of Siemens VAI. "The slag is cooled with air. It is poured onto a rapidly turning rotary plate and broken apart and granulated through centrifugal force alone." (Figures 7 and 8) The cooling air heats up to approximately 600°C. If the air is then fed through a heat exchanger, its thermal energy can be used to generate steam, which can then be directly used as a heat source or converted into electricity. "For every ton of blast-furnace slag, about 1.5 GJ of energy, or slightly more than 400 kWh, can be recovered in this way," adds Flick. "In the case of a blast furnace, that would represent an electrical generation capacity of between 10 MW and 30 MW, depending on the size of the furnace." With this solution, the need for costly processing of cooling water and expensive cooling towers is eliminated. Furthermore, the granulated material doesn't

With a new Dry Slag Granulation process, molten slag can be granulated without water, making it possible to recover vast amounts of its inherent heat.

Andreas Flick, Chief Technology Officer (CTO)

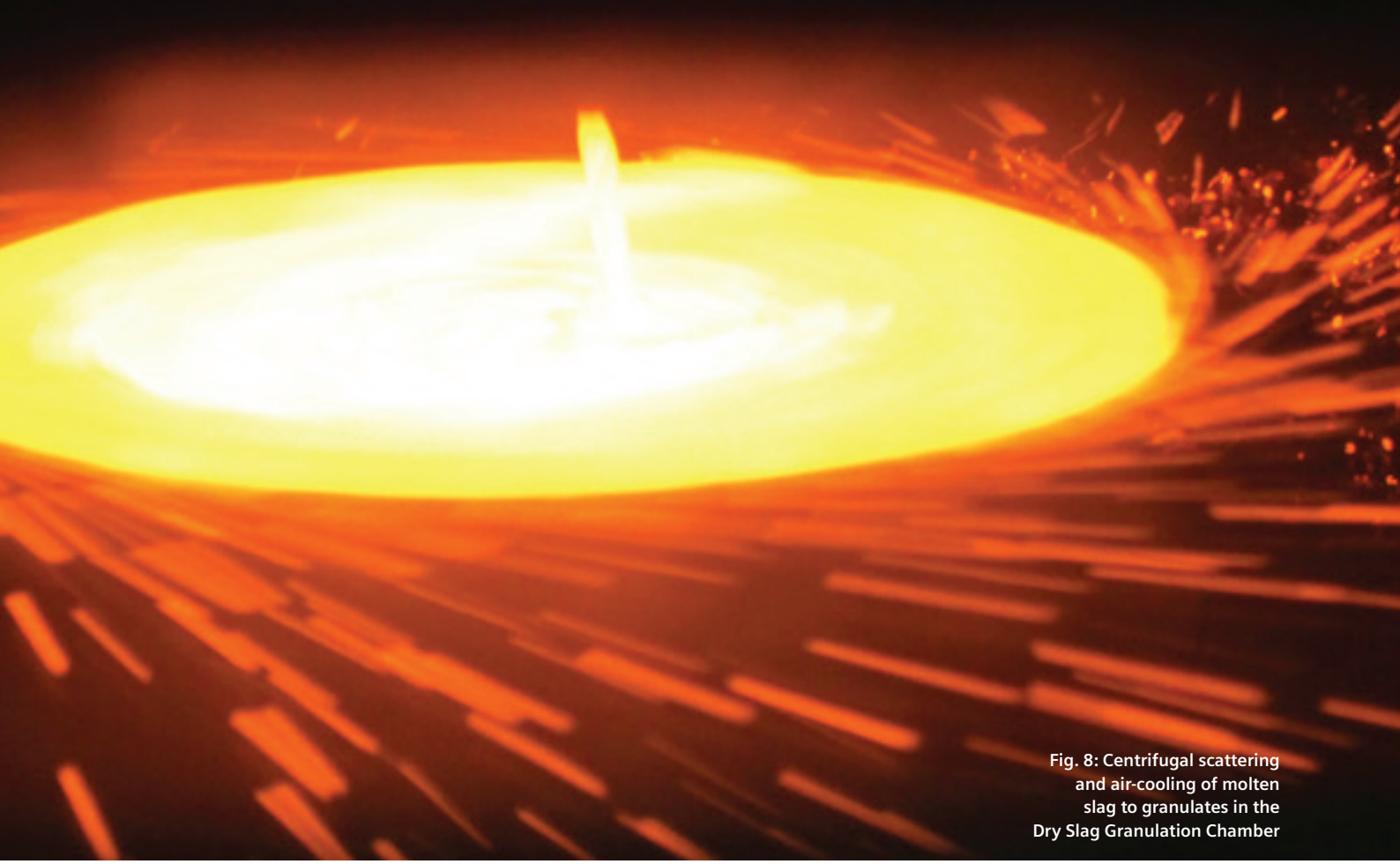


Fig. 8: Centrifugal scattering and air-cooling of molten slag to granulates in the Dry Slag Granulation Chamber

need to be dried. That saves another 130 kWh of energy for each ton of slag. In view of all of these advantages, the Austrian steel manufacturer voestalpine and Siemens VAI intend to build a DSG demonstration plant in Linz.

Maximum flexibility in converter steelmaking

Hot metal from a blast furnace, together with scrap, flux material and alloying agents, is charged into LD (BOF) converters and processed to steel by means of oxygen blowing. In order to increase the ratio of scrap and other iron carriers – such as hot-briquetted iron – that can be used in converter steelmaking, Siemens VAI engineers have developed the so-called Jet Process. With this technology, coal, oxygen and lime are blown into the molten hot metal through bottom tuyeres, while oxygen-enriched air at a temperature of approximately 1,300°C is injected at near-sonic speeds onto the bath using a top lance. The coal combusts within the hot metal and releases energy, while the emitted CO gas is postcombusted to CO_2. The heat generated from the postcombustion step is conveyed into the bath by the high-speed, oxygen-enriched air stream. Thus, a large percentage of the chemical energy contained in the coal can be utilized to increase the portion of scrap and HBI charge materials in the converter from about 20% to up to approximately 50%. In this way, depending on the availability and costs for hot metal, scrap and HBI, the overall charge mix-

The overall energy demand can be reduced by up to 45% in Arvedi ESP lines compared with conventional casting and rolling plants.

Andreas Jungbauer, Sales Manager, Endless Strip Production

Fig. 9: From casting to coiling – overview of the Arvedi ESP line in Cremona, Italy

ture can be optimized in a highly cost-effective manner. (See separate article in this issue, pages 46 to 49.)

Non-stop casting to coiling

For a number of years now, Siemens VAI has been offering an extremely energy-efficient technology for the production of hot-rolled coils directly from liquid steel. Known as Arvedi ESP (Endless Strip Production), the process was developed and implemented at the steelworks of the Italian steel producer Acciaieria Arvedi SpA in Cremona. Liquid steel from the converter is not, as is usual, cast as slabs and intermediately stored, but immediately processed to thin and ultra-thin hot-rolled strip. "The cast steel is allowed to pass without stopping through the production line, from casting to rolling to coiling in an uninterrupted process," explains Sales Manager Andreas Jungbauer at Siemens VAI in Linz. "Thanks to the continuous mode of this production line, far less reheating is required to reach the necessary rolling temperature of 1,200°C." As such, the overall energy demand can be reduced by up to 45% in Arvedi ESP lines compared with conventional casting and rolling plants. Processing costs and CO_2 emissions are slashed and total yield is increased. In addition to the Arvedi ESP plant that has been in operation in Cremona since June 2009 (Figures 9 and 10), two additional facilities in China are expected to enter service in 2015. In the meantime, an order was received from the

Processing costs and CO_2 emissions are slashed and total yield is increased.

Fig. 10: Continuous casting automation screen for the Arvedi ESP process

same customer for the supply of three more Arvedi ESP plants, which will bring the total annual production capacity of all five lines to more than 11 million tons of high-quality, ultra-thin hot strip. (See separate article in this issue, pages 58 to 61).

Automation is decisive

Last but not least, advanced automation systems are decisive for improving process efficiency and reducing energy consumption throughout the entire steelmaking process. "During the previous decade, the focus was always on producing more and producing faster. Now there are substantial overcapacities, meaning that steel mill utilization levels are often only 70% or 80%," says Fleischanderl. Technology sold by Siemens VAI under the brand name Green Button to numerous sectors of the industry optimizes the energy use of industrial processes irrespective of the current rate of plant utilization. For example, pumps and fans for dust-removal equipment can be automatically throttled or switched off when they are not needed. Initial field tests have shown that such steps can reduce the associated energy demand by up to 40%. One example, says Fleischanderl, is Precon, an automation solution that optimizes the power feed to electrostatic precipitators used for converter offgas cleaning. "If the steel industry were to use all of the currently available Siemens VAI technologies to reduce the consumption of energy and raw materials and to minimize CO_2 emissions, it would be doing practically everything that makes sense economically and is physically possible," he says.

A glimpse into the crystal ball

A major breakthrough in iron- and steelmaking, Fleischanderl believes, is only possible by switching to renewable energies. For example, the energy demand of electric arc furnaces could be satisfied with electricity from wind or solar power plants. Furthermore, renewably produced hydrogen could substitute a large amount of the coal and coke that is used for hot metal production. Similar to these materials, hydrogen is both a fuel and a chemical reducing agent capable of extracting oxygen from iron oxide in ore. In such a constellation, the only thing coming out of the smokestacks of steel mills would be water vapor. For that, of course, there would first have to be sufficient quantities of "green" hydrogen available. But that could be the case just a few decades from now, according to Fleischanderl. And he believes converting processes in steel mills wouldn't be a major problem. "We're already well prepared for that," he adds.

Pioneering the future

Innovation has always been the cornerstone for progress and prosperity. This article has presented but a few examples of areas where Siemens VAI is actively contributing to advances in the iron and steel industry with pioneering developments. Dedication to excellence, close cooperation with customers, and the will to succeed are the attributes that have defined our company's past, and which point the direction into the future.

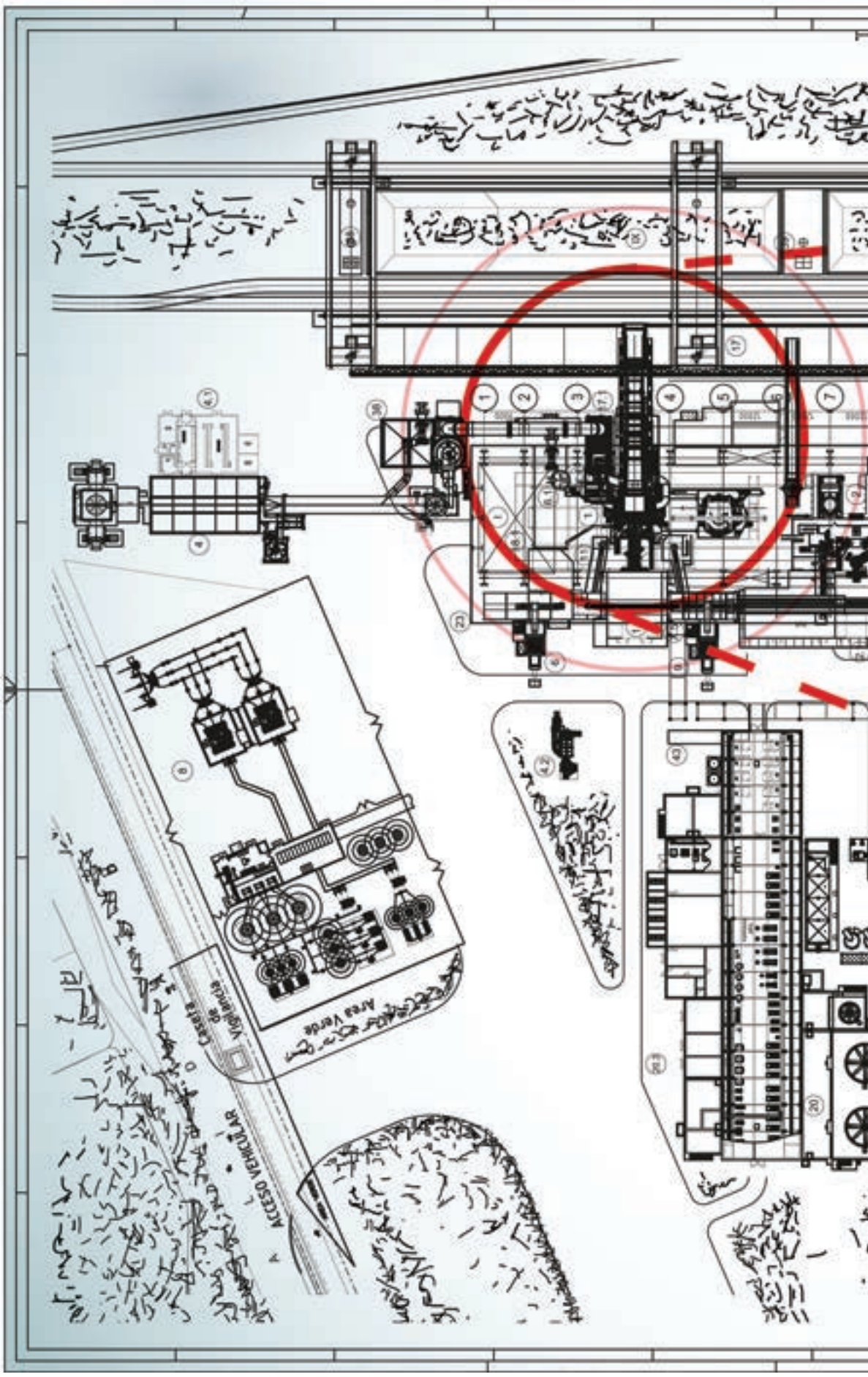
This article is based on a report that was first published in the spring issue of the Siemens magazine "Pictures of the Future" (pp. 34–37).

View the EAF Quantum electric furnace in three dimensions on your Apple iPad

Augmented Reality Is Here

The Talleres y Aceros S.A. de C.V. (Tyasa) minimill in Ixtaczoquitlán, Veracruz, Mexico

The possibility to use iPads to view 2-D images in three dimensions allows users to get a feeling for the design complexity involved in the construction of metallurgical plants. For the first time, Metals Magazine is offering an augmented reality experience to underline Siemens VAI's commitment to innovation – both for metals production facilities and for enhancing the reader's visual impact. The following pages show a design layout of the recently commissioned 100-ton scrap-based shaft-type EAF Quantum plant successfully operating at the steelworks of the Mexican producer Tyasa.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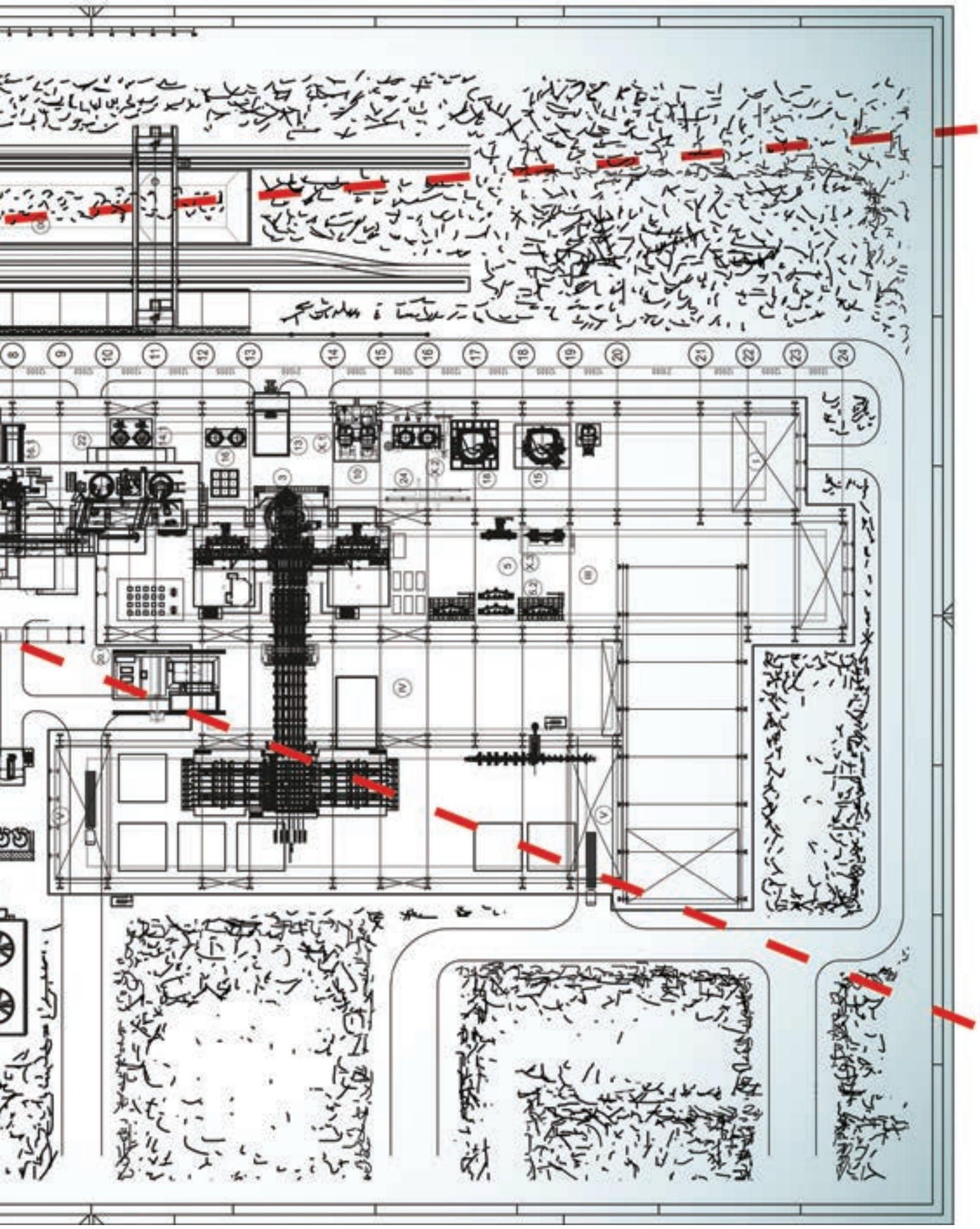

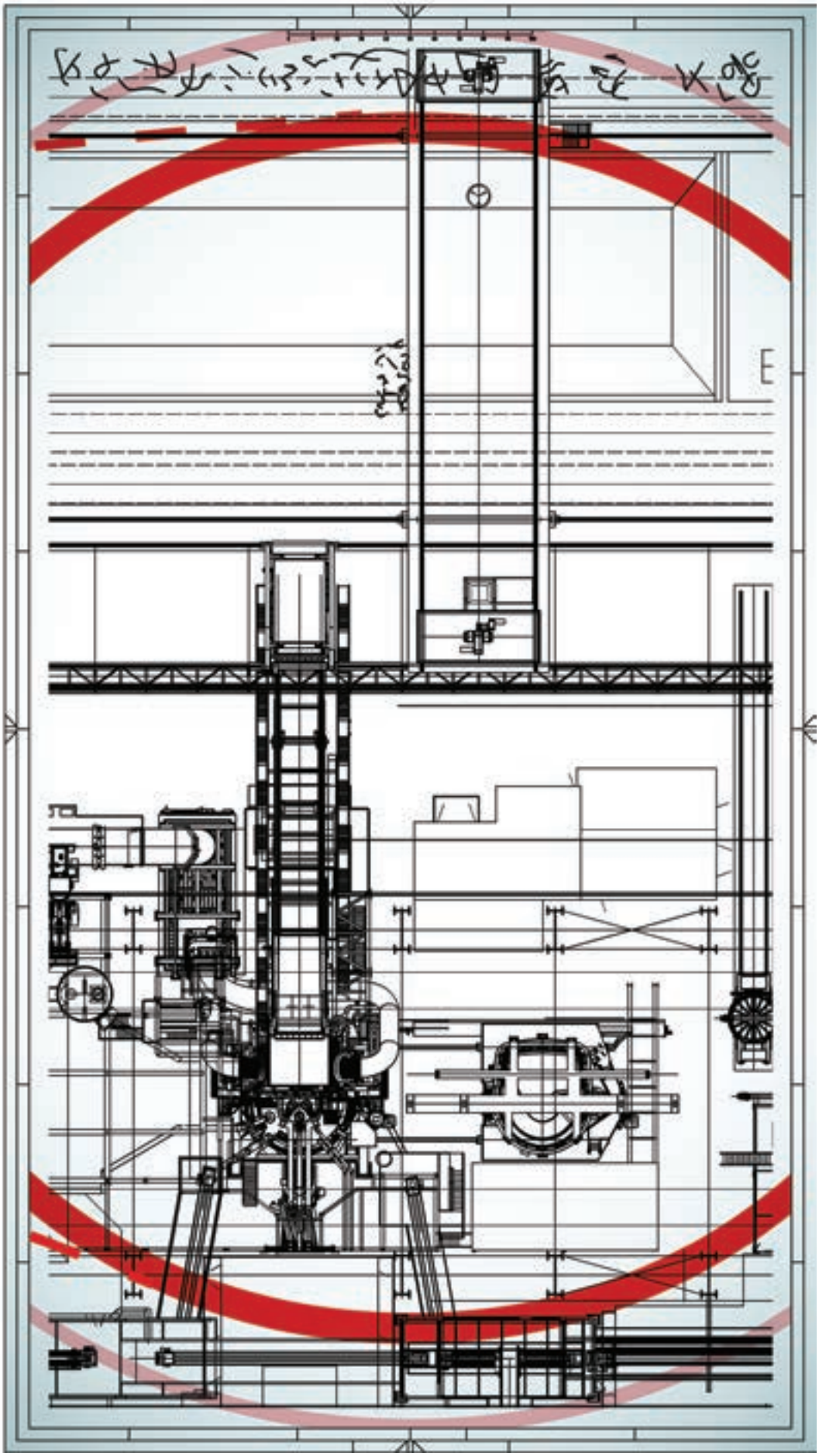

Layout of the complete Tyasa minimill (left two pages) and the EAF Quantum zoom-out (right page)

Metals Magic

Quantum Mini Mill app

Move your iPad across the image to see the plant in three dimensions.

Download the app for iPad. See also www.siemens-vai.com/apps for more information. (Suitable for iPad 4 or higher, and iPhone 5 or higher.)

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For more information, please contact:

Daniel Sachse, Marketing Manager, Electric Steelmaking

Michael Wöss, Marketing Manager

(appsupport.industry@siemens.com)

Construction of the world's largest HBI plant in Corpus Christi, Texas, now in full swing

Go West!

Fig. 1: Schematic view of the Midrex direct-reduction plant for the production of hot-briquetted iron under construction in Corpus Christi, Texas, U.S.A.

Siemens VAI and consortium partner Midrex are building a 2 million t/a hot-briquetted iron (HBI) MIDREX® direct-reduction plant in Texas for the Austrian steel producer voestalpine. Known as the "Go West project," the plant's environmentally friendly process will reduce iron ore using competitively priced American natural gas. The ground-breaking ceremony took place in April 2014 and the plant is due to begin operations in late 2015 (Figure 1).

"With Siemens and Midrex, we have by our side highly competent partners with proven technology."

Wolfgang Eder, CEO and Chairman of the Management Board of voestalpine AG

Capitalizing on the low natural gas costs in the United States, voestalpine is participating in the reindustrialization of North America by building the world's largest Midrex HBI plant. This ironmaking facility will produce a value-added metallic briquette that will be used in the company's own blast furnaces and which will also be available as a high-quality metallic product for markets worldwide.

In July 2013, Siemens Industry, Inc., USA, and consortium partner Midrex Technologies, Inc. received the order from voestalpine Texas LLC to build the direct-reduction plant in the U.S., and quickly named it the "Go West project." At the contract signing, Wolfgang Eder, CEO and Chairman of the Management Board of voestalpine AG, said, "With Siemens and Midrex, we have by our side highly competent partners with proven technology."

When it commences operation at the La Quinta Trade Gateway site in San Patricio County, near the city of Corpus Christi in late 2015, the Midrex plant will produce 2 million tons of HBI per year. voestalpine is investing about €550 million, which also covers comprehensive infrastructure improvements and upgrading of the existing port facilities on the Gulf of Mexico. The direct-reduction plant will provide voestalpine's Austrian steel production sites in Linz and Donawitz with access to cost-effective and environmentally friendly HBI. About half of the plant's annual production will be shipped to Austria; the remaining half will be sold to partners

HBI is still the only recognized way to safely ship DRI by sea, according to the International Maritime Organization (IMO).

interested in longer-term supply contracts. In August 2014, Altos Hornos de México (AHMSA), Mexico's largest steel manufacturer, signed a five-year agreement with voestalpine for an annual supply of 400,000–650,000 tons of high-quality HBI from the new voestalpine location.

Core technology, engineering, mechanical equipment and electrical systems for the direct-reduction plant are being delivered by a consortium comprising U.S.-based Midrex Technologies, Inc. and Siemens Industry, Inc. Midrex has been the leading innovator and technology supplier of iron ore direct-reduction solutions for more than 40 years.

Direct reduction – safer and cleaner ironmaking

Most commercially mined iron oxides occur in the form of hematite (Fe_2O_3) and magnetite (Fe_3O_4), both with an iron content in the range of 65% to 67%. The direct-reduction process removes the bonded oxygen from pelletized iron ore at elevated temperatures by means of a reducing gas that is generated from natural gas. Reduction takes place in a sealed, low-pressure reduction shaft, which is not vented to the atmosphere. The iron oxide pellets are charged into the reduction shaft through feed pipes, reduced to metallic iron and finally discharged from the furnace cone.

Instead of using coke as the main reducing agent as in traditional blast furnaces, the new direct-reduction plant will use only natural gas, which is much more environmentally friendly. Carbon dioxide (CO_2) emissions will be considerably reduced, thus lowering the carbon footprint of voestalpine's steelmaking operations. This represents an important step toward the achievement of the Group's energy-efficiency and climate-protection objectives.

Despite its high furnace-exit temperature of approximately 700°C (1,300°F), the direct-reduced iron (DRI) is not in a molten state. The highly metallized DRI is immediately briquetted into palm-sized, pillow-shaped HBI and then cooled for easier and safer transportation (Figures 2 and 3). This briquetting step reduces the danger of product handling compared to traditional blast furnaces where hot metal is tapped at temperatures in the range of 1,500°C (2,700°F).

HBI benefits for blast furnace operation

The electric steelmaking production route is not the only consumer of DRI/HBI. Conventional wisdom has always held that DRI is not suitable as a significant feed material for a blast furnace. However, more and more integrated steel producers today are considering the use of HBI for their blast furnaces on a regular basis, rather than just on occasions when one blast furnace is down in order to increase the hot metal output of their other furnaces. The reasons for the increased interest of HBI as an iron carrier for blast furnace operations are as follows:

MIDREX® is a registered trademark of Midrex Technologies, Inc.

Project specifics and advantages for the local community

Roads:
540,000 sq. ft. (50,200 m²)

Reinforced concrete:
1.6 million cu. ft. (45,300 m³)

Mechanical equipment:
13,000 short tons (11,800 metric tons)

Structural steel:
20,000 short tons (18,150 metric tons)

New jobs:
150

Construction jobs:
800

• **Higher productivity:** Primary reduction work has already taken place outside the blast furnace in a direct-reduction shaft furnace. More reduction gas is thus available within the blast furnace to reduce the remaining burden, which results in increased blast furnace productivity. A rule of thumb is that for each 10% increase in burden metallization, production output rises by 8%.

• **Lower coke consumption:** When less reduction gas is required to reduce the burden at the same productivity level, coke consumption is lowered. Again, a rule of thumb is that for each 10% increase in burden metallization, the coke rate decreases by 7%.

• **Reduced CO_2 emissions:** Iron ore reduction in a Midrex plant is based on the use of natural gas, which is processed by a reformer to generate a reduction gas that consists of approximately two-thirds H_2 and one-third CO. During the reduction process, CO is converted to CO_2 and H_2 to H_2O. The reduction of iron ore by means of hydrogen gas creates no CO_2 at all. In a blast furnace, the major source of the reduction gas is coal, which produces mostly CO and CO_2, and very little H_2.

Fig. 2: Conveyor transport of HBI

Safer transport and storage of HBI

Another important benefit of HBI is that it can be shipped more easily and safely. According to the International Maritime Organization (IMO), HBI shipments remain as the only recognized way to safely transport DRI by sea. IMO transportation guidelines for HBI briquettes are considerably less stringent than those for DRI. Ships with DRI cargoes must have their holds inerted with a non-reactive gas such as nitrogen. Maintaining the required nitrogen gas level can be costly over long voyages, such as during ocean crossings.

The insurance cost for HBI cargoes is also considerably less than those for DRI shipments. HBI can be stored at almost any location, much like scrap steel. Contrary to this, DRI must be kept not only out of the rain but also off the ground in order to prevent contact with moisture, which could lead to oxidation and combustion.

Go West, Go Forward

The Go West project thus offers an impressive example of a cleaner and safer form of ironmaking that takes advantage of lower-cost American natural gas. With its new direct-reduction facility, voestalpine can reduce its carbon footprint and simultaneously profit from the increased global demand for HBI.

voestalpine Texas LLC:
Matthias Pastl, Head of Corporate Communications
& Environmental Management

Midrex Technologies:
Christopher Ravenscroft, Manager Global Marketing/Communications

Siemens VAI:
Christian Böhm, Head of Sales, Smelting and Direct-Reduction Plants
Johannes Rothberger, Technical Sales Manager
for Direct-Reduction Plants
Erwin Unterauer, Commercial Sales Manager
for Direct-Reduction Plants

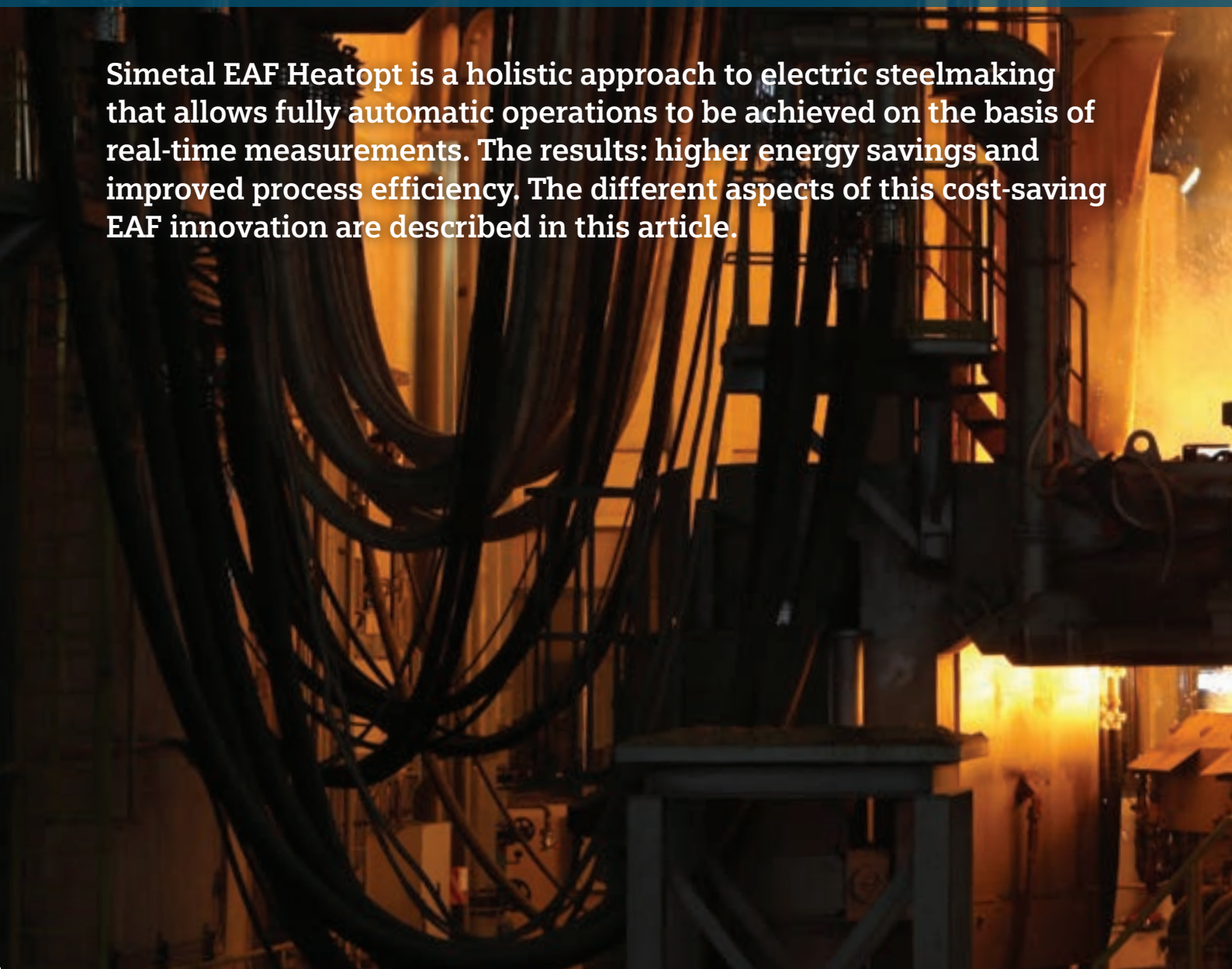
For more information, please refer to:
www.voestalpine.com/texas
www.midrex.com

Fig. 3: Close-up view of HBI product

Heatopt – an intelligent and holistic process-control system from Siemens VAI for optimized electric steelmaking

Mastering the Realm of Fire

Simetal EAF Heatopt is a holistic approach to electric steelmaking that allows fully automatic operations to be achieved on the basis of real-time measurements. The results: higher energy savings and improved process efficiency. The different aspects of this cost-saving EAF innovation are described in this article.



Even for an experienced operating staff, it is difficult to consider all of the relevant factors for assuring profitable electric steelmaking.

Fig. 1: Simetal EAF Heatopt: a milestone development for improved process control in electric steelmaking

The Heatopt system offers a complete holistic approach that also includes upstream and downstream process steps.

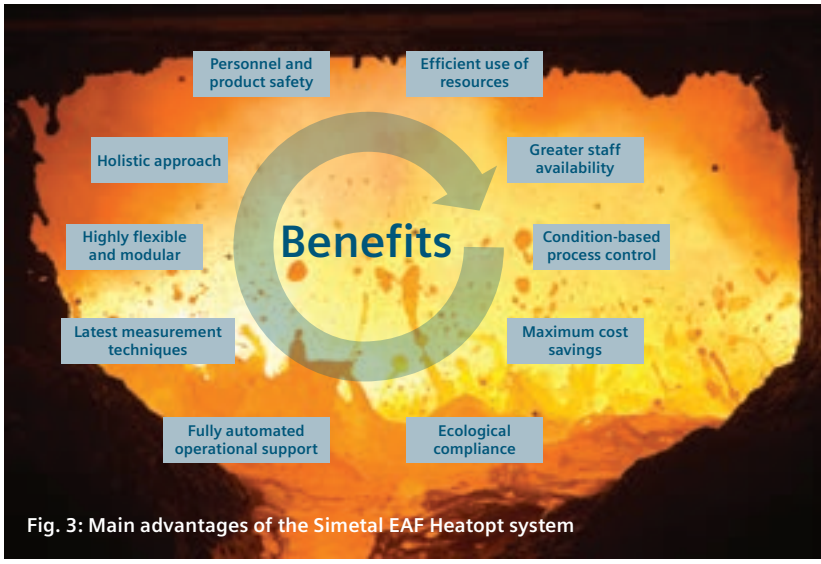


Fig. 3: Main advantages of the Simetal EAF Heatopt system

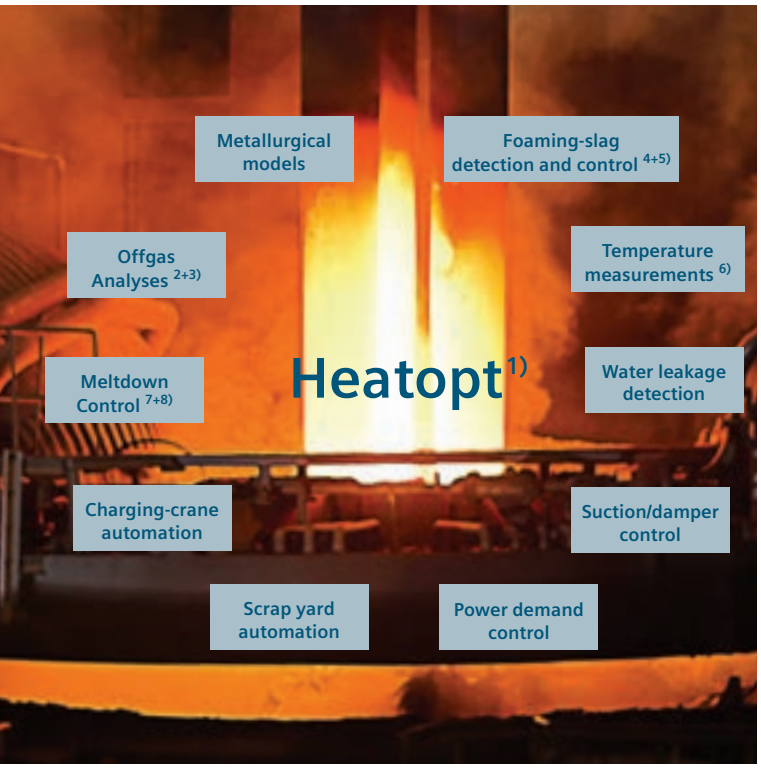


Fig. 2: Main features of the holistic Simetal EAF Heatopt process model

Examples of integrated Heatopt submodels:

1) Heatopt (holistic energy and transparency optimizing)
2) Lomas (low-maintenance gas-analyzing system)
3) SAM (single-air measurement)
4) SonArc FSM (foaming slag manager)
5) SlagMon (slag monitoring system)
6) RCB Temp (Refining Combined Burner with temperature measurement)
7) SonArc CSM (condition-based scrap melting)
8) ECS (electrode control system)

Fig. 4: Simetal EAF Chargeopt automates and optimizes the charging of scrap into the electric arc furnace at Riva SAM Neuves Maisons, France

Most control solutions for the EAF deal only with specific subsystems: burners, electric-arc power, postcombustion and carbon injection. These independent subsystems are usually regulated by time or energy factors. However, an isolated approach toward achieving automatic operation can lead to a waste of resources, such as electrical power and chemical-energy input. Even for an experienced operating staff, it is difficult to consider all of the relevant factors for assuring profitable electric steelmaking. Simetal EAF Heatopt from Siemens VAI supports an optimized furnace control by simultaneously taking into consideration all measurement values and prevailing conditions (Figure 1).

Model description and benefits

Heatopt responds to continuously changing process conditions in the EAF such as different scrap compositions and arrangements from charge to charge. Such changes cannot be managed by means of conventional non-dynamic setpoints where rigid control diagrams based on time and energy are used. Furthermore, the use of sophisticated measurement techniques and condition-monitoring systems is required in order to achieve a deeper understanding of EAF processes.

Figure 2 shows the main features of the Heatopt process-control system and the associated submodels, which provide a dynamic view of the process in addition to material and energy flows. Scrap and material handling, as well as energy recovery, are included in the system. The Heatopt system thus offers a complete holistic approach that also includes upstream and downstream process steps. This, combined with intelligent control algorithms and process guiding at a high level of automation, provides the operator with the ability to fully handle, modify and optimize electric steelmaking operations.

Heatopt manages the electrical and chemical power input of the EAF applying closed-loop control. It regulates the transformer and reactor rates and the impedance setpoint on the basis of real-time process conditions. Continuous monitoring of the furnace offgas composition, offgas flow rate, and the level and distribution of slag are taken into account. From this data, Heatopt optimizes the input of natural gas and oxygen for refining and postcombustion, as well as carbon and oxygen for slag management. Additional benefits of the system include the monitoring and control of greenhouse gas emissions and improved safety that is achieved by the detection of potentially hazardous conditions such as water leaks in the furnace (Figure 3). Different features, components and benefits of Simetal EAF Heatopt are described in more detail in the following.

Automated charging

A recently designed laser-based measuring system known as Simetal EAF Chargeopt enables the scrap bucket on the transfer car and the location of the charging crane to be precisely positioned, ready for charging (Figure 4). The bucket is automatically hooked by the crane, lifted from the car and transferred to the furnace, where automatic scrap charging takes place. This operation is directly linked to furnace control, especially to the roof movements, to minimize the charging time.

Following the "next bucket" signal from the Heatopt control system, scrap is located and the bucket charged on a just-in-time basis according to the melting progress. Scrapyard management is also closely coordinated with the EAF melting process. Simetal EAF Scrapopt, a new automation system for scrap yards, obtains its information from Heatopt, while the charge calculation provides the correct scrap composition and scrap layer sequence ready for the automated charging control system.

Melting progress

Melting is supported by tools to measure and monitor temperature, melting progress, offgas composition, possible water leakage and tapping control. A new contact-free temperature-measuring system, Simetal RCB Temp, is fully integrated into the long-established Refining Combined Burner (RCB) technology (Figure 5). As such, it is no longer necessary to insert lances through the slag door. Strict control of the furnace temperature by control models is the basis to achieve consistent process operations and repeatable results, enabling the exact tapping time to be predicted during furnace power-on. Benefits can be summarized as follows:

Benefits of RCB Temp

- Reduced operating costs and required consumables
- Substantially increased personnel safety
- Higher furnace productivity with reduced power-off times
- Consistent process parameters for repeatable results
- Decreased energy consumption through accurate determination of the ideal furnace tapping time

SonArc CSM (Condition-based Scrap Melting), an add-on for the electrode control system, observes in real time the meltdown behavior inside the furnace and adapts the electrical setpoints to provide process-oriented control of the electrical power input. It also determines the optimal point for charging subsequent buckets of scrap and provides real-time visualization with the potential to show any loss of arc shielding resulting from scrap movements such as scrap cave-ins.

For optimum slag foaming, SonArc FSM (Foaming Slag Manager) controls carbon and oxygen injection. Slag height and distribution inside the furnace are monitored and controlled to cover the arcs, thus minimizing arc radiation and

Proven benefits of Heatopt at SDI Roanoke

- Decrease in gas and oxygen consumption by 15%
- Decrease in carbon consumption by 5%
- Productivity increase by 3.6%
- Lower conversion costs by more than $2/ton of tapped steel

therefore reducing refractory wear. It also enables optimized furnace operation during the flat-bath period.

Both SonArc modules are based on the same hardware components, which minimizes costs associated with installation, maintenance and spare parts. Furthermore, both systems monitor conditions inside the furnace by analyzing structure-borne sound emissions and the spectrum of secondary currents. A combination of these characteristics determines the factors for totally automated furnace operation from scrap meltdown to steel tapping (Figure 6).

Offgas analysis

Simetal Lomas uses a patented low-maintenance gas-sampling probe to analyze gas composition for furnace control and explosion prevention. The probe is positioned at the center of the duct diameter to ensure true offgas analyses of CO, CO_2, H_2, O_2 and CH_4 by avoiding peripheral air ingress and eddies that trap older offgas (Figure 7). Already well proven in more than 140 LD (BOF) converters, the Lomas probe was adapted and improved to withstand highly aggressive EAF offgas. Modifications were made for greater abrasion resistance, reliable tip cleaning and cooling, and reduced thermomechanical stress. A maintenance check is recommended only every three months and the probe life is around two years at a 99% availability.

Water leakage detection

The Lomas probe also detects any increase in humidity of the offgas, which can point to a water leak in the furnace or in the offgas stack. Simetal Lomas detects possible water leaks in the EAF in two different ways simultaneously:

- Water dissociated into H_2 and O_2
- Water that leaves the EAF as a vapor, as indicated by a humidity sensor

While measuring dissociated water is a well-known approach, the additional strategy of measuring vapor in the gas is new. This not only offers redundancy should one sensor fail, but also increases validity of the results in case of sensor contamination, thermal drifts or aging.

Slag detection at tapping

Minimizing slag carryover is essential for higher steel output and improved steel quality. Knowledge of the slag condition can also contribute to reduced additions of deoxidizing and alloying agents as well as minimized metal re-phosphorization and improved steel desulfurization. When the amount of slag carryover is reduced to a minimum, steel analyses are far more accurate, and the lifetime of the steel ladle refractory is also improved.

The thermographic slag-detection system, Simetal SlagMon, provides an accurate method of assessing the tapping stream. Various radiation emissions in the infrared range are conveyed by fiber-optic cable for continuous monitoring by an image-processing algorithm, making it easy to differentiate between steel and slag. An alert signal is generated when slag is detected, which can be used to control the shut-off device on the taphole.

Post-steelmaking processes

The direct link to EAF post-processes, such as energy recovery solutions and ID fan control, completes the holistic approach. While taking into consideration the furnace pressure and possible false air measurements by the Lomas system, the system regulates the ID fan suction power. This ensures constant furnace pressure at around 10 Pa and avoids an over-oxidized furnace atmosphere. The result is reduced electrical energy consumption by the ID fans and lower electrode consumption, as the furnace atmosphere contains more combustible CO.

Already well proven in over 140 LD (BOF) converters, the Lomas probe was adapted and improved to withstand highly aggressive EAF offgas.

First industrial reference

The first industrial installation of the Simetal EAF Heatopt system was at U.S. steel producer SDI Roanoke (company of Steel Dynamics, Inc.), Virginia, in 2012. It consists of the Heatopt control package, the Lomas analyzing system and a slag-detection unit. The main benefits achieved with the process-optimization system include a decrease in gas and oxygen consumption by 15%, an average decrease in carbon consumption by 5%, and a productivity increase by around 3.6%. This has resulted in lower conversion costs totaling more than $2/ton of tapped steel.

Dr. Markus Dorndorf, Head of R&D, Electric Steelmaking
Daniel Tieseler, Consulting Product Manager, Electrics & Automation

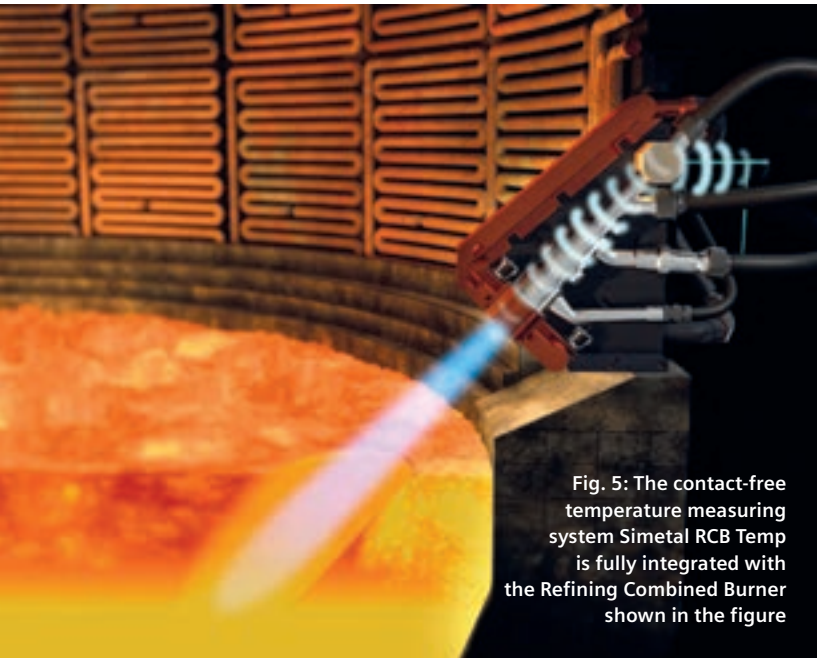


Fig. 5: The contact-free temperature measuring system Simetal RCB Temp is fully integrated with the Refining Combined Burner shown in the figure

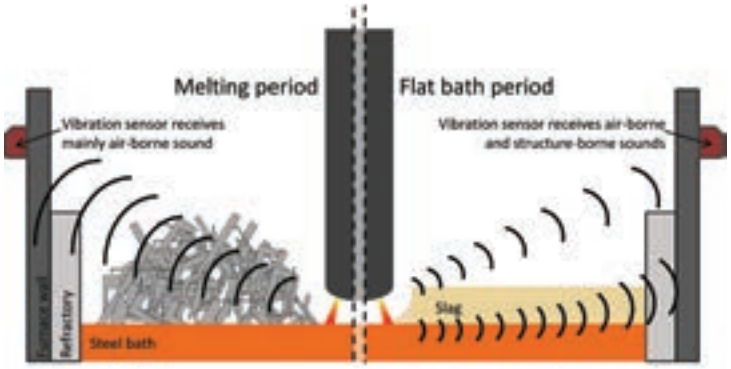


Fig. 6: Real-time SonArc vibration observation during melting (left using CSM) and flat-bath period (right using FSM)

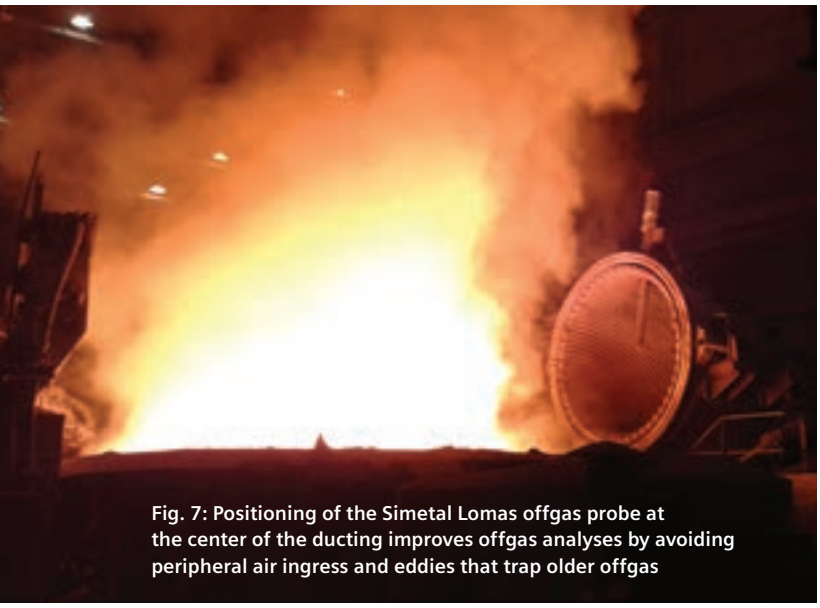


Fig. 7: Positioning of the Simetal Lomas offgas probe at the center of the ducting improves offgas analyses by avoiding peripheral air ingress and eddies that trap older offgas

Vastly improved EAF process control with Heatopt has resulted in cost savings of more than $2/ton of tapped steel for a U.S. electric steel producer

Successfully commissioned electrode control systems at Steel Dynamics and Harrison Steel

U.S. Customers Profit From EAF Know-how

Intelligent electrode control is decisive for optimized EAF performance

Siemens VAI supports electric steelmakers with technological packages that are designed to improve the efficiency and productivity of their electric arc furnaces. This capability is demonstrated by two recent U.S. projects that were completely engineered, managed and built by Siemens VAI specialists in the United States.

A wide range of solutions and services are offered from Siemens VAI to maximize the performance of electric arc furnaces (EAFs). For example, the highly innovative Siemens VAI electrode control systems Simelt and Arcos have been well established on the market since 1970 with more than 500 installations to date. Additional solutions in the Siemens VAI Simelt portfolio include Simelt MDC (Melt Down Control) and Simelt NEC (Neural Energy Control), in addition to add-on products such as SonArc FSM (Foaming Slag Manager) and SonArc CSM (Condition-Based Scrap Melting). Two U.S. steel producers have recently benefited from products offered from the Simelt portfolio.

Steel Dynamics, Inc. – greater cost efficiency and flexibility

To remain competitive in a globally challenging steelmaking business, Steel Dynamics, Inc. (SDI), a U.S.-based steel producer, is moving aggressively to improve its cost efficiency and flexibility to respond to changing raw material and energy markets. At the company's minimill in Roanoke, Virginia, a 50/56 MVA-powered EAF is capable of producing 91 metric tons (100 short tons) of steel per heat with an average tap-to-tap time of 65 minutes – equivalent to 22 heats per day for an annual production of 590,000 metric tons (650,000 short tons). Business activities with Siemens VAI started in 2011 when a Simetal Lomas offgas monitoring system was installed in addition to the Simetal EAF Heatopt system. In January 2014, the Simelt AC electrode control system was commissioned. This state-of-the-art, highly standardized solution not only has contributed to increased availability and to lower energy consumption of the Roanoke EAF, it also allows furnace output to be increased, if required. Installation of the system took place during a maintenance

Fig. 1: Improved EAF operations with the new Simelt AC electrode control system at SDI Roanoke, U.S.A.

Fig. 2: Screenshot for customized reporting, data analysis, trending and exporting at SDI Roanoke

shutdown. Start-up was quick, and the electrode regulator could be tuned during ongoing furnace operations (Figures 1 and 2).

The 50 MVA transformer uses a voltage tap changer at a fixed position, meaning that improvements were achieved solely by the higher regulation quality of the Simelt AC system. During the first weeks following the restart of the upgraded EAF, operators at Steel Dynamics reported a more stable arc condition. This resulted in an average power-on time of 43 minutes – a decrease of 7 minutes at higher current curve settings. With the same power-on time of 50 minutes and with a lower current curve setting, the average specific electrical consumption decreased by approximately 5 to 7 kWh/ton to about 314 kWh/ton.

Simelt AC proved its value during an unplanned outage of the static VAR compensation (SVC) system in May 2014. During the time the SVC was offline, operators in Roanoke were surprised that they did not have to add 5 to 7 minutes to the power-on time, as they had to in the past when the SVC was down. "The power-on time remained the same and we used less electrical energy," says Mike Meador, Electrical Supervisor at Steel Dynamics. "I am guessing the electrode control was responsible, since that is the only thing different from the last time this happened. Those are very good numbers with no SVC." Management at Steel Dynamics is also pleased to know that production can be sped up very quickly should this be required by the market.

Harrison Steel – improving its competitive position

Harrison Steel Castings Company in Attica, Indiana, is a privately owned company that supplies large, highly engineered carbon and low-to-medium-alloy steel castings for a wide range of applications. Its customers include the agriculture, construction, mining and petroleum industries; nuclear, solar, and wind-power-generation companies; and manufacturers of pumps and valves, compressors, gas turbines and automotive vehicles internationally. The foundry is equipped with two 20-ton Lectromelt EAFs and a 7-ton American Bridge EAF.

Simelt advantages:

- Optimized melting performance and reduced energy consumption on the basis of dynamic control parameters
- Highly user-friendly operator support and comprehensive graphical display of all control functions
- Extended refractory life through avoidance of furnace hot spots
- Comprehensive reporting and maintenance features to ensure highest EAF efficiency

Simelt AC electrode control

The centerpiece of Siemens Simelt solutions is the Simelt AC electrode control system. Its highlights include independent impedance control for each phase as well as dynamic impedance and current control, which can also be dynamically influenced via changes of the harmonics. In this way, arc stability can be continuously regulated during power-on time. Other system features include advanced scrap cave-in detection, and a new offline circle diagram complete with a tuning wizard to provide easy tuning for the operators. To extend refractory and mechanical furnace lifetime, the electrode regulation system comprises a special refractory index-balancing tool to control arc radiation.
It can also be used to achieve an asymmetrical energy distribution of the arc when required. Electrode regulation is accompanied by a comprehensive set of reporting and analyzer functions that support the operator to enhance furnace performance. Automated hydraulic speed tests as well as two- and three-phase dip tests with data export capability contribute to an optimum utilization of hydraulic and mechanical equipment.

Fig. 3: Tapping of electric arc furnace at Harrison Steel, U.S.A.

Harrison Steel had been experiencing problems related to the existing digital electrode regulation system for its two 20-ton EAFs (EAF Nos. 3 and 4). Periodically, each phase would get out of balance. Furthermore, there was very little documentation for process analysis, and the regulation system did not allow for precise, repeatable control during melting. The company therefore decided to upgrade its electrode regulation system and contracted Siemens VAI in mid-2012 for the task. According to Harrison Steel, the Siemens VAI system was selected because of the large number of references, the local support, and the potential the system offered to improve overall EAF operations.

Installation and commissioning of the Simelt solution on the two EAFs had to be completed within one weekend shutdown, and production was scheduled to recommence on the following Monday morning. Thanks to the excellent teamwork between Harrison Steel and the local Siemens VAI staff, furnace restart was achieved on time and to the customer's satisfaction (Figure 3).

The advantages of Simelt AC soon became clear. Operators reported a more balanced furnace condition in addition to smoother electrode and column movement. Older, useful operational control features could also be retained following migration to the new system. Timely signaling of events, alarms and warnings now allows operators to recognize problems sooner and spend less time troubleshooting. Information that was previously obtained from the EAF control panel is now clearly visible on a single, easy-to-read screen.

The highly innovative Siemens VAI electrode control systems Simelt and Arcos have been well established on the market since 1970 with more than 500 installations to date.

Control for most heats is automatic, and manual control for special heats is easy to perform.

Looking ahead, Harrison Steel intends to increase its furnace output level with the support of the Simelt MDC (Melt Down Control) system. This will enable them to decrease the specific electrical energy and electrode consumption figures even more (which was already noted by the producer), and to begin operating at higher transformer tap settings for shorter tap-to-tap times. Siemens VAI will continue to provide support to help Harrison Steel meet its production targets and for any furnace issues that may arise.

Levi Knowlton, Project Engineer, Harrison Steel Castings Company
Mike Meador, Electrical Supervisor, Steel Dynamics, Inc.
Daniel Tieseler, Consulting Product Manager, Electrics & Automation

An innovative solution to maximize scrap and HBI rates in converter steelmaking

The Jet Process

Fluctuating prices of scrap and hot-briquetted direct-reduced iron (HBI) in recent years – along with growing pressure from public authorities to further reduce the CO_2 footprint – has heightened the interest of integrated steel producers to increase the share of scrap and HBI that can be used in converter steelmaking. The new Jet Process, a highly efficient technological development offered by Siemens VAI, now allows the portion of solid materials charged into the converter to be dramatically increased.

Hot metal, scrap and HBI are the three primary iron carriers that are used in steelmaking processes. The inherent energy of the hot metal and the heat that is released during the oxygen-blowing step make it possible to charge up to approximately 20% solid materials in steelmaking converters. If postcombustion techniques are applied, this rate can be increased to around 30%. For a higher solid-material charging rate, additional energy for melting and heating is required. This extra energy can be provided by electrical power or by taking advantage of the chemical energy of coal. The generation and use of electricity, however, normally incurs considerable energy conversion losses and relatively high costs. The Jet Process was therefore developed to utilize the chemical energy of coal in a highly efficient manner to enable higher portions of solid materials to be directly used in converter steelmaking.

Process equipment and description

The centerpiece of the Jet Process is a converter that is equipped with bottom-blowing tuyeres for the injection of oxygen, coal and lime into the converter. It is complemented with a hot-blast lance system that is positioned above the converter mouth for postcombustion purposes. Figure 1 depicts the main equipment items of the Jet Process and Figure 2 shows the arrangement of tuyeres and piping of a typical bottom-blowing converter.

The coal injected into the hot metal in addition to the coal already in solution are combusted in two steps: combustion of C to CO in the bath, and postcombustion of CO to CO_2 above the bath by a hot blast. Two-thirds of the chemical energy stored in the coal is released in the second step of this combustion process. Hence, it is essential to ensure good postcombustion and an efficient transfer of the generated heat to the hot-metal bath. This is made possible by the hot blast, which is heated to approximately 1,300°C in a pebble heater, enriched with oxygen up to 30%, and blown at near-sonic speed onto the bath surface in the converter. As a result of the velocity, volume and momentum of the jet blast, a significant portion of the surrounding gases with their huge heat content are conveyed

Replacing a portion of the hot metal with scrap considerably reduces the CO_2 emissions per ton of steel tapped from the converter.

With the Jet Process, the portion of solid materials charged to the converter can be increased to well over 50%

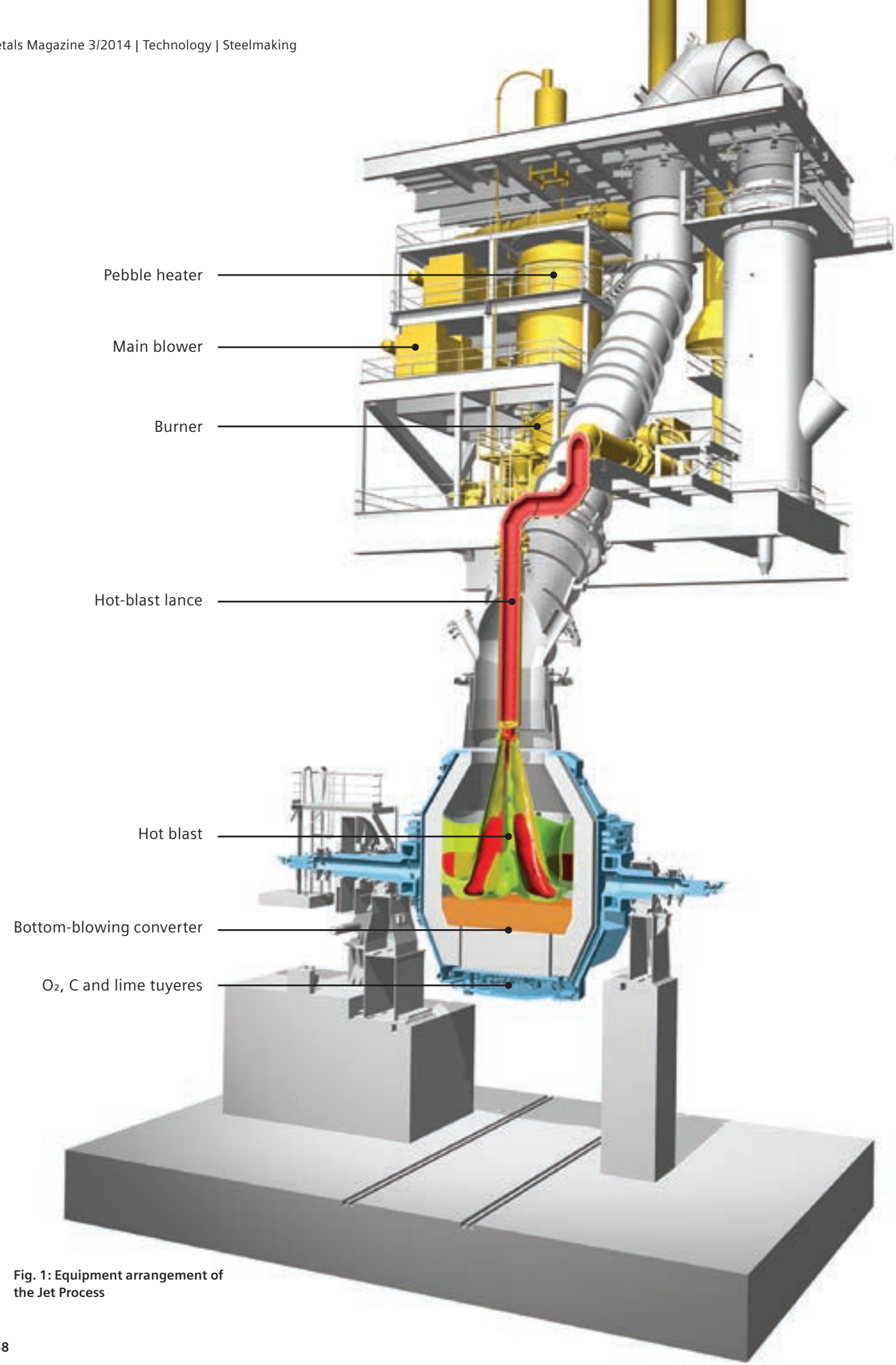


Fig. 1: Equipment arrangement of the Jet Process

An excellent utilization rate of the chemical energy contained in the coal is thus achieved, typically in excess of 50%.

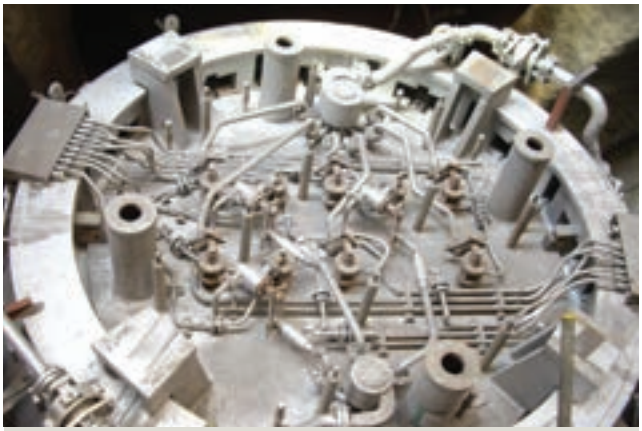


Fig. 2: Converter bottom with tuyeres for oxygen, coal and lime injection of a typical bottom-blowing converter

to the bath surface. This leads to a high input of heat into the liquid metal, intensive bath mixing and extremely efficient process reactions. An excellent utilization rate of the chemical energy contained in the coal is thus achieved, typically in excess of 50%. This figure is in contrast to the much lower efficiency rate of electric steelmaking due to the large energy losses that occur during electrical power generation.

Oxygen for decarburization of the hot metal is blown via tuyeres through the converter bottom into the bath. These tuyeres act like flame cutters, and large pieces of scrap can be melted quickly and efficiently. Similar to the hot blast of the Jet Process, bottom blowing intensively mixes the bath as well; hence, all reactions are accelerated and rapidly reach the equilibrium state. Furthermore, bottom blowing reduces the percentage of iron and iron oxide that is lost with the slag, and the tendency for slopping is decreased compared to standard top-blowing converters. Lime powder blown through tuyeres into the converter accelerates desulfurization and slag formation, and a smaller slag volume is generated. These factors result in increased productivity and process yield.

Maximum process flexibility

The Jet Process is easily adapted to different scrap or HBI rates by adjusting the amount of coal injected into the hot metal. Theoretically, solid-charge rates from 0% to 100% are possible with this flexible process. With up to 30% scrap charges, no coal injection is required because the heat contained in the hot blast combined with CO postcombustion heat provides enough energy. For scrap or HBI rates close to 100%, step-wise or continuous charging in combination with hot-heel operation is necessary. To further increase operational flexibility, a modular converter design was developed that allows a conventional LD (BOF) converter bottom and an oxygen-blowing lance to be quickly installed so that the converter can be operated as a typical LD converter, should this be more feasible.

Areas of application

There are a number of economically attractive market opportunities for the Jet Process. For example, if prices for scrap or HBI are lower than the costs for hot metal, application of this process with a converter charge of 50% scrap/HBI and 50% hot metal could be a highly feasible option.

Other scenarios where the Jet Process offers unique advantages are during a hot-metal bottleneck resulting from a blast furnace blow down, a furnace standstill for revamping purposes, or to increase the total steelmaking output. In such cases, the Jet Process can be used to maintain or increase the overall converter output with higher scrap/HBI charging rates. The only investment necessary is to adapt existing converters to the Jet Process, which is far less expensive than installing added hot-metal capacity and the associated coking and sintering plant expansions.

Finally, the Jet Process can contribute to a notable reduction in CO_2 emissions. In a typical integrated plant, huge amounts of CO_2 are generated during hot-metal production. Replacing a portion of the hot metal with scrap considerably reduces CO_2 emissions per ton of steel tapped from the converter, even though carbon is used in the Jet Process as the energy source. Plant operators can thus reduce CO_2 emissions or increase production while keeping CO_2 emissions constant.

Efficient and economic

The Jet Process is ideally suited for medium to high scrap/HBI rates in converters of any size. It represents an attractive upgrading option for producers to flexibly respond to varying prices for hot metal, scrap and HBI. Converters equipped with this solution thus close the gap between conventional LD (BOF) plants and electric arc furnaces. As demonstrated at the steelworks of one of the world's largest producers, the Jet Process is very reliable and economically promising.

Krzysztof Pastucha, Expert Stainless and Special Steelmaking
Dr. Erich Wimmer, Expert Fluid Simulations
Dr. Gerald Wimmer, Head of Technology, Converter Steelmaking

Improved caster performance throughout Europe with innovative technology from Siemens VAI

Keeping Pace With the Market

Fig. 1: Modernized billet caster at Acciaierie di Calvisano, (Feralpi Group, Italy)

With its expertise in the supply of new casters and the modernization of existing facilities, Siemens VAI is the partner of choice for many steel producers throughout the world.

The setup of a company at the end of an economic downturn is usually a key factor for the company's success in the subsequent economic upturn. As the following examples show, numerous European steelmakers have improved their continuous casting operations with advanced solutions from Siemens VAI.

With its expertise in the supply of new casters and the modernization of existing plants, Siemens VAI is the partner of choice for many steel producers throughout the world. In the projects described below, the technical backgrounds, challenges and solutions may differ. However, the projects can generally be classified according to three main production targets: productivity increase, yield increase, and reduction of operational expenditures (OPEX) – or a combination thereof.

Feralpi Calvisano, Italy

Target: Yield increase
Solution: New machine head

Acciaierie di Calvisano S.p.a., part of the Feralpi Group of Italy, awarded Siemens VAI a contract for the modernization of its billet caster at the Calvisano steelworks in Italy. The project target was to improve the internal and surface quality of the billets and to enable the casting of round, in addition to square, billets. The original four-strand billet caster was installed in 1973 by a third party and has a nominal annual capacity of roughly 750,000 tons of billets with square cross sections ranging from 120 mm by 120 mm to 160 mm by 160 mm. The existing equipment included an electromechanical oscillator that was not capable of adjusting the mold-oscillation parameters.

Following the revamp that was completed in early 2013, the caster is now equipped with a new machine head that is capable of producing higher-quality steel grades in addition

On the basis of the excellent results with the Feralpi Calvisano project, Feralpi subsequently awarded Siemens VAI a contract to upgrade its five-strand billet caster

Fig. 2: New caster machine head at Acciaierie di Calvisano, (Feralpi Group), Italy

to round billets with diameters ranging from 140 mm to 180 mm (Figures 1 and 2). The scope of supply also included curved molds with integrated electromagnetic stirrers (EMS) and tube molds with a length of 900 mm. A DynaFlex mold-oscillating device that enables flexible adjustment of the oscillation parameters over the entire frequency range of the unit was installed. This solution is also characterized by its ease of adjusting the stroke, frequency and waveform during the casting process itself, and the absence of any servo-hydraulic components in the equipment.

The steel grades cast in the line include low- and medium-carbon steel; high-grade steel; micro-, low-alloy and alloyed steel; and spring and case-hardening steel. The strand guides are now equipped with electromagnetic stirrers, and the straightening zones were modified to allow continuous strand straightening. The last of the three secondary cooling zones of each strand was also upgraded, and the cooling bed was revamped to handle round billets.

Elbe-Stahlwerke Feralpi, Germany

Target: Yield and productivity increase
Solution: New machine head with a retractable Dynaflex oscillator

Thanks to the excellent results with the Feralpi Calvisano project, Feralpi subsequently awarded Siemens VAI a contract to upgrade its five-strand billet caster located at Elbe-Stahlwerke Feralpi GmbH (ESF) in Riesa, Germany. The customer's target was to improve billet quality with technical features that included inline stroke adjustment, non-sinusoidal oscillation capability, inverse oscillation capability, a new mold equipped with a Diamold tube, and a newly designed secondary cooling system. In addition to quality improvements, ESF also wished to increase its production output. Retractable Dynaflex oscillators were therefore installed in the caster strands. This solution allows the mold to be exchanged on a strand without interrupting the casting process, which thus increases the productivity and flexibility of the caster. At the push of a button, all mechanical connections are hydraulically released and the entire billet-machine head – including the mold, mold table and the oscillator itself – are retracted from the casting position by means of a moveable carriage outfitted with support wheels. From stop to restart, the entire procedure requires only 15 minutes to a maximum of 20 minutes, and includes mold replacement, insertion of the dummy bar, and all mold-packing operations.

ArcelorMittal Bremen, Germany

Target: Yield increase, reduction of OPEX
Solution: New machine head

In September 2014, Siemens VAI implemented a project for ArcelorMittal Bremen GmbH, Germany, to replace the machine head on the 2-strand slab caster. The existing equipment was no longer state of the art and the oscillating masses were relatively high. The machine head of the 2-strand caster will therefore be equipped with a new mold and with the technology packages DynaWidth and DynaFlex. The target of this upgrading project is to increase the availability and reliability of the plant as well as to further improve product quality. Modernization of the first strand is scheduled to be completed in the fall of 2014, and the second strand in 2015.

The new equipment was designed in such a way that the existing steel structure of the two strands did not have to be modified, which reduced construction costs and shortened the downtime necessary for conversion work. Furthermore, the power consumption of the hydraulic oscillator is now only

Fig. 3: Mold and oscillator during workshop testing, ArcelorMittal Bremen, Germany

The target of this project is to increase the availability and reliability of the plant as well as to further improve product quality.

approximately one-third of the previous level, which decreases production costs. The mold was also designed so that it can be equipped with an electromagnetic braking system. Figure 3 shows the mold and oscillator during workshop testing.

ThyssenKrupp Steel Beeckerwerth, Germany

Target: Yield increase
Solution: New Level 2 cooling model, new Yield Expert process-optimization system

Siemens VAI installed advanced process models on the CC1 and CC2 slab casters at the Duisburg-Beeckerwerth steelworks of ThyssenKrupp Steel Europe AG. The project scope comprised the integration of the process model Yield Expert on CC1, and the Yield Expert and the secondary cooling system Dynacs 3D on CC2. The integration was performed during scheduled production stoppages only.

Dynacs 3D is a process model that dynamically calculates the required water flow rates for a wide range of transient casting conditions such as steel-grade changes, casting-speed variations, varying tundish temperatures, tundish exchanges, and at the start and end of a casting sequence. The water flow rate for each cooling zone is determined to maintain a defined surface temperature throughout the entire casting process. Already during commissioning, the Siemens VAI team demonstrated the capability of the Dynacs 3D secondary cooling model: With the help of Dynacs 3D offline simulations, an optimized spray distribution pattern could be identified by simulating different nozzle types. The caster was subsequently equipped with new nozzles that resulted in a reduction of defective slabs and scarfing requirements (Figure 4).

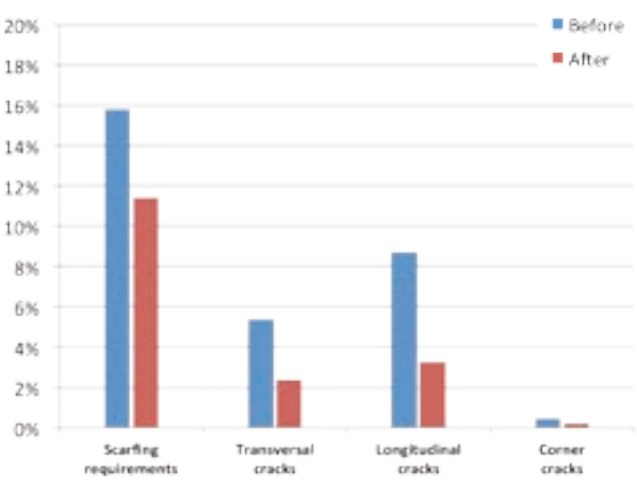


Fig. 4: Reduction of defective slab ratio and scarfing requirements at ThyssenKrupp Steel Beeckerwerth, Germany

ThyssenKrupp Steel Bruckhausen, Germany

Target: Yield increase, productivity increase
Solution: New machine head automation

In July 2011, ThyssenKrupp Steel Europe's Duisburg-Bruckhausen works awarded Siemens VAI a contract to modernize the automation system of its 2-strand Compact Strip Production mill (CSP). This modernization comprised an improvement of the entire basic-automation system and the installation of technological packages that included LevCon for mold-level control, Mold Expert breakout prevention, DynaWidth online slab-width adjustment, DynaFlex oscillator control for flexible adjustment of the oscillation parameters, and automatic strand-taper control.

The main issue that motivated ThyssenKrupp to initiate this modernization project was to achieve a major improve-

This project represented an exciting challenge for the Siemens VAI design department in Linz.

Fig. 5a and 5b: Hydraulically adjustable twin divider for Hüttenwerke Krupp Mannesmann, Germany (left: in the workshop, right: installed)

ment in product quality. During the short scheduled production shutdowns, the technological packages were successively integrated into the existing automation environment. In the final step, the basic-automation system was replaced with the latest PLC control technology and with a PCS 7 process-control system from the Siemens Simatic family. These measures not only improved the productivity of the CSP line but also the plant's availability and output.

Hüttenwerke Krupp Mannesmann, Germany

Target: Productivity increase, yield increase
Solution: Width-adjustable twin divider

Hüttenwerke Krupp Mannesmann GmbH (HKM) operates three continuous slab casters in Duisburg-Huckingen, Germany. Continuous Slab Caster 1 (CC1) is a two-strand caster that is designed with curved molds to produce 260-mm thick slabs. Both strands of this caster, originally supplied by another company, were converted to twin-slab operation in 2001 in order to cast narrow slabs with widths of between 325 mm and 700 mm as the input material for medium-strip production.

In March 2013, Siemens VAI received an order to modernize CC1 with the aim to increase the caster's production capacity by approximately 10%. A hydraulic mold divider for the online-width adjustment of the twin slabs was installed (Figures 5a and 5b). The mold divider was designed to enable it to absorb higher forces and to allow additional rolls to be inserted for improved strand support. With the former mechanical device for mold-width adjustments, only one lateral strand-guide roller could be used in the width-adjustment system. This was because the required forces to adjust the mold with additional rollers would have been too high for the components of the mechanical system. Furthermore, width changes were only possible manually during casting breaks. Another disadvantage was that the accuracy of mold-taper modifications was limited due to mechanical backlash of the gearbox. Consequently, the casting speed and also the quality of the cast slabs were not satisfactory.

Benefits of the new hydraulic mold-divider system:

- Automatic narrow-side adjustments
- Exact position-controlled adjustments
- Improved support of the divider narrow sides and outer-mold narrow sides with the installation of additional rollers
- Reduced slab bulging
- Improved internal slab quality
- Higher casting speeds for increased caster output

The project represented an exciting technological challenge for the Siemens VAI design department in Linz. The supplied mechatronic solutions had to function within a highly confined space and under the harsh operating conditions of a machine head. Caster modification activities took place during a scheduled ten-day plant standstill. Plant start-up successfully commenced on December 2, 2013, in accordance with the strict project time schedule.

Fig. 6: Laser measurements with Opal system on an outer-bow segment, Outokumpu Avesta, Sweden

Fig. 7: Optimized caster performance with advanced caster upgrading solutions from Siemens VAI

Outokumpu Avesta, Sweden

Target: Quality improvement with condition monitoring
Solution: Opal measurement system

At Outokumpu Avesta, the segment rollers were previously aligned in the maintenance area with the use of rulers. This procedure, although it is well proven and widely practiced, has several disadvantages: It is time consuming and typically two maintenance engineers are needed. The necessary number of shims and their positioning has to be calculated by hand or with additional software. Finally, there is no automatic quality documentation.

Avesta was on the lookout for a better solution, particularly for a system that is easy to use so that mistakes could be reduced and reproducible results delivered. The company also wished to have an automatic quality documentation system installed. Avesta finally chose the Opal measurement system from Siemens VAI as an upgrade package for its maintenance stand. The selected solution also included the Siemens VAI Equipment Expert System. Opal is based on a high-precision leveling laser. It is used as the reference for measuring the strand-guide rollers and as a measurement tool for the roller position with respect to the laser plane (Figure 6).

Benefits of the Opal system:

- Computer-aided maintenance support
- Electronic data management to enable condition monitoring
- Traceable and reproducible measurements
- Documented maintenance quality reports

The Opal system, combined with the Siemens VAI Equipment Expert system, allows the following data to be tracked:

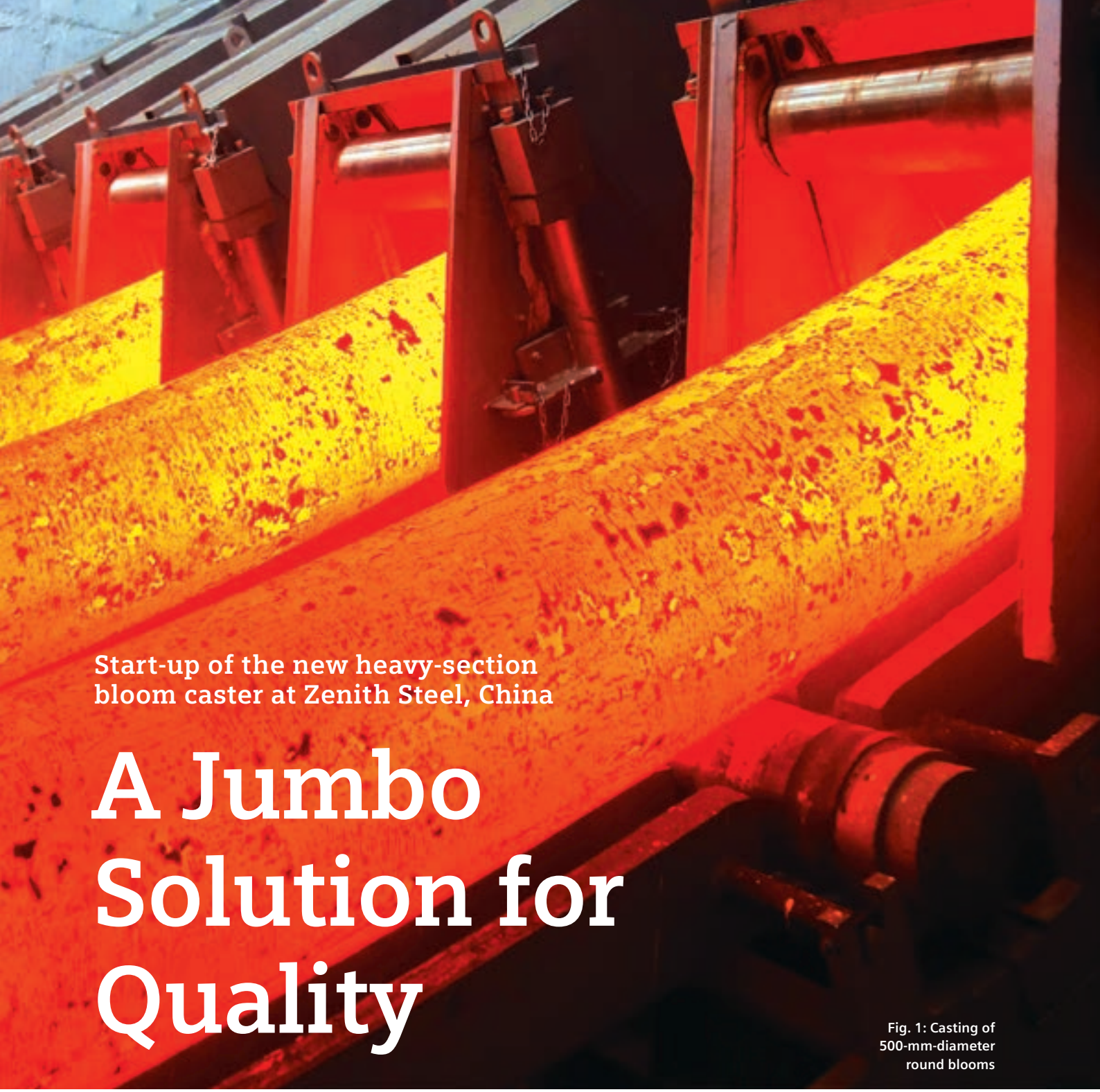
- Equipment status (casting, ready for use, defect, repair)
- Testing, maintenance, measurement and repair protocols
- Serial number
- Lifespan/operation time

The Opal system is so easy to handle that Avesta was able to significantly reduce the time required for the segment alignment procedure and to also optimize the quality and the reproducibility of alignments.

Steady increase in modernization projects

The number of caster modernization projects has been steadily increasing in recent years. At relatively low costs, it is possible to optimize existing facilities to achieve immediate improvements with respect to productivity, quality and yield. Many European steel producers have already taken advantage of these opportunities – and have found a valuable partner in Siemens VAI to attain a decisive competitive advantage.

Dr. Martin Hirschmanner, Head of Engineering, Continuous Casting
Reinhold Leitner, Product Life-cycle Manager, E&A Continuous Casting
Paul Pennerstorfer, Head of Technology and Innovation, Continuous Casting
Mauro Pistoni, Sales and Proposal Manager (Regional Sales Italy)
Thomas Fürnhammer, Mechatronics Engineer



Start-up of the new heavy-section bloom caster at Zenith Steel, China

A Jumbo Solution for Quality

Fig. 1: Casting of 500-mm-diameter round blooms

On July 3, 2013, the new jumbo caster supplied to Changzhou Zhongtian Iron & Steel Co. Ltd. (Zenith Steel) was started up. With the capability to cast round bloom diameters up to 600 mm, Zenith Steel has taken a major step forward in the production of highest-quality blooms for the most demanding downstream applications. The caster is highlighted by the installation of the latest solutions and technological packages from Siemens VAI.

In April 2011, Siemens VAI received a contract from the Chinese steel producer Zenith Steel to supply a 5-strand bloom caster that allows round blooms to be cast with diameters ranging from 360 mm to 600 mm, and rectangular blooms with cross sections of up to 490 mm x 370 mm. The steel grades comprise low- to high-carbon structural steels, alloyed and low-alloyed steels, as well as pipe steel grades. Round blooms with a diameter between 360 mm and 500 mm are further processed to seamless pipes, while the largest rounds with a diameter of 600 mm are used for forging applications. The caster has a machine radius of 14 m, a metallurgical length of 32 m and operates at casting speeds up to 0.8 m/min. A total of 1.3 million tons of blooms can be produced per year (Figure 1).

The plant features many of the advanced technological packages offered by Siemens VAI for the production of high-quality steel. This includes electromagnetic stirring, soft reduction, the application of advanced online automation and simulation models, and the Simetal VAIQ quality-prediction system. Caster equipment also comprises a butterfly ladle turret with independent lifting arms and ladle weighing, a semi-gantry-type tundish car, and a T-shaped tundish complimented by a stopper-rod system with automatic mold level control (Simetal LevCon). The curved tube mold is oscillated by a Simetal DynaFlex hydraulic oscillator for the online adjustment of the stroke, frequency and wave pattern. The strand-guide system consists of three segments and seven withdrawal units equipped with Simetal DynaGap Soft Reduction technology. The withdrawal stands are designed in such a way that they are capable of exerting varying degrees of force. Small forces can be applied to support the strand weight without creating any internal cracks or other load-related strand defects. The withdrawal units can also exert high forces when soft reduction is applied during rectangular bloom casting.

The well-proven Dynacs secondary strand-cooling system is comprised of four air-mist cooling zones that are backed by online temperature and solidification analyses. A chain-type, bottom-feeding dummy-bar system is used at the start of casting operations. The run-out area is equipped with an in-line torch-cutting machine, deburrer, cross-transfer device and cooling bed. Figure 2 shows a bloom torch-cutting procedure. The project scope also covered the supply of complete Level 1 automation systems and advanced Level 2 process-optimization software such as Simetal CC Control and Simetal CC process optimization.

Successful start-up

Caster installation commenced in late 2012 and as early as mid-2013 the first blooms with 500 mm diameters were successfully produced on the new caster. Start-up and commissioning proceeded smoothly to the full satisfaction of the customer. The outstanding internal bloom quality is seen in Figure 3. All guarantee figures were quickly met following the first heat, and in November 2013 the customer signed the final acceptance certificate.

Wolfgang Schönhart, Project Manager, Continuous Casting
Franz Wimmer, Continuous Casting Technologist

Zenith Steel

Zenith Steel belongs to China's top 20 steel producers. The privately owned company operates an integrated iron- and steelworks in Changzhou, Jiangsu province, which is comprised of eight BOF (LD) steelmaking converters with an annual production capacity of 10 million tons. Zenith Steel supplies blooms for the production of pipes, bearings and springs. The production of a wide range of structural steels completes the company's production portfolio.

Start-up and commissioning proceeded smoothly to the full satisfaction of the customer.

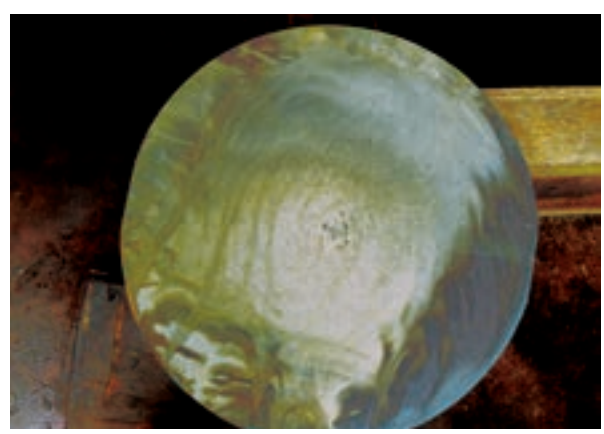
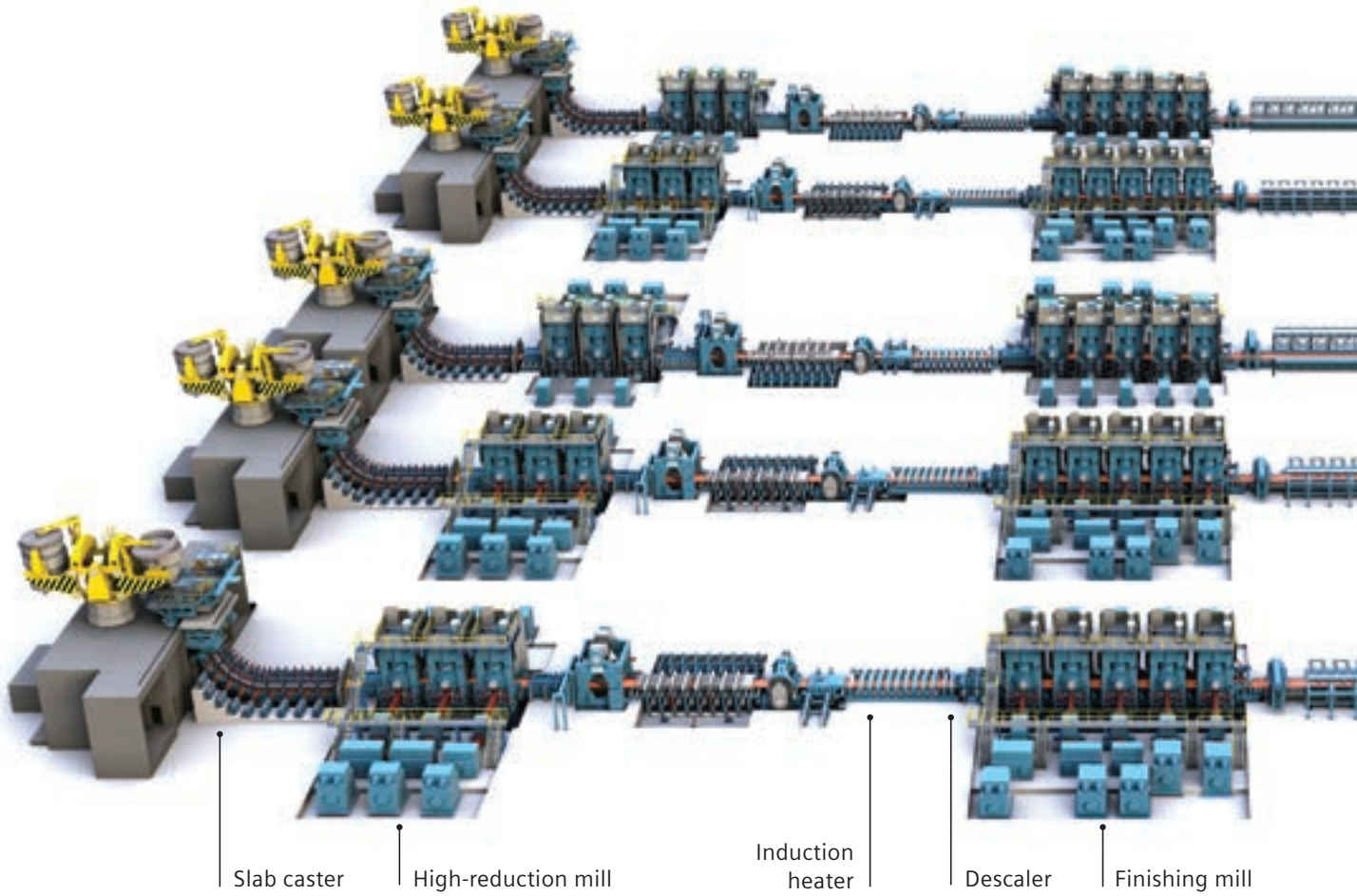


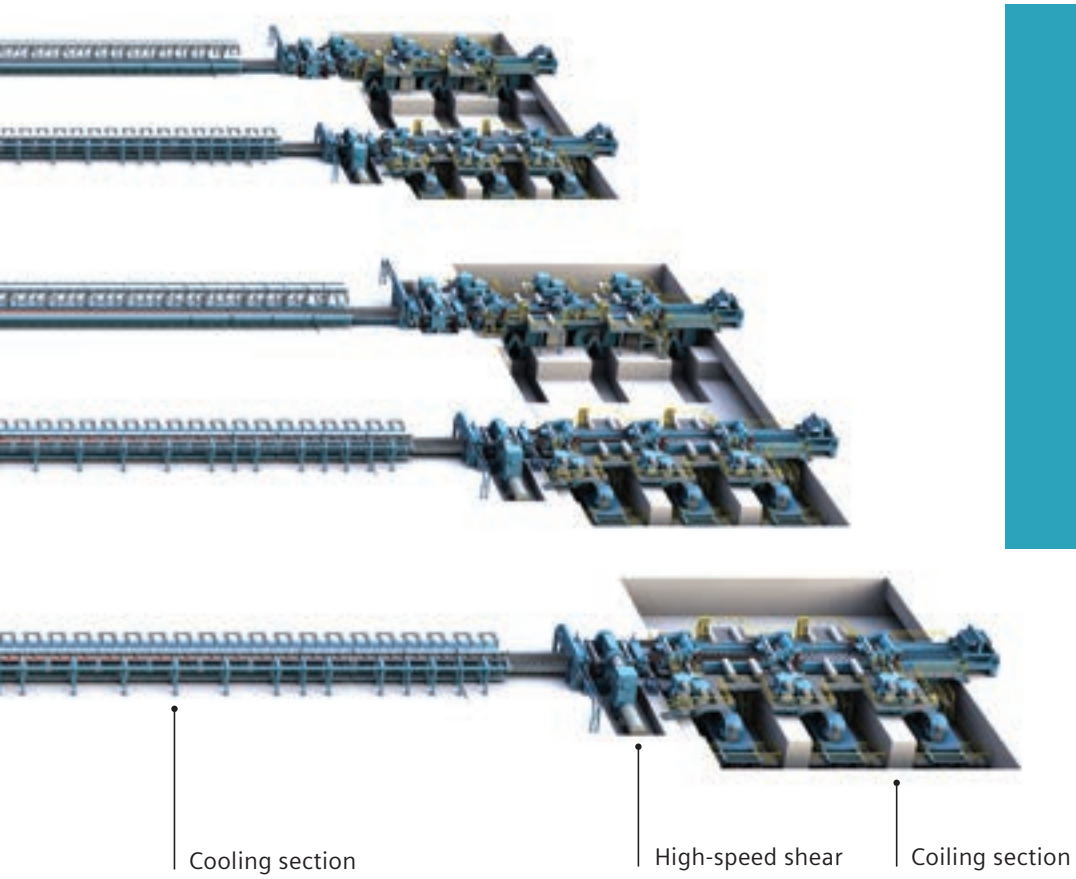
Fig. 2: Torch cutting of a bloom

Fig. 3: Sample of a medium-carbon 600-mm round section demonstrating the extraordinarily high degree of internal steel homogeneity



A Chinese steel producer chooses the Arvedi ESP process to excel in the market

Five Arvedi ESP Lines for China



Schematic view of the five Arvedi ESP plants under construction in China

The 180-m-long Chinese plants will be far more compact than conventional casting and rolling mills.

Two new Arvedi ESP lines are now nearing completion at the steelworks of a well-established Chinese steelmaker. The same customer recently ordered three additional Arvedi ESP lines, which, upon completion by the year 2016, will enable a total of more than 11 million tons of thin-gauge, hot-rolled strip to be produced by all five lines.

In China's saturated steel market, an eastern Chinese steel producer selected the Arvedi ESP (Endless Strip Production) process to enhance its product mix to include high-quality, thin-gauge hot-rolled strip. Following an initial investment in mid-2013 for two new Arvedi ESP plants, each with an installed annual production capacity of 2.55 million tons, a second order was placed with Siemens VAI for the supply of three additional Arvedi ESP lines that will have a combined rolling capacity of 5.95 million tons of steel per year. The lines are designed for the production of different strip-width ranges that extend from 900 mm to 1,600 mm (three lines), and from 900 mm to 1,300 mm (two lines). In each of the five lines, strip can be rolled to a minimum thickness of 0.8 mm. A wide variety of steel grades will be produced for a broad spectrum of steel products and industrial sectors.

Siemens VAI is responsible for the engineering of the Arvedi ESP plants, as well as for the supply of mechanical equipment, media-control systems, technological packages and automation systems. The line will be controlled by completely integrated basic-automation (Level 1) and process-optimization systems (Level 2) for all casting and rolling operations.

Overall plant configuration

The layout and the expected results of the five new plants are based on the plant design and performance of the Arvedi ESP production line at Acciaieria Arvedi SpA, which has been successfully operating in Cremona, Italy, since 2009. The 180-m-long Chinese plants will be far more compact than conventional casting and rolling mills. A short line length means lower investments for land, civil works, buildings, piping, cabling and construction. Four plants are positioned

As-received photograph of construction activities in the high-reduction mill area of the Arvedi ESP complex in China

As-received photograph of construction activities in the finishing mill area

pairwise in a mirrored arrangement with the drives installed on the outer side of each line, and with the control pulpits and roll shops positioned between the line pairs. Liquid steel for the wider Arvedi ESP lines will come from new LD (BOF) meltshops with 300-ton converters, and for the narrower lines the steel will be supplied from existing converter meltshops with 63-ton converters.

Continuous casters

The bow-type casters of all five lines will perform continuous strand bending and unbending, and they will be equipped with a straight mold for the casting of steel at thicknesses between 90 mm and 110 mm. Online strand-width adjustments are performed using DynaWidth mold-width adjustment technology. This solution allows the targeted strand width to be accurately met without the need for an edger. The casters are equipped with 11 strand segments each, and the metallurgical length of all casters is just over 20 m. Three high-reduction mill stands are installed immediately after the final caster segment in order to utilize the remnant heat energy of casting for the initial rolling step. In addition to major energy-cost savings, this allows an optimized crown and wedge control to be achieved with work-roll bending, since the hot core of the cast strand is softer and therefore has a higher formability for shape control.

Induction furnace

The intermediate strip that exits the high-reduction mill then enters the induction heater, which features a short length of only 10 m. This enables the strip to pass through the furnace in less than 15 seconds, which is a decisive factor for minimum scale formation. Only one descaler – installed immediately before the five-stand finishing mill – is therefore required for the entire line. Unnecessary strip-temperature losses are thus avoided, allowing a more perfect control of the thermomechanical rolling parameters.

Finishing mill

Following reheating and descaling, the intermediate strip then enters the finishing mill equipped with five 4-high finishing stands. Because strip shaping has already taken place in the high-reduction mill, only the first two finishing stands are equipped with SmartCrown rolls that are designed with a bottle-shaped roll contour. This serves as the basis for final rolling of perfectly flat strip by the last three finishing stands, which are outfitted with conventional work-roll contours. Long-stroke shifting of the work rolls under load, which is regulated by a wear-compensation model, maximizes the service life of the rolls before surface grinding is required. What's more, thanks to the endless mode of operation in Arvedi ESP plants, strip impact on the rolls – typical for batch-operated plants during strip-head threading – is eliminated. This aspect also contributes to a significant extension of the work-roll lifetime. For example, in a typical production sequence comprising 3,000 tons of liquid steel, a total of 170 km of strip – with a considerable portion of 1 mm gauge – is rolled by the final stand.

Benefits of endless rolling technology

- Superior geometrical quality and flatness of strip
- Outstanding surface quality
- High strip homogeneity along the entire length (no strip head or tail)
- Considerably extended work-roll lifetime
- Reduced consumption of alloys for production of advanced steel grades
- Excellent process stability

Onsite training of Chinese operational and maintenance personnel at the Arvedi ESP plant in Cremona, Italy

Strip cooling and coiling

Rolling is followed by laminar cooling after which tension-free cutting is carried out by a high-speed shear. The endlessly produced strip with coiled weights of up to 32 tons is distinguished by highly uniform geometrical and mechanical properties throughout its entire length. Because strip-head and -tail cropping is unnecessary with endless production, an average yield of more than 98% is achieved from liquid steel to the coiled product in Arvedi ESP lines.

The fully integrated automation system, supplemented with an advanced tracking model, ensures exact cutting procedures and coil scheduling in accordance with production orders. The entire process, including all plant technology and automation systems, are protected by Arvedi and Siemens VAI patents.

Varied product mix

The product mix of the new Chinese plants will comprise low- and ultra-low-carbon steels, medium-carbon steels as well as high-strength low-alloyed (HSLA) and dual-phase steel grades.

Thanks to the constant process parameters of endless operation, particularly with respect to the strip-temperature profile, production of advanced steel grades is accomplished with a far higher degree of accuracy compared to conventional casting-rolling processes. For example, over-alloying is avoided during production of HSLA and pipe grades, which results in considerable cost savings for producers. The positive influence of endless operation on the metallurgical properties of the rolled strip is shown in a YouTube film, which can be accessed below via the QR code.

Comprehensive training for Chinese plant operators

Quick ramp-up of the new Arvedi ESP lines to their designed production capacity will be supported by comprehensive training of Chinese operational and maintenance personnel. Basic training comprises theoretical training at Siemens VAI in Linz and Erlangen for mechanical, electrical and automation equipment. This is followed by three weeks of theoretical and practical instruction at the Arvedi ESP plant in Cremona. In a second module with hands-on training, operators are involved with routine operational and maintenance practices for two months at the Arvedi plant in Cremona.

During the first year of operation at the Chinese ESP plants, on-site training and assistance will be provided by specialists from Acciaieria Arvedi. The combination of experienced Arvedi experts and well-trained customer personnel will ensure reliable plant operations and the production of high-quality final products.

Meeting market demands

The reliability and stability of the Arvedi ESP process has been well proven in more than five years of operation at Acciaieria Arvedi. A broad range of advanced steel grades are produced for a wide range of industrial applications. Thanks to the uniform and exceptional quality of the thin- and thick-gauge strip, the products command premium prices on the market.

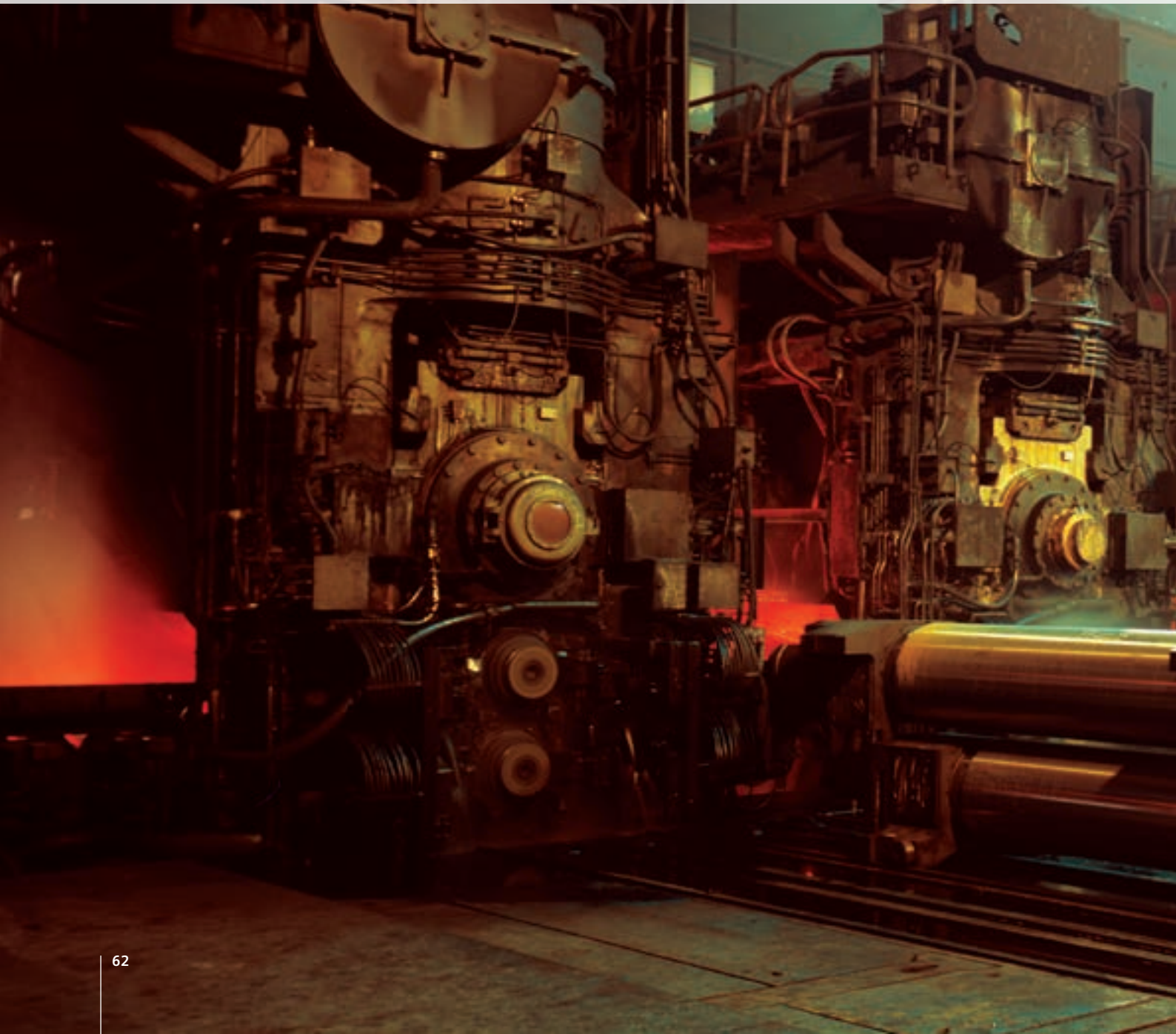
Major cost savings result from the significantly lower energy consumption, reduced alloying requirements and high product yield. With consideration to the numerous benefits offered by the Arvedi ESP process, the five new plants under construction in China will provide the customer with the basis for long-term business success in China and abroad.

Andreas Jungbauer, Sales Manager, Endless Strip Production

See why the endless production mode of the Arvedi ESP process is superior for the manufacture of new and advanced steel grades.
http://www.youtube.com/watch?v=WN4cZUYVPUQ

Modernization of the drive systems at three hot-rolling mills of ArcelorMittal in Europe

Customized Standardization



Since December 2012, Siemens VAI has been replacing the existing DC main drives with more powerful AC systems at three ArcelorMittal finishing mills in Europe. The three projects – in Dunkirk, Florange, (both France) and Ghent (Belgium) – are part of ArcelorMittal's comprehensive modernization plans that aim to boost productivity and reduce costs. At the same time, the hot-rolling mills are also being equipped with the production technology necessary to process sophisticated steel grades.

The flexibility of the Siemens motor design makes it especially suitable for modernizations.

Finishing mill in the ArcelorMittal plant in Ghent, Belgium

A maintenance capex program valued at €150 million has been underway at ArcelorMittal sites in Dunkirk, Florange and Ghent since 2012. ArcelorMittal's main targets include a continuous adaptation of the product mix to meet customer expectations and contribute to a more sustainable environment, and the delivery of steels and steel solutions that enable its customers to develop lighter and "greener" products. Standardization of the drive systems across the different plant locations is playing a major role in these projects.

Siemens VAI has been supplying the motors, converters and transformers for all 17 mill stands at the three sites in addition to handling on-site activities such as installation, erection supervision, commissioning and customer training. To supply a single motor that covers the requirements of all stands of the three production sites, Siemens VAI engineers performed detailed analyses of the current and future production schedules of the plants with respect to motor power, torque and speed. Consideration of these points helps determine the optimum size of the motor in terms of electrical operation data.

A common solution approach for different plants histories

The plants in Dunkirk, Florange and Ghent were built at different times and have different technology and modernization histories. Therefore, adapting the existing structural environment presented a special challenge. In Dunkirk, each stand has three DC machines coupled on one shaft, while in Ghent and Florange the stands are equipped with one or two DC motors in series. Furthermore, over the years one of the plants received an additional stand, which was already equipped with AC technology. This has resulted in completely different motor pit dimensions. Additionally, the motor design had to cater to different axis heights. This meant that the decisive limiting mechanical parameters were the axis height and the motor pit dimensions.

Siemens VAI engineers were commissioned to design a single AC motor with a higher total power but with outer dimensions that allowed the motor to fit on the same foundation as a single DC unit. Modifications of the foundation had to be minimized to achieve the required short shutdown times.

For applications like these, the main drive motors are usually engineered as 6- up to 24-pole machines. Siemens optimized the motor design especially for the modernization application. Thanks to the non-salient features of the Siemens rotors, it is possible to dimension the motors in 6- to 12-pole design to meet the requirements of a hot-strip mill application. The 12-pole motor in particular offers the benefit of outer dimensions close to a DC machine with additional

Close cooperation between ArcelorMittal and Siemens VAI during the installation of a new AC motor

Siemens VAI, as a full-service supplier, developed a concept to keep the shutdown for the replacement of two drive trains within 12 days.

Project status and progress

Since December 2012, seven stands have been successfully commissioned. Work commenced with two stands in Ghent and one in Dunkirk. After the good results on the first stand in Dunkirk and in accordance with the accelerated time schedule stipulated in the contract with Siemens VAI, the scheduling in Dunkirk was sped up. As such, in August 2013 two stands in Dunkirk were revamped – four months ahead of plan. In December 2013, another two stands in Ghent followed.

With these successful modernization steps, ArcelorMittal has tightened the migration schedule for the third and fourth phases in Ghent and Dunkirk as well as for the second phase in Florange. Subsequently, the commissioning of all 17 stands will be completed during the summer of 2015.

The ArcelorMittal Europe – Flat Carbon Products Division is pleased with the positive progress in the upgrade of its hot-strip mills in Dunkirk, Florange and Ghent. With regard to the Siemens VAI product and services performance, managers at the plants have praised the minimum shutdown time and the on-time start-up. Furthermore, a 100% production ramp-up was achieved within a few days. The installed AC systems have integrated well with the other DC drives stands and fast optimization was possible with the inter-stands looper control.

savings in weight due to smaller electrical steel lamination packages. The flexibility of the Siemens motor design makes it especially suitable for modernizations.

For the chosen 12-pole version, the outer dimensions fit on all motor pits. The special design of the motor feet allows the motors to be installed on multiple base frames with different bore masks. This attribute also facilitates the use of just one spare motor for all stands, thus minimizing fixed assets and required shutdown times.

The usual design of Siemens motors in this power range is with pedestal bearings. The advantages are an optimized force flow into the foundation and minimized motor weight. An alternative solution is the compact machine design. For this, the base frame and housing of the motor have to absorb high forces, which requires a very solid and rigid design for the motor frame and housing. Consequently, it is significantly heavier. The advantage of the compact machines, though, is that installation and replacement can be performed in a very short shutdown time and with less effort.

Standardized and customized

Aside from the standardization aspect and the request for a very short shutdown time, one of ArcelorMittal's main targets is to produce a new product mix comprising higher-strength steels. Different product mixes at all three sites finally led to the decision to install three kinds of motors with different power ratings. The use of a single motor would have had the highest degree of standardization but would have meant over-dimensioning and a solution that was not cost optimized at two sites.

The final choice was for a 12 MW compact machine for the Dunkirk site and for three stands at the Florange site. Furthermore, in Florange a 8.6 MW compact machine with increased torque was selected for one stand. The footprint of this machine is mechanically compatible with the base frame of the 12 MW compact machine with lower torque. A 14 MW pedestal bearing machine was chosen for the Ghent site to meet the mill's higher requirements regarding achievable rolling torques. Despite the longer shutdown times usually required for pedestal bearing machines, Siemens VAI, as a full-service supplier, developed a concept to keep the shutdown for the replacement of two drive trains within 12 days. The standardization of the drives allows the sites in Dunkirk and Florange to share one spare motor.

ArcelorMittal in Dunkirk, Florange and Ghent

The integrated production sites of ArcelorMittal Atlantique in Dunkirk, France; ArcelorMittal Lorraine in Florange, France; and ArcelorMittal Belgium in Ghent belong to the ArcelorMittal Europe Flat Products Division. The Dunkirk site has an annual capacity of 4.5 million tons of hot strip. An important customer for the end products is the auto-motive industry. ArcelorMittal in Florange receives slabs from Dunkirk for hot rolling and finishing, and the site's main customers are also from the automotive industry. ArcelorMittal Gent has a wide hot-strip mill and produces more than 5 million tons of flat steel a year for applications in the automotive and domestic appliance industries, among others.

The target was a maximum degree of standardization but with a degree of customization to adjust to operator requirements.

Left: Encoder alignment for high-precision control quality and best performance

Above right: View of the hydraulic system of the AC motor

Below: Siemens motor in compact design with bearings mounted within the unit housing

The motor requirements revealed the challenging character of standardization among different plants or even different stands within a single plant. The standardization concept does not stop with the motor but also sets demanding challenges to be met by the converter technology.

Highest flexibility for converter systems

The electrical requirements for the converter system mainly result from the necessary motor power and torque, which are different for each site. The Siemens Sinamics SM150 voltage source converters are based on IGCT (integrated gate-commutated thyristor) technology. The optimized pulse pattern (ROTOS) minimizes the switching losses and results in an efficiency of up to 99%. Through the installation of capacitor cubicles for the converters at the Ghent site, the output current can additionally be increased. These properties together with the high overload capability allow both required power ranges to be achieved by the identical Sinamics SM150 medium-voltage source converter based on 5.0 kA IGCT technology without over-dimensioning it for one of the sites. In this way the converter system has been perfectly optimized to the site-specific motor requirements.

New installation locations outside the former electrical room result in long cable runs between the converter and the motor or transformer and converter. This creates a need for increased cable capacity and the associated higher peak voltages. This in turn means higher stress for the stator insulation system. Only special filter systems can reduce the stress and deliver the flexibility for the installation location. Not only the location but also the available space has been a significant parameter. The ability to install cabling from top and/or bottom, and the opportunity to install the converter in one row or separated in single power units, allows the special conditions of each plant to be taken into consideration.

Customer-supplier collaboration

Open-mindedness on the part of the customer and the willingness of the supplier to act as a consultant – with the openness and flexibility to integrate the customer's ideas – resulted in an optimized revamp concept. The customer has also expressed a high level of satisfaction. The target was a maximum degree of standardization but with a degree of customization to adjust to operator requirements. This shows that standardization might be limited but that it is not incompatible with customization.

As a single-source full-service supplier, Siemens VAI is able to cover all the different modernization requirements thanks to its long experience and professional knowledge in the field of engineering, commissioning, installation, supervision, service, after-sales service and project execution.

Christian Delcourt, Sales Siemens Belgium, Customer Key Account for AM Dunkerque and Florange

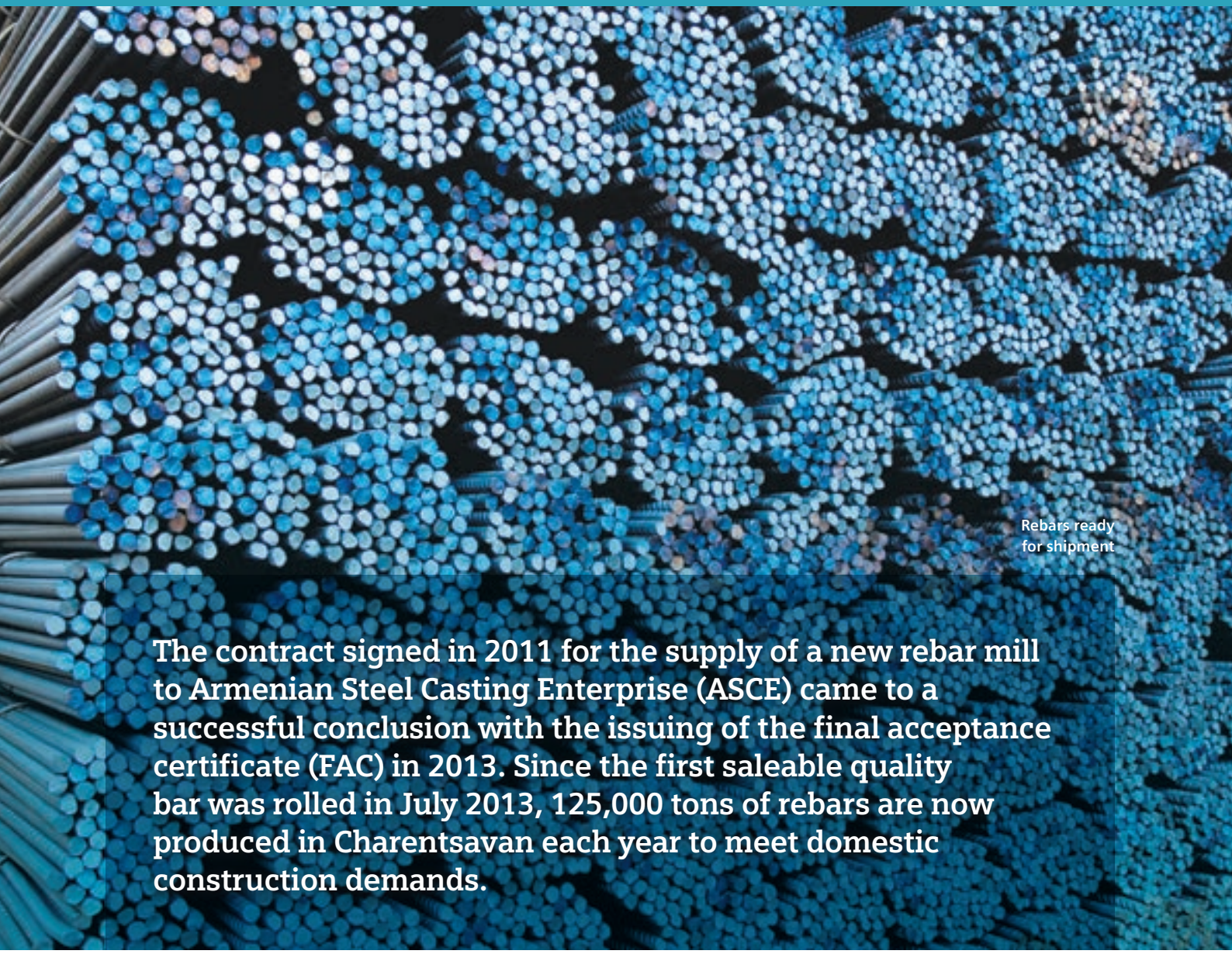
Helmar Jungfer, Sales, Drives Modernization

Franz Kiefer, Sales Group Leader, Drives Modernization

Marco Sarrazyn, Siemens Belgium Sales, Customer Key Account for AM Gent

A new rebar mill from Siemens VAI rejuvenates Armenia's construction industry

Armenia's First Modern Bar Mill



Rebars ready for shipment

The contract signed in 2011 for the supply of a new rebar mill to Armenian Steel Casting Enterprise (ASCE) came to a successful conclusion with the issuing of the final acceptance certificate (FAC) in 2013. Since the first saleable quality bar was rolled in July 2013, 125,000 tons of rebars are now produced in Charentsavan each year to meet domestic construction demands.

Armenian Steel Casting Enterprise (part of ASCE Group OJSC) is a manufacturer of steel castings, molds and pattern tools for foundries, and it is the local market leader in scrap recycling. The company's obsolete rolling mill needed to be replaced in order to enter the reinforcing bar (rebar) market. In December 2011, ASCE commissioned Siemens VAI to supply a new mill capable of rolling 125,000 tons of rebars per year. The mill is located in the town of Charentsavan, about 50 km north of Yerevan, the capital city of the Armenian Republic.

The customer requested a simple yet reliable mill design that would provide the flexibility for cost-effective operation and the ability to respond quickly to changing market demands from the civil construction sector. The plant was designed for a small annual output and with a tight investment budget.

"Siemens technology and expertise made this installation possible, which is indeed the most modern bar mill in Armenia," said Vahan Hazutyunyan, member of the board of directors at ASCE. "We are confident that the new mill will allow ASCE to extend its range of products and services for the Armenian market."

Technical excellence and reliable operations

In the first step, 120-mm-square billets are preheated in a push-type gas-heated furnace with a capacity of 25 t/h. A single roughing reversible sliding stand then rolls the billets in six reversing passes, followed by a continuous ten-stand train for final product rolling to rebar diameters ranging from 8 mm to 32 mm. All stands have the Siemens VAI Red Ring design. To optimize productivity, bars with diameters extending from 14 mm to 32 mm are rolled in a single strand, while 10 mm and 12 mm bars are rolled in the two-slit mode and 8 mm bars in a three-slit mode. After rolling, the bars are quenched so that their final tensile and yield strengths comply with the local standards for each steel grade processed. The final bar exits the rolling mill at a maximum speed of 7 m/s, after which it is braked by an inlet slide and then deposited onto a cooling bed that is 42 m long and 8 m wide. After cooling, the bars are cut to the desired length by a static shear and prepared for final dispatch.

Project cooperation

The success of the project was assured by the close cooperation among different European Siemens units together with the customer. Siemens VAI Long Rolling in Marnate, Italy, supplied the overall plant design, process design and all process equipment. The scope extended from the billet-reheating furnace to the finished-product handling equipment. A water-treatment plant was also supplied. Siemens Russia in Yekaterinburg provided the electrical and automation equipment.

Project success

Cold commissioning activities began in late May 2013. Within two months, the first billet was successfully rolled into saleable quality bars. The final acceptance certificate was jointly signed on March 12, 2014. The new mill represents a clear vote of confidence by the ASCE Group, as this was the second Siemens VAI project for the group after the 2-strand billet caster that feeds the new mill.

Armenia's newborn steel industry

The Republic of Armenia is located at the crossroads of Europe and Asia in a mountainous region on the southern side of the Caucasus massif. More than half of the country's exports have been ore concentrates and metals. However, the country had to previously import all of its structural steel. The billet caster and the new bar-rolling mill that were supplied by Siemens VAI for the ASCE Group have rejuvenated the steel industry in Armenia, creating a new specialized manufacturing sector for the local construction industry. About 40% of the produced rebars are exported to neighboring countries.

Siemens VAI bar mill equipped with Red Ring stands

David Meunier, Project Manager, Long Rolling
Stefano Salentino, Area Sales Manager, Long Rolling

A continuous cast aluminum mill in Oman produces electrical conductor grade and aluminum alloys

Capacity Boost for The Middle East

Two-thirds of aluminum rolling mill demand is for low- to medium-tonnage systems that produce one to eight tons per hour. An example of this type of mill is in Oman, where Siemens VAI partner Southwire obtained an order for a continuous cast aluminum mill for a customer in 2008 to produce electrical conductor (EC) and 6201 aluminum alloys. The mill equipment was designed and manufactured by Siemens VAI in the United States.

Companies in the Middle East benefit from low energy costs, but continue to seek new markets to diversify the region's industrial strengths. One example is the production of aluminum rod for the power transmission industry. Oman Aluminum Processing Industries LLC (OAPIL) purchased a Southwire Continuous Rod (SCR) continuous cast aluminum rod system from Southwire Company, LLC, which subcontracted the design and construction of the rolling mill to Siemens VAI in July 2008.

The mill equipment, which was designed and manufactured by Siemens VAI in Worcester, Massachusetts, U.S.A., consists of a 500 mm entry shear, three 325 mm independently driven roughing stands, seven 205 mm independently driven finishing mill stands (Figure 1), and a complete dual-reel coiler arrangement. Running at 8 tons per hour, the mill produces electrical conductor (EC) and 6201 aluminum grades. The motors and controls for the mill were also supplied by Siemens.

Maximized production

An important component in the new mill is the dual-reel coiler system, which enables the finished product spooling operation to keep pace with the rolling process and therefore maximize production. The coiler makes it possible for OAPIL to automatically change the spooling from one reel to another without lowering the mill exit speed as the first reel fills to a desired weight. The system includes a dividing shear to cut the rod, creating a new front end for transfer from one reel to the other. The resulting coils are very dense, which aids in downstream handling and fits compactly in shipping containers. Figure 2 shows a finished coil.

The last step in the process consists of four-way coil strapping, which ensures coil integrity during transportation. Process control systems provide a high level of system diagnostics, recipe management and the capability for remote services, ensuring accurate and real-time assessment of faults to maximize mill utilization.

Southwire is the only equipment manufacturer in this market segment that operates the same equipment it sells every day. A group of OAPIL staff members therefore came to the United States to see Southwire's facility in Hawesville, Kentucky, where Southwire owns and operates three SCR continuous cast rod systems equipped with Siemens VAI aluminum rolling mills. These mills are similar in function to the new OAPIL mill and were used to train the Omani operators for the aluminum casting and rolling process.

A reputation for high quality

The mill operators were trained well. Five years later, the medium-tonnage mill supplied to OAPIL operates beyond its as-sold capacity, having produced more than 51,000 tons of special alloy aluminum rod in 2013. The excellent production performance and high quality of rod from the Southwire

Fig. 1: Finishing mill of continuous cast aluminum rod system at Oman Aluminum Processing Industries LLC (OAPIL)

The dual-reel coiler system enables the finished product spooling operation to keep pace with the rolling process and therefore maximize production.

Southwire and Siemens VAI

Based in Carrollton, Georgia, U.S.A., Southwire Company, LLC has a nearly 50-year relationship with Siemens VAI and its predecessor company, Morgan Construction Company, for the design and manufacture of non-ferrous mills. In that time, the partners have produced close to 100 reference systems together, both for copper and aluminum. The OAPIL mill represents one of a growing number of non-ferrous facilities in the Middle East, which include new SCR Continuous Cast Rod systems that have recently started up in Egypt, Saudi Arabia and the United Arab Emirates, with another on order in Abu Dhabi.

SCR Technologies and Siemens VAI equipment have enabled Oman to develop a good reputation in the market – so good that it now exports a significant percentage of its high-quality rod to the United States.

Dr. Bruce V. Kiefer, Intellectual Property Manager
David Gow, Non-Ferrous Program Manager

Fig. 2: Finished coil

The new 3-stand aluminum hot-rolling mill at Novelis Korea

An existing single-stand reversing hot-rolling aluminum mill at Novelis Korea Limited (Novelis) was directly linked to a new Siemens VAI 3-stand tandem hot-rolling mill. This mill expansion allowed the company to more than double its 2011 production output of nearly 200,000 tons of aluminum coil and plate products, improve product quality and roll thinner coiled products. Novelis is now a key supplier of high-quality aluminum sheet to the Asian automotive industry.

Siemens VAI solutions help Novelis Korea expand production of automotive aluminum sheet

Breathing New Life Into an Existing Mill

The aluminum hot-rolling mill at Novelis (formerly Alcan) is a veritable workhorse. Originally built and started up by Davy Mckee Ltd. (now Siemens VAI) in 1993, the nominal mill output was increased from 150,000 t/a to 198,000 t/a in 2011 through the optimization of the rolling schedule and product mix. Following a decision in 2011 to expand its production of automotive sheet for the growing Asian market, Novelis placed an order with Siemens VAI to supply a new tandem hot-finishing mill that was to be installed at the end of the existing hot-mill exit tables. At the time, the line consisted of a 2.8-m-wide, single-stand twin-coiler hot mill and two downstream 2.2-m-wide, 4-high variable-crown cold mills. Today, the original hot mill operates with the new tandem mill and is used for roughing passes on thin-coil products (≤ 6 mm) and for all thick-coil and plate products.

Installation of the new tandem mill was carried out with minimum disruption to ongoing plant production. Following a shutdown of the existing hot mill that lasted only ten days, the new mill commenced operations in June 2013. The aluminum hot-rolling facility rolls strip up to 2,200 mm wide at thicknesses down to 1.8 mm. In the following, a brief overview of the supplied equipment is presented, which is based on the integrated Siroll Alu solution platform for aluminum hot-rolling mills.

Light-duty shear

The light-duty shear, which is positioned between the older reversing mill and the new tandem finishing mill, is a fully hydraulic up/down cutting shear. The use of a pneumatic down holder instead of hydraulic equipment above the hot product minimizes fire risk. The double-raked blades with a V-cutting profile assist threading into the finishing stands, which reduces the possibility of bite refusals. The scrap-handling system with a motorized bin-traverse mechanism and an elevator to lift the bin to floor level for subsequent removal is designed to enable fast bin changes. Table 1 shows relevant cutting parameters for two aluminum grades.

Tandem mill

The three mill stands are equipped with top-mounted double-acting roll-load cylinders with bottom-mounted continuous wedge-pass line-height adjustments to maintain a constant strip-pass line. The roll-bending block is designed for positive and negative work-roll bending on all stands. The roll balance force is automatically activated prior to strip tail-out at each stand to prevent skidding between the work- and back-up rolls. The back-up rolls are mounted on cylindrical roller bearings to ensure low eccentricity values. The back-up bearings are interchangeable with the existing twin-coiler hot mill. Table 2 lists the most important technical data of the tandem mill.

Work-roll chock-mounted scratch brushes (nylon bristles) with hydraulic load control, mechanical penetration stops and zero-dwell oscillation are provided to remove oxide and dirt from the work rolls. These are driven by variable-speed AC drives. Internal brush lubrication is applied when the drive shaft is running.

Siemens ISV (Integral Solenoid Valve) pulse-modulated work-roll sprays, placed on both the entry and exit sides of all stands, control the thermal crown of the rolls and hence

This mill expansion allowed the company to more than double its 2011 production output, improve product quality and roll thinner coiled products.

Novelis is now a key supplier of high-quality aluminum sheet to the growing Asian automotive industry.

Examples of rolled aluminum products during the final acceptance test (FAT)

Table 1:

Shear-cutting parameters for aluminum alloys

Aluminum alloy	3003	5182
Max. strip thickness	60 mm	45 mm
Cutting temperature	≥ 250°C	
Max. cutting force	4,000 kN	

Table 2:

Main technical data of the tandem mill

No. of mill stands	Three 4-high stands
Work rolls	750 mm diameter x 2,500 mm width
Back-up rolls	1,500 mm diameter x 2,400 mm width
Max. load	40,000 kN
F3 speed	450 m/min
Mill drive power	3 x 5,000 kW (AC)
Roll bending force	+/- 2,000 kN

Table 3:

Technical data of the edge trimmer

Blade diameter	610 mm
Max. cutting thickness	6 mm for all alloys
Max. speed	550 m/min

improve strip profile and shape. Strip wipes and blowoffs on both sides of all stands prevent coolant carryover. Interstand strip-cooling sprays lower the strip temperature in support of high pass speeds.

Driven strip-tension-measuring rolls with oscillating cleaning brushes are installed between the stands. Side-shifting automatic work-roll change with automatic connection of all drive-side services ensures quick-roll change. Provisions were also made for the installation of future stands: the supporting foundations, entry tables and guides were designed specifically to accommodate the F0 stand.

The process automation takes values measured at the multi-channel X-ray gauge to provide continuous feedback of the strip gauge and profile for in-coil control of the gauge and profile. In-strip temperature control is achieved by controlling the speed and taking the measured temperature from the calibrated pyrometers at the entry and exit sides.

Edge trimmer

Trimming blades are automatically positioned by the mill setup computers with consideration to the strip width and horizontal and vertical clearances of the blade. Offset adjustments to ensure an optimum yield when rolling high-magnesium alloys and toe-out adjustments for strip-

edge quality and ease of threading were also provided. A separate drum-type scrap chopper with an independent drive and six off-helical blades per drum is located below the strip pass line. Table 3 provides additional details of the edge trimmer.

Coiling equipment

The down-coiling equipment is operated with a maximum threading speed of 4 m/s. It comprises a driven deflector roll with an oscillating brush, tailing roll, downcoiler and high-speed belt wrapper. The coiler mandrel is fitted with liners that require no lubrication; hence, potential contamination of the coil bore is prevented. Table 4 lists the main technical details of the coiling equipment.

Coils are automatically removed from the coiler mandrel, transferred for sidewall temperature measurements and then lowered to the floor level by a coil car. The coil is transferred automatically across the mill bay by a floor-mounted coil buggy to the weighing station and walking beam located in the coil storage bay.

Fluid systems

The fluid systems include the roll-coolant systems for mill stands and interstand strip cooling; high-pressure hydraulic systems for the light-duty shears, mill load and roll bending; medium-pressure hydraulic systems for all other equipment; centralized oil-lubrication systems for the tandem mill drive, edge trimmer and coiler gearboxes; and oil-air lubrication systems for mill rolls and strip pass-line rolls.

The condition of the roll coolant has a significant impact on the finished strip quality and is vital for smooth operation of the mill. Installation of vacuum filters, tramp oil skimmers, heaters, coolers, make-up systems as well as modern pressure control using variable-speed pump drives and comprehensive monitoring maintains the coolant in an optimum condition. The roll coolant is used extensively for work- and back-up roll cooling, strip cooling, bite lubrication, scratch-brush cleaning, lubrication of the edge-trimmer blades, and for side-guide rolls and pass-line rolls to prevent the buildup of aluminum on the surfaces.

Commissioning

The majority of the existing mill entry roller tables were replaced with heavy-duty tables to receive the slabs from the pusher furnace. This was done in January 2013 during a nine-day standstill period. The existing mill was only shutdown again for less than 30 hours in June 2013 to implement the changes required for the communication with the existing 20-year-old mill computers. The first coil was successfully rolled during the first attempt on June 20, 2013, which was less than two years after the order placement. All basic automation was commissioned on test coils up until the first trimmed coil was produced on the line on July 4, 2013.

Production with trimmed coils was then slowly ramped up. The full range of aluminum alloys was rolled in October 2013, including 5182/5083 grades that comprised more than 800 coils. The minimum gauge of 1.8 mm for the aluminum alloy 3104 was successfully produced in November 2013 for the first time. Final acceptance tests, including equipment functional performance tests, commenced in August 2013, and product performance tests started in November 2013. The products that were tested for gauge, profile and temperature performance are shown in Table 5.

All tests were completed successfully and Novelis signed the final acceptance certificate on February 14, 2014. This project represents the fourth aluminum hot-tandem mill supplied by Siemens VAI since 2005, and further strengthens the companies position as a leading supplier of aluminum hot-strip mills.

Table 4:

Technical data of coiling equipment

Mandrel diameter	610 mm
Max. tension	236 kN
Max. speed	500 m/min
Drive power	1 x 1,500 kW (AC)

Table 5:

Products tested during the performance tests

Aluminum grade	Product dimensions (thickness x width)
1235	3.0 mm x 1,690 mm
3104	2.2 mm x 1,555 mm
5052	2.7 mm x 1,265 mm and 1,670 mm
5182	2.7 mm x 1,550 mm

Entry table of the new 3-stand hot-finishing mill (2013)

Stuart Leflay, Technical Manager, Aluminum Technology

Continuous modernization of two aluminum hot-strip mills secures market leadership of Alunorf

A Long-term Partnership

Lightweight, corrosion-resistant, formable, recyclable – these count among the properties that make aluminum the material of choice for a wide range of applications. Aluminium Norf GmbH (Alunorf), owner of the world's largest aluminum rolling and remelt plant, continually invests in its production facilities to ensure that all operations are state of the art. Currently, Siemens is assisting with modernizations at Alunorf's hot-strip rolling mills Nos. 1 and 2.

Alunorf holds a position as one of the best and most economic aluminum rolling mills in the world.

Fig. 1: DC main motors of Hot Strip Mill No. 1: the Siemens-supplied motors are still operating since their original installation in the mid-1960s

Alunorf holds a position as one of the best and most economically operating aluminum rolling mills in the world. In order to maintain this status, the company is dedicated to fully optimizing its production facilities through continual improvements. One of Alunorf's trusted technology partners is Siemens VAI. A special aspect of this partnership is the long-term planning efforts the two companies take to keep automation systems up to date. This has made it possible, for instance, for Siemens to allocate the same specialists for all project phases in advance. A similar strategy involves putting project management in the same hands for each upgrade step. This personnel continuity reduces project risks – and the Alunorf and Siemens teams can build up a good working rapport with short lines of communication. As a result, problems that inevitably arise in such challenging modernization projects can be quickly resolved – and strict time schedules are kept.

Table 1:

Upgrade details for Hot Strip Mill No. 1

Contracts	Description
Drives for RM screw-down system	Two new AC motors powered by Sinamics S120 drives
Drives for the close coupled edger system	Two new AC motors powered by Sinamics SM150 drives
New AC main drive for existing mill stand	Existing DC motor to be replaced with a synchronous motor, which will be fed by a Sinamics SM150 medium-voltage source converter
Relocated DC drive for the new stand	The newly supplied mill stand to be powered by the refurbished DC drive system
New coiler drives	Replacement of the current three DC motors on a common shaft by a single induction motor with the same frame height
Extension of basic automation	Modification and extension of the existing Siemens basic automation system (hard- and software) by a Siemens-Alunorf team

As can be expected, the excellent working style has benefited two ongoing projects at the hot-strip mills Nos. 1 and 2 in Neuss, Germany. Together with the customer, the existing automation is being extended to fulfill the tasks of the modernized mills. Special attention is given to the integration of new solutions into the existing environment, the long-time reliability of the products and systems supplied, and the very tight shutdown times for the necessary equipment and system replacements. For the projects described below, all conversion steps carried out up until now were completed within the scheduled time or even earlier.

Hot Strip Mill No. 1

The main equipment items of Hot Strip Mill No.1 are a roughing mill with an edger, two dividing shears, a three-stand finishing mill and a belt-type coiler. The mill was started up in the mid-1960s, and of the original equipment the Siemens-supplied DC main motors are still in operation (Figure 1). Over the years, several projects have been initiated to increase production capacity, and Siemens has played a leading role in supplying electrical and automation equipment. For example, in 1999 Siemens completely modernized both Level 1 and Level 2 automation when the drive control was changed from mercury-arc rectifiers to thyristor rectifiers. Following various modernization projects, by 2005 Alunorf had the same automation technology in both hot mills, which allowed the company to optimize service and maintenance.

In 2010, the decision was made to increase the annual output of mill No. 1 to match that of the newer mill No. 2. This could only be made possible through three mechanical modifications: a new faster screw-down system in the roughing mill stand; a new edger positioned closer to the roughing mill stand; and an additional fourth finishing mill stand and speed and power increase for the entire finishing train. See Table 1 for details.

As ongoing production has the highest priority, these three projects have to be carried out in three phases, each during the annual shutdown at the end of the year. To take advantage of the limited time available, installation will be done in three shifts to complete the work in the given time frames. Siemens was chosen as the electrical supplier for all three projects. Completion of all projects is scheduled for early 2016.

Hot Strip Mill No. 2

Hot Strip Mill No. 2 consists of a roughing mill with an edger, two dividing shears, a four-stand finishing mill and a belt-type coiler. The rolling mill went into operation in 1994 and was originally outfitted with Siemens equipment that comprised Simovert D for the main drives and Simaydyn D for Level 1 automation. As with Mill No. 1, Alunorf has followed a strategy of permanent modernization and improvement to keep production operations at the cutting edge. An example for this is the modernization of the Level 2 process optimization system.

With the drive and automation systems becoming obsolete, modernization of the electrical equipment is part of the long-time investment plans of Alunorf. Accordingly, two major projects have been initiated: The first is the update of the main drive system with the Sinamics SL150 cycloconverter solution (Figure 2). Over a period of three years starting in 2012, two motors were converted to the new drive system, always during the year-end shutdown. This ensures that the conversion can be executed within the scheduled production standstills and that the annual investment budget is not overstrained.

Fig. 2: Sinamics SL150 converters for the Hot Strip Mill No. 2

Fig. 3: Migration of the existing software of the No. 2 mill to the new hardware platform Simatic TDC (left: old system, right: new system)

(Courtesy of Aluminium Norf GmbH)

About Alunorf

Alunorf, located in Neuss, Germany, is the largest aluminum casting and rolling facility in the world. The company, which employs more than 2,200 people, produces a wide range of high-quality hot- and cold-rolled products. Up to some 1.6 million tons of aluminum are rolled on two hot mills, followed by cold rolling in five cold mills and coiling.

The second major project is the revamp of the basic automation system (Level 1). Alunorf was highly satisfied with the functionality of the original automation system, which was perfected over the years by Alunorf specialists themselves and by Siemens personnel. The decision was therefore made to migrate the existing software to the new hardware platform Simatic TDC by using additional standards and components from the Siroll Alu environments. This ensures the same functionality with the new system. The migration is being carried out step by step. This means rack-by-rack tests in parallel during the weekly maintenance shutdowns and final replacement (one by one) after operational approval has been collected during the production phase (Figure 3). The Simatic TDC racks are being placed in the location of the old racks in the existing cubicles. The migration was completed for the roughing mill in 2013. For the finishing mill, the migration is still ongoing based on the agreed-upon time schedule.

An exemplary partnership

Alunorf follows a long-term strategy to keep its production plants competitive and to remain on the top ranking of the world's aluminum flat-product manufacturers. A modernization program extending over several years ensures continued productivity and reduces interruptions and risks to an absolute minimum. Siemens, a reliable and experienced long-term life-cycle partner, provides the required solutions and operational support.

Alfred Dümmler, Senior Sales Manager
Klaus Wiemann, Senior Project Manager

Use of fiber-optic laser welders at Hyundai Hysco improves welding performance

Superior Welding Results

To meet the growing requirements for value-added steel products, in 2011 Hysco decided to install a continuous galvanizing line and a combined galvanizing-annealing line at the company's Dangjin works in South Korea. The processed steel comprises commercial-quality (CQ) and high-strength steels (HSS) with thicknesses between 0.3 mm and 2.3 mm and widths from 800 mm to 1,650 mm. The order included the supply of advanced welders with an annealing system for HSS welding and welding quality control with the use of a charge-coupled device (CCD) camera.

On the basis of the excellent welding results that had been demonstrated at other plants, Hysco selected the Fiber Laser Welder LW 21L from Siemens VAI, although at the time it had only been on the market for about a year. The first two orders received for the new laser welders were for an annealing line dedicated to silicon steel production for ArcelorMittal in France, and for an inspection line for US Steel in Slovakia.

The Fiber Laser Welder LW 21L significantly boosts welding performance with respect to strip cutting, welding speed and welding strength, all with maximum repeatability and reliability.

A new generation of fiber-optic laser welders was installed by Siemens VAI in the strip-processing lines at Hyundai Hysco. Along with superior welding performance, the supplied welding technology offers enhanced strip quality required for increasingly demanding downstream applications.

Strip welding with the new Fiber Laser Welder LW 21L

Welding procedure in progress

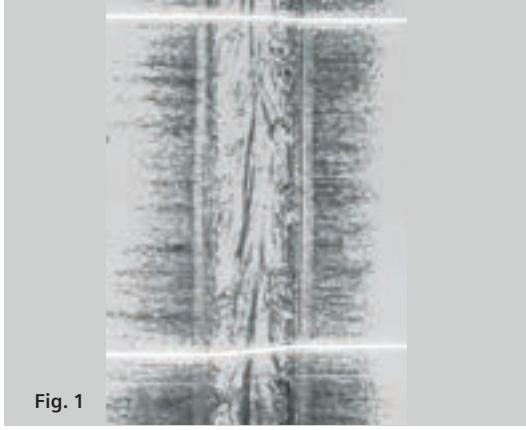


Fig. 1

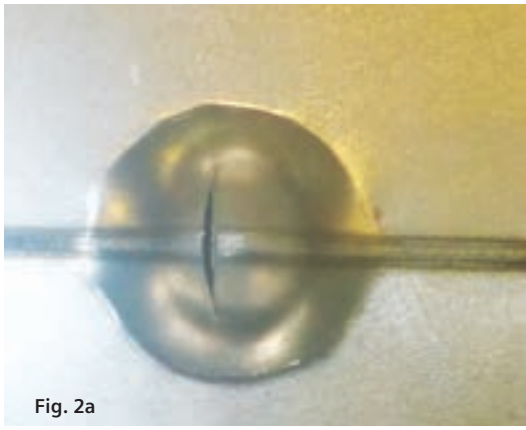


Fig. 2a

Fig. 2b

Innovative welder technology

The novel Fiber Laser Welder LW 21L features a combination of a solid-state laser source with the transport of the laser beam by means of optical fibers. This system significantly boosts welding performance with respect to strip cutting, welding speed and welding strength, all with maximum repeatability and reliability. The integrated mechatronic package includes a pneumatic panel, hydraulic manifold, chiller unit, and all necessary electrical and automation systems. The LW 21L has lower maintenance requirements because mirrors are not necessary. Furthermore, energy consumption is reduced thanks to the better efficiency of the solid-state laser source. The rigid design of the frame and beams ensures accurate geometry of the beam path to ensure precise cutting and welding results. The welder is ideal for use in strip processing and inspection lines.

Strip tail and head ends are cut and welded by dedicated laser heads mounted on a vertical, high-precision linear

Main benefits of the Fiber Laser Welder LW 21L

- Enhanced welding performance for all steel grades and operating conditions
- Use of a proven and reliable solid-state laser source
- Lower energy consumption compared to conventional welding machines
- Low maintenance requirements due to absence of mirrors

The novel Fiber Laser Welder LW 21L features a combination of a solid-state laser source with the transport of the laser beam by means of optical fibers.

Fig. 1: Image from the CCD welding-quality-control camera. The welding seam (roughly 1 mm wide) is seen in the center of the picture, and the two white laser lines across the top and bottom of the picture are used to quantify and qualify the weld geometry

Fig. 2: Welding test with commercial quality steel (2a) and dual-phase steel (2b)

Fig. 3: The Hysco team at the workshop facilities of Siemens VAI France in Montbrison

Welder performance was a key issue for the two processing lines considering their high throughput levels, wide range of steel grades, varying strip mechanical properties, and high entry line speeds.

table. Actuation is achieved by means of electrical servomotors. During cutting operations, a controlled, high-pressure gas flow guarantees the efficient ejection of melted metal for the formation of proper strip edges. Argon gas is used for welding operations to shield the welded area against possible oxidation. Protection of the welding head against fumes is accomplished by a compressed air cross jet and protection glass. All components are easily changeable. The necessary cooling of the laser source and the welding head is conducted by an autonomous chiller unit with a closed-loop secondary circuit. A camera-based weld-quality-control system using a CCD camera continuously monitors the weld seam and provides real-time data to the operator (Figure1).

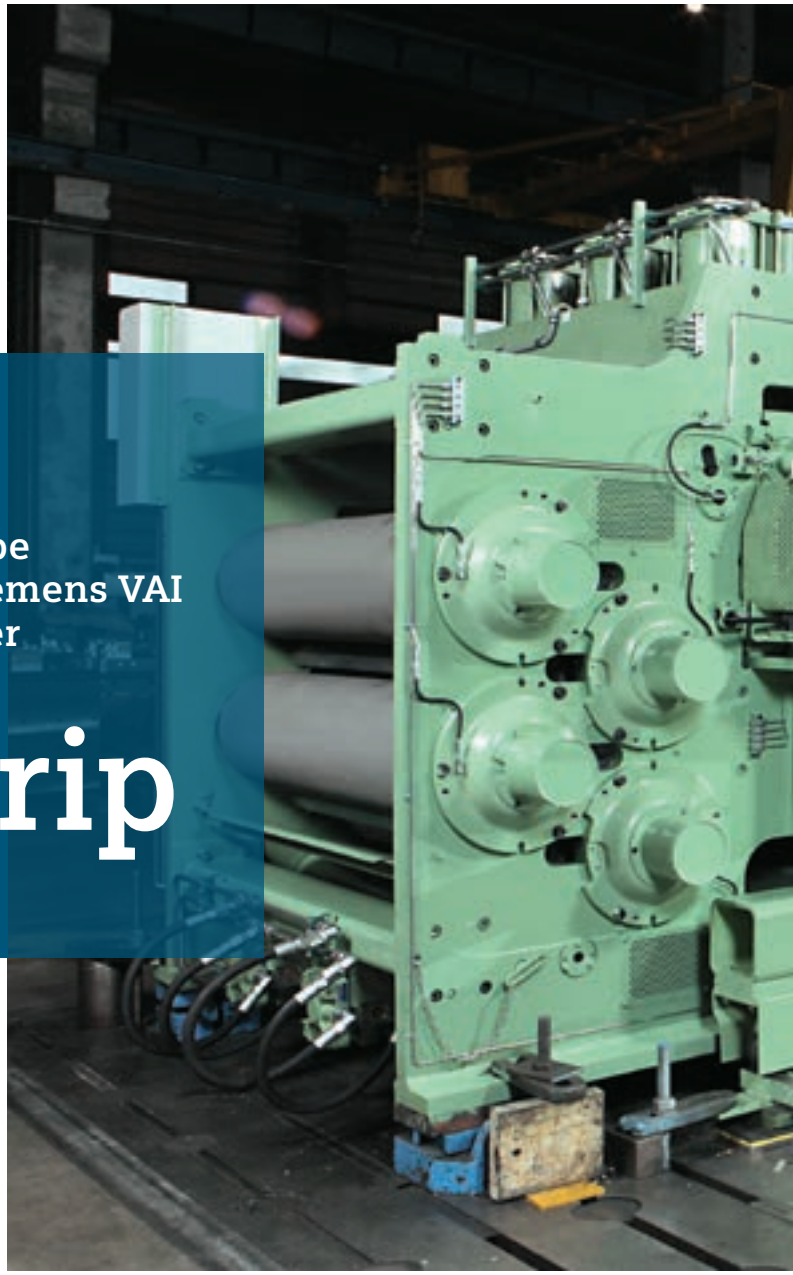
Performance tests

Welding performance tests were carried out following the installation and commissioning period. These were successfully executed on a very tight time schedule. The main test criteria were welder availability, welding quality and cycle time covering a wide range of products that included CQ, HSS and alloyed steel grades (Figure 2). Welder performance was a key issue for the two processing lines considering their high throughput levels, wide range of steel grades, varying strip mechanical properties and high entry line speeds of up to 700 m/min.

A teamwork effort

The close cooperation between the customer and supplier during all phases of the project was a key factor for the successful implementation of the welding machines. The teamwork effort extended from the engineering phase and workshop testing in Siemens VAI facilities up to installation, start-up and on-site commissioning (Figure 3). Currently, discussions are underway to conclude a service agreement with Hyundai Hysco to ensure continued optimum performance of the Fiber Laser Welders LW 21L.

Emmanuel Chaillot, Project Manager
Hervé Thomasson, Welder Product Manager



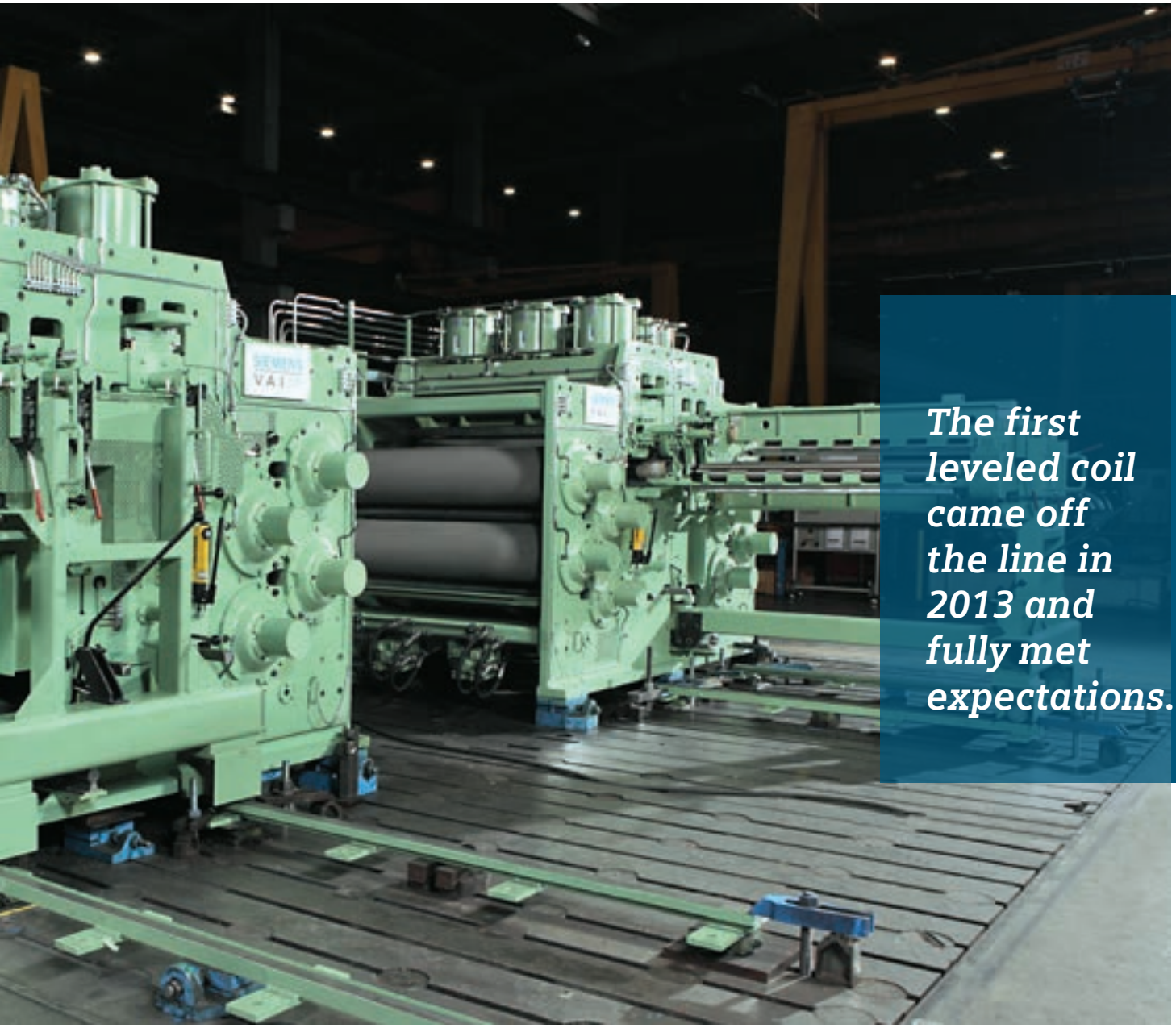
Even the most severe strip shape defects are no match for the Siemens VAI MTL21L multiroll tension leveler

Flatter Strip

The trend toward zero-defect quality with respect to strip surface and shape places high demands on steelmakers. The MTL21L multiroll tension leveler from Siemens VAI helps flat-steel manufacturers to meet these requirements. The benefits of this tension leveler solution were recently demonstrated on the new strip-processing lines of a Chinese customer.

In early 2012, a Chinese quality-steel supplier placed an order with Siemens VAI for the supply of two MTL21L multiroll tension levelers for installation in its electrolytic tinning lines. The company focuses on meeting the demands of the automotive sector for thinner product gauges and double reduced (DR) materials*, which are known to be the most difficult products to level. The main reasons for the selection of MTL21L tension levelers were their high performance, operational reliability, practical design and numerous references. While most tension levelers are able to correct severe wavy edges, other strip shape defects such as cross bow, coil set and bow blanks remain a challenge. The MTL21L from Siemens VAI, however, meets all requirements.

*Double reduced materials are products where the thickness has been cold-reduced in two separate steps.



The first leveled coil came off the line in 2013 and fully met expectations.

Manufacture of the MTL21L multiroll tension levelers in the Siemens VAI workshop in France ensures the highest-quality workmanship

Precision manufacturing

The execution of the tension leveler order started with a detail design review with the customer. The two MTL21L units were then entirely manufactured at the Siemens VAI workshop in Savigneux, France, to ensure that the most stringent quality standards were met for the high-precision machinery. For example, an accuracy of 0.02 mm is achieved inside the housings. Following hundreds of checks and no-load tests, the two tension levelers were shipped to China in late 2012.

Installation of the units in the customer's production lines in China took place under the supervision of experts from Siemens VAI France and Siemens China. The first leveled coil came off the line in 2013 and fully met expectations. Since then, production levels on the new electrolytic tinning lines have been ramped up, and the customer is highly satisfied with the strip quality results.

References

Since 1995, numerous MTL21L multiroll tension levelers have been supplied to steel producers across Europe and the United States, and in South Korea and Kazakhstan. This first installation in China was followed by a second contract for a MTL21L from another customer near Shanghai.

Jean Jacques Servanton, Product Manager for Controlled Elongation Machines

André Courtot, Project Manager, Cold Band

Two Chinese stainless steel producers benefit from the advanced CAPL facilities with outstanding strip quality and high line productivity.

A Siemens VAI consortium demonstrates proven competence in implementing two Chinese strip-processing lines

A Superb Team Effort

Two Chinese stainless steel producers, JISCO and TCSS, placed orders with Siemens VAI for the supply of continuous annealing and pickling lines that were completed in 2013 and 2014. For both projects, a Siemens VAI-led consortium was decisive for getting the projects completed on time and to the full satisfaction of the customer.

Outstanding cold-rolled and annealed strip at Tiancheng Stainless Steel Products Co. (TCSS)

JISCO cold annealing and pickling line

JISCO is a state-owned company based in Jiayuguan, in the northwest province of Gansu. As part of a cold-strip expansion project, Siemens VAI received the order for the supply of its latest high-speed CAPL. The main target of JISCO is to produce top-quality austenitic and ferritic stainless steel strip. The line is designed at four levels, which called for complex engineering and tight coordination efforts. Partner companies were entrusted with the supply of the pickling section and the furnace section.

JISCO plant data

Line layout	Elevated on 4 levels
Production capacity	500,000 t/a
Process speed	160 m/min.
Entry and exit speed	220 m/min.
Skin pass mill	2-high type

JISCO production data

Material to be processed	Cold-rolled stainless strip
Product grades	200, 300 and 400 series
Surface finish	2B
Strip thickness	0.3 mm to 4.0 mm
Strip width	750 mm to 1,600 mm

For both projects, a Siemens VAI-led consortium was decisive for getting the projects completed on time and to the full satisfaction of the customer.

Cold annealing and pickling line installed at JISCO

TCSS cold annealing and pickling line

TCSS is a privately owned company. To extend its stainless steel production, TCSS built a greenfield plant in Guanghan, close to Chengdu in the Sichuan province. The CAPL is the key plant facility in the cold-strip complex. The line design features a compact and flat layout (400 m in length) that reduced civil and structure costs. Maintenance work is facilitated by direct crane access to any section of the line. For this turnkey project, the customer scope was limited to erection execution only, which allowed TCSS to focus on its core business – the production of high-quality stainless steel. The project was completed within 25 months in accordance with the contract schedule.

TCSS plant data

Line layout	Flat, on single level
Production capacity	250,000 t/a
Process speed	100 m/min.
Entry and exit speed	140 m/min.
Skin pass mill	2-high type

TCSS production data

Material to be processed	Cold-rolled stainless strip
Product grades	200 and 300 series
Surface finish	2B
Strip thickness	0.3 mm to 3.0 mm
Strip width	800 mm to 1,300 mm

In less than five months after the first coil, the critical performance tests were passed and production ramp-up was successfully achieved.

Finished coil at TCSS

Cold annealing and pickling are the last core process steps in a steel plant where the final quality of the product is determined – especially with respect to surface requirements. Continuous Annealing and Pickling Line (CAPL) technology from Siemens VAI was recently started up at the steelworks of Jiuquan Iron & Steel (Group) Co., Ltd. (JISCO) and Tiancheng Stainless Steel Products Co., Ltd. (TCSS) in China. In total, the two lines are capable of producing 750,000 tons of 2B stainless steel strip per year. While one project involved an expansion, the other was for an entirely new plant. Nonetheless, Siemens VAI could apply the same approach: a consortium led by Siemens VAI in France with the support of the local Siemens organization in China.

For the JISCO and TCSS projects, the Siemens VAI consortium was responsible for:

- Complete engineering
- Supply of the terminal equipment and the duo-skin pass mill
- Electric and automation engineering and supply
- Quality assurance of the locally manufactured equipment
- Construction and commissioning

The consortium offered the advantage that technical issues could be identified and immediately solved by local specialists with the back-up support of wider Chinese and French engineering teams. For production ramp-up, process experts were available on-site – who also trained the customers' operation teams so that they could achieve the best production results.

The effectiveness of the consortium is underlined by the fact that sellable products from both customers' continuous annealing and pickling lines were immediately available right from the first processed coil, even though the lines were still in the commissioning and fine-tuning phase. Furthermore, in less than five months after the first coil exited the line, the critical performance tests were successfully passed and production ramp-up to nominal capacity was achieved.

These projects, finalized in 2013 and 2014, are a demonstration of the project management expertise of Siemens VAI for large consortium projects. Both JISCO and TCSS benefit from the advanced CAPL facilities with outstanding strip quality and high line productivity.

Olivier Lietar, Senior Project Manager
Stanislas Mauuary, Head of Cold Band Stainless Steel

Siemens VAI performs energy efficiency study for CSN to reduce waste-heat losses

From Waste Heat To Profit

Fig. 1: Recovery of the waste heat from the hot sinter on the sinter cooler at CSN's Presidente Vargas Steelworks can reduce energy costs

In an effort to minimize energy costs and thereby improve the competitiveness of its Presidente Vargas steelworks, Companhia Siderúrgica Nacional S.A. (CSN), headquartered in Volta Redonda in the Brazilian state of Rio de Janeiro, approached Siemens VAI in 2012 to perform a waste-heat recovery study. The target of this study was to identify waste-heat sources throughout the entire iron and steel production chain, and to propose measures to recover and profitably utilize this energy potential (Figure 1).

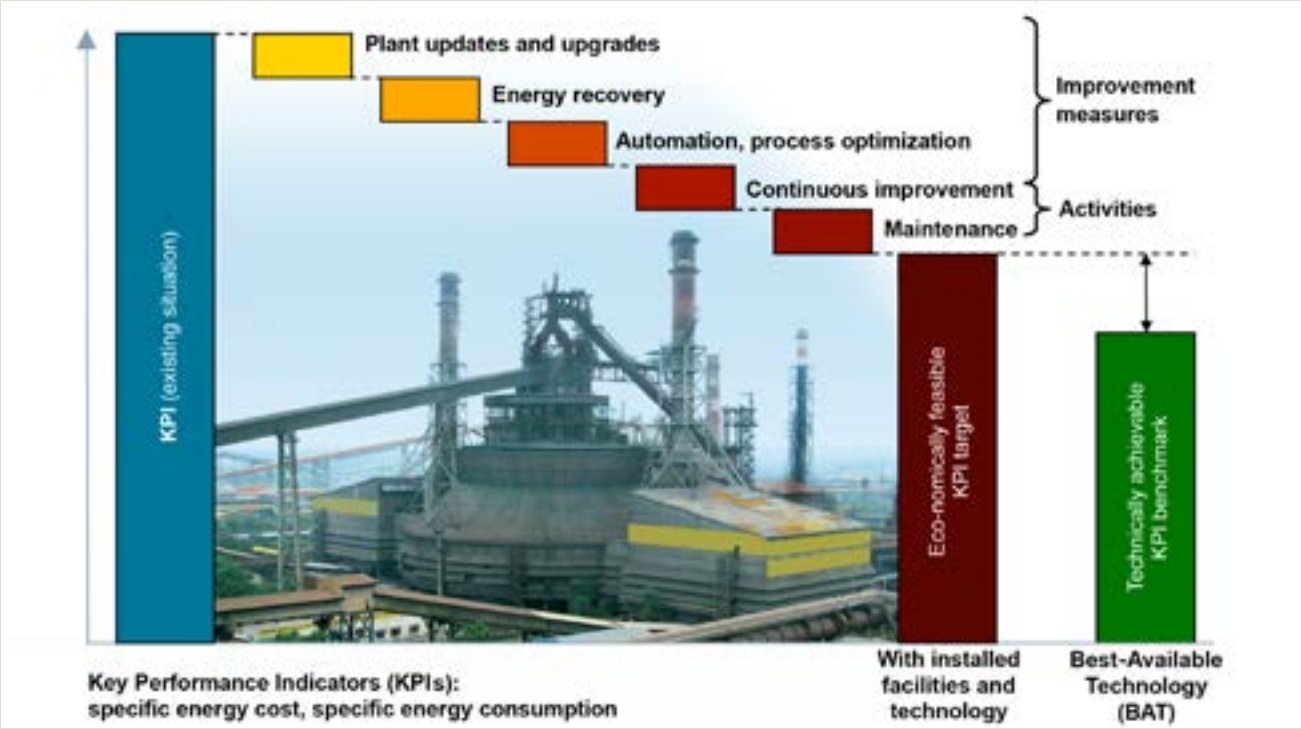


Fig. 2: Step-wise approach for improved energy efficiency and cost savings

As a first step toward determining the most feasible and efficient waste-heat recovery solutions, the customer is first asked to complete standardized questionnaires. Specific and more detailed data from individual plant areas is also requested for the study. Once all data has been compiled, Siemens VAI experts investigate the local and external energy situation in order to properly assess a plant. On the basis of this information, key performance indicators (KPIs) can be defined and the current energy situation is compared to international benchmark figures (Figure 2).

The waste-heat recovery potential of existing waste-heat sources is then estimated and – in close coordination with the customer – the optimum plant and system solutions are proposed to maximize the overall benefits. The achievable performance improvements are calculated and quantified in the technical evaluation. If desired, services can also include a complete design concept to integrate the recommended solutions into the existing energy network. This information serves as the basis for the customer to select the most attractive and feasible solution after which the improvement measures can be implemented.

CSN – A diversified range of high-quality products

CSN is one of the largest steel producers in Brazil. Its iron- and steelmaking activities cover the entire steel production chain, from iron ore mining to the production and sale of a diversified range of value-added products that include coated galvanized flat steel and tinplate. The company's main plant is the Presidente Vargas Steelworks in Volta Redonda in the state of Rio de Janeiro. In 2013, the steelworks had a crude steel output of 4.7 million tons, which was primarily used in the domestic automotive, construction, packaging, home appliance and capital goods industries.

Fig. 3: Coke dry-quenching plant, Ruukki Production, Raahe, Finland

Energy-recovery study at CSN

Applying this step-by-step approach, experts at Siemens VAI identified recoverable heat sources and quantified the heat-recovery potential at CSN's coking plants, sinter plants, blast furnaces, steel mill, slab-reheating furnaces of the hot-strip mill and annealing lines. This information served as the basis for recommending technological solutions to recover the otherwise lost thermal energy at these plants and included an evaluation of the best options to apply the recovered heat energy within the steelworks. For the proposed solutions, an estimation of the implementation costs, capital expenditures, operational costs and project implementation time was also provided.

Highlights of the investigation results

Coking plant: CSN currently operates four coke batteries with an annual coke production of more than one million tons. All produced coke is wet quenched in the nearby quenching towers and the sensible heat of the hot coke is lost to the atmosphere. The study investigated the possibility of implementing coke dry-quenching (CDQ) technology in order to recover the sensible heat of the coke after the coking process and to produce coke with a very low moisture content. The CDQ process minimizes wastewater pollution and fume emissions to the environment. Dust discharges are also significantly reduced. Siemens VAI engineered and supplied CDQ systems at Ruukki Production in Raahe, Finland (Figure 3).

Calculations showed that the implementation of CDQ technology at CSN would allow approximately 65 t/h of high-pressure steam to be produced that would enable an annual net power generation of about 150 GWh. Beside CDQ technology, other technologies to utilize the waste heat from the coking plant were investigated and an advanced Coking Process Management System (CPMS) was also proposed.

Sinter plant: Three sintering strands at the Presidente Vargas steelworks are currently producing approximately 6.6 million tons of sinter per year that is cooled by ambient air in circular, cell-type sinter coolers before the sinter is transported to the screening station. In order to quantify the waste-heat potential at the sinter coolers, thermographic and pyrometric measurements were conducted by Siemens VAI (Figure 4). Using these measurements, a solution to feasibly recover a significant portion of the available thermal energy in a waste-heat recovery steam generator was evaluated and proposed.

Furthermore, to maximize the productivity of the sinter machine and to ensure a constant sinter temperature at the sinter discharge point – which contributes to improved performance of the waste-heat recovery system – engineers from Siemens VAI proposed an advanced sinter burn-through-point control system.

The remnant heat energy of the molten slag amounts to approximately 1.5 GJ of energy per ton of slag.

Blast furnaces: CSN's Blast Furnaces Nos. 2 and 3 with working volumes of 1,570 m³ and 3,800 m³, respectively, are capable of producing approximately 5.0 million tons of hot metal per year (Figure 5). The blast furnace slag is transported to the nearby slag pits where it is granulated

Fig. 4: Pyrometric measurements of the sinter cooler

Fig. 5: View of Blast Furnace No. 3 at CSN

with the addition of large volumes of water. The remnant heat energy of the molten slag amounts to approximately 1.5 GJ of energy per ton of slag. In order to utilize the sensible heat of the hot slag, Siemens VAI investigated the possibility to substitute the existing water-quenching facilities with a dry slag granulation (DSG) process, an innovative technology under development and successfully tested in a laboratory-scale plant by Siemens VAI. The installation of an industrial-scale demonstration plant at the steelworks of a European steel producer is currently being considered.

In order to further increase the energy efficiency of hot-metal production at CSN, the possibility to preheat the combustion air and gas of the hot stoves of Blast Furnace No. 2 in combination with an advanced combustion-control system was evaluated. Measures to increase top-gas utilization at the blast furnaces were also proposed.

Converter steelmaking: CSN operates three 230-ton LD (BOF) converters that are capable of producing a total of 5.2 million tons of liquid steel per year. Currently, hot offgas exiting the converters is cooled to approximately 700°C in a water-cooled stack using large quantities of water before the offgas is dedusted. The inherent thermal energy is lost with the cooling water. In order to utilize this energy, several options were investigated to recover the offgas heat to produce process steam. Replacement of the existing water-cooled stack with an evaporative cooling stack was suggested as one of the solution options.

In order to increase the portion of converter gas from which CO-rich gas can be recovered for the generation of energy, an automatic gas switch-over station based on a continuous and precise analysis of the CO composition of the gas was also proposed.

Hot-strip mill: At CSN slabs are reheated to the required rolling temperature in four walking-beam-type reheating furnaces that have an annual throughput of approximately 1.25 million tons each. Recuperators are installed at the furnaces to preheat combustion air using the thermal energy of hot waste gas. To utilize the residual thermal energy in the waste gas, the installation of a waste-heat boiler system downstream of the recuperator was proposed to further cool the flue gas in an efficient manner.

Annealing lines: The three annealing lines installed at CSN have an annual design capacity of 240,000 tons each. A solution was presented to substitute the process steam that is normally used for heating the rinse tank and for strip drying. Accordingly, the energy contained in the flue gases of the annealing furnaces would be used to perform these tasks. With the proposed solution, up to 8 t/h of process steam can be saved at each of the processing lines.

The right mix

As a life-cycle partner for energy-efficient solutions, Siemens VAI evaluated and proposed a number of solutions to recover the waste heat from CSN's production facilities and to ideally utilize this energy within the steelworks. Calculations of the expected energy savings and an estimation of capital expenditures and operational costs of the proposed measures now serve as the basis for subsequent investment decisions by CSN.

According to Elio Adolfo Oviedo Diaz of CSN, "As a sustainable steel producer, we want to improve the energy performance of our processes through the recovery of process waste heat and to become more self-sufficient in regard to energy. The Siemens VAI study identified and elaborated a number of potential improvements and projects in the area of heat recovery that will significantly improve our energy efficiency."

Elio Adolfo Oviedo Diaz, Senior Specialist
(Equipment and Process Technology Division), CSN

Silva Thaianne Esquierdo, Engineer
(Equipment and Process Technology Division), CSN

Gerald Strasser, Process Engineer for
Energy Technology Plants, Siemens VAI

Slab storage area at ArcelorMittal Eisenhüttenstadt, Germany

ArcelorMittal Eisenhüttenstadt profits from the Simetal Siloc logistics system

Optimized Storage Logistics

Logistical operations at steel plants – particularly in the downstream finishing area – have a direct impact on overall production efficiency and profitability. As part of a plant-wide modernization program, the Simetal Siloc storage logistics system was installed at the integrated steelworks of ArcelorMittal Eisenhüttenstadt GmbH in Germany. The resulting benefits include optimized material workflows, simplified stock control and shorter manufacturing cycle times.

"The new Siemens system meets future requirements for the planned modification and optimization of the technological and logistic processes in our company."

Dr. Ralf Bösler, Primary CEO at ArcelorMittal Eisenhüttenstadt

ArcelorMittal Eisenhüttenstadt is an important European supplier of high-quality, coated and uncoated flat steel products for the automotive, domestic appliance and construction industries. In the company's finishing area, slabs are accepted, inspected, scarfed, transported, and stored according to scheduling and quality specifications. In line with the production schedule, slabs are then selected and transferred to the hot-rolling mill. This is followed by inspection and finishing of the rolled products and preparation for dispatch. The plant personnel has to constantly coordinate the movement of 12 cranes, various storage areas, and the ongoing activities at numerous roller tables, trolleys, inspection tables, and at the slitting and cross-cutting stations. Before the Simetal Siloc logistics system was installed, planning and slab stacking in the finishing area was done manually and independently of the higher-level production scheduling. The result: costly and time-consuming restacking of products in all storage areas.

Logical and lucrative logistics

To improve the existing logistics and storage situation at its steelworks, ArcelorMittal Eisenhüttenstadt placed an order with Siemens VAI for the installation of the new Simetal Siloc logistics system. This process-optimization solution receives its input data from the higher-level production planning system (PPS), the material-tracking system (MTS) and the dispatch system. Simetal Siloc coordinates the work of the individual systems in the finishing area according to the slab quality parameters and disposition instructions of the received material. For example, the crane operator receives automatically generated transport orders on the cab terminal. This enables the operator to stack slabs in an ideal sequence on the basis of their composition and the order processing schedule. Simetal Siloc applies its own safety rules to secure the stability and arrangement of the stacked slabs and to protect the slabs from impact or stacking damage. The crane operator can also perform unscheduled restacking operations manually. Slab restacking movements are automatically registered by the system and entered into the database. The stored information is therefore always up to date, and all material movements can be visualized and accounted for.

The heart of the expandable and modular logistics system is the Simatic IT and Simetal Siloc product platform. It provides a large number of organizational and commercial metrics in the form of clear graphics and tabular evaluations. For example, it can show how many crane movements have been made per shift for any category of slab, so that the time and cost for each operation can be exactly calculated.

Main benefits of the Simetal Siloc logistics system

Optimized production workflows and simplified stock control: resulting from an ideal product scheduling that ensures a continuous flow of slabs from the slab casters to the finished product storage area

Reduced manual stacking operations: thanks to automated transport orders and clear operator stacking instructions that enable the sequence of the stacked slabs to be optimized according to their composition and production planning

Total transparency guaranteed: due to the availability of a large number of individual key performance indicators as self-explaining diagrams and statistical reports

Significantly improved operations

The Simetal Siloc logistics system now provides ArcelorMittal Eisenhüttenstadt with a precise overview of its stock at all times, including the more than 40,000 slabs that pass through the slab storage area each year. The system not only optimizes the sequence of the stacked slabs according to their composition, it also automates logging of manual restacking operations. Simetal Siloc thus improves workflows and simplifies stock control. Cycle times are also reduced because the slabs can be charged to the hot-rolling mills at a higher temperature.

Dr. Ralf Bösler, Primary CEO at ArcelorMittal Eisenhüttenstadt, explains, "The new Siemens system, above all, meets future requirements for the planned modification and optimization of the technological and logistic processes in our company. The advanced strategies for storing and retrieving the slabs provide a good basis for this." As a confirmation of the success of the installed system, in April 2014 ArcelorMittal Eisenhüttenstadt issued the final acceptance certificate for the new Simetal Siloc logistics system from Siemens VAI.

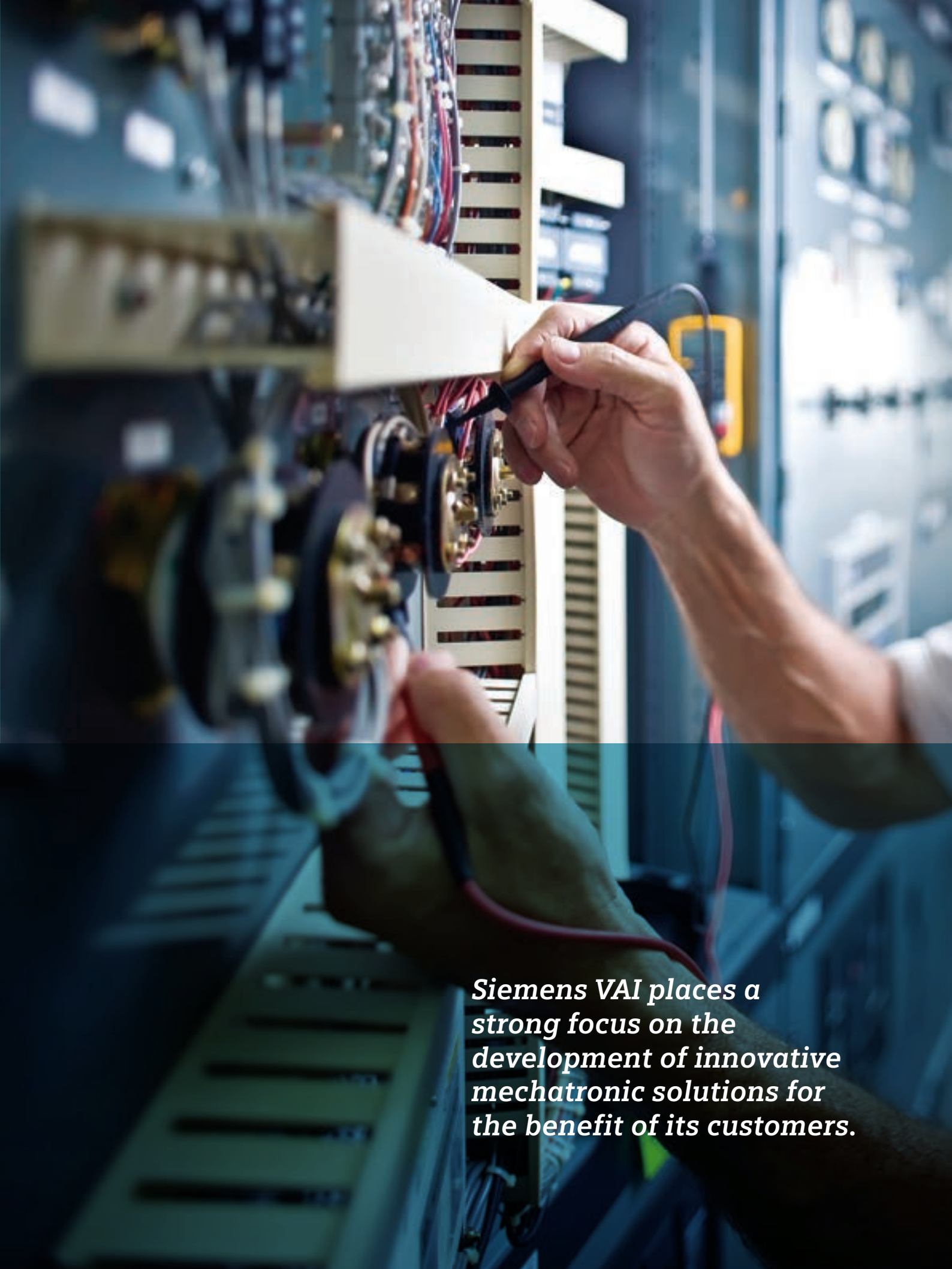
Rene Grabowski, Sales Manager IT4Metals

Mechatronic solutions serve as the basis for optimized plant performance

Mechatronics
Access to Precision

Continuous plant and process optimization, expert knowledge, and permanent feedback and evaluation of operating experience are vital to remain competitive and successful in the metals industry. With enormous progress made over the last decades in sensors, software and information technology, new potential for equipment performance improvement has become available. Siemens VAI places a strong focus on the development of innovative mechatronic solutions for the benefit of its customers.

Experts from different fields work closely together to create optimized systems, from stand-alone measurement devices up to fully integrated mechatronic packages



Siemens VAI places a strong focus on the development of innovative mechatronic solutions for the benefit of its customers.

Use of the Foaming Slag Manager has resulted in significant cost savings in carbon consumption through the precise injection of coal into the furnace.

Fig. 1: Foaming slag in an electric arc furnace

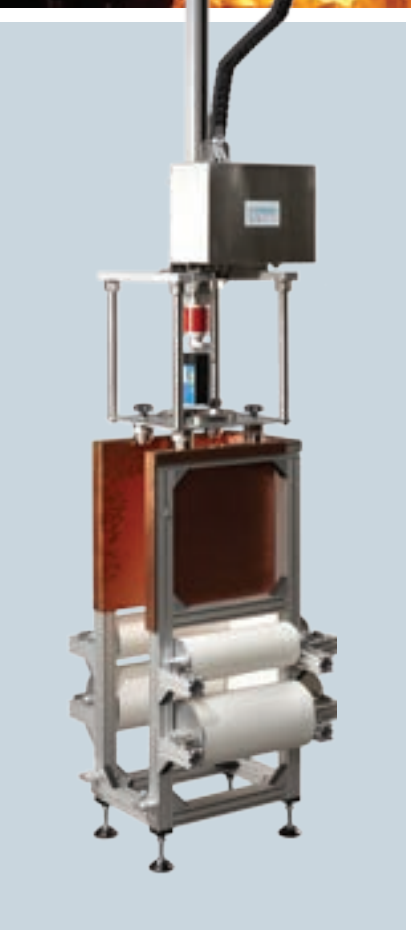


Fig. 2 (left): Simetal Mold Checker for slabs

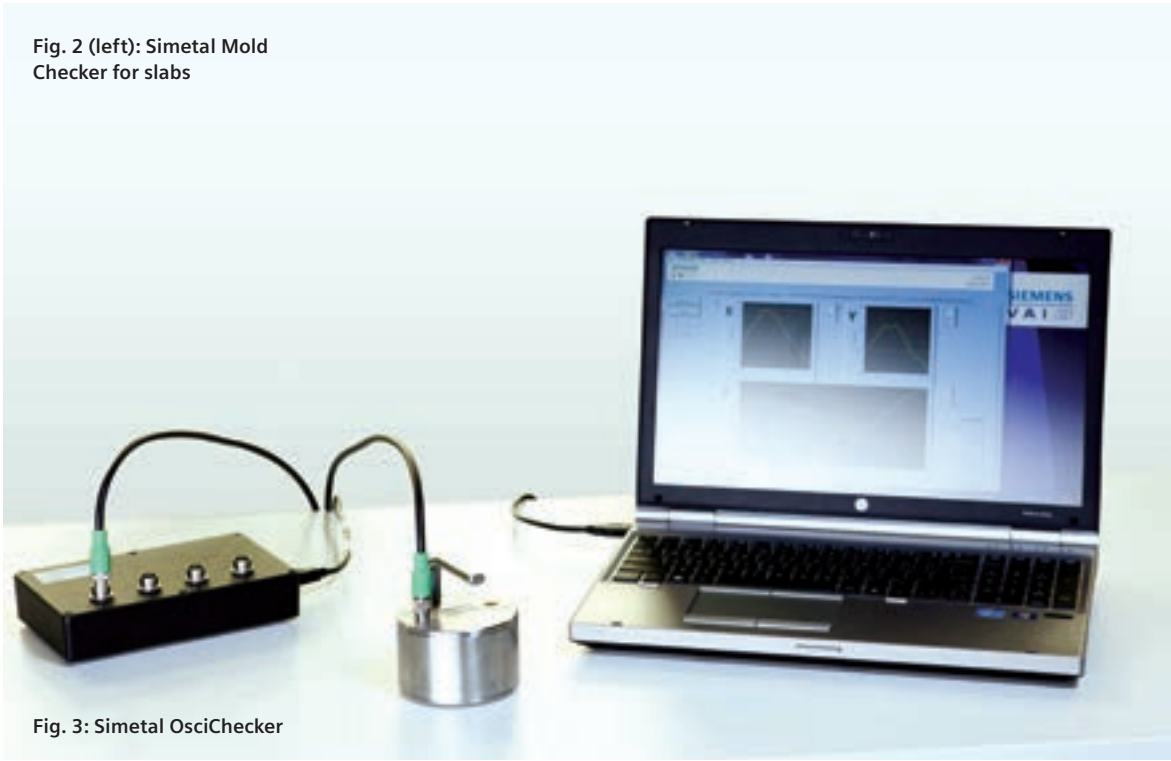


Fig. 3: Simetal OsciChecker

In recent years, mechatronics has become established as an indispensable, interdisciplinary engineering science for many industry sectors and applications. Today, mechatronics is much more than just a combination of mechanics, electronics and software; it consists of a full spectrum of technical developments and disciplines that include engineering, product design and human-machine interfaces.

In order to meet increasingly demanding technical and commercial requirements in the metals industry, Siemens VAI has established an international competence center for mechatronics in Linz, Austria. A number of experts from different fields work closely together to create optimized systems, from stand-alone measurement devices up to fully integrated mechatronic packages. Their efforts focus on maximizing the benefits for producers, such as quality improvement, profitability, safety and environmental protection. The following overview presents various examples of where mechatronic solutions have been applied in iron and steel production.

Optical measurement systems

Simetal SlagMon: Contactless optical measurement techniques now enable new applications in steel plants that would not be possible with conventional measurement systems. One of the most successful tools for optimizing the tapping process in LD (BOF) and EAF steelworks is the Simetal SlagMon optical slag-detection system. Permanent monitoring of the tapping stream with the aid of an infrared camera ensures a quick and reliable differentiation between steel and slag. As soon as slag is detected, the taphole closing unit (e.g., Simetal Slag Stopper) is triggered or an alarm for operator-guided vessel tilting is generated. Simetal SlagMon is a very precise and efficient system that significantly reduces slag carryover into the ladle. Its compact design allows easy integration in all existing plants.

Simetal SlagMon

Reliable slag detection to minimize slag carryover

Customer benefits:
- Fast and reliable slag detection
- Improved steel quality through a reduction of slag carryover
- No modifications to the converter/EAF necessary

Selected references:
voestalpine, Austria
PJSC Azovstal, Ukraine
Nizhniy Tagil, Russia
Total No. of installations: 37

Simetal Optical Foaming Slag Manager: Foamy slag in the EAF can be monitored and controlled with this solution. The slag height is determined by a camera targeted at the slag door. A continuous and reliable detection and regulation of the foamy slag in an EAF is thus possible (Figure 1). Through the use of a complex image-processing algorithm, temporary visual obstructions do not hinder the reliable detection of the foamy slag height. The prototype and first installation of this system has been successfully operating for three years at the Marienhütte electric steel mill in Graz, Austria. Its use has resulted in significant cost savings in carbon consumption through the precise injection of coal into the furnace to ensure the proper foamy slag height.

Simetal Optical Foaming Slag Manger

Precise and reliable detection of foaming slag height

Customer benefits:
- Detection of slag height even during power-off
- Detection algorithm for temporary visual obstructions
- Advanced control algorithm to reduce carbon consumption
- Applicable for AC and DC EAFs

Reference:
Marienhütte, Austria

Improved quality and productivity in continuous casting

Simetal Mold Checker: State-of-the-art continuous casting requires that all equipment, systems and components are properly adjusted throughout the entire lifetime of the machine. Simetal Mold Checker is an example of a mechatronic solution that supports operators with these activities. It is the world's first laser-based system that enables complete 3-D geometrical measurements of slab, billets and bloom molds (Figure 2). The Mold Checker not only measures mold taper, it also delivers a complete analysis of mold wear – including the position and depth of scratches. Additionally, the gap and alignment of foot rolls are measured automatically. Among others, the benefits of these measurements include improved surface quality of the cast product, prolonged mold use and the avoidance of strand breakouts.

Simetal Mold Checker

3-D laser measurements of slab, bloom and billet molds

Customer benefits:
- Cost savings through extension of the mold lifetime
- Accurate measurement of wear, taper and foot rolls
- Detection and evaluation of scratches at any position within the mold

Selected references:
Acciaierie Venete, Italy
Belarusian Steel Works (BMZ), Belorussia
Dneprovskiy Metallurgical Plant (DMKD), Ukraine
Gerdau Cartersville, Georgia, U.S.A.
Lech-Stahlwerke, Germany
Nanjing Iron & Steel Group, China
Nizhniy Tagil Iron and Steel Works (NTMK), Russia

Simetal OsciChecker: Another key issue for high-quality casting is regular monitoring of oscillator movements. This can be done during maintenance breaks with the Simetal OsciChecker or online with the Simetal OsciMon system (Figure 3). Both systems perform measurements with up to four sensors used per strand. Highlights of this solution include a rigid-body model through which evaluated mold movements are permanently compared to a rigid body. In this way a misinterpretation of measurements due to non-calibrated or misplaced sensors is avoided.

Simetal OsciChecker and Simetal OsciMon

Complete diagnostics of oscillator movements and condition

Customer benefits:
- Avoidance of breakouts and caster shutdowns through predictive maintenance
- Improved strand surface quality with information about the condition of oscillator guidance
- Intelligent cross check with rigid-body model

Selected references:
Angang Steel Company, China
Baosteel Group, China
Lech-Stahlwerke, Germany
Omutninsk Metallurgical Plant, Russia
Shougang Group, China
ThyssenKrupp Steel Europe, Germany
voestalpine, Austria

Simetal Strand Checker: Perfect strand guidance is essential for high internal slab quality. This is supported with the use of a multifunctional maintenance system known as Simetal Strand Checker (Figure 4). This device not only measures roll gap, roll rotation and alignment with its unique spray-water sensors, it also checks the condition of the secondary cooling system.

Simetal Strand Checker

Measurement of roll gap, rotation, alignment and spray water

Customer benefits:
- Fast measurements and automatic data transfer
- Direct connection to Simetal DynaGap for segment calibration
- Optimized strand-guidance conditions

Selected references:
Arvedi Group, Italy
BlueScope, Australia
Jindal Group, India
Gerdau Acominas, Brazil
Maanshan Iron & Steel Co., China
Shanghai Meishan Iron & Steel Co., China
voestalpine, Austria

Online monitoring in rolling and processing lines

The large portfolio of plant condition-monitoring systems from Siemens VAI offers a host of benefits for producers.

Siroll EdgeMon: This online monitoring system performs an automatic quality assessment of the trimmed strip edges. When worsening edge quality is detected, operator warnings are generated. The main features of Siroll EdgeMon include the optimization of the trimming process parameters as well as condition monitoring of the cutting knife (Figure 5).

Siroll EdgeMon

Inline quality inspection of the side-trimming process

Customer benefits:
- Increased stand time of the knife blades by up to 50%
- Reduced edge defects and generated scrap
- Lower follow-up costs in subsequent processing steps

Selected references:
ArcelorMittal Europe (2 locations)
Borçelik, Turkey
Tata Steel Europe (2 locations)

Simetal DMon: This condition-monitoring system records the vibration characteristics of the drive trains and provides a comprehensive analysis of the results. One cause for changes in vibration characteristics is bearing wear. As such, bearing deterioration can be detected at a very early stage, which makes Simetal DMon an indispensable tool for carefully planning maintenance work – and preventing unscheduled plant standstills.

Siroll DMon

Early inline recognition of worn rotating parts in drive trains

Customer benefits:
- Repair cost savings of up to 75%
- Avoidance of unplanned production stops
- Reduction of stock costs for spares

Selected references:
Angang Steel Company, China
ArcelorMittal Eisenhüttenstadt, Germany
Novelis, South Korea
Novelis, Switzerland

Siroll ChatterBlockMon: Sophisticated vibration analyses are reliably performed by the Siroll ChatterBlockMon system. The term chatter denotes resonance vibrations of a mill stand that can result in chatter marks on the steel strip surface. In extreme cases, chatter leads to strip breakage and even equipment damage. Siroll ChatterBlockMon detects mill stand vibrations and signals the plant automation system to immediately decrease the line speed in case of excessive chatter.

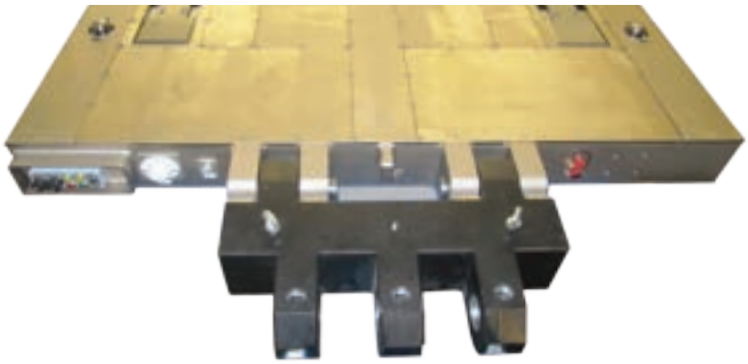


Fig. 4: Simetal Strand Checker

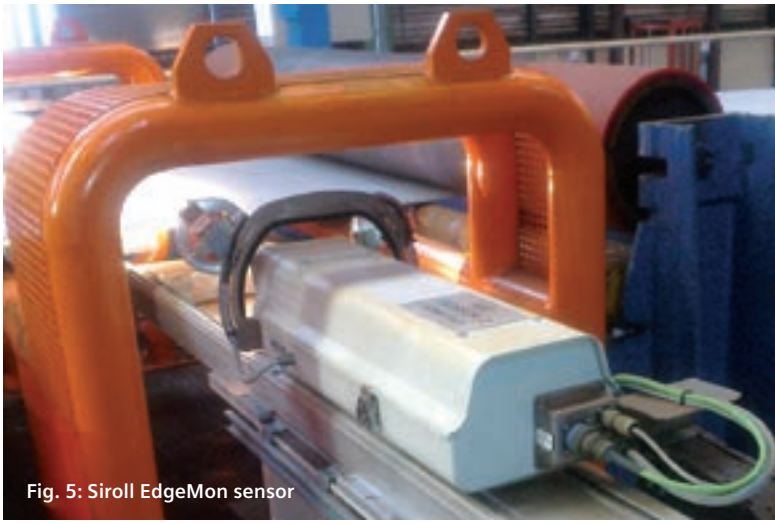


Fig. 5: Siroll EdgeMon sensor

State-of-the-art plant operation is unthinkable today without advanced mechatronic solutions.

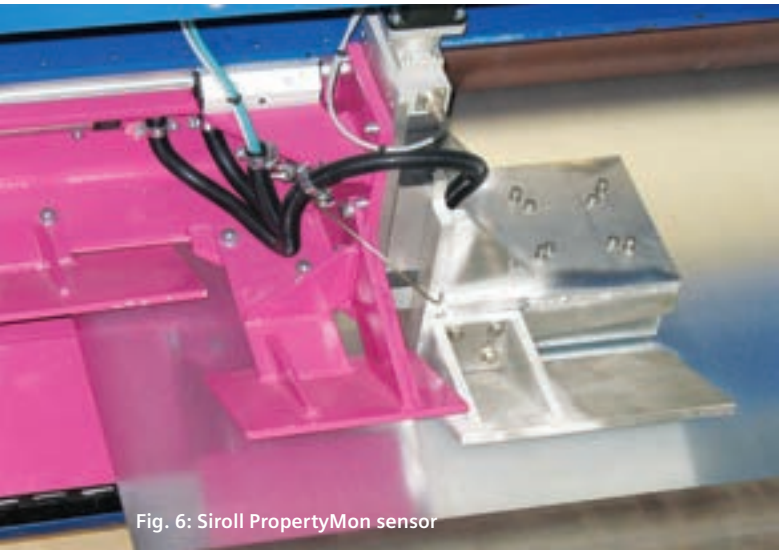


Fig. 6: Siroll PropertyMon sensor

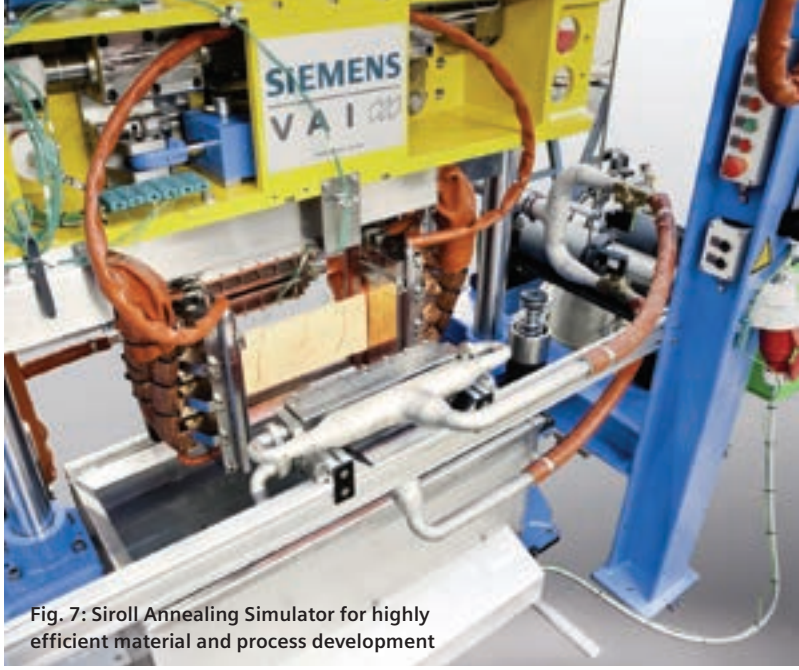
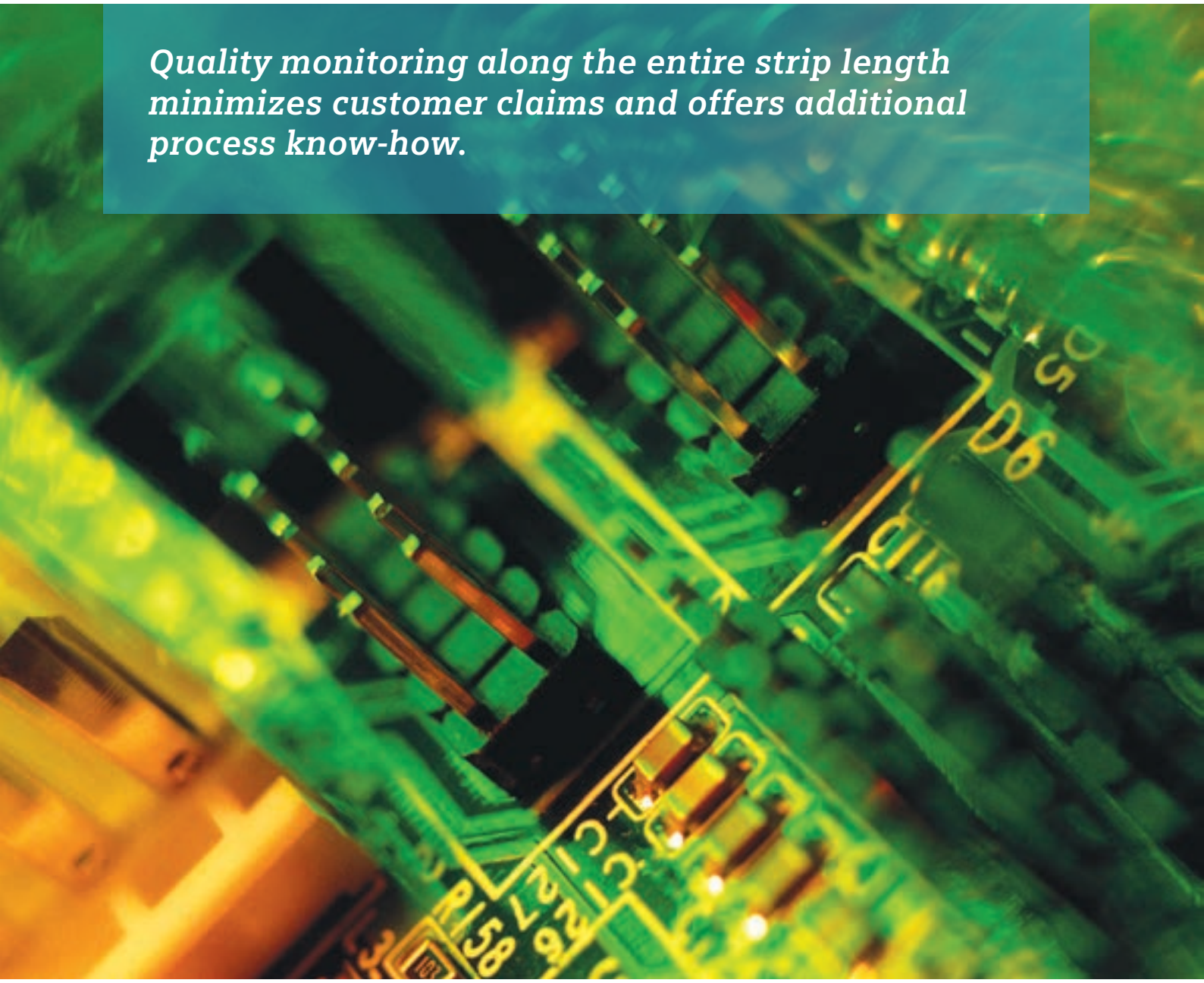


Fig. 7: Siroll Annealing Simulator for highly efficient material and process development

Quality monitoring along the entire strip length minimizes customer claims and offers additional process know-how.



Siroll ChatterBlockMon

Reliable detection of mill chatter and automatic line slowdown when threshold values are exceeded

Customer benefits
- Minimum strip breakage in cold-rolling mills
- Significantly reduced product downgrading and scrap generation
- Avoidance of plant damage

Selected references:
Angang Steel Company, China
Companhia Siderúrgica Nacional (CSN), Brazil
Posco, South Korea

Siroll PropertyMon: This innovation enables continuous inline monitoring and measurements of the mechanical properties along the strip length and width. In contrast to quality inspection via individual test samples, a continuous inline inspection is made possible, which allows evolving mechanical strength parameters to be detected along the entire strip length. Quality monitoring along the strip length minimizes customer claims and offers additional process know-how – important for process improvement and stabilization (Figure 6).

Siroll PropertyMon

Inline measurement of mechanical steel strip properties

Customer benefits:
- Avoidance of customer claims
- Reduction of scrap at the strip head and tail by 50–70%

Selected references:
Tangshan Iron and Steel Group Company, China
voestalpine, Austria

Siroll Simulators: Efficient material and process development

The development of new steel grades as well as continuous process optimization and further development of material and process know-how is a key factor for successful high-quality steel and aluminum producers. To do all of the development and optimization trials on the production plant is expensive, risky and sometimes not even possible. For example, certain process phases in production are not accessible for taking samples.

One possibility to receive more detailed insight into the material treatment process is to use specially designed experimental simulators. To enable this, Siemens VAI developed together with leading steel producers a comprehensive portfolio of sophisticated laboratory-scale test facilities – the Siroll Simulators. The philosophy behind the design of this solution is to separate the most important sub-steps of the process chain and to study the individual steps by means of experimental simulation in the laboratory. Thereafter, the obtained extended knowledge is transferred back to the industrial production line.

The operational behavior of the Siroll Simulators is characterized by outstanding performance regarding dynamics, accuracy and repeatability. Precise temperature tracking control allows the operation of any prescribed annealing cycles with the highest degree of accuracy. As a result, each individual process step can be simulated, inspected and interrupted in order to assess the actual state of specified sub-steps.

Siroll Simulators represent mechatronic development tools that generate significant cost advantages in terms of time needed and material used to handle future challenges in material research and process optimization.

Siroll Simulator

Physical offline simulation for material and process development
Main benefits:
- Cost-efficient offline development with no production risk or stoppage
- Significantly reduced development times
- Accumulation of detailed operational know-how for material and process development
- Access to sample material in each process step

Selected references:
Baosteel Group, China
Pohang University of Science and Technology, South Korea
Shougang Group, China
ThyssenKrupp Steel Salzgitter, Germany
voestalpine, Austria

Pioneering mechatronic solutions

Siemens VAI is one of the initial pioneers of mechatronic solutions for the metals industry. Customized and highly specialized systems are developed either in company-owned lab facilities or jointly with universities, R&D partners and customers. The more than 1,000 Siemens VAI mechatronic references in metallurgical plants worldwide are an indication of the benefits that are available for producers. Process efficiency improvements, online system and equipment monitoring, and reduced maintenance costs are just a few of the advantages. Customers interested in improving their production processes with the support of advanced mechatronic solutions are invited to contact the Siemens VAI competence center for mechatronics for more information.

Nicole Oberschmidleitner, Head of Mechatronics
Dr. Thomas Pfatschbacher, Head of Technology, Casting and Rolling
Christoph Sedivy, Technical Sales/Product Manager, Mechatronics

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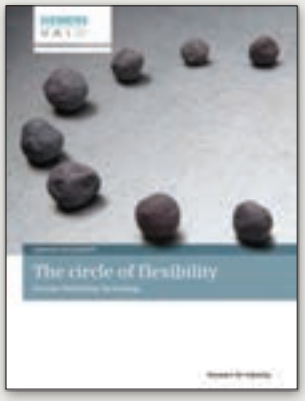

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The 100-ton shaft-type EAF Quantum was recently started up at the minimill of the Mexican steel producer Talleres y Aceros (Tyasa) and has since successfully passed all performance tests. The furnace requires 20% less power than conventional EAFs due to the preheating of scrap in a shaft with the furnace offgas.

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