metals & mining

The magazine for the metals and mining industries

Issue 2|2008

SIEMENS VAI

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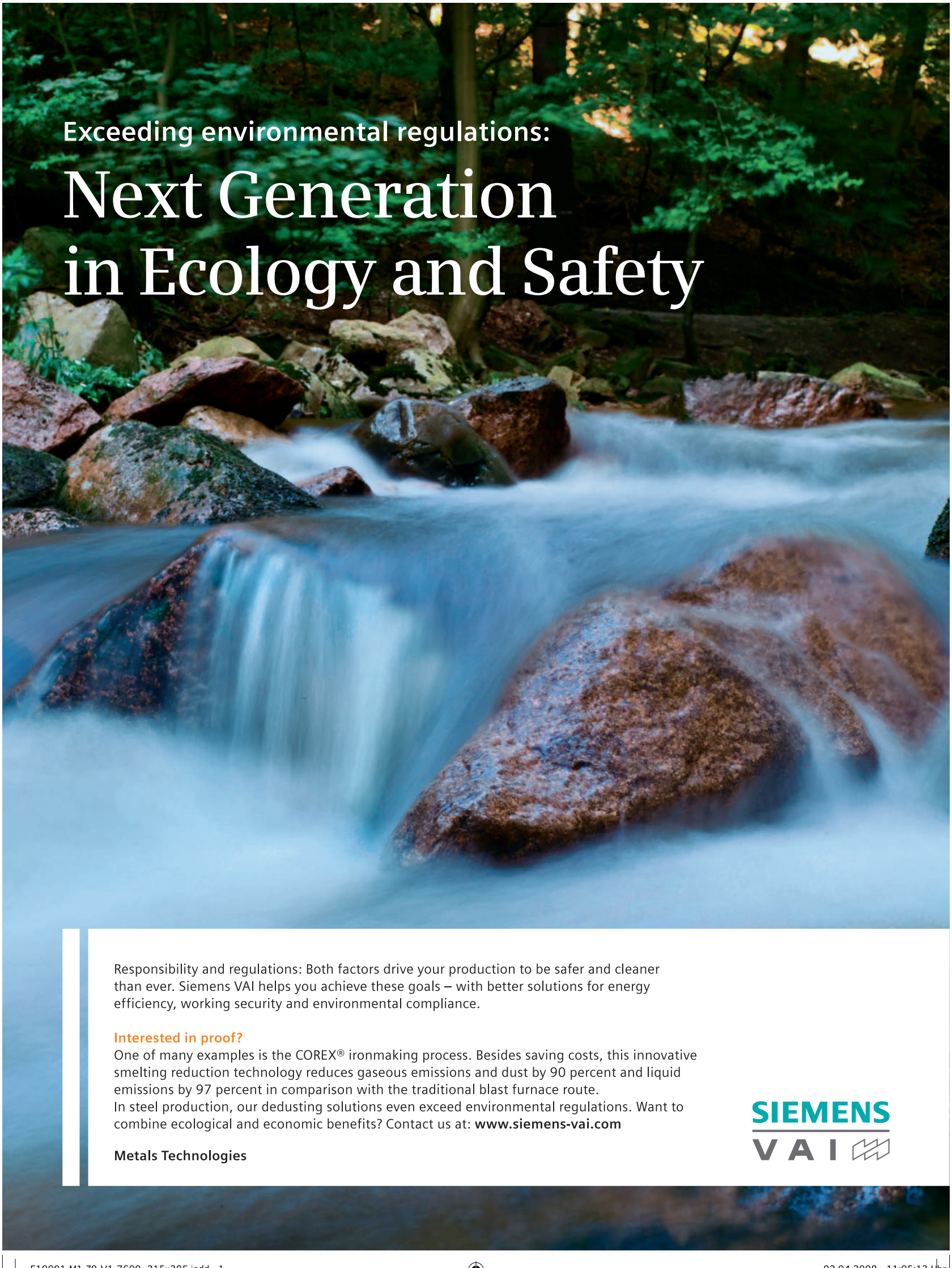
Fruits of Technology



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Metals Technologies

SIEMENS VAI

Dear Readers,

Dr. Richard Pfeiffer

This issue of metals&mining is filled with many superlatives: "World's largest," "world's first," "world's thickest," "world record" and so on. The last few years, in particular the year 2007 up to now, have witnessed a continuous series of major project successes which are good examples of the many "fruits of technology" that we, together with our customers, are now reaping from the seeds of vision and innovation that were planted in the past. Exciting news and topics are presented in the following articles for each step in the ferrous-metals production chain, from the mine to the metal, and from the roots to the fruits.

A second major focus of this issue of metals&mining deals with environmental issues, in particular, the dramatic improvements achieved in sinter-offgas cleaning. With the introduction of Meros technology, not only can the strictest environmental standards for sinter plant offgas emissions be exceeded by far today, but also those expected in the future. Advances in this field truly represent a decisive step forward in the implementation of "the green steel works" of tomorrow.

And it has not only been technological successes of which we can be proud of. Our company has just undergone a major spurt in growth by some 1,100 specialists through the recent acquisition of Morgan Construction Co., the acknowledged leader in the supply of equipment for the long-product rolling sector. This combined capability of technological and automation expertise in wire, bar and section mills will enable us to even better serve our customers in the future with solutions for superior production performance and product quality.

The tenth Continuous Casting Conference of Siemens VAI was held in May 2008 in Linz, Austria, and coincided with the fortieth anniversary of our company's start as the leading supplier of continuous casters. Over 500 technology experts from dozens of countries from across the world attended this event where the latest advances and developments in this exciting and dynamic field were presented.

We are sure that you will find the topics of this issue of metals&mining highly informative and instructive. May we invite you to discover which "fruits of technology" would be ripe for your plant and we look forward to your comments.

Yours sincerely,

Dr. Richard Pfeiffer
President and Chairman of the Board of Siemens VAI

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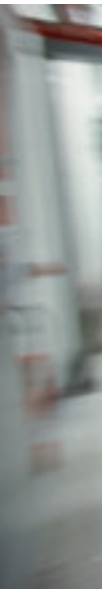

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Stronger Portfolio

With the agreement of all of the responsible authorities, Siemens has now taken over Morgan Construction Co., the rolling mill specialist based in Worcester, Massachusetts, USA. This company achieved sales of USD 230 million in 2007, and employs some 1,100 people in the USA, China, India, the U.K. and Brazil. Morgan Construction will be managed as a Siemens Group Company by Siemens VAI Metals Technologies, Linz, Austria, a business unit in the Industry Solutions Division. Dr. Richard Pfeiffer, CEO of Siemens VAI Metals Technologies, said, "This takeover of Morgan's production plants will also enhance the value chain of Siemens VAI in the U.S., Indian and Chinese markets." Morgan Construction is a worldwide supplier of wire-mill equipment for the long-product sector, and has constructed over 500 wire, bar and billet mills in more than 40 countries. "The integration of these two companies will enable us to set the market standards for future technological development." ■

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Order from Xstrata

Siemens Industry Solutions Division has received the order from Xstrata Copper to supply electrical equipment for a copper mine in South America. The project includes motors and drive systems for a semi-autogenous grinding (SAG) mill and two ball mills with the associated power supply equipment. The order volume is about 30 million euros.

Siemens is responsible for configuration, production, and delivery of the electrical equipment for the ore mills. The SAG mill is to be fitted with a gearless drive with an output of 21 MW; the ball mills will also be equipped with gearless drive systems with outputs of 16.4 MW each. The scope of supplies also includes transformers, protection equipment, and human-machine interface equipment. ■

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Xstrata plc is the fourth largest copper producer in the world

Turnkey Technology

Siemens is to equip the new cold-rolling plant of the Bokaro Steel Plant in the Indian state of Jharkand with turnkey process technology. Siemens is responsible for the design, engineering, supply, installation and commissioning of the core lines of the plant, which includes a coupled tandem pickling line, with a capacity of approximately 1.3 million metric tons per year, a hot-dip galvanizing line and an electrolytic strip-cleaning line. The start-up is planned for 2010. ■

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Modernized Mill

Siemens was awarded an order by Nikkei Siam Aluminium Ltd., Thailand, to modernize the company's aluminum rolling mill by supplying new mechanical equipment, as well as process and drive systems. This is intended to both increase productivity and further improve product quality to cope with the growing demand of automotive-related industries. The new equipment will more than double both the rolling speed and the coil weight. ■

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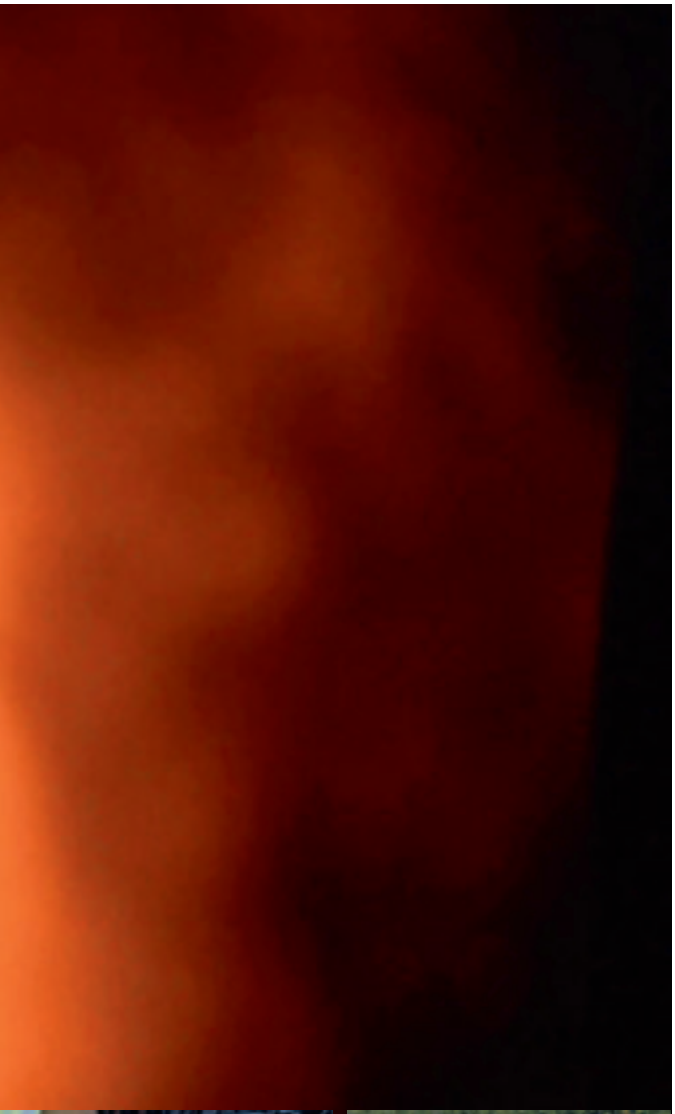
Plant Start-ups and Acceptance Certificates (January 1 to March 31, 2008)

Company	Country	Project
Alchevsk Iron & Steel Works	Ukraine	Start-up of a 300-ton LD (BOF) converter, including primary- and secondary-dedusting/cooling systems
Arcelor Mittal	South Africa	FAC for two new stoves for 'D' Blast Furnace
Arcelor Mittal Inox (formerly Acesita)	Brazil	Start-up of 19 stainless-steel transfer ladles
Azovstal Iron & Steel Works	Ukraine	Start-up of a 300-ton twin-ladle furnace, including receipt of FAC
Baoshan	China	Start-up of new plate mill at Pudong works (E&A supply)
Baosteel	China	FAC for hot-skin-pass mill
Bhushan (BPSL)	India	Start-up of new compact hot-strip mill (E&A supply)
BlueScope Steel Limited	Australia	Start-up of four upgraded mold-level control systems for continuous slab-casting machines
Borcelik	Turkey	Start-up of pickling line after revamp and extension
Chengdu Xilian Iron & Steel Co. Ltd.	China	Start-up of 70-ton EAF and receipt of Provisional Acceptance Certificate
Companhia Siderurgica Huachipato	Chile	PAC for start-up of first sublance for Converter No. 2
Corus Scunthorpe	United Kingdom	PAC for new gas-cleaning plant for Queen Bess Blast Furnace
Deutsche Edelstahlwerke	Germany	Start-up of modernized 6-strand billet caster
Essar	India	FAC for extension of tandem cold mill from 4 to 5 stand and coupling with pickling line
Habas Aliaga Iron and Steel Plant	Turkey	Start-up of a 1.2 million-t/a "4-slit-rolling" rebar mill
ILVA	Italy	FAC for blast-furnace expert system
Isdemir	Turkey	Start-up and commissioning completion of expanded and modernized coke-oven by-product plant
Jinan Iron & Steel Co. Ltd.	China	Start-up of new single-strand slab caster
KUMZ	Russia	Start-up of hot-mill modernisation, including AGC
Libyan Iron and Steel Company	Libya	Start-up of modernized 4-strand bloom caster
Maanshan Iron & Steel Company	China	FAC for annular gas scrubber for Blast Furnaces 'A' and 'B'
NLMK	Russia	FAC for two slitting lines
North American Stainless	USA	Start-up of a 150-ton ladle furnace
Novolipezk Metallurgical Combine (NLMK)	Russia	Start-up of upgraded 2-strand slab caster/CC-6 (machine head and strand-guide system) and upgraded 2-strand slab caster/CC-4 (bender)
Pangang Group Chengdu Iron & Steel Co. Ltd.	China	Start-up of 70-ton EAF and receipt of Provisional Acceptance Certificate
Shagang Shuni	China	Start-up of new annealing line and two galvanizing lines (E&A supply)
Stahl Gerlafingen	Switzerland	Start-up of the modernized finger-shaft electric arc furnace with offgas-treatment system, including receipt of Final Acceptance Certificate
Taiyuan Iron & Steel (Group) Co., Ltd. (TISCO)	China	FAC for supplied 180-ton twin-stand RH degassing plant
Tata Steel	India	FAC for conversion of Casting Machine No. 1 to vertical mold and upgrading of Casting Machines No. 2 and No. 3
Thainox	Thailand	Start-up of new Sendzimir mill (E&A supply)
Wisco	China	FAC for new annealing line and Galvanizing Line No. 3 in Cold Strip Plant No. 2 (E&A supply)
Zhenjiang Dingsheng Aluminium	China	PAC for three foil-mill automation upgrades, comprising automatic flatness control and automatic gauge control

COVER STORY >



Vario images

Innovative solutions help address new market challenges

Fruits of Technology

Siemens VAI innovation in mining, iron & steel, rolling & processing and services has one goal – to provide customers with new technologies enabling them to be more efficient, to be more competitive and to reduce environmental impact. The following pages introduce some of the fruits of that technology.

Corbis

In mining, gearless drives ensure the highest operating efficiency of any available variable-speed drive

Prices for many metals reached record levels in 2007, triggering a burst of new mining investment and exploration. Siemens focuses on R&D to help producers locate and mine new raw material deposits at lower costs and with fewer emissions to the environment.

New developments in iron- and steelmaking at Siemens VAI allow lower-cost raw materials to be utilized, ensure the production of top-quality products and minimize emissions. In, for example, the Corex and Finex processes, coking and sintering plants are no longer required to produce hot metal, meaning enormous cost and environmental advantages. Technological packages and the application of expert systems are the basis for fully automated production operations with minimal operator interaction.

Siemens VAI is at the forefront of developments to satisfy the growing demand for HSS (high-strength steel) and AHSS (advanced high-strength steel) steels and has developed the Siroll^{CIS} Completely Integrated Solution product family to enhance mill productivity. Siemens VAI is applying the next generation of thin-slab casting and direct-rolling technology in building the world's first endless strip production (ESP) plant.

With its service organization, Siemens VAI combines mechanical, technological, electrical and automation expertise to render comprehensive services over the whole life-cycle of a plant. The aim is to minimize the total cost of ownership for plant operators through a sustainable partnership. Best practices comprise just-in-time migrations for automation components, spare parts monitoring and workshops for mechanical services.

Innovation in mining

Siemens had already developed the first gearless drive system for the cement mill in Rohrdorf, Germany in 1970. Gearless drives ensure the highest operating efficiency and lowest energy consumption. The system has been employed in a number of mining applications with outstanding results.

Siemens has also developed the worldwide first gearless drive system for draglines. At the Chinese Zhungeer coal mine in Inner Mongolia, a 13,000 HP Simine^{CIS} DRAG gearless AC drive system is being installed for hoist and drag motion of the dragline (see article "Gearlessly into the Mine" on page 20).

The "Frozen Charge Shaker" was developed by Siemens. It is a valuable additional feature of the Simine Mill GD system and enables a controlled detachment of the grind medium that may have become compacted in the grinding shell while the mill was stationary. This feature prevents expensive damage to the mill shell, eliminates the need for manual cleaning and thereby reduces downtime and, consequently, production losses. The first two projects where the "Frozen Charge Shaker" will be applied are currently (May 2008) in the commissioning stage (RPM, Brazil, and Lumwana, Zambia).

Iron smelting processes operate especially efficient when the ore is charged to the blast furnace in the form of pellets of uniform size and physical characteristics. The pelletizing process is performed in an ore dressing plant where ore concentrates are heated in a controlled manner. The recently introduced Granulometer, part of the Siemens Simine^{CIS} Pellet integrated system, provides enhanced control of the pelletizing process.

Siemens VAI applies the latest electrical, automation and environmental solutions for example in the No. 3 blast furnace of Arcelor Mittal Tubarão, Brazil

In the Granulometer system, a video camera monitors the surface of the moving pelletized material. The images are fed into a computer where a patented algorithm is applied to determine the individual pellet sizes to within an accuracy of 0.25 mm. Feedback is provided to the process operators every twelve seconds which facilitates tighter control of the pellet quality, increased throughput and lower energy consumption.

Innovation in iron and steel

Siemens VAI applies the latest electrical, automation and environmental solutions at every step of the iron- and steel-production chain. A complete meltshop is currently under construction by Siemens VAI at Sadat City, Egypt for the Egyptian Sponge Iron & Steel Company (Beshay Steel). The plant will produce 1.3 million t/a of rolled bars and sections primarily for the Egyptian construction industry. Up to 100 percent HDRI (hot direct-reduced iron) will be charged into a 165-ton EAF via a hot-link system, achieving major savings in electrical energy costs. The plant is scheduled for start-up in March 2009 and also includes a 165-ton ladle furnace, 6-strand high-speed billet caster and the related electrical and automation systems. In March 2008, Beshay Steel placed an order with Siemens VAI for a second meltshop with an identical production capacity of 1.3 million tons of steel per year. A 165-ton vacuum degassing plant will be installed to satisfy the demands for the production of high-quality steels.

Siemens VAI is currently engineering and providing key equipment and systems for a new blast furnace for Tata Steel at Kalinganagar, India as part of an integrated iron and steel works currently under construction. The furnace will feature a hearth diameter of 13.8 meters and will have a nominal output of 3.2 million tons of hot metal per year. A high coal-injection rate of 160–200 kilograms per ton of hot metal will be applied to reduce the total coke consumption, enabling a low fuel-consumption rate in the range of 500–535 kilograms per ton of hot metal.

In November 2007, Siemens VAI received a major order from the Chinese steel producer Anshan Iron & Steel Group Corporation (Anshan) for two new single-strand medium-thick-slab casters to be installed in Chaoyang City, western Liaoning Province. When commissioned in mid-2009, the facility will produce hot-rolled coils of low- to high-carbon and alloyed-steel grades of cast steel with a capacity of 2.5 million tons per year. The project scope for Siemens VAI includes engineering, advanced technological packages and a sophisticated quality-control system.

Anshan is a major Chinese steel producer with an annual output exceeding 16 million tons. The latest contract is the eighth slab caster to be ordered from Siemens VAI and is an outstanding example of long-term cooperation between a steel producer and an engineering and plant-building company.

Innovation in rolling and processing

The year 2007 was a big step forward for Siemens VAI in the business of rolling and processing. At Arcelor Mittal in Poland, the first new hot-strip mill built in Europe in the last ten years went into operation. The mill is designed to produce high-quality hot strip in a wide range of steel grades and incorporates the latest >>

Corbis

>> technologies from Siemens VAI, including SmartCrown and the PowerCoiler. Currently, another Siroll HM hot-strip mill for the Indian producer Jindal stainless and the first ESP plant for Arvedi in Italy are under construction. Siroll HM automation solutions are going strong in China, where Siemens VAI received orders for a total of eight new hot-strip mills that will be equipped with basic and process automation.

Plate mills for processing high-strength steels have become one of the most advanced technical sectors in the industry. Efficient and effective control of the complex production process is crucial for operating such a plant economically. Siemens VAI has further developed Siroll PM to enable operators of existing mills to upgrade their facilities, enabling them to compete with modern plants that are purpose-designed to roll high-strength steels. Siroll PM plate mills and technological equipment such as the Mulpic intensive-cooling system or the heavy-plate shear are on the forefront of innovation. Siemens VAI Mulpic has established itself as the clear market leader in this field (see article "David versus Goliath" on page 46). Recently, several plate mill projects in China and India went successfully into operation and led to follow-up contracts.

The design of tandem cold mills for the production of advanced high-strength steel grades requires detailed analysis of various requirements. Cold rolling mills of Siemens VAI combine mill layout and technological equipment with high-performance drive and automation technology into the integrated system Siroll^{CIS} CM (see article "Major Market Success" on page 54). Leading steel producers such as voestalpine, Corus and SAIL have already ordered tandem cold mills that are either already in operation or in the engineering phase.

Special equipment of Siemens VAI, such as welding machines, skin-pass mills, tension levelers for processing lines, and carousel coilers, has also proven its worth in cold mills and processing lines. The equipment is manufactured in Siemens VAI workshops which ensures high quality and continuous improvement.

Innovation in services

Siemens VAI recently established the Metals and Mining Service & Support Center (MSC) to serve as the single point of contact for all metallurgical and mining-related customer service needs anywhere in the world. At the MSC, an expert help desk answers customer inquiries and responds to any problems that may occur during the operating phase of a plant. The help desk is staffed by qualified service managers with many years of experience in automation in industrial environments to deal with such inquiries competently and quickly. The MSC may be contacted by all Siemens VAI customers and Siemens regional companies via dedicated communication channels such as e-mail and fax. There is a separate telephone number for customers with service agreements, who may call the MSC around the clock.

The highly qualified service managers can fall back on the global Siemens knowledge network when dealing with inquiries. In addition, innovative mechanisms ensure that MSC team and service network personnel find out what they need to know about supplied solutions quickly and efficiently and are thus in a position to be proactive in initiating migrations and spare part deliveries. This means the customers not only have an unique communication channel to Siemens services, they can also be sure of the quickest possible response times to safeguard plant availability and high product quality.

With the involvement of specialists from Siemens Corporate Technology (CT) a completely new approach has been taken in solving the challenge of monitoring the foaming-slag process and automating carbon injection. The result is Simetal^{CIS} Simelt FSM – the foaming slag manager. The slag level is not detected with a microphone or by analysis of the electrode current and its harmonic contents, but by using sensors for structure-borne noise. Such sensors, mounted at the furnace panels, "listen" into the furnace like operators do. With a newly developed software for analysis of the sound transmission and based on results generated by

The acquisition of rolling mill specialist Morgan will enhance the value chain with manufacturing locations in the U.S., China and India

the new software module, a dynamic and optimized carbon control was implemented. First tests and highly successful subsequent trials could be done at an EAF of the Lechstahlwerke steel works in Germany. Based on the evaluated data, the new Simetal^{CIS} Simelt FSM reduces production costs up to 1 euro/ton, in some cases even more depending on the EAF type and the foaming slag handling. Due to reduced energy and carbon consumption, the system is also helping to reduce environmental impact, for example by lowering CO_2 emissions.

Setting the pace for the future of technology

The aim of Siemens VAI is to provide a complete service and product portfolio to its worldwide customers in metals and mining. This is achieved through a combination of in-house development and strategic acquisition of companies that complement Siemens VAI capability. A recent example is the acquisition of Morgan Construction in April 2008. Morgan Construction is a rolling mill specialist with worldwide standing, having constructed over 500 wire, bar and billet mills in more than 40 countries. The combination of Morgan's products and expertise with the existing Siemens VAI Italy departments (specializing in bar, merchant bar, and section mills) plus the leading position of Siemens in systems automation will enable Siemens to provide an outstanding "full liner" solution with leading technology for the worldwide long product rolling mill market. This takeover of Morgan's production plants will also enhance the value chain of Siemens VAI particularly in the U.S., Indian and Chinese markets.

Another leading technology company to come within the Siemens banner is Shape Technology Ltd., which recently became a division of Siemens VAI Special Products. Prior to being acquired by Siemens, Shape Technology, based in Christchurch, U.K. was a specialist in shape- and width-measurement products and services, specifically developed for the metals industry. The product expertise it brings to Siemens includes width gauges, spray systems, shape meters, crop-shear control, wire rod and bar gauges and edge-defect detection. The first product to be introduced by the new division is the Siroll^{CIS} Edgewipe system (see "Edge of Green Technology" article on page 48). With this product, spray systems and edge-detection technology from Shape Technology is combined with Siemens' experience in cold-mill rolling to bring both a quality and environmental improvement to aluminum strip production. ■

More information
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∧ Slab caster, Carinox, Belgium

< Corex C-3000 plant, Baosteel, China

∨ Electric arc furnace, Hadeed, Saudi Arabia

Fruits of experience, fruits of innovation

Kaleidoscope of Successes

The year 2007 has been certainly unique in the history of Siemens VAI. The large number of extraordinary plant start-ups and order intakes from across the globe at every step in the iron and steel production chain has been breathtaking and warrant a brief review. In the following, only but a few of many examples of remarkable technological milestones are presented, each of which represents a particularly impressive fruit of technology.

Overview of Meros plant, voestalpine Stahl, Austria

The world's first industrial Meros plant was started up in August 2007 at the Sinter Plant No. 5 of the Austrian steel producer voestalpine Stahl. Representing a quantum leap in environmental technology, dust, acidic gases and harmful metallic and organic components present in the sinter offgas are reduced to previously unattained levels in the steel industry. (See separate article in this issue.)

Ironmaking

The world's largest direct-reduction plant with an annual production capacity of 1.76 million tons of direct-reduced iron (DRI) commenced operation in July 2007 by Siemens VAI together with its consortium partner Midrex Technologies, Inc. The plant, with a production capacity of about 220 tons of DRI per hour, was designed to enable the hot transport of the reduced iron directly to the adjacent EAF steel mill for major savings in electrical energy costs. (See separate article in this issue.)

At Lebedinsky GOK Gubkin, Russia, Siemens VAI and its consortium partner Midrex Technologies, Inc. commissioned the first Midrex HBI (hot-briquetted iron) plant ever built in Russia and the largest HBI plant in the world. The plant, which was started up in October 2007, has a production capacity of 1.4 million tons of HBI per year. (See separate article in this issue.)

The new blast furnace of Arcelor Mittal Tubarão (Arcelor Mittal Group) began production in July 2007 at the company site in Vitória, Brazil. The furnace has a rated capacity of 2,800,000 tons of hot metal per year. Siemens VAI was responsible for the design, core- >>

>> equipment supply, construction and commissioning, which were implemented on a turn-key basis in consortium with other companies. (See separate article in Issue No. 1/2008.)

China's first and the largest Corex plant ever supplied by Siemens VAI to date (1.5 million t/a) was started up in November 2007 at Baosteel, China. Substituting coke, a wide range of coals can be directly used in the process for smelting-reduction operations, considerably reducing raw-material costs and environmental emissions. (See separate article in Issue No. 1/2008.)

In April 2007, the world's first industrial Finex 1.5M plant with an annual hot-metal production capacity of 1.5 million tons was tapped for the first time at Posco's Pohang Works in Korea. The process, jointly developed by Posco and Siemens VAI, allows hot metal to be produced on the basis of low-cost iron-ore fines and non-coking coal. This reduces hot-metal production costs by approximately 15% in comparison with the blast-furnace route. (See separate article in Issue No. 1/2008.)

Steelmaking

The first "Ultimate-type" EAF with a heat size of 300 tons began melting operations in January 2007 at the Turkish steel producer Colakoglu Metalurgji. This new furnace generation incorporates the latest electric steelmaking technologies of Siemens VAI for highest power input and performance. In March 2008, a total of 8,450 tons of steel were tapped at Colakoglu within 24 hours – a world production record. (See separate article in Issue No. 2/2007.)

< **Midrex direct-reduction plant, Hadeed, Saudi Arabia**

Scrap charging of Ultimate furnace, Colakoglu, Turkey

Continuous casting

The thickest slab ever cast on a bow-type caster with a straight mold took place on June 29, 2007 at voestalpine Stahl, Austria. 355-mm-thick and 1,600-mm-wide slabs were cast on the No. 5 Continuous Caster which had been upgraded by Siemens VAI. The slabs are subsequently rolled to plates for use in particularly demanding downstream applications. (See separate article in Issue No. 3/2007.)

Following the successful start-up of the ultra-thick-slab caster at voestalpine Stahl, Posco placed an order with Siemens VAI in October 2007 for the supply of what will be the world's largest continuous casting machine when it is completed at the Korean producer's Pohang Works in February 2010. The new 2-strand slab caster will be capable of casting slabs with 400-mm thicknesses.

Casting of ultra-thick slabs at voestalpine Stahl, Linz, Austria

In October 2007, Siemens VAI received the biggest single order ever placed in India for continuous casting machines. Three long-product casters, comprising two new 6-strand billet casters and one new 4-strand bloom/beam-blank combi-caster, will be supplied to Steel Authority of India Limited (SAIL) for installation at the company's IISCO Steel Plant in Burnpur in the Indian State of West Bengal.

Integrated plants

In March 2007 the huge Carinox stainless steel project in Charleroi, Belgium came to a successful conclusion for Siemens VAI. This new meltshop facility of Arcelor Mittal – the largest single-line stainless steel production facility in the world – boasts an annual production of one million tons of ferritic, martensitic and austenitic stainless-steel grades. Siemens VAI supplied the EAF, AOD converter, twin-180-ton-stand ladle-treatment station, slab caster and auxiliary plants and systems. (See separate article in Issue No. 1/2008.)

Also in March of 2007, the new steel mill at Saudi Iron & Steel Company (Hadeed) in Al-Jubail, Saudi Arabia, with an annual capacity of 1.4 million tons of flat products, was completed by Siemens VAI. This challenging project comprised the supply of the EAF, ladle furnace, slab caster, auxiliary plants and the related automation and dedusting systems. (See separate article in Issue No. 3/2007.)

A Siemens VAI-led consortium received an order in September 2007 from Liepajas Metalurgs, Latvia for the construction of an integrated turn-key minimill. The new plant, which will be capable of producing 810,000 tons of steel billets and 400,000 tons of steel bars and profiles per year, will include an EAF, ladle furnace, secondary metallurgical facilities, dedusting plant and a long-product rolling mill. With the plant start-up scheduled for 2010, the existing steel-production route based on open-hearth furnaces can be shut down.

The Brazilian Villares Metals project, comprising the upgrading of a billet caster and the supply of a new multi-line long-product rolling mill, came to a successful conclusion for Siemens VAI with the receipt of the Final Acceptance Certificate in October 2007. Villares Metals, the leading supplier of high-alloy and specialty-steel long products in Latin America, can now produce up to 80,000 tons of the most sophisticated high-alloy and specialty alloy-steel grades. (See separate article in this issue.)

Concluding remark

Experience and innovation are the two factors which are decisive for the success of a technological company. Siemens VAI looks back on an experience record comprising thousands of implemented metallurgical projects worldwide and an ambitious and courageous tradition of technological innovation in the iron and steel industry. The few examples of extraordinary projects presented in this article are the fruits of a solid technological background, which can now be equally reaped by our own company as well as by our customers. ■

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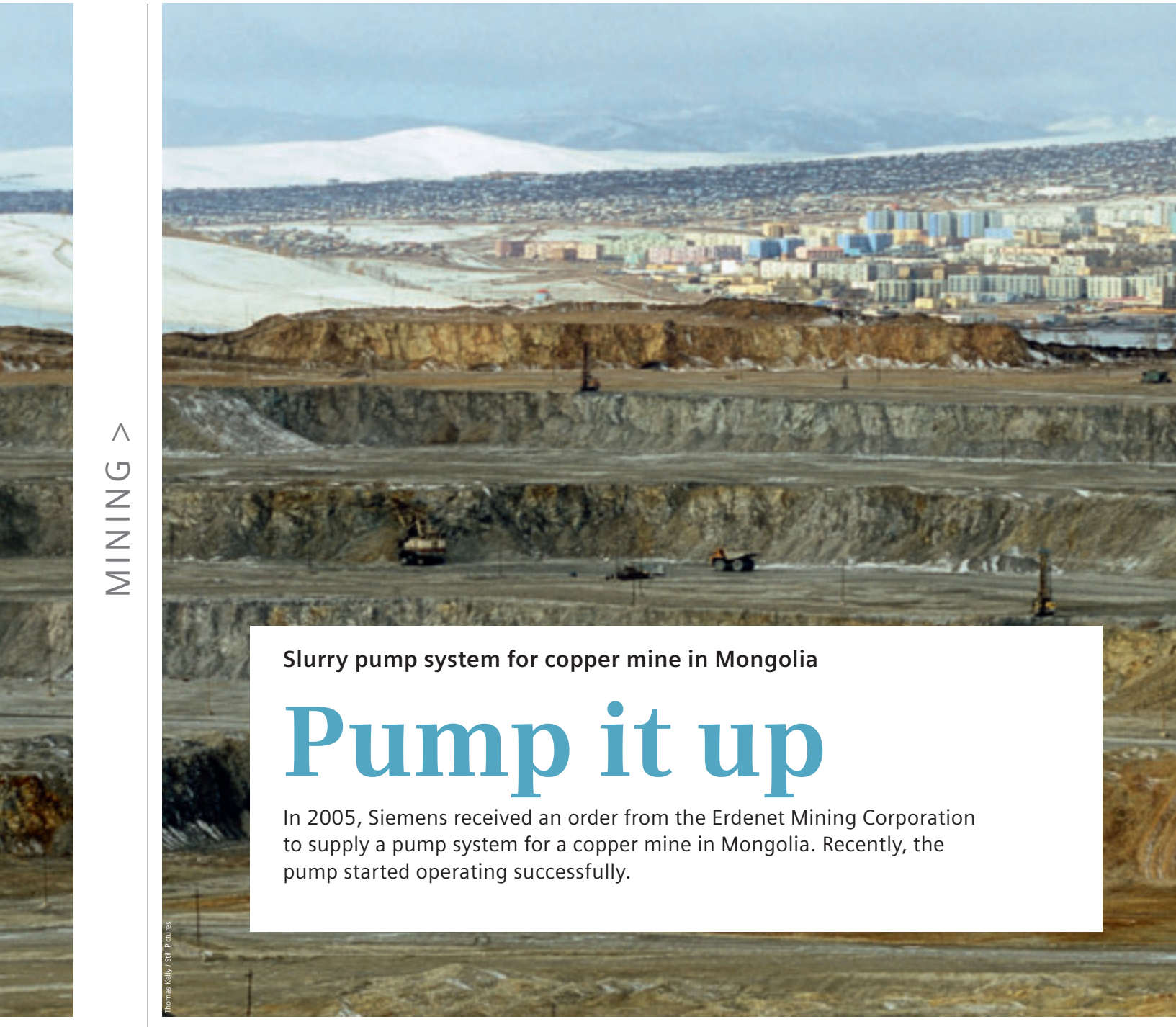

Thomas Kelly / Still Pictures

Slurry pump system for copper mine in Mongolia

Pump it up

In 2005, Siemens received an order from the Erdenet Mining Corporation to supply a pump system for a copper mine in Mongolia. Recently, the pump started operating successfully.

The purpose of the pump system is to improve the tailings extraction process in the copper mine and to cope with the increase in the mine's production. The complete system including medium-voltage switchgear, transformer, medium-voltage frequency converter, motor, pump, and control system was supplied and commissioned by Siemens. It is the largest slurry pump ever supplied to a mine, with a flow rate of 15 000 m^3/h at a TDH of 80 m.

The state-owned Erdenet Mining Company operates a copper mine near Erdenet, a city in the north of Mongolia, and extracts 25.3 million tons of copper ore in 2005. At an annual production rate of 126.000 tons copper and a cutoff of 0.59 percent copper, the life of the mine is expected to last about 35 years. The mine is located in Orkhon province approximately 400 km northwest of Ulaanbaatar, the capital of Mongolia. Mining is the largest and most important industry for the country, which is presently undergoing a period of economic growth.

New technology is therefore being introduced to increase production. The system has to cope with ex-

Copper mine near Erdenet, Mongolia

treme differences in temperature. Summer temperatures can reach up to 35 degrees Celsius, winter temperatures can be as low as minus 40 degrees Celsius. If the pump fails, the entire extraction process has to be stopped. Consequently, system reliability is a major issue.

Cyclone and water pumps

This Slurry pump system pumps the rock mass left over from the ore concentration process and transports it to the settling pond. For these purposes, Siemens is supplying the Simine Pump system with a KSB slurry pump manufactured by GIW in the United States. The pump is powered by a slowly operated squirrel-cage induction motor, and a gearbox between motor and pump. The frequency-controlled drive enables precise adaptation of the speeds. This speed control ensures that the flow rate of the pump can be exactly adjusted to the wastewater accumulated in the process plant. The pump system is operated by a Sinamics GM 150 medium voltage frequency converter system of the latest generation.

This will ensure that the necessary energy is used more effectively and that up to 30 percent savings can be achieved compared to conventional systems. Because the system is optimized for current and future load conditions, the wear rate of the pump is optimized and there is less need for maintenance and repair work. The pump drive is operated by a multilingual graphic visualization system that can be operated in German, English and Russian. By means of a Teleservice interface in the S7 controller, Siemens service specialists can connect via Internet to the drive system from anywhere in the world to support the service crew of EMC during troubleshooting or regular maintenance works. This, in turn, leads to greater pump availability. Increased throughput and shorter downtime make a substantial contribution to higher overall productivity.

Largest slurry pump ever supplied to a mine

Within the scope of a former project, Siemens has already supplied lighting systems for halls and production lines as well as submersible pump systems including control units to the Erdenet Mining Company to supply the mine and the whole city of Erdenet with freshwater collected in the valley of the Selenga river about 70 km north of Erdenet. ■

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New drive systems for draglines

Gearlessly into the Mine

Until now, draglines all over the world were outfitted with geared drive systems motors only. Siemens and Bucyrus have jointly developed a gearless AC drive system – Simine^{CIS} DRAG. One of the first systems to be employed is in the Chinese Zhungeer coal mine. Draglines already in use can be retrofitted.

The 13,000 HP drive systems with a performance of 9.7 Megawatts are used for Hoist and Drag motion of the dragline. By eliminating the gears, the cost for maintenance and operation are reduced in comparison to conventional drives. The extended service intervals reduce maintenance and increase the excavator's availability. Gearless AC drive systems also offer up to 20 percent more efficiency and use less energy, thus reducing operating costs.

Simine^{CIS} DRAG combines reliable electronics and controls proven in thousands of Siemens – powered locomotives and mining shovels, with gearless ring motors which have been in reliable service in grinding mills, mine winders, chain excavators and conveyors for more than 25 years. Siemens combined these proven, reliable components into a new, revolutionary Dragline drive system.

A new drive in coal mining

Siemens is currently outfitting the first Bucyrus 8750 excavator with the new drive system for use in the Chinese Zhungeer coal mine, 120 km south of Hohhot, the capital of the Nei Monggol province (Inner Mongolia). The mine is operated by the state-owned Shenhua Group Corporation based in Beijing. In the Nei Monggol province, coal has been strip-mined for some time. Near the city of Zhungeer 4 coal-fired power plant currently are in operation and one or two more are planned.

The dragline's ring motors are outfitted with 9 winding systems. The ring motors were delivered in two halves and had to be assembled on-site. The assembly was especially difficult as 90 percent of the work had to be done outdoors. The roof was added later and all hoisting jobs had to be carried out by mobile crane. Bad weather conditions and coal dust from the mine close-by further impaired the work. Sandstorms appeared almost every day and heavy winds made assembling the poles difficult. "Testing was done sometimes under extreme conditions. Aside from some starting problems, the unit has proven to be very successful. A top result for a new technology!" describes project director Ralf Lechtenfeld.

The drives are controlled by AC IGBT inverters supplied and installed by Siemens Energy & Automation in Atlanta. The excavator has been in operation since December 2007.

Main Benefits

- Higher machine productivity
- Higher drive system efficiency
- Less maintenance
- Lower life cycle operating costs
- Seamless integration of Siras and Midas

Seamless integration of Siras and Midas

To achieve high uptime and short MTTR (Mean Time To Repair), Siemens offers the most advanced and user-friendly maintenance computer in the industry. It shows the mine electrician where the problem is, and which part is needed to fix it.

The dragline system also seamlessly integrates with Siras and Midas. Siras remote diagnostics uses Internet technology to "keep the factory on the machine." Siemens and Bucyrus service technicians and other experts can log on from around the world and can do the same work as the electrician on board of the dragline with the exception of tightening a screw. Midas harvests a wealth of data during normal operation and makes it available for productivity analysis and optimization. ■

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The Bucyrus excavator with the new drive system for use in the Chinese Zhungeer coal mine

Gearless drives for the dragline

Siemens as main electrical contractor in the mining industry

One for All

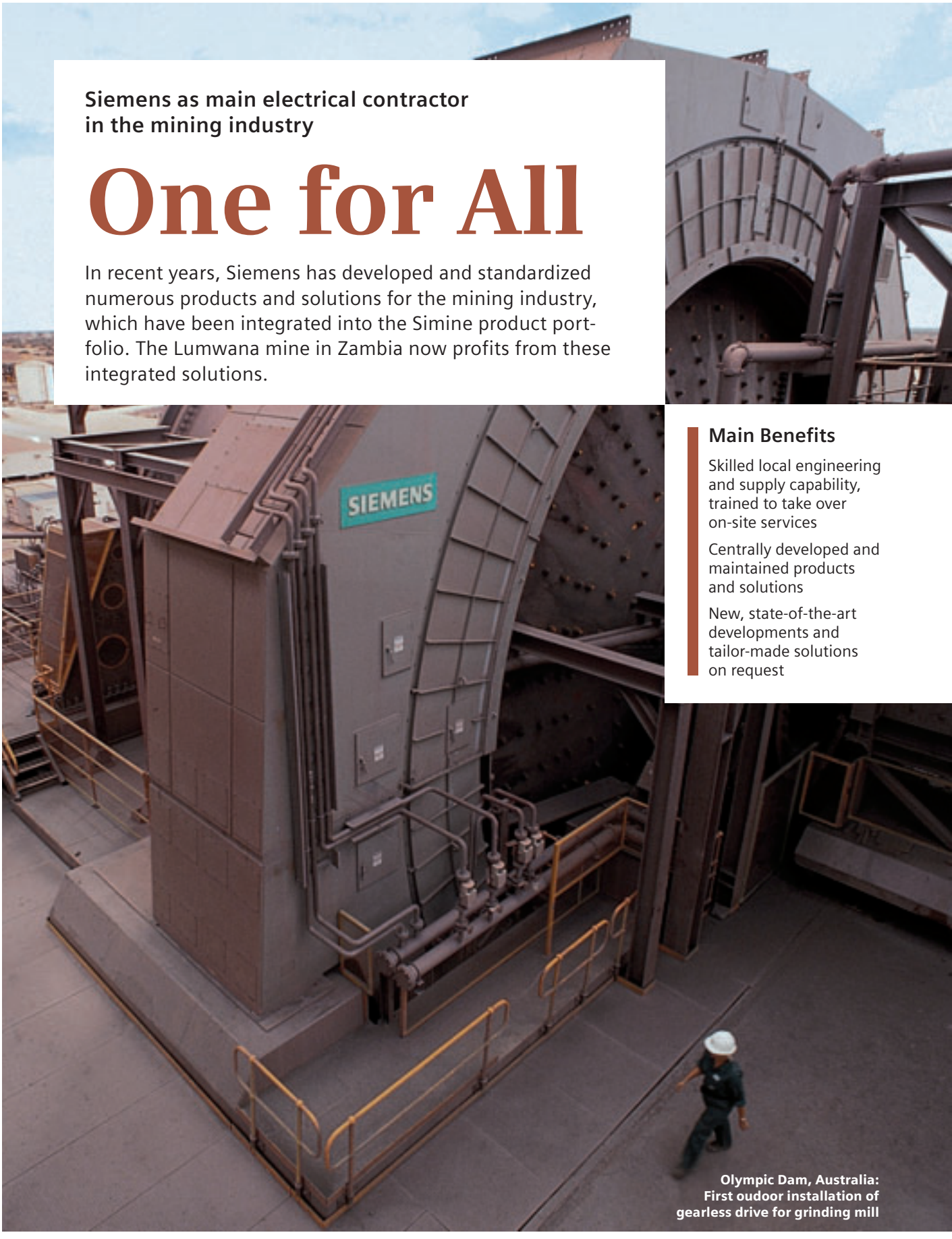
In recent years, Siemens has developed and standardized numerous products and solutions for the mining industry, which have been integrated into the Simine product portfolio. The Lumwana mine in Zambia now profits from these integrated solutions.

Main Benefits

Skilled local engineering and supply capability, trained to take over on-site services

Centrally developed and maintained products and solutions

New, state-of-the-art developments and tailor-made solutions on request



Olympic Dam, Australia: First oudoor installation of gearless drive for grinding mill

These products have all been engineered and developed with the goal of easy integration into the plant. They take into account all aspects of the plant: process technology – this means that only interface engineering is required between the mechanical and electrical packages; information technology, where open interfaces allow plantwide communication between the plant units and between the field level and the enterprise resource planning (ERP) level; and life cycle maintenance, service aspects and requirements have been considered in the development and implementation of the Simine products.

Safe and reliable operation

To gain the greatest benefit from the expertise and experience of Siemens, customers and/or their consultants involve Siemens at a very early stage in a project, when studies are carried out. Siemens is able to contribute its experience to the concepts and solutions selected, ensuring safe and reliable operation while optimizing operational costs. A further decisive factor is delivery times, especially of long-lead items, in order to meet challenging project deadlines. There the international sourcing capabilities of Siemens create added value. International project teams with local engineers take over responsibility for the packages implemented and provide a solid foundation for the site services required during the installation phase as well as later on during other life cycle phases.

During the ongoing engineering and execution of a project, the advantage for a customer is that the interfaces between the various electrical packages, such as power (high-voltage and medium-voltage), Supervisory Control and Data Acquisition (SCADA) system, low-voltage distribution and motor control centers (MCCs), automation, and so on, are handled by a single partner. Siemens also manages the interfaces to the other packages, such as technological and mechanical equipment and civil works. Prior to delivering the equipment to the site, a comprehensive factory test is conducted to prove the functionality and performance of the equipment as well as to train the personnel who will be responsible for the operation and maintenance later on. Once delivered, the equipment is installed and commissioned, followed by the start-up phase, during which – thanks to the extensive tests already carried out – the plant rapidly ramps up to high output.

In a demanding market where quality, delivery times, and costs play a major role, Siemens combines skilled local engineering and supply capability (trained to take over on-site services) with centrally developed and maintained products and solutions and new, state-of-the-art developments and tailor-made solutions on request.

The Lumwana Copper Mine in Zambia, which is scheduled to begin production in the second half of 2008 (as well as previous projects in German brown coal open-pit mines in operation for many years) is a good example of Siemens' role as a main electrical contractor in the mining industry.

Lumwana Copper Mine

Siemens has received orders from Equinox Minerals Limited, Canada, for the supply of electrical equipment and systems for open-cast mine haulage trucks, grinding mills, and "in-pit" electrical infrastructure, required for the development of its new Lumwana Copper Mine in Zambia. The mine, located in the country's North-Western Province, will be the single largest copper mine on the African continent.

For transportation of the ore from the pit to the crushing stations, Siemens will supply the equipment required for the electrification of 27 haul trucks, along with the associated in-pit trolley assist system. All trucks will be equipped with the latest AC drive technology.

For continuous monitoring of all mining operations, a comprehensive communication system will be supplied. The main component of the communication system is a fail-safe fiber-optic backbone known as an OTN (Open Transport Network). The fiber-optic network will be used to convey all data and communication associated with the mine's operations. The transmission and provision of high-quality video signals (CVBS or S-Video) will enable real-time viewing of all mine operations and critical plant equipment such as crushers, overland conveyors, pumps, the mine fleet, and so on. The entire mining operation can thus be monitored and controlled remotely by monitors in the communications center.

With the help of the eWD electronic documentation system, a comprehensive suite of documentation and information pertinent to the specific mine installation will be generated during the commissioning phase. This ensures that all relevant information is available online to facilitate maintenance and optimization of the mine.

Siemens is to equip the new mine with the entire in-pit electrical infrastructure. All the equipment will be developed, built, installed, and commissioned by Siemens. First-line maintenance of the equipment is also included in the project scope. ■

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eposint – a major leap ahead for environmentally friendly sinter production

Outshining the Challenge

In connection with an increase in the hot-metal output from the main blast furnace at the integrated steel works of voestalpine Stahl, it was necessary to expand the sinter production by approximately 30% to ensure that the percentage of sinter in the blast-furnace burden would remain about the same. However, the existing sinter-offgas treatment system was not capable of handling an additional 200,000 Nm^3/h of offgas. The solution to this problem was the introduction of a new offgas-recycling process known as eposint – an acronym for Environmental Process Optimized SINTering. The expanded sinter plant with the eposint solution was started up in March/April 2005 and the resulting environmental benefits have been well proved in more than three years of continuous operation.

Figure 1: Hooded sinter strand with offgas recirculation ducts seen to the right

Already in the early 1990s, it was decided to concentrate all sinter production at voestalpine Stahl at the Sinter Plant No. 5 to reduce environmental emissions. To maximize sinter productivity from the remaining sinter strand, the pallet width was widened by 15% to 3.4 meters in 1990, and the height of the sinter bed was gradually increased to 700 mm – a world record at the time. In a campaign under way at voestalpine Stahl to expand its overall steel production to six million tons per year, the capacity of Blast Furnace "A" was also increased. An additional 30% boost in the sinter plant output – from 2.2 to 2.8 million tons per year – was necessary to assure that the percentage of sinter in the blast furnace burden would not be reduced, but remain in the range of approximately 40%. When Erwin Zwittag, chief process technologist of the voestalpine Stahl sinter plant, was confronted with the challenge to produce more sinter, the solution for him was straightforward: "The required capacity increase could be easily met by extending the length of the sinter strand from 56 to 74 meters. The problem was that the existing offgas-treatment system could not handle the additional offgas quantity from 600,000 to 800,000 Nm^3 per hour. It was clear to me that the only way to increase sinter production without increasing the quantity of sinter offgas would be to recirculate a portion of the total offgas volume back to the sinter strand. In this way, the entire offgas quantity emitted to the environment could be kept at the same level as before."

This is possible because the air volume sucked through the sintering bed still contains approximately 12–13 percent residual oxygen. After enrichment by a small amount of supplementary air to assure a minimum oxygen content of about 16 percent, this would be sufficient for the complete combustion of the fuel and a high velocity of the flame front through the sinter bed. Zwittag: "We then considered which wind boxes should be selected for recirculation purposes in order to assure that the temperature of the sinter offgas to the stack and also to be recirculated would be high enough to prevent condensation of acidic gases, which would cause ductwork erosion. Furthermore, we decided to carry out a series of investigations to determine from which section of the sinter strand the highest concentrations of dust and pollutants were exhausted, for example, sulfides, heavy metals, and organic compounds. It could be shown that this zone was in the third quarter of the sinter-strand length. The result was eposint."

Decisive advantages

Following the extension of the sinter strand to 74 meters, the number of wind boxes was increased from 14 to 19. After passing through a gas-mixing chamber, the offgas is conveyed to a recirculation hood above the sinter strand. A picture of the hooded sinter strand into which the recirculated offgas is directed can be seen in Figure 1 and a schematic diagram of the eposint process at voestalpine Stahl is shown in Figure 2. Only the offgas from the wind boxes 11–16, containing the highest concentration of dust and pollutants, is recycled. With this solution, environmental emissions are considerably reduced. "Recirculated dust is trapped in the sinter bed, sulfides are bound in the basic sinter mix and dioxins and furans are effectively destroyed as they pass through the flame front," says Zwittag. With an increased suction pressure of the sinter offgas from the selected wind boxes, there is no decrease in productivity. Oxygen enrichment of the recycled gas is achieved by adding hot exhaust air from the cooler. This also provides the added benefit of reducing the coke breeze consumption for sintering by 2–4 kg per ton of produced sinter and also reduces the ignition gas consumption by 20% – meaning substantial operational cost savings."

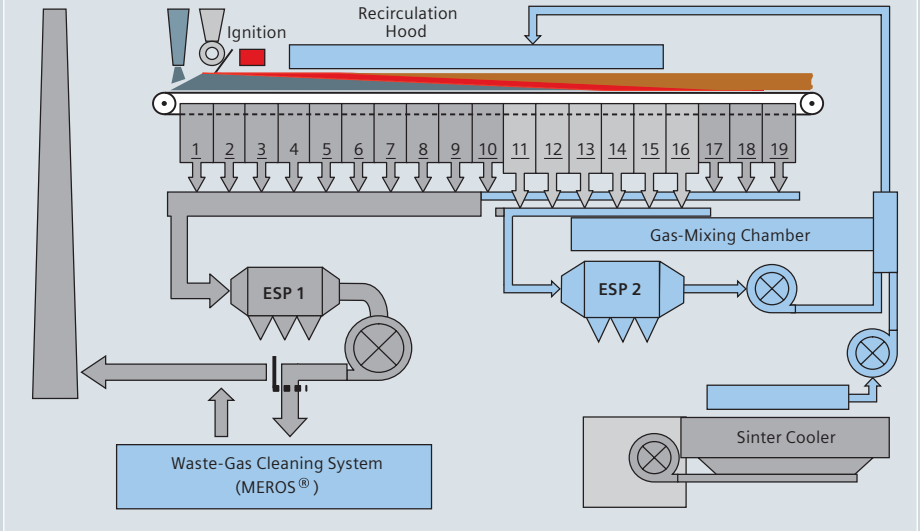

Figure 2: Overview of the eposint process at voestalpine Stahl, Austria

The sinter hood in the eposint Process is installed in order to achieve optimum operational results. It does >>

	Before	After
Sinter-Strand speed (m/min)	1.6 – 1.7	2.2 – 2.4
Sinter production (t/24h)	6,350	8,300 (8,500)
Productivity (t/m²/24h)	37.6	36.6 (38.3)
Ignition-gas consumption (MJ/t sinter)	50	40
Coke-breeze consumption (kg/t sinter)	45	40 – 43
Dust concentration (mg/Nm³//g/t sinter)	46//104	38//66
SO_2 concentration (mg/Nm³//g/t sinter)	420//952	390//677
NO_x concentration (mg/Nm³//g/t sinter)	240//544	240//416
HF concentration (mg/Nm³//g/t sinter)	1.0//2.3	0.6//1.0

Figure 3: Key sintering data before and after installation of eposint

>> not extend to the end of the sinter strand, which would unnecessarily heat up the final sinter-strand section. On the contrary, an open final strand section at the end allows fresh air to be drawn through the sinter bed in the area of the last few wind boxes. This cools the upper sinter layer more efficiently. The sinter hood itself only encloses the sinter bed and pallets. By means of a specially designed labyrinth seal, the hood is 100% gas-tight, safe, and reliable.

Another unique feature of the eposint process is its high degree of flexibility to respond to varying operational conditions. Depending on the composition of the sinter mix and other operational factors, the area of the temperature increase along the sinter strand varies. Therefore, in order to ensure an optimized gas recirculation with respect to the concentration of dust and pollutants in the waste-gas stream, the offgas flow from additional wind boxes can be independently directed either to the stack or recirculated to the process, if the system is designed in this way.

Results

In comparing the main sinter plant data before and after the sinter-strand extension and installation of eposint, the sinter output was increased from about 6,350 tons per day to a maximum of 8,500 tons per day. Through the recirculation of approximately 200,000 Nm³ of offgas, this increase in productivity could be achieved without an increase in the volume of waste gas emitted to the environment.

The application of the eposint selective offgas recycling process at the voestalpine Stahl sinter plant has led to a number of key advantages. These include a significantly reduced specific waste-gas volume per ton of produced sinter, lower specific operational costs for waste-gas cleaning, lower specific coke consumption and ignition fuel-gas rates, and decreased absolute emissions of dust, SO_x, NO_x, CO_2 and certain heavy metals (e.g., Hg) because of their entrapment in the sinter bed. Dust and other particle-bound heavy metals still in the offgas are further separated in a downstream electrostatic precipitator. Examples of selected process and emission values before and after the installation of eposint are seen in Figure 3.

Concluding remarks

The successful development and application of the eposint process at voestalpine Stahl is an excellent example of the benefits of a close cooperation between a renowned steel producer and metallurgical plant builder. Although the idea behind the eposint process originated with voestalpine Stahl, it was the joint implementation of this project by both partners, combining extensive process, production, engineering and plant-building expertise, which led to a fully optimized solution and excellent results. Erwin Zwittag: "The highest grant ever received by voestalpine from the Federal Government was for the eposint development and implementation. A key reason for this was because of the energy savings that are realized with the process. Following three years of 'show-case' operation, no problems were encountered with gas leakages, abnormal ductwork corrosion, automation glitches or mechanical-equipment failure. Everything worked perfectly from the start without problems, and that is an impressive confirmation of the advantages of the eposint Process." ■

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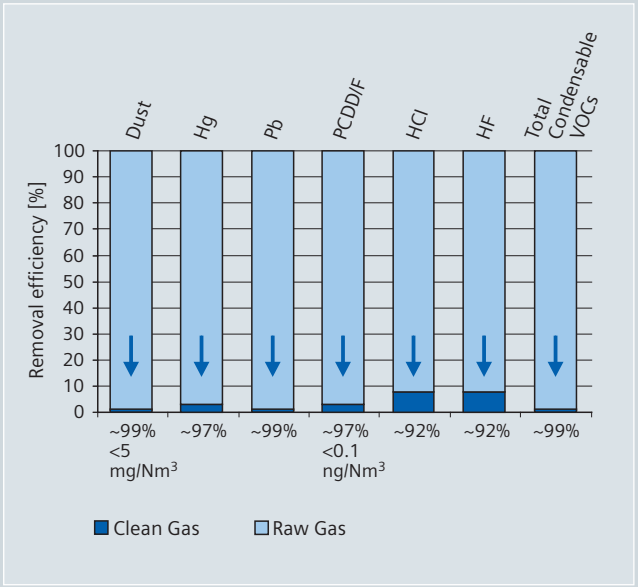
Meros plant start-up – Lowest emission values achieved in sinter-offgas cleaning

Not Seeing Is Believing

The new Meros dry-type sinter-offgas-cleaning system from Siemens VAI was started up on an industrial scale in August 2007 at the Sinter Plant No. 5 of the Austrian steel producer voestalpine Stahl. With this landmark technology, environmental emissions from sintering operations are now reduced to record-low levels.

Dr. Alexander Fleischanderl did not sleep that well on the night of August 13, 2007. As the inventor of the Meros environmental process, THE BIG DAY was about to begin. A multi-million-euro investment by the Austrian steel producer voestalpine, involving years of planning, process engineering and plant construction, would soon be put to the test – and there was far more than personal prestige at stake. "Although intensive investigations and optimization work had been previously carried out in a semi-industrial demonstration plant, up-scaling by a factor of ten to treat up to 1,000,000 m^3 of sinter gas per hour is a huge step forward for a new technology," said Fleischanderl. Just after the break of dawn on August 14, operators, controllers, process engineers, and software specialists gradually crowded into the control room of the sinter plant. People outside kept looking up nervously to the top of the stack to see if there would be any change to the dust plume rising into the sky. >>

Sinter stack before (7:40 a.m.) and after (9:10 a.m.) start-up of Meros plant on August 14, 2007



Sinter-gas-cleaning efficiency with Meros

>> At precisely 8:00 a.m. Mr. Erwin Zwittag, Chief Process Technologist of the sinter plant said "OK Push the start button." But nothing happened at first because of a short-circuit switch. And then the second try (8:20). Fleischanderl further: "All at once, everybody left the control room and ran outside to look at the sinter stack. The typical dust plume had disappeared. The first emission measurements confirmed how well the process was working. We were honestly surprised at how smoothly everything went. Apart from several minor software and mechanical problems, our best expectations were fully met."

Project implementation and results

The Meros plant was installed by Siemens VAI on a process-turnkey basis and started up on time. The entire project was carried out with minimal interference to normal sintering and gas-cleaning operations. A total shutdown period of less than five days was necessary for the modification and integration work with the existing gas-cleaning system. The Meros Process

View of Meros plant at voestalpine Stahl, Austria

reduced dust emissions by more than 99 percent to less than five milligrams per Nm^3. Emissions of mercury and lead were reduced by 97 percent and 99 percent respectively. Organic compounds such as dioxins and furans (PCDD/F) were eliminated by about 97 percent and total condensable VOCs by more than 99 percent. SO_2 emissions were also considerably reduced. During the first six months of operation, the plant had an overall operational availability exceeding 99%.

Fleischanderl: "Not only were the strictest EU environmental regulations for sinter plants fully met at voestalpine, but the increasingly stringent values expected in the future are already fulfilled today with the Meros Process. We see this technology as a milestone development, which sets new benchmarks for high-performance sinter-offgas cleaning." ■

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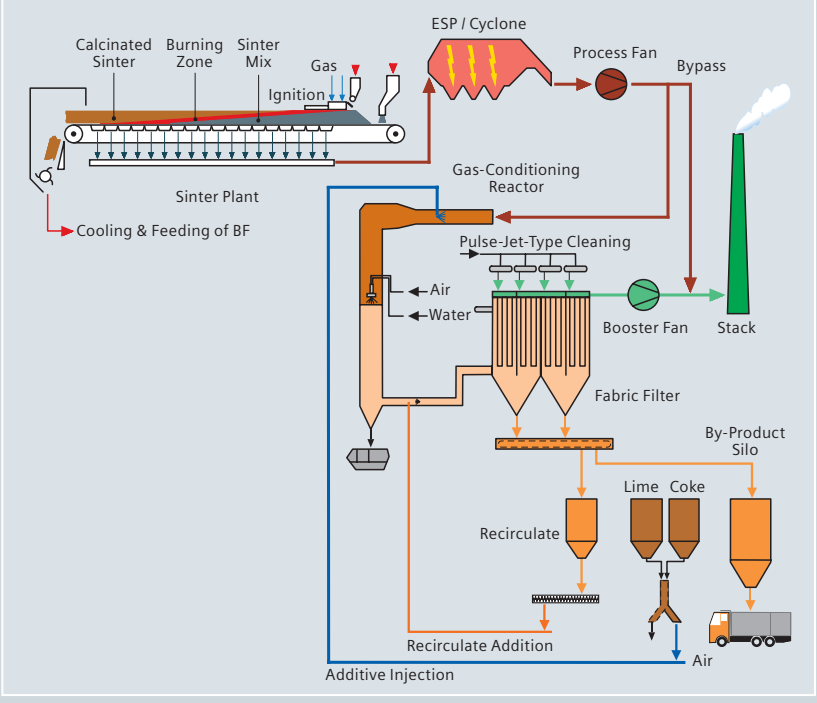
Meros Plant for Masteel

On March 28, 2008, Siemens VAI received the second order for a Meros plant, this time from the Chinese steel producer Maanshan Iron & Steel Company Ltd. (Masteel). The new facility will be installed at the No. 1 Sinter Plant of the company's integrated iron and steel works located in Maanshan, Anhui Province. Up to 1,000,000 m^3 of sinter offgas will be treated per hour, reducing emissions to levels unattainable applying conventional technologies. Siemens will supply process technology, plant engineering, and key equipment and will also provide training and advisory services. The completion of this project is expected by mid-2009.
"The Meros plant at the Maanshan steel works, which will be the first one to be built outside of Europe, will be a milestone for environmentally compatible technology in China," said Tobias Plattner, head of the project team. "It underlines China's growing emphasis on 'green solutions,' and we expect that this facility will mark the beginning of a new era of sinter-offgas cleaning in China."

Meros Process description

MEROS, an acronym for Maximized Emission Reduction Of Sintering, is a new environmental process characterized by a series of treatment steps in which dust, acidic gases and harmful metallic and organic components still present in the sinter offgas after the electrostatic precipitator are further reduced to previously unattained levels. In the first step, special C-based adsorbents and desulphurization agents (sodium bicarbonate or hydrated lime) are injected into the sinter offgas stream in the counter-current direction to bind heavy metals and organic compounds. Due to the large surface area of the adsorbants, the harmful substances adhere to the surface of the additives and can be more easily removed from the offgas stream in the downstream process steps. In the second step, the gas stream passes to a conditioning reactor (when hydrated lime is used) where the gas is moisturized and cooled to a temperature of about 100 °C by means of an injected fine mist using dual-flow, i.e., water and air, nozzles. This accelerates the chemical reactions required for binding and removing SO_2 and other acidic gas components. (If sodium bicarbonate is used as the desulphurization agent, the conditioning reactor step is not necessary.) In the third step, the offgas stream which exits the conditioning reactor passes through a bag filter equipped with special high-performance fabrics where the dust with the trapped pollutants is removed. In order to enhance the gas-cleaning efficiency and to significantly reduce additive costs, a portion of this dust is recycled to the offgas stream after the conditioning reactor. This also accelerates the formation of a filter cake on the surface of the bag filter which enhances the removal of fine dust in the offgas stream. When the filter cake reaches a certain thickness at which the gas flow through the bag filter is impeded, a reverse jet of air dislodges the filter cake from the surface of the bag filter. The dust removed from the system is conveyed to intermediate storage silos for subsequent disposal or for use in other applications such as in the cement industry.



Flow sheet of the Meros Process

Interview with Dr. Alexander Fleischanderl: Meros and more

A Clear View

Dr. Alexander Fleischanderl is the pioneer of the Meros Process. Since 2003 he has been involved with the process development, its implementation and industrial start-up which took place on August 14, 2007 at the steel works of voestalpine Stahl in Linz, Austria. Dr. Lawrence Gould, editor for **metals** & **mining**, interviewed A. Fleischanderl on March 20, 2008 about the background, benefits, and outlook of this breakthrough environmental technology.

Dr. Alexander Fleischanderl, Head of Technology for Steelmaking and Environment at Siemens VAI

"An exciting time for Meros."

What was the spark behind the original Meros idea?

Dr. Fleischanderl: Actually, it was more of a glow and less of a spark. Other technologies such as Airfine and Wetfine had been previously installed by Siemens VAI to treat the sinter offgas, however, with the German Clean Air Act (TA-Luft) coming into force in 2002, the required emission levels could no longer be met. So we were forced to think about new approaches to meet the legislation levels. To be successful meant to be fast, to follow the worldwide trend in the direction of dry technologies, to differentiate from our competitors and also to have a bit of luck.

What steps took place in connection with the development and implementation of Meros?

Dr. Fleischanderl: We already had a number of well proven, in-house technologies upon which we could build. It was clear that we had to depart from the fluidized-bed approach which had already been long employed in other systems. A completely new approach was necessary. Under the given boundary conditions it did not take long to develop "the cooking recipe," and to calculate and design the process in detail on the basis of existing process modules. But we eventually reached the point where things could not proceed further with just paper work.

We were fortunate in that at that time the capacity of the steel works at voestalpine was to be increased and that the municipal authorities were demanding far stricter emission values to be also implemented for the sinter plant as well as in connection with the plant expansion. It was obvious that the wet-type sinter-off-gas-cleaning process in operation since 1993 had to be replaced. The authorities demanded a demonstration plant to prove that the new target levels could be met. Siemens VAI subsequently received an order in October 2004 from voestalpine to install a 1:10-scale Meros Demonstration plant capable of treating 90,000 m^3/h. And this plant was in walking distance from our company headquarters.

What were the contributions of voestalpine in the implementation of Meros?

Dr. Fleischanderl: Today, we can honestly say that voestalpine was a stroke of luck for Meros. Following the successful installation and operation of the demonstration plant, the next chapter of the Meros success story could be written. Both project teams wanted a fast start-up and that the environmental requirements be

met as quickly as possible. voestalpine operated the pilot plant around the clock for more than two years and performed innumerable measurements during the optimization campaigns together with the Siemens VAI team. I was allowed to control plant operations on-line with my own PC from my office. That shows the immense trust and confidence that voestalpine placed in our efforts. Thanks to the successful and comprehensive results from the demonstration phase, the order was subsequently granted for the installation of the full-scale industrial plant.

Can you say anything about investment and operating costs?

Dr. Fleischanderl: The investment figure strongly depends on the specific environmental requirements and the split in the customer-supplier scope and supply. We have an efficient calculation tool that enables us to quickly – typically within a few days – make a budget offer on the basis of specific production, plant, and process parameters. Concerning the operating costs, the Meros process is at least 50 percent less expensive than the previous wet-type technologies, although the emission levels are far lower.

How does Meros compare with competing technologies and what are the distinctive differences?

Dr. Fleischanderl: The key difference is that all of the other competing technologies employ a "fluidized-bed" process. To operate a fluidized bed, it is necessary to have an enormous dust-recirculation rate in the range of about 1,000 g/Nm^3, which is roughly 60 times higher than the dust-recirculation rate in the Meros Process. Otherwise, the fluidized bed would collapse. Also, the quantities of cooling water necessary for gas conditioning could cause major sticking problems. But above all, this means that there is a far greater dust load that the bag filters have to treat. And this is the main disadvantage of these processes. The lifetime of the filter bags is drastically shortened, and replacement is typically required within 2–3 years – a huge cost factor! We estimate that with Meros we will only have to replace our bag filters every ten years or so. Furthermore, far more energy is required for the reverse-pulse jets to remove the filter cake on the bag filters with other technologies. We also have the flexibility to employ different additives such as hydrated lime, sodium bicarbonate or sodium hydroxide, depending on the emission limits, costs and availability.

Is there still room for improvement?

Dr. Fleischanderl: Of course – especially the use of additives for desulphurization has to be further investigated to ensure optimum results. And as is typical with any new industrial plant, a certain overcapacity and overdimensioning is normal to make sure that risks at the beginning can be kept to a minimum. Now that the plant is working, it is much easier to see where weights, sizes and dimensions can be reduced while still achieving the same results. We are currently standardizing plant sizes on a modular basis to be able to quickly respond to market inquiries.

Is zero-emission sintering technology theoretically and economically achievable on the basis of Meros technology some day in the future?

Dr. Fleischanderl: This is essentially possible today on the basis of current technology. It is really a question of economy, feasibility, and common sense. How much do you want to invest to remove the last few milligrams or nanograms of emissions, when pollution sources are so much higher elsewhere, say from automobiles or from other countries with low pollution standards? What is impressive is that in just a period of only 15 years, through the successive installations of Airfine, eposint and Meros technologies at voestalpine, the emission values from the sinter plant have been lowered to levels which at one time seemed impossible to reach.

The "Upper Austrian Innovation Prize" was awarded to Siemens VAI and voestalpine for the eposint and Meros technological innovations. See Awards & Events section of this issue of metals & mining.

Could Meros be applied in other industrial fields such as the cement and paper industries or in power plants or municipal incinerators?

Dr. Fleischanderl: Certainly. But a certain amount of time and learning curve would be necessary for the application in other fields to specify the optimum process parameters. Presently, we are more interested in focusing our efforts in the metallurgical industry. It is also obviously a question of available personnel resources.

What's going on now in the project landscape?

Dr. Fleischanderl: It is a big bonus for us that we have had voestalpine as a partner in the project and that the Meros plant is in operation across the street from our company headquarters. We are receiving inquiries from potential customers around the world and they all want to see the plant. Again, it's a question of personnel resources and market focus. We are already in the final stages of negotiations with a number of customers and another contract has already been received from Maanshan Steel in China. This is an exciting time for Meros! ■

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Interview with Hannes Sigmund on the EU Commission's recommended Environmental Protection Package

CO_2 Reductions at What Cost?

View of voestalpine steel works, Linz, Austria

"voestalpine would prefer to invest in the European steel industry, however, not at the expense of non-competitive steel production due to inacceptable environmental cost burdens. The new European-wide CO_2 emission-trading system up to 2013 is, in principle, a good starting point for a fair and balanced treatment of those industry sectors subject to emission-trading regulations, which includes the steel industry." Hannes Sigmund, General Manager of Strategic Environmental Management and the environmental spokesman of the Austrian steel and processing group voestalpine, spoke with Dr. Lawrence Gould from **metals**&**mining** on April 7, 2008 about the background and ramifications of the proposed Environmental Protection Package for the voestalpine AG and the potential impact on major company investment decisions in the near future.

On March 18, Austrian television reported that Wolfgang Eder, CEO of the voestalpine AG and Head of the group's Steel Division, threatened a halt in investments to expand steel production at its Linz works if the EU does not change its present plans regarding the allocation of CO_2 certificates for the energy-intensive industries, in this case, the steel industry. Is this a serious threat, or part of a poker game going on at a high political level? What's going on?

Hannes Sigmund: This is not a poker game. It's very serious and it's a matter of survival for the steel industry of Europe. In the EU emission-trading system, all energy-intensive industries are required to present CO_2 certificates. Up until now, these were granted by the member states as a motivation tool for investing in CO_2-reducing technology. That, unfortunately, did not work. Now, a preliminary draft is on the table with recommendations from the European Commission which is referred to as the Environmental Protection Package (EPP). If this is made into law, which is expected by June 2009, then this would mean that the energy-intensive industries will be forced to buy CO_2 certificates at their own cost. The implication of this is that in time, the EU steel industry will be at a considerable disadvantage compared to non-EU steel producers and will have no chance of surviving in an increasingly competitive international steel market.

Also, the EU package is not fair for steel producers within the EU which have already made major investments in environmental protection. We at voestalpine, for example, have invested enormous sums in energy-efficient technologies over the years. For example, our Blast Furnace "A" is now down to a specific reductant rate very close to the theoretical minimum required to produce hot metal. This is a world benchmark figure. Why should we be forced to buy CO_2 certificates when there are so many other steel producers, especially in non-EU countries such as China and India, which are not even close to this figure. Besides, they generally also have a much higher production output than we do, which greatly increases the CO_2 burden to our environment. That is simply not fair!

In what way could pending EU laws on CO_2 reductions affect voestalpine's investment plans in the so-called Edelweiss project – a completely new steel works which is to be built at a green-field site with access to the Black Sea?

Hannes Sigmund: First of all, I would like to point out that the outstanding benchmark emission values that we now achieve at our own Linz Works will be just as valid for the potential green-field project. However, if this new steel works will also be forced to buy CO_2 emission certificates, this would mean that within Europe there would be no advantage for us to install these superb environmental technologies. The consequence of this, if the EU commission doesn't change its intentions, is that that we would seriously consider building the new steel plant in a non-EU country where the CO_2 certificate regulations are not as strict.

What steps is the voestalpine presently undertaking to amend the contents of the proposed environmental protection package?

Hannes Sigmund: We are forming an alliance with other European steel producers and are also building a lobby comprised of Austrian and European politicians. What we are basically demanding is as follows: First of all, a 100 percent free-of-charge allocation of CO_2 certificates for steel producers operating at the benchmark level, which should be valid for the whole industry sector. Secondly, we are requesting compensation for increases in external electricity costs because, in comparison, the electrical power industry simply passes on their costs to consumers – a windfall profit which we don't have. An especially important point which we want to emphasize is that all steel imports to the EU must be subject to the same benchmark values. If foreign steel producers do not meet these figures, then they must also be forced to buy CO_2 certificates in the same way that European producers are required to do. That would be a much fairer basis which would not distort the free-market economy. There are many other requirements, however, these are the key issues.

Hannes Sigmund, Environmental spokesman of voestalpine AG

Finally, it is paramount in importance that the EU Commission gives a strong indication of their intentions to modify the EPP with respect to these key issues. It will be time for a decision by the end of this year at the latest because we have to finalize our investment plans for the future.

Thank you, Mr. Sigmund, for your explanations and probing insight into this highly controversial topic. ■

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Start-up of the Hadeed Midrex direct-reduction plant

World's Largest DRI Plant

The world's largest direct-reduction plant with an annual production capacity of 1.76 million tons of direct-reduced iron (DRI) was successfully started up in July 2007. This facility features the hot transport of DRI directly to the EAF steel mill. The project was executed on a turn-key basis by Siemens VAI together with its consortium partner Midrex Technologies, Inc. for Saudi Iron & Steel Company (Hadeed). It is part of the new Steel Mill Expansion Project with a nominal capacity of 1.4 million tons of flat products per year.

Hadeed direct-reduction plant and EAF steel bay

Hadeed, a company of Saudi Basic Industries Corporation (SABIC), is located in Al-Jubail on the eastern seaboard of the Saudi Arabian peninsula. As one of the largest steel producers in the Middle East, a wide range of long- and flat-steel products are manufactured that find use primarily in the construction, petroleum, pipe and household-appliance industries. In response to the continually growing regional demand for high-quality flat-steel products, Hadeed commissioned Siemens VAI to build a new 1.4 million t/a EAF-based steel mill, including a Midrex direct-reduction (DR) plant, adjacent to the existing flat-steel production facility (Metals & Mining No. 3/2007, pages 26–27). Steel production commenced on March 27, 2007, followed by the start-up of the DR facility in July 2007. DRI and scrap are melted in the EAF in a ratio of approximately 75 to 25 respectively.

The new plant, the fifth DR plant in operation at Hadeed, is a Midrex module of the Megamod series. Featuring an inner diameter of 7.0 meters, this shaft furnace is the largest built in the world to date. The plant has a production capacity of about 220 tons of DRI per hour, all of which is consumed in the new steel mill. A further highlight of this project is that DRI from the DR plant can be mechanically transported in the hot condition by means of an insulated conveyor transport to two storage bins in the steel mill for subsequent charging into the EAF at temperatures above 650 °C. With this solution electrical energy savings of up to 20 percent for melting work (130–150 kWh/t) can be achieved and a reduction in the electrode consumption by 0.5–0.6 kg/t liquid steel. Furthermore, shorter tap-to-tap times and a corresponding increase in the liquid-steel output is possible.

Long history of successful projects with Hadeed

The successful start-up of the new DR plant is the latest in a series of major projects that Siemens VAI implemented for Hadeed. Already in the early 1980s, an EAF steel mill was supplied and expanded to enable the production of more than 2.6 million tons of long products. In 1996, a contract was received for an integrated flat-steel production facility with a design capacity of 800,000 t/a. This included the complete EAF steel works, slab caster, hot- and cold-rolling mills as well as the strip processing and finishing facilities. Beginning in July, 2004, a project was carried out to expand the rolling capacity of the hot-strip mill to two million t/a. Finally, the successful start-ups of the Steel Plant Expansion Project and the world's largest DR plant in 2007 have set new milestones in the metallurgical plant-building industry. ■

Additional information under:
www.siemens.com/metalsandmining_magazine

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Start-up of the Lebedinsky Midrex HBI plant

World's Largest HBI Plant

Siemens VAI and its consortium partner Midrex Technologies, Inc. successfully started up the production facility for hot-briquetted iron (HBI) at Lebedinsky Mining and Processing Integrated Works (Lebedinsky GOK) near Gubkin, Russia. The new plant has a rated capacity of 1.4 million tons of hot-briquetted iron per year. The contract, which was previously awarded to Siemens VAI and Midrex in February 2005, was completed within 30 months. The plant started up in late October 2007 and all performance guarantees were fulfilled in December 2007.

Lebedinsky GOK, a company of Metalloinvest Holding, is the largest mining group in Russia. The company is a producer of high-quality iron-ore concentrates, pellets and HBI for the domestic and international markets. The feed for the new HBI plant consists of 100% pellets produced from Lebedinsky GOK iron ore.

1.4-Million-t/a HBI Midrex direct-reduction plant, Lebedinsky GOK, Russia

Outstanding product quality well-suited for transport

A new direct-reduction facility, Lebedinsky GOK II, was built near the city of Gubkin, located about 700 kilometers south of Moscow in the Belgorod region of Russia. The iron ores, comprised mostly of magnetite, are first concentrated and then processed to DR-grade pellets. In a Midrex direct-reduction shaft, the pellets are reduced to metallic iron followed by hot-briquetting to HBI with a metallization degree exceeding 93 percent. The briquettes, which have a density exceeding five g/cm^3, are ideally suited for transport due to the improbability of self-combustion and the low quantity of fines generated during handling.

The consortium was responsible for the supply of the material-handling system for the oxide iron ores (including day bins and screening equipment), the Midrex shaft furnace (including inserts and refractories), the 17-bay Midrex reformer with recuperator, the hot-discharge system (including product-discharge chamber and briquetter feed legs), the hot-briquetting system (including briquetting machines and HBI-cooling system), process gas compressors, the power stack system, the product-screening station, electrics, instrumentation, automation and utilities as well as for advisory services and training. Since the plant start-up, the plant has been running at capacity, fully meeting customer expectations. ■

Additional information under:
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Modernized finger-shaft EAF at Stahl Gerlafingen, Switzerland

Technology Renaissance

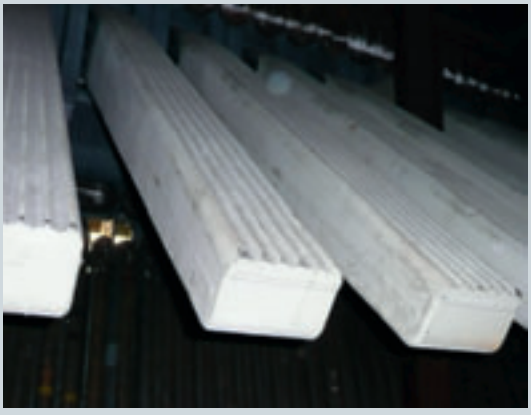
A finger-shaft electric arc furnace, which Siemens VAI had originally supplied to Stahl Gerlafingen AG, Switzerland – now a subsidiary company of the Beltrame Group – had been in operation since 1996. In order to increase furnace productivity and reduce emissions, Siemens VAI was commissioned in February 2007 to modernize the furnace in accordance with the latest equipment design features and operational experience with shaft furnaces.

Stahl Gerlafingen is the leading Swiss supplier of reinforcing steel products. The company is located in the town of Gerlafingen, which is in the Canton of Solothurn in the northwestern part of the country. Each year, a mountain of scrap comprising up to one million tons of old cars, building structures and household items, etc., is collected in Switzerland, three quarters of which is melted and rolled to commodity steel products at Stahl Gerlafingen. These are sold as merchant bars, rebars, structures, steel mesh, accessories, flat steel bars, universal plates, and wire rod to the local and regional market which are used in the construction, machine-manufacturing, automotive and shipbuilding industries.

Already in the year 1996, the company operated a shaft furnace which was supplied by Siemens VAI. Following more than eleven years of productive service life, Stahl Gerlafingen commissioned Siemens VAI to modernize their electric arc furnace to increase steel production and to decrease offgas emissions from the shaft – a particularly important target because the steel plant is located in the midst of the town of Gerlafingen. The project scope comprised the engineering, supply and installation of a new shaft and furnace equipment. This included the roof of the EAF vessel, the shaft-support structure, the shaft itself, the scrap-retaining fingers within the shaft, a shaft-roof slide gate, a tighter offgas exhaust system equipped with a movable collar for better dilution-air intake, and a newly designed scrap-basket-guidance and -positioning system to improve scrap charging into the shaft to minimize spillage. The hydraulic, automation and visualization systems were also upgraded.

Results

On January 3, 2008, the modernized shaft furnace was started up, two days ahead of the contract schedule. Roughly 80 tons of liquid steel are now tapped every



Shaft furnace

The shaft furnace is a highly innovative, energy-saving solution of Siemens VAI employed in electric steelmaking. Through the preheating of scrap in a shaft installed above the EAF by utilizing the latent as well as chemical heat of the EAF offgas, the electrical energy consumption and tap-to-tap times can be significantly reduced. At Stahl Gerlafingen, special scrap-retaining "fingers" suspend the scrap within the shaft where it is preheated for the next charge. After the liquid steel has been tapped, the fingers open downward and the first charge of preheated scrap drops into the EAF shell. The second scrap basket is then immediately charged into the emptied shaft. As the scrap inside the EAF shell melts, the scrap within the shaft gradually descends. Once there is enough room in the shaft, the fingers are closed again and the first scrap charge for the next heat is loaded. In this way, 100 percent of the entire scrap charge can be efficiently preheated.

Recent order for finger-shaft furnace from Severstal, Russia

For a new one-million-t/a long-product steelmaking facility under construction at Balakovo, about 1,000 kilometers southeast of Moscow, the Russian steel producer OAO Severstal awarded Siemens VAI another contract for the installation of a finger-shaft electric arc furnace, which will have a steel output of 125 tons per heat. Severstal once again decided for shaft furnace technology on the basis of the excellent operational results achieved with their two Siemens VAI finger-shaft furnaces in operation at Cherepovets in northwestern Russia. A ladle furnace, dedusting system, and billet caster will also be provided for this project.

40 minutes, more than two minutes faster than previously. This allows an average of thirty-six heats to be produced per day, significantly increasing steel production. This is primarily the result of the faster and more efficient charging of scrap into the shaft in addition to improved scrap preheating. Average energy savings for melting are in the range of 10 kWh for all heats. The natural gas consumption for postcombustion could be reduced by more than six percent due to the enhanced offgas-control system and reduced dilution-air intake. Emissions to the surrounding steel bay were also slashed thanks to the much tighter shaft design and the faster scrap-charging system, which shortens the time that the shaft top has to remain open. Finally, the design of the shaft top and funnel, together with exact scrap-bucket positioning for charging, means less scrap spillage and potential damage outside the shaft, reducing downtime and maintenance.

Concluding remarks

According to Walter Noack, head of the project team, "Following a project duration of only ten months and a furnace downtime of just over three weeks, the upgraded furnace could be restarted. The implementation of this project was a particular challenge for Siemens VAI. This was because much of the on-site work had to be carried out parallel to ongoing production operations to the greatest extent possible. Within only a few weeks, the specified contractual guarantee figures could be exceeded and overall furnace availability was above 98 percent. Power-up to 100 percent of productivity was reached in almost one week." ■

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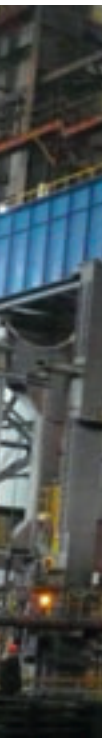
View of the shaft furnace from the front, Stahl Gerlafingen, Switzerland

Steel rain from preheated scrap



First heat of the new 300-ton converter, January 12, 2008 (both pictures)

Start-up of the new converter meltshop at Alchevsk Iron & Steel Works, Ukraine

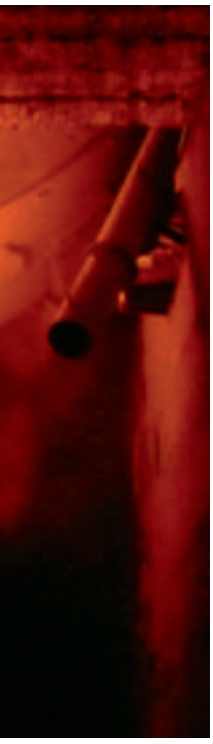
A New Era in Steelmaking

With the production start of the first of two huge converters with a tapping weight of 300 tons of molten steel, the Alchevsk Iron & Steel Works entered a new era in steelmaking. When the second converter is started up in mid-2008, the new meltshop will be capable of producing 5.5 million tons of steel per year that will be cast as high-quality slabs. The completion of this challenging project will open a window of opportunity for increased sales to the local and international markets.

Between four and six hours. That's the time it takes to make steel in the existing open hearth furnaces at Alchevsk. Up to thirty percent. That's the production loss that Alchevsk currently has with ingot casting and rolling. Lost market opportunities, intolerable working conditions, belching smokestacks – these are among the many reasons why the farsighted decision was made to implement a major expansion and modernization program at one of the oldest steel works in the region – founded in 1896.

Turning vision into reality

Already in December 2003, a series of projects commenced for the installation of the latest and most advanced technologies to increase the steel output at Alchevsk from 3.7 million tons to above 7 million tons by within 2008. Siemens VAI has already implemented the orders for a new 300-ton twin-shell ladle furnace (start-up: August 2005), a 300-ton VOD plant (start-up: May 2007) and two 2-strand slab casters (start-ups: August 2006 and May 2007). These plants were housed in a separate production bay next to the future site of the new meltshop.



Converter

Type	Two LD converters (300 tons tapping weight)
Oxygen blowing lance	1,200 Nm^3/min
Suspension system	VAI-CON® Link
Additional systems	VAI-CON® Stopper (pneumatic slag stopper), bottom stirring and steel sampling with VAI-CON® CD sublance system

Converter Offgas Cooling and Cleaning

Primary gas flow	Up to 290,000 Nm^3/min
Offgas cleaning	Dry-type electrostatic precipitator (Siemens VAI-type ESP)
Clean-gas dust content after ESP	35 mg/Nm^3

Secondary Dedusting Systems

Exhaust points	Converter charging and tapping, hot-metal re-ladling and desulphurization areas, flux and ferro-alloy systems
Raw-gas flow	Up to 3 million m^3/hr
Clean-gas dust content	< 20 mg/Nm^3

Automation

Level 1 Automation

MCCs (motor-control center), PLCs, visualization and process control software for:

- Hot-metal area
- Two LD converters
- Alloying and additive systems
- Primary, secondary and auxiliary dedusting
- Grinding mill

Level 2 Process Optimization

Hardware, system software and application software (including dynamic process models) for:

- Hot-metal re-ladling
- Hot-metal desulphurization
- Two LD converters
- Sublance system

On May 11, 2005, a contract was signed with Siemens VAI for the implementation of a major meltshop project. The scope of supply included the complete engineering of the plant, overall project management, and the supply of process equipment. This included hot-metal handling and ladle desulphurization stands, two 300-ton LD converters, ladle treatment equipment, primary and secondary offgas treatment, ladle and converter maintenance facilities, the entire additive and alloy bunker system comprising 56 bunkers, in addition to Level 1 and Level 2 process automation. The steel grades to be produced and cast include low-, medium-, and high-carbon steels, HSLA (high-strength, low-alloy), micro-alloyed and pipe grades (X70).

Start-up

The project was carried out in accordance with a tight time schedule. The new meltshop was linked with the adjacent continuous casting bay. A key challenge of this project was to efficiently execute the huge volume of construction activities – 10,000 tons of equipment and about 17,000 tons of building materials had to be installed – and to cope with harsh climatic conditions when winter season temperatures can plunge down to minus 30 degrees Celsius. On January 12, 2008, 300 tons of liquid steel were tapped for the first time from the new converter. Production ramp-up proceeded smoothly and charge-to-tap times of 40 minutes could be achieved. The excellent cooperation between the customer and project teams of Siemens VAI in addition to the skilled and highly trained operators from Alchevsk were decisive reasons for the overall success of this project thus far. The next converter start-up is scheduled for the summer of 2008. In the meantime, another order was received for the supply of a gas-switchover station to direct the offgas from the LD converters to either the flares or to a planned gas-holder for subsequent future use.

Concluding remarks

This major future-oriented investment under way at Alchevsk will position the company among the most modern and cost-effective steel producers in Eastern Europe. Instead of steel production times in terms of hours, high-quality steel will be produced far more efficiently and quickly. Instead of up to thirty percent production and yield losses with the ingot casting/rolling route, less than 10% product losses will be incurred along the LD steel production and continuous-casting route. Drastically reduced environmental emissions by a factor of more than 100 will not only benefit company employees and the citizens of Alchevsk, but the entire region as well. And with improved productivity and steel quality in combination with the increased flexibility to changing product demands, new doors will be opened to the market for long-term and sustainable growth. ■

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Introducing the new dry-type I-STAR Revolver Rollers for improved slab-caster operations

Really a Dry Topic

Since 2003, a new dry-type caster roller has been under development by Siemens VAI which no longer requires external spray-water cooling. Referred to as the I-STAR (Intermediately-Supported Trans-Axle Roller) Revolver Roller, this solution offers a number of operational, product-quality, maintenance and environmental benefits for producers. This roller type was extensively tested and is now in industrial operation in slab casters in South Africa and Korea.

I-Star Revolver Roller

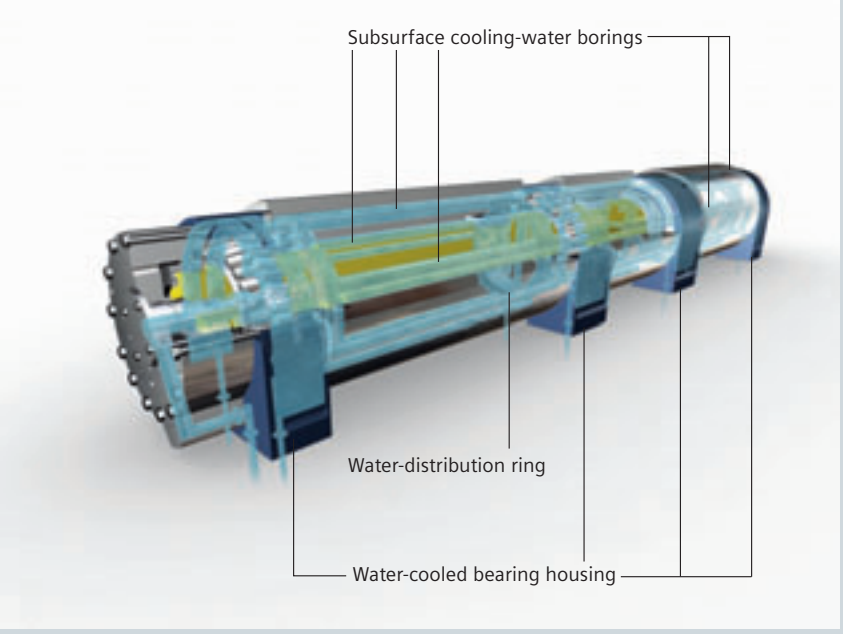
Conventional caster rollers require external spray cooling to prevent roller surfaces from overheating during casting. Even after the slab has entered the horizontal part of the caster where external spray cooling is no longer required, water must still be continually sprayed onto the roller surfaces to prevent roller failure. This is undesirable as it can lead to overcooling, inhomogeneous cooling, and adverse metallurgical conditions, resulting in possible slab deformation, quality deterioration, and bearing damage. Furthermore, excessive quantities of wet-greasy scale may build up which are difficult to remove from the segment area and which tend to harden on the top of the roller-bearing housings where they can scratch the slab surface.

For these and other reasons, Siemens VAI commenced with the development of a new generation of caster rollers which no longer require external spray-

water cooling. Following extensive investigations and field tests at slab casters in Austria (voestalpine Stahl/CC 5), Finland (Ruukki Raahe Steel Works/CC 6) and the USA (Mittal Steel USA at Sparrows Point/MD), an optimized solution was implemented in which cooling water from the roll center is directed to the peripheral zones of the roller. The water then flows through a series of near-surface channels bored through the roller body, effectively cooling the roller surface to an acceptable temperature range.

A cool roller solution for hot strands

The I-Star Revolver Roller is the ideal roller solution for the horizontal zone of the caster where the strand no longer requires external spray cooling. The lifetime of the segments and rollers is prolonged as corrosion from the effects of water does not take place. The scale that sheds from the slab surface is dry and can therefore be more easily removed from segment area. Because wet-greasy scale is not present, it cannot accumulate and harden on the top of the roller-bearing housings, eliminating scratching of the slab surface. Slab cooling is equalized, thus supporting uniform heat removal and strand solidification. The costs for the treatment of industrial water are reduced and, because the internal cooling water is recycled to the rollers, less make-up water is required – particularly important in countries with limited water supplies.



3-D view of the I-Star Revolver Roller

A recent operational trend in continuous casting is to supercool the strand in the upper part of the machine in order to increase the range of possible casting speeds, both for high-speed casting as well as for low-speed casting as required for the production of crack-sensitive steel grades such as peritectic steels. However, when the strand is overcooled, torch-cutting may take too long, requiring a reduction in the casting speed, which reduces productivity. With the elimination of external roller cooling in the horizontal machine section, the slab surface is reheated prior to slab-cutting due to the remnant heat from the inner part of the slab. Furthermore, the higher temperature of the slabs exiting the machine allows energy cost savings to be achieved during slab reheating for plants with hot charging/rolling operations.

Alternatively, for the casting of both highly crack-sensitive steel grades as well as ultra-thick slabs requiring the application of "super-soft cooling" in the caster-bow area, there is the danger that the surface of conventional rollers could overheat due to insufficient spray-water quantities. I-Star Revolver Rollers are therefore the ideal solution for numerous casting applications.

In existing slab casters experiencing problems with roller-spray cooling, I-Star Revolver rollers can replace conventional rollers. They are cooled and operate using the existing external spray-cooling system. This provides additional roller protection, increases the margin of operational safety and reduces unplanned maintenance.

First industrial applications

I-Star Revolver Rollers were first installed in the V2 slab caster of Mittal Steel South Africa in Vanderbijlpark in early 2007. This was followed by the installation of more than 400 rollers of this type in a 2-strand slab caster at Posco's Gwangyang Works in November of the same year. According to Johann Pöppl, co-developer of the I-Star Revolver Roller, "Field-test results up until now indicate a reduced roll wear and a cleaner segment environment, meaning reduced bearing damage, and fewer marks on the slab surface. We are confident that the new I-Star Revolver Rollers will one day become the 'solution of choice' for the roller assemblage in the horizontal caster section, as well as along nearly the entire strand length when critical steel grades and ultra-thick slabs are to be cast." ■

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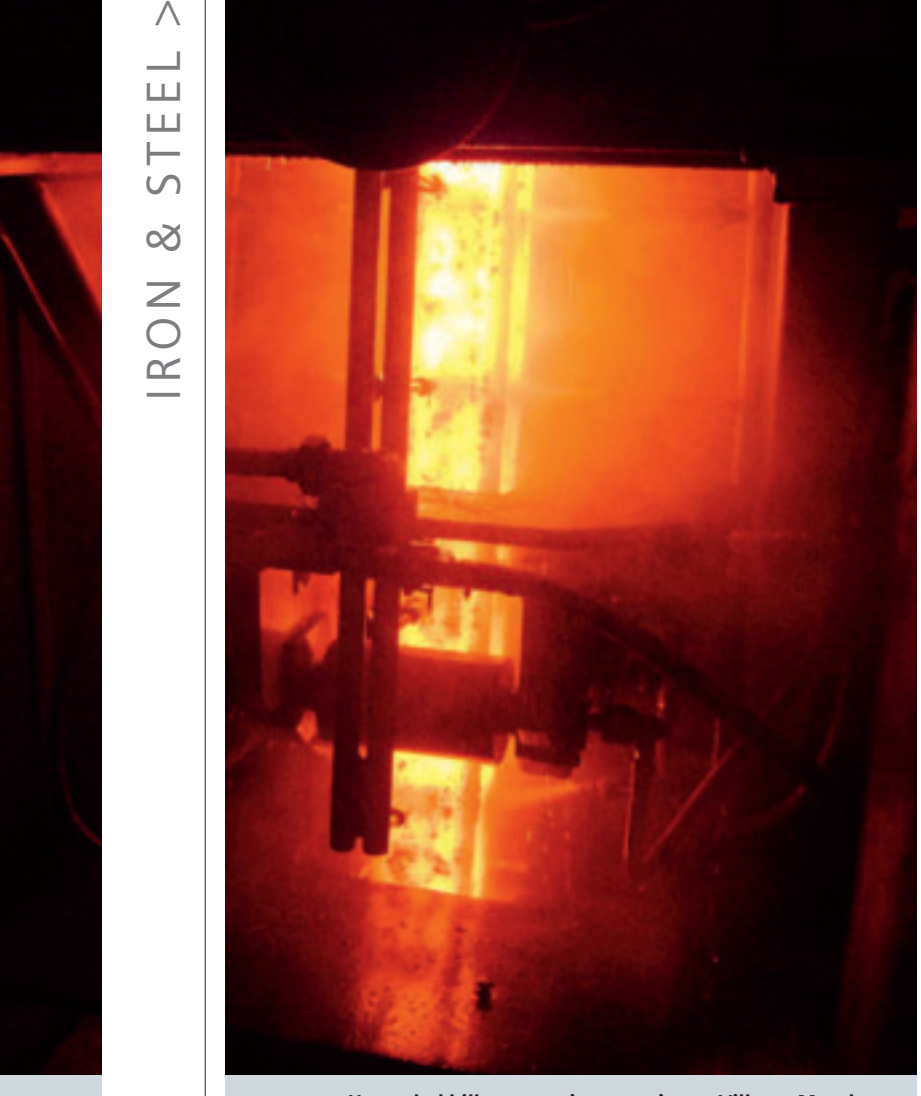
Start-up of upgraded billet caster and new multi-line rolling mill at Villares Metals, Brazil

Benchmark for Excellence

Beginning March 2005, Siemens VAI implemented two landmark projects for the Brazilian specialty steel producer Villares Metals. One was for the upgrading of a single-strand billet caster and the second was for the installation of a new multi-line long-product finishing mill. The project activities at Villares Metals, which were carried out on a turnkey basis, came to a successful conclusion with the receipt of the Final Acceptance Certificate in October 2007.



Upgraded billet caster in operation at Villares Metals, Sumaré, Brazil

Villares Metals, a company of the Austrian Böhler-Uddeholm Group since 2004, is the leading producer of high-alloy and specialty-steel long products in Latin America and one of the top three producers of valve-steel products in the world. At the company's Sumaré plant, near São Paulo, up to 80,000 tons of the most sophisticated high-alloy and specialty alloy steel grades can now be rolled into a wide range of round, square and hexagon bars, wire rod and flat-bar products. These are comprised of tool, valve (austenitic and martensitic), stainless (austenitic, ferritic, martensitic, PH, duplex and super-duplex), and high-speed steels in addition to an extensive range of special alloy grades (e.g., corrosion-resistant, high-temperature-resistant, maraging, and surgical implants). Besides serving the domestic market, Villares Steel exports its products to the United States, South America, Europe, and numerous other countries worldwide.

Billet caster

Following a number of years of excellent service life, the existing single-strand billet caster at Villares Metals had to be upgraded. This was necessary in order to meet increased demands placed on productivity and product quality as well as to boost the number of steel grades that could be continuously cast, instead of having to be cast as ingots. A contract was signed with Siemens VAI on September 1, 2006, for the caster upgrade, which included significant modifications to the tundish, caster head, strand-containment system, and the secondary-cooling system.

The revamp started with the installation of a new hydraulic stopper system to better regulate the flow of steel from the tundish to the mold. In conjunction with

Bar line

Wire-rod line

the Siemens VAI LevCon mold-level-control system, a constant molten-steel level (+/–2 mm) inside the mold can now be assured – a prerequisite for avoiding billet-surface defects and possible slag inclusions in the steel. The previous electromechanical lever-type mold-oscillation was replaced with Dynaflex hydraulic oscillation, allowing the on-line adjustment of mold-oscillation parameters (stroke and oscillation frequency) according to the steel grade and casting speed. A new external mold stirrer was installed to enhance the steel homogeneity. The previous mold was substituted with a Dia-mold-type mold and extended to 800 mm in length for better strand support. Molds with different tapers were supplied to correspond to the shrinkage characteristics of the various steel grades cast for optimum heat removal and strand-shell formation. The secondary-cooling system was modified to enable different spray configurations to be applied, depending on the cooling requirements of the steel grade. Finally, a new billet-guiding system inside the cooling chamber was provided.

On October 10, 2007, the first heat (stainless steel 304 grade) was successfully cast on the upgraded caster. Billets with 145-mm-square sections are produced. Start-up proceeded smoothly without problems and all guarantee figures were quickly met. Promising tests were also carried out on high-speed, high-carbon tool steels, which are normally cast only via the ingot-casting route.

Finishing mill

The new multi-line finishing mill installed at Villares Metals incorporates a straight bar line, a wire-rod line, a large-flats line in addition to cooling and handling facilities. Approximately 1/3 of the steel rolled comes from the billet caster and 2/3 of the steel comes from the blooming mill. The layout of the mill is designed to enable maximum flexibility in scheduling rolling campaigns to meet rapidly changing market requirements and small-order lots.

Bar line

The “core” of the mill is the bar line, capable of rolling bar to sizes from 12.7 to 76.2 mm. Squares and hexagons measuring 17.5 to 54.0 mm can also be produced in addition to smaller flat products. Billets coming from the single-strand billet caster are size-reduced in a 3-high rougher after which they pass through the tunnel furnace for temperature reheating and equalization for rolling requirements. They are then rolled to the required sizes by 16 CCR-type (Cassette-type Compact Rolling) stands positioned in a 45° arrangement in alternating right- and left-hand sequences to assure no-twist rolling operations. These are divided into four CCR-stand groups with crop and dividing shears installed between each group. CCR stands are characterized by their extremely high rigidity, necessary for the precise rolling of special steel grades with narrow dimensional tolerances. Rapid roll-change operations are carried out whenever a new family of products is to be rolled, both inline for the cassette and offline for the rolls.

Groove changes and gap adjustments are also quickly adapted to satisfy new process parameters. After rolling, the bars are either cooled on a 42-meter-long cooling bed, followed by cutting, bundling and strapping, or transferred to the wire-rod line for further size reductions.

>>

Rolling stand of large-flats line

>> Wire-rod line

The wire-rod line is the 2nd line of the mill. It is capable of rolling wire products with diameters ranging from 5.0 to 13.5 mm. It is designed in a monoblock stand arrangement comprising two separate finishing blocks of six and four stands each. This configuration supports an optimum control of operations along the line and allows bar ends to be cropped as required. The monoblock stands are arranged 90° in an alternating left- and right-hand configuration to each other and at an angle of 45° from the shop floor. This configuration, together with a symmetric roll gap adjustment, assures a no-twist and fixed pass-line operation. Bar diameters from 6.7 to 11.1 mm are finished on the first monoblock, and bar diameters from 5.0 to 6.5 mm on the second one. High rolling speeds and high production rates characterize this line. For example, a maximum speed of 50 m/s is achieved on the second block with a roll-ring diameter of 175 mm.

Maintenance is facilitated in that access for roll changing is available from both sides of the rolling blocks. Most components of all ten stands are identical or optimized to reduce spare-parts requirements. All roll rings have the same size for easier roll management.

The pinch-roll unit assists the bar in passing through the coil-laying head. It is designed in such a way that both rolls move identically to make the pinch. A bar nose-end-positioning system ensures that the leading end of the first ring of each coil does not snag on the cooling conveyor, but that it is laid with its nose end in a trailing position. The roller-type cooling ring conveyor features separately driven sections to minimize hot spots. It is designed to operate in three different modes, according to the steel grade:

- Fast cooling – using axial flow fans to blow air through the bar rings
- Normal cooling – where the fans are switched off but the insulated covers are not used
- Slow cooling – where the fans are switched off and insulated covers enclose the bar rings within the conveyor system

Following cooling, the coils are compacted and bound in the automatic binding machine.

Large-flats line

Flat-rolled products with widths ranging from 70 to 250 mm and with a maximum thickness of 63 mm can be independently produced in the large-flats line, reducing the set-up time of the complete mill. The flat block is fully CNC-controlled (computer numerical controlled) and comprises two stands in V/H (vertical/horizontal) arrangement which operate in the reverse mode for up to eight passes. (Provisions were made for the installation of a third stand in the future.)

The flat block covers the production of a wide range of flats through simple and quick adjustments, employing grooveless cylindrical rolls eliminating the need for roll changes. The two stands are individually driven with adjustable speeds, allowing the temperature profile and the output to be optimized depending on the steel grade. Minimum tension control assures

Project Milestones

2005

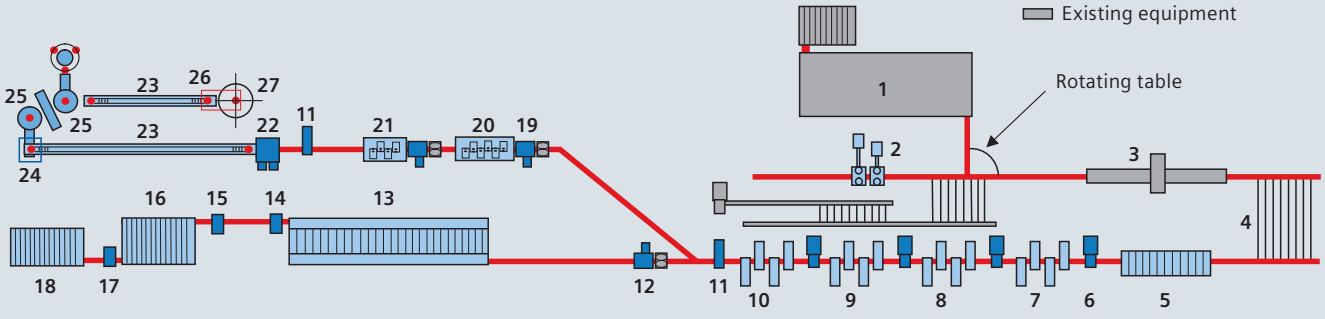
February:	Contract signature for technical specifications
March:	Contract effectiveness
October:	Start of civil works

2006

June:	Bar line delivery completed
October:	Bar line erection completed Flat-rolling block and wire-rod line delivery completed
December:	First hot-rolled bar in bar line Flat-rolling block erection completed

2007

January:	Wire-rod line erection completed
February:	First hot-rolled bar of flat-rolling block
March 7:	First coil produced in wire-rod line
May 7:	Shutdown of old mill
October:	Receipt of Final Acceptance Certificate



Legend

Large-flats line: 2
Bar line: 4–18
Wire-rod line: 19–27

1 Furnace (Capacity: 25 t/h)
2 Flat-rolling train
3 3-High rolling stand
4 Cross transfer
5 Tunnel furnace
6 Pendulum shears
7 Roughing train
8 Intermediate train
9 Pre-finishing train
10 Finishing train
11 Measuring gauge
12 Pinch roll and dividing shear
13 Cooling bed
14 Abrasive saw
15 Abrasive saw (future)
16 Layer transfer and bundling
17 Combined strapping machine
18 Bundle-discharging system
19 Pinch roll and flying shear
20 1st Monoblock
21 2nd Monoblock
22 Laying head
23 Cooling conveyor
24 Coil-forming station
25 Coil-discharge and -lifting device
26 Coil-tilting station and transfer car
27 Turnstile

Layout of the multi-line rolling mill, Villares Metals, Sumaré, Brazil

low-tension rolling. Roller tables on both ends of the flat block, which feed the bar into the flat block, are hydraulically raised and lowered to adjust to different product sizes. Bar centering is done by aligning manipulators on both fronts of the flat block by means of two movable rams, which are hydraulically operated. Guiding supports are provided on the top and bottom of the vertical stand to hold the bar in flat position. The vertical stand uses rolling rings mounted on reusable shafts, while the horizontal stands employs conventional solid rolls.

RollMaster for mill automation and setup

In accordance with the order schedule and on the basis of a database containing the properties of more than 200 steel grades and special alloys, rolling pass schedules are automatically calculated and the corresponding mill setup applied on the basis of Siemens VAI RollMaster software. The roll gap of each stand is adjusted and other setting changes for the rolls, grooves and guides, equipment speed and torque are carried out, taking into consideration the steel grade, dimensions of starting stock, finished products as well as the desired temperature profile. Optimized rolling programs are stored in the form of recipes, alloying the operator to immediately initiate a rolling sequence – even for new steel grades and product dimensions. The result is an enhanced production output due to reduced mill setup times and an improved repeatability of product characteristics. RollMaster is well proven in over 15 mills worldwide.

Concluding remarks

The new multi-line rolling mill is part of a major investment program under way at Villares Metals to increase productivity and further improve the quality of the steel used for highly demanding applications. Flexible, efficient and profitable production, even for small order lots and changing market demands, is made possible by the compact mill layout, advanced equipment design, and well-proven process and automation solutions. The project proceeded smoothly and without production loss of the existing facility, thanks to the outstanding cooperation and expertise of the customer and supplier teams. The fast production ramp-up can be attributed also to the technical know-how exchange with Böhler Uddeholm and intensive training of customer personnel at a reference plant in Poland (BGH Polska). ■

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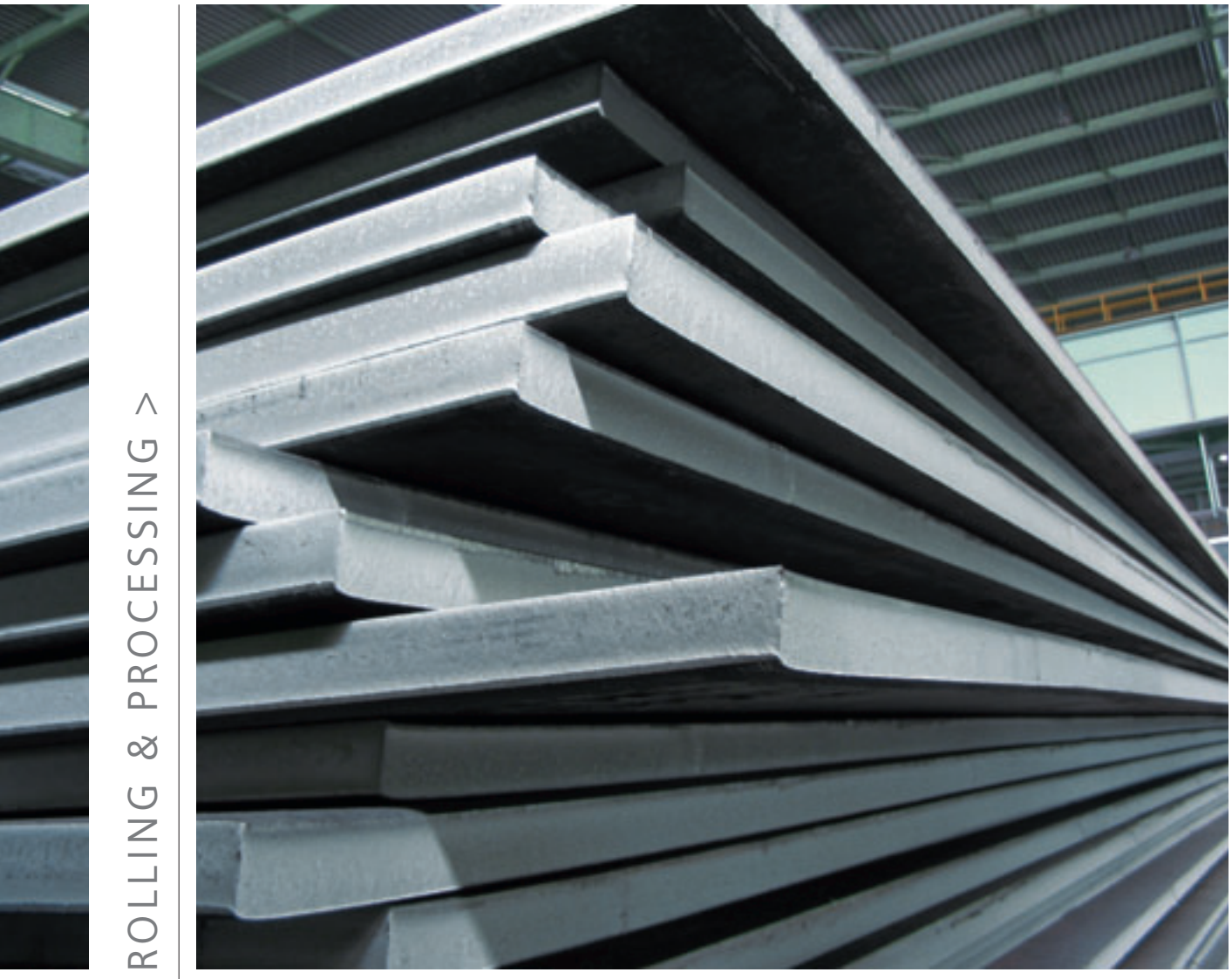


Competitive technology for the modern plate mill

David versus Goliath

Plate mills, needless to say, are not the kind of asset that wears out. The physical duty implicit in plate manufacture means that the machinery is extremely robust. With attentive maintenance, therefore, the equipment of the plate mill should last almost forever. But will it?

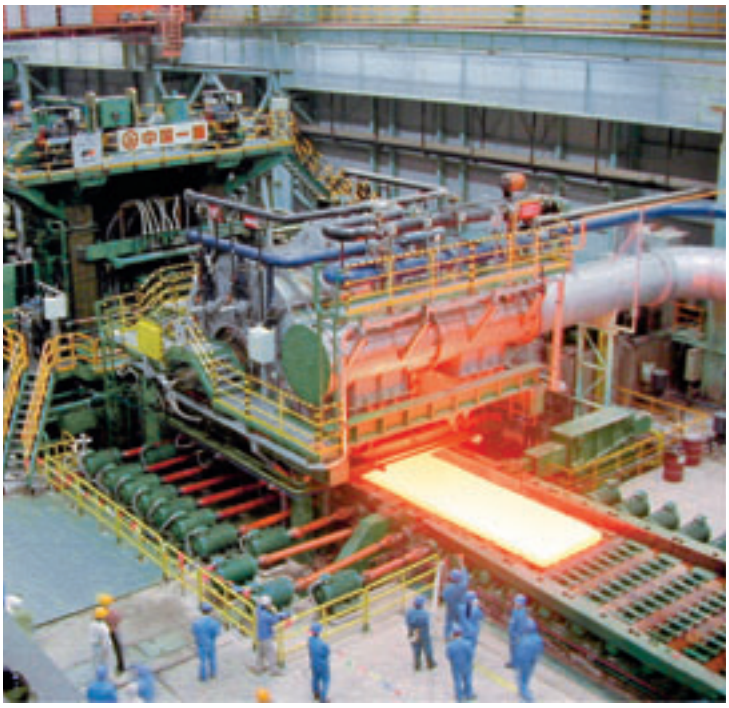
Wuyang 4.1 m wide plate mill, China

The longevity of the plate mill hinges on another factor. It may be durable enough to operate at its design duty for a very long time, but what if that duty requirement changes? Plate is part of a trend toward higher strength that's evident in every kind of steel product. The principle of lightweighting (using stronger steel at thinner gauges) is driven by simple business economics, and reinforced in terms of the sustainability of global resources.

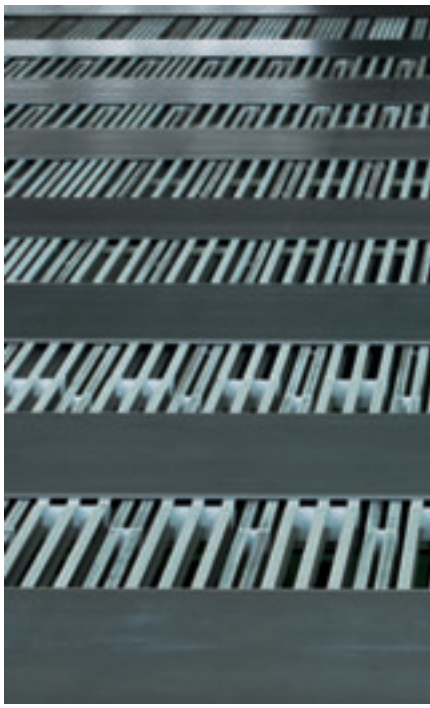
The resulting trend toward higher rolling duty in the plate mill is not just a matter of dealing with increased deformation strength in the roll bite. Along with increased strength come additional product quality attributes, and these too are becoming more exacting. The quality standards for plate are unusually demanding because the applications of the product need exceptional safety and surety. The costs of failure in construction or use of a sub-sea gas pipeline, to give just one example, are enormous, but just one defective plate is potentially capable of precipitating such a failure. This degree of application criticality is not unique. The same observation can be made about ship plate for bulk freighters or structural plate for bridge building.

The mills being built today anticipate modern plate application requirements. Today's plate mills are immense, and an operating specification at full overload of 10 megawatts of power and 20 meganewtons of rolling force per meter of width has become the norm. On the other hand, a plate mill that was built twenty years ago (and there are very many of these operating around the world) was designed by engineers who could not foresee these modern requirements. The load and torque capacity of these mills is typically no more than two thirds of the modern benchmark, and sometimes less.

In the best David and Goliath tradition, though, the competitive position is not a simple matter of the bigger mill being bound to win. By judicious selection >>



Nisco plate steckel mill, Nanjing, China (left)



>> of upgrade technology, a relatively low-powered mill can produce high strength steel both efficiently and economically.

The process metallurgy of high-strength plate

Historically, high-strength plate was produced by solid solution alloying with high carbon and manganese levels, where necessary augmented by off-line heat treatment. Modern high-strength plate grades are instead produced by microalloying at low carbon levels coupled with the use of a special rolling and cooling practice. The modern technique has been developed because it yields steel of superior quality, particularly in terms of enhanced weldability (through lower carbon equivalents) and toughness (through finer microstructures). Microalloying relies on a combination of grain refinement and precipitation mechanisms for strengthening. This strengthening is not exhibited until the late stages of rolling, and only completely developed in cooling beyond the mill. This is, of course, exactly what the "Davids" are looking for: higher strength product from a less severe rolling duty. On the downside, a specific temperature-strain path must be followed in order to achieve the properties. Most of the rolling can be accomplished above a critical temperature (the temperature at which the precipitation mechanisms arrest recrystallisation in the hot steel), but a certain amount of strain must be applied after recrystallisation has ceased. This means that two phases of rolling are separated by an idle period of stock cooling, usually referred to as the "hold."

The keys to so-called thermomechanical-controlled rolling (TMCR) in a lower-powered mill are therefore:

- a set-up calculation for the mill that incorporates the metallurgical science
- a means of compensating for the lost asset utilization caused by the holds
- a suitable cooling system beyond the mill

These three technological features can be integrated to realize an ideal solution. They also demonstrate a new trend in plate mill engineering, with customers' requirements moving beyond the design and supply of heavy machinery to include the development of value-adding processing systems. With its broad technology and engineering capability base, Siemens is ideally equipped to fulfill this emerging need.

Elements of a plate mill upgrade for TMCR

The fixed asset among these core features of the Siemens plate mill upgrade portfolio is the post-rolling cooling system. The Mulpic system combines high cooling rates with exceptional full-surface uniformity, so that metallurgical flexibility is maximized while at the same time preserving product flatness and freedom from residual stress. With twelve system sales in the last four years, Mulpic is now established as the clear market leader among accelerated cooling systems worldwide. A first sale to a major Japanese steelmaker was announced in 2007: Japanese mastery of plate cooling began in the late 80s, and their home technology has until now been considered unassailable.

Mulpic has been developed through cooperation with CRM in Belgium. In its different modes of use, it

can achieve a wide range of product-specific benefits, including:

- elimination of separate heat treatments in some traditionally quench-and-temper processed grades
- finer grain structure and thus increased strength and toughness in TMCR grades such as linepipe and shipplate
- higher rolling rates through higher finishing temperatures for general construction plate

The accelerated cooling system was described as the fixed asset element of a TMCR upgrade because it is normally approached as a one-off investment. The control systems can be treated in the same way, but an alternative approach of progressive development and refinement is also possible, matching the evolution of the plate-maker's business needs and market opportunities. For this reason, Siemens is organized to serve plate mill automation customers through a consulting service as well as through a product engineering group.

The recovery of utilization in TMCR can be achieved by multi-piece rolling (also known as interleaving). Several plates occupy the mill line at once, with the rolling phase of one absorbing the idle holding time of another. The resultant marshalling problem and its optimization criteria are complex, since uniformity of plate properties depends on repeatability of heating, cooling and strain cycles. Siemens has applied for patents in respect of advanced techniques, and the latest systems have demonstrated as many as six plates in process at once.

A metallurgically-based mill set-up calculation has already been realized for strip. The development impetus in that sector comes from model-based quality certification, leading to avoidance of test-house costs and accelerated product delivery. In plate, with its safety-critical applications, physical testing will not be so readily relinquished, and so the investment justification has to be different.

Siemens is actively developing a plate mill version of its successful strip mill Microstructure Monitor product. In order to form the core of the Level 2 control model that determines the rolling schedule, several radical features are needed. The better on-line models already incorporate a yield stress calculation that takes account of the phase behavior of the steel. In addition to this, the full on-line model has to identify the microstructure required for the specified properties and to calculate the temperature-strain path necessary to induce it. Cooling as well as drafting needs to be incorporated, so that model-based control must be applied to the full line process.

Ancillary technology

In addition to the TMCR features described above, Siemens has developed a full range of ancillary technologies for increased product range and quality through a plate mill upgrade. These include heavy-duty shearline equipment, with a latest variant in the fully hydraulic SmartShear, and a complete range of leveling equipment. Hydraulic gauge control conversion, including the incorporation of plan-view rolling, can also be undertaken. Motor and drive upgrades, process automation enhancements and a full range of technical, consulting and operational services complete the upgrade portfolio.

Siemens is of course also market-leading supplier of new plate mills, and so can assist in cases where an upgrade cannot meet the business requirements (a rolled width increase, for example) or indeed in larger-scale upgrades such as the addition of a second stand for increased capacity or a conversion to plate-Steckel operation for increased piece weight.

In conclusion, it's worth remembering that investment in a rolling mill, or indeed in any industrial asset, should target clear business outcomes. The most successful plate mill upgrade projects are planned to achieve specific things to serve specific markets. In this respect, an expert steelmaker working in partnership with an expert plant-builder is more powerful than either working alone, and Siemens stands ready to take its part in that partnership. ■

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Commissioning on the conventional hot-strip mill at ArcelorMittal, Poland

Leading Forming Technology

On 2007 June 17, at the hot-strip mill of the ArcelorMittal Group in Cracow, Poland, the first coil was produced. ArcelorMittal now has the most modern hot-strip rolling mill in Europe. The mill was supplied by Siemens VAI on a turnkey basis.

With a maximum strip width of 2100 millimeters, this hot-strip mill is one of the widest of that kind in Europe. The new mill in Cracow should be designed according to the market requirements in Poland. It was therefore important to serve the market segment of wide automobile sheets. The thickness range includes very thin qualities as low as 1.2 mm for which a market for the direct distribution of hot-rolled wide strip in Poland exists. At the same time, sheets up to a thickness of 25.4 mm are required for pipe grade applications. Due to the restrictions set by the EU, the production capacity is currently limited to 2.4 million tpy. The plant concept, however, is designed for an expansion up to 4.5 million tons.

The hot-strip mill was supplied as a turnkey installation. Apart from the technological equipment and the complete electrical, drive and automation systems, the project included construction, the roll-shop and auxiliary installations – including water treatment equipment. Training of the operating and maintenance personnel was as well carried out as the installation and the commissioning.

Layout of the mill

The mill consists of a reheating furnace, a reversing 4-high roughing mill with a hydraulic edger, an Encopanel heat retention system and a crop shear. The six-stand finishing train is equipped with work roll bending and shifting, which enables a larger adjusting range for profile and flatness control (SmartCrown). The laminar cooling section uses quickly switchable "SmartCoolers" in the fine cooling zone for precise control of the cooling process. Two "PowerCoilers," each with four wrapper rolls, ensure reliable coiling of all products up to thick high-strength steel grades. A coil conveyor with inline inspection station for the coils completes the mill area.

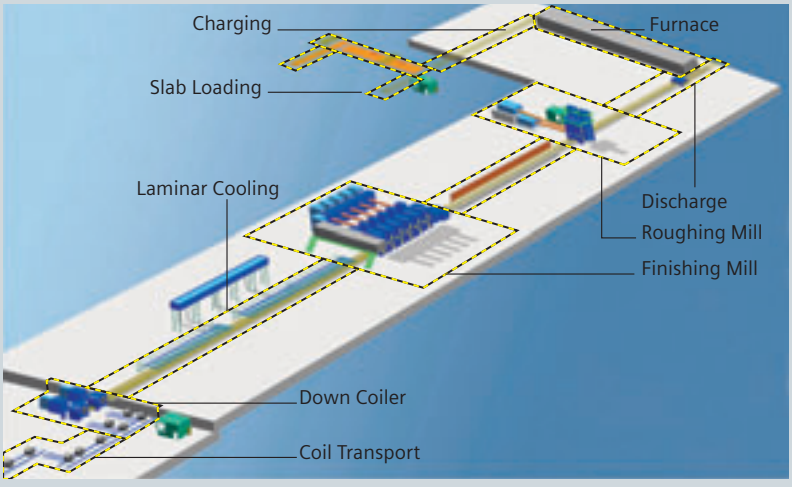
Safety at work

An important property of the plant is the integrated safety concept. A comprehensive safety plan was drawn up for adopting the highest EU safety standards. Ever decreasing throughput times and therefore also considerably shorter construction periods require special attention regarding the safety coordination of these projects. A functioning Safety Management System for the safety of all persons concerned in the construction of a plant is therefore a precondition. Information, training and monitoring, as well as creating safety awareness, are the central elements. Siemens VAI's Safety Policy is the source for all safety measures. The plant was divided into nine safety areas which each have their own safety management. The safety management includes:

- Access control to critical mill area
- Emergency stop system integrated into automation system.
- Failure-safe PLC systems for all safety-relevant functions.

Plant Data

Annual production:	2.4 million tons (4.5 million tons)
Work roll length:	2400 mm
Strip width:	800 – 2100 mm
Strip thickness:	1.2 – 25.4 mm
Max. coil weight:	35 t
Specific coil weight:	21.6 kg/mm
Products:	structural steel, AHSS, API pipe grades (X70, X80), multiphase steels (DP, TRIP), HSLA steel, silicon steel, austenitic and ferritic steel



Safety areas of the mill in Cracow

• Several emergency stop strategies with highest consideration of personnel and material protection.

The safety concept was presented and approved by the authorities right before installation. It was extremely important to be in compliance with the various statutory and safety rules and regulations of the Government of Poland as well as those issued by ArcelorMittal Poland.

World record with 23-month project execution

On 28 June 2007, the first coil was produced – only 23 months after the signing of contract. The start-up of the plant was achieved by the end of October with approximately 75,000 tons per month. In the following months, the plant was scheduled to run with 200,000 tons per month. At the end of October, widths between 1000 – 1700 mm and thicknesses as low as 1.65 were rolled. The wide range of products includes standard carbon steels, high-strength steels and highly developed steels with thicknesses between 1.2 – 25.4 mm. Meanwhile also thick gauges up to 25.4 mm were successfully rolled. A high-quality strip was also produced with extreme widths and thicknesses such as 1.2 mm x 1000 mm and 2.0 mm x 2000 mm.

Excellent plant performance: Example PowerCoiler

In the coiling section, two PowerCoilers are installed to allow for an improved coiling of high-strength and other advanced steel grades, especially for thicker gauges. A key focus of this development was to employ the pinch rolls and the first wrapper-roll unit to prebend the incoming strip, so that the overall power demands for the initial coil windings could be significantly reduced with a simultaneous reduction of friction between the strip and coiler aprons.

With the PowerCoilers, excellent coils could be produced at various steel grades and strip dimension. Also with the steel grade S355 at a thickness of 25 mm and a width of 2000 mm a perfect coil was produced. The PowerCoiler has the unique capability to coil up to 2100 mm wide strip in a thickness range from 1.2 to 25.4 mm without problems at an excellent quality. ■

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Special products: Siroll^{cis} Edgewipe

Edge of Green Technology

As quality levels in the steel and aluminum industry increase, so too, does material waste and the impact on the environment. Siemens VAI special products, such as Siroll^{cis} Edgewipe, improve product quality, primarily to increase yield, while reducing the environmental impact of the production process.

While each product in the Siemens VAI Special Products portfolio can reduce environmental impact in some form, the Siroll^{CIS} Edgewipe is particularly important for reducing harmful waste. Designed for the efficient removal of residual edge bead coolant from aluminum strip during the rolling process, Siroll^{CIS} Edgewipe benefits the yield, quality, and performance of the aluminum production process.

Need for lower coolant carryover and migration

Studies of coolant migration from the entry side to the exit side of aluminum cold rolling mills have shown that the top and bottom surfaces of the strip are almost completely dry when they leave the mill bite. Strip contamination caused by roll coolants occurs downstream of the mill bite, it is this area that needs to be addressed when considering systems to prevent coolant carryover wetting the outgoing rolled product.

Conventional preventive coolant carryover methods include mill guarding, backup roll wipers, neck guards, and air blow-off systems. Mill design also plays an important role, and attention to anti-drip structures above the pass line, sump design to prevent pooling of the coolant under the exit table, and effective and balanced fume extraction systems are key areas that have a direct effect on strip dryness. All of these conventional preventive coolant carryover methods, when combined and optimized, result in a reasonably effective system to reduce unwanted coolant carryover on the strip.

However, there is one significant area of coolant carryover that is not addressed by these methods. This is the unwanted coolant carried through the unfilled portion of the roll gap, outside of the strip width, which tends to adhere to the vertical edges of the strip in the form of a bead of coolant that, if left unchecked, then migrates to the adjacent bottom surface.

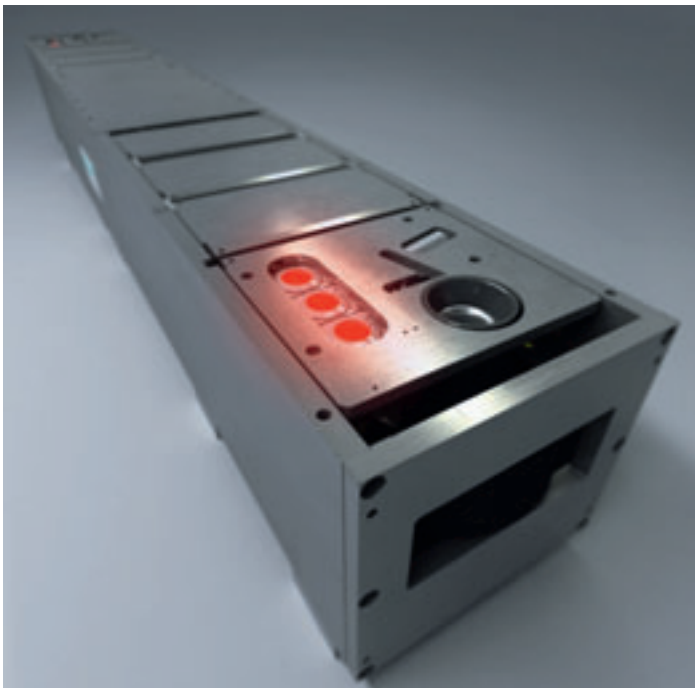
The coolant carryover presents itself as a bead of coolant sticking to the edge of the strip and is more pronounced the thicker the strip thickness. The result of the coolant bead on the strip edges may often be seen as a river of coolant pouring down the sides of a recently rolled coil. Migration of the edge bead coolant between the individual laps of the coil presents additional staining problems, particularly if the coil is then to be annealed. This can often be seen as dark staining on the surface of the strip.

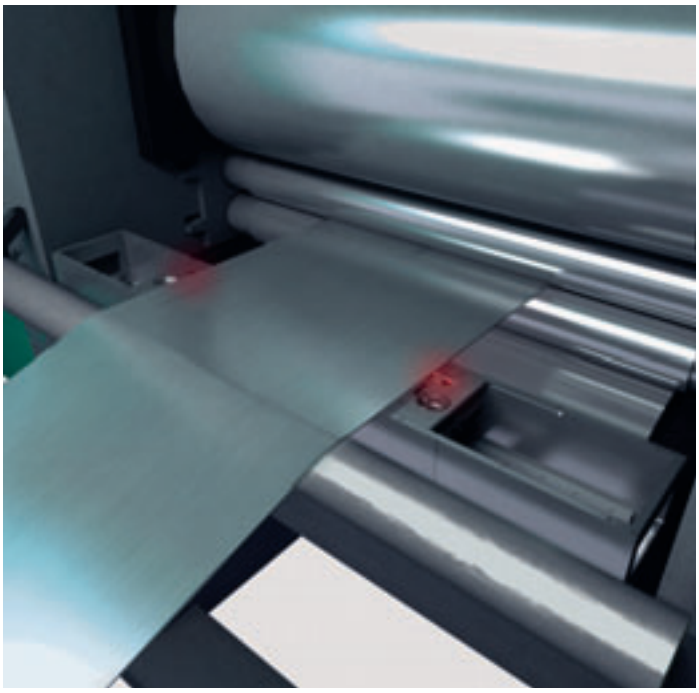
Superior strip drying

Siroll^{CIS} Edgewipe is designed to work in conjunction with the conventional mill strip drying equipment. It is installed below the pass line on the exit side of a mill, close to the mill bite. It uses focused air sweeper jets and knock-off jets to blow the coolant bead from the strip edge. A local coolant catchment device is associated with each set of knock-off jets and these catch the resulting plume of coolant and exhaust into the mill sump using an air mover system.

For the knock-off jets to be effective, precise positioning of the jets relative to the strip edge is important. The jets must be positioned to accommodate differing strip widths and any strip movement that may occur during the rolling process. This is achieved by mounting the sweeper jets, knock-off jets, and coolant catchment air movers on two carriages located on either side of the strip. Each carriage can be moved independently of the other using hydraulic cylinders with integral transducers, enabling the carriages to be moved over a range from minimum strip width to maximum strip width, or moved outside of the strip width to a parked position.

Strip edge positioning is achieved using a dynamic closed-loop infrared detection system that comprises an infrared emitter and two infrared receivers mounted on each carriage. The automatic edge detection sys-





Siroll^{CIS} Edgewipe infrared strip edge detection system

tem also enables the feedback from the carriage transducers to provide an output of strip width and strip centering. This is particularly useful for shape control systems that rely upon accurately centered strip and where no other strip width/positioning measurement is available on the mill.

A constant exit table pass-line ensures that the knock-off jets always intersect at the strip edge, thus ensuring good edge bead removal. Each pair of knock-off nozzles is configured for a different pass line height and switched according to the position of the strip above the Siroll^{CIS} Edgewipe.

Robustly built and with a width of only 300 mm, Siroll^{CIS} Edgewipe is easily fitted into existing cold mill exit tables as well as new mill installations. The system is suitable for both kerosene and water-based coolants and for all strip thicknesses, although it is most effective for strip thicknesses of 0.5 mm and above. ■

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Siroll^{CIS} CM makes the difference in new rolling mills

Major Market Success

Worldwide, the order books for rolling mills are full. Siroll^{CIS} CM is the Siemens VAI solution package designed for building the most-advanced mills able to meet the latest market requirements.

The current order boom in rolling mills is primarily due to two factors. On the one hand, strong growth in raw steel production is increasing demand for additional rolling mill capacity. On the other, the development of high-density steel grades requires cold rolling mills that are able to roll advanced materials economically. These mills include coupled pickling line tandem cold mills (PLTCM) with an output of 1.2 million tpy and more (see article in the 01/2008 issue of this magazine).

The 1990s were characterized by the transition from discontinuous to continuous operations for cold tandem mills, particularly in combination with a pickling line. This made it possible to increase the performance of an existing mill with a relatively small capital investment. Features included the greater availability of equipment, new generations of automation systems and advanced rolling strategies, all of which made it feasible to control complex, coupled operating modes.

Integrated solutions

Several years ago, Siemens VAI developed mill layout concepts and automation solutions for the rolling of high-density steels. By combining the mill layout and technological equipment with high-performance drive and automation technology into the integrated Siroll^{CIS} CM solution, Siemens VAI is now able to offer a unique performance portfolio in the marketplace.

The first mills of this kind are already in operation or undergoing commissioning. Mid-2007, for example, the 5-stand continuous Tandem Cold Mill No. 2 began operations at voestalpine Stahl in Linz, Austria, after just 23 months construction time. It includes 4-high technology and has a work roll shifting system with SmartCrown technology and work-roll bending. Operational experience to date has shown outstanding rolling results, even with critical, high-density materials.

A 4-stand continous line and pickling tandem mill at Corus Staal in Ijmuiden, The Netherlands, is now being built. It features 6-high technology and includes an intermediate roll shifting and work and intermediate roll bending systems. Here, too, high-density steel grades are being rolled with the help of Siroll^{CIS} CM.

By the same token, two reversing mills are being designed for Dunaferr in Hungary and Borcelik in Turkey, with commissioning scheduled for 2008.

Maximum local content in China

The government in China has been at the forefront of the movement worldwide to maximize local content through supply by domestic companies. This has led to Chinese companies virtually ceasing to import on a turnkey basis. In the case of WISCO, the company can look back on a long-standing relationship with Siemens, which reaches back to the time of the first tandem mill (TCM). Several years ago, in fact, this mill was rebuilt

CTCM No. 2 of voestalpine Stahl, Linz, Austria

Recently Ordered Cold Mills

	Capacity (tpy)	Width (mm)	Start-up	Mill Type
Wisco PLTCM No. 3	1,150,000	700-1430	End 2009	5-stand 6-high
Tonghua 2 RCM	430,000	850-1280	Mid-2009	2-stand 6-high
Hanbao PLTCM No. 2	2,150,000	2080	Early 2010	5-stand 6-high
Jiangsu Dajiang	1,000,000	700-1250	End 2009	5-stand 4-high
SAIL PLTCM	1,200,000	800-1560	End 2010	5-stand 6-high

into a PLTCM by Siemens VAI, to include technological equipment from VAI Clecim and the complete upgrade of the automation technology by Siemens.

In 2004, Siemens supplied the electrical equipment for PLTCM No. 2. WISCO decided to build PLTCM No. 3 at the end of 2007, under the supervision of Siemens VAI, which is providing the complete automation and significant portions of the technological equipment. This includes the laser welding machine, the FAPLAC pickling control, the hydraulic actuators and the carousel tension reels. An automation solution based on the Siroll^{CIS} CM concept, here and elsewhere, is helping to increase mill performance, including at Hanbao (formerly Handan) PLTCM No. 2, Jiangsu Dajiang CTCM, and Tonghua 2-stand RCM, all orders that have been booked in 2008.

Major order from India

The high point among orders in 2008 has been a major contract from the Steel Authorithy of India Ltd (SAIL), which has ordered a complete PLTCM, a CGL, and an ECL for the Bokaro Steel Plant. The Completely Integrated Solutions (CIS) approach from Siemens VAI will play a significant role in the design of these facilities by providing an optimal mill layout through a high degree of standardization.

As it has been for years with electrical equipment and automation systems, the Siroll^{CIS} concept is now becoming a standard for mill design by providing uniformity in equipment and systems across several mill types. This reduces the number of solutions required, leads to a higher degree of reproducibility, and promotes better quality in the products being made. For SAIL, this will simplify maintenance by reducing the number of individual components without sacrificing a uniform look and feel in operations. ■

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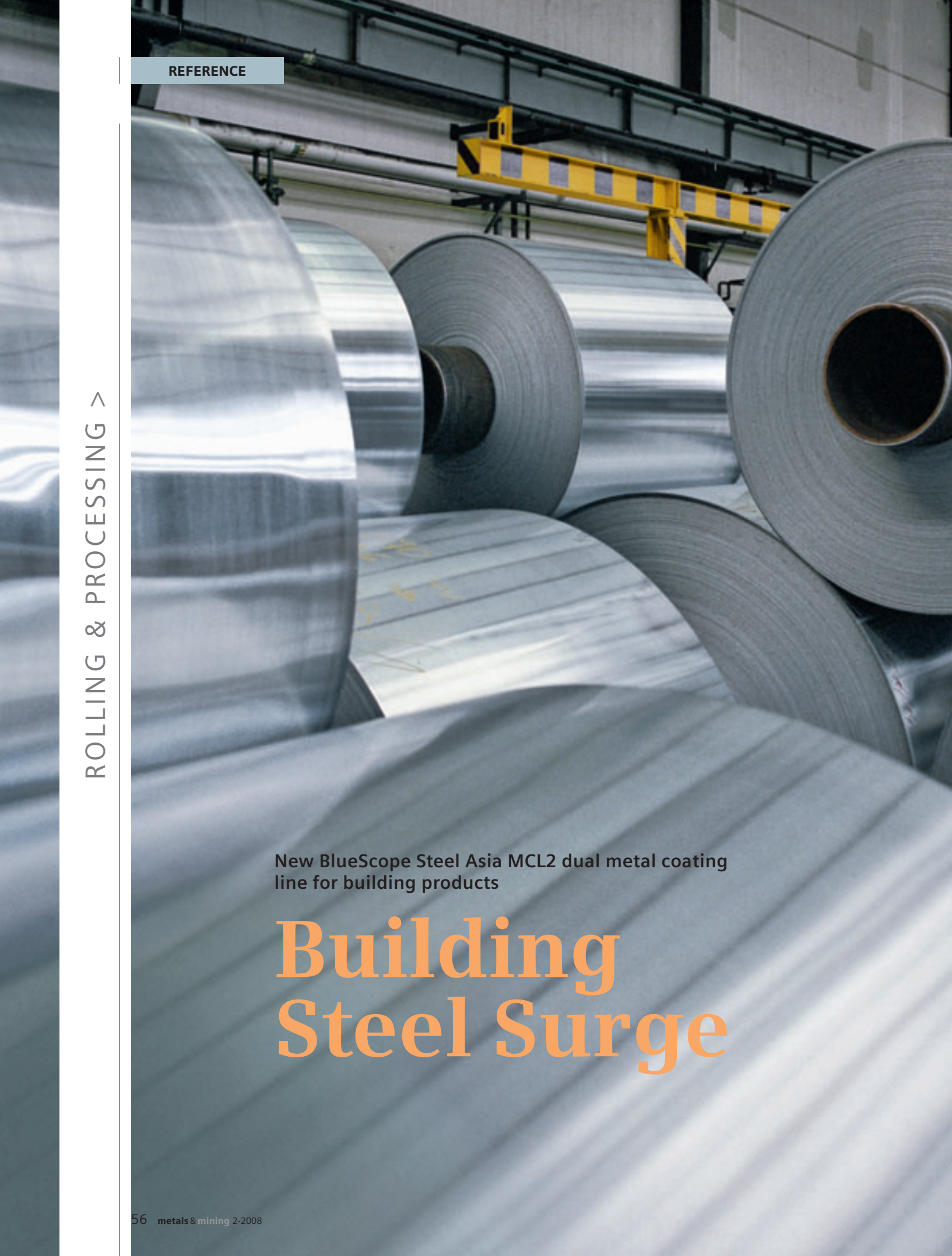

New BlueScope Steel Asia MCL2 dual metal coating line for building products

Building Steel Surge

Late in 2003, BlueScope Steel (Thailand) Ltd invested in a new 200,000 tpy dual continuous metal coating line able to produce Zincalume coated steel from 0.3 mm to 1.2 mm thickness and galvanized steel from 0.3 mm to 1.6 mm thickness. The challenge was to enable quick changeover from Zincalume to galvanized product and vice versa, without sacrificing production efficiency during short campaigns. The line has integrated surface conditions and post-treatment sections to allow high-quality grade of product in building application. This project has now achieved its performance milestone for dual continuous metal coating lines.

In Thailand, BlueScope Steel's business strategy, through which production capacity follows closely on market demand, gave rise several years ago to the need for the new Metal Coating Line No. 2 (MCL2), which was realized in 2003 and designed for on-demand campaigns of galvanized and Zincalume with very short changeover times between campaigns. Metal Coating Line No. 1 has been dedicated to Zincalume only. MCL2 has been designed to produce 200,000 tpy of galvanized and Zincalume coated full hard and CQ steel strip for building applications.

As preparation for strip entry into the coating line, BlueScope Steel favored vertical accumulators with vertical annealing furnace. The vertical furnace, based on entry direct flame reduction heating with radiant tube heating and soaking sections, was supplied by Stein Heurtey of France, and features quick temperature response (lower thermal inertia); highly flexible operation; evaporation of oil from the incoming strip surface; and a protective atmosphere to prevent strip surface oxidation.

Large capacity coating pot

The metal coating section itself is designed for dual coating and for a changeover from prime-to-prime product in less than one hour. One 145 T capacity galvanizing pot with 800 kW power conversion has been fitted with self-empowered bogies. A second, 65 t pot, for Zincalume coating with 1600 kW power conversion has with self-empowered bogies and is fed by a pre-melt pot through a dry type gas heated launder. One dry type gas heated launder with one pre-melt pot with 800 kW power conversion enables fine Zincalume preparation.

Metal coating takes place by dipping the steel sheet into a pot of molten coating metal. The metal is contained within a ceramic-lined vessel with an open top, the heat to melt the coating metal and maintain it at the working temperature being provided by channel-type electric inductors. Each pot has two or four inductors to establish the required thermal rating.

Essentially, each inductor is a transformer with two air-cooled primary coils wound around a laminated steel core, a twin loop of molten metal acting as the secondary winding. Heat is generated within the loops of molten metal by the action of the induced current acting against the resistance of the liquid metal. Each inductor is supplied from SCR rectifying bridge to allow fine voltage and amp control.

The pot bath metal temperature is detected by immersion thermocouples and controlled by a temperature controller mounted in the master operating panel. Two thermocouples are mounted on the pot structure with elements immersed in the molten metal. One is connected to the controlling temperature recorder, the other to a digital readout instrument. The former provides the control signal; the latter is set at a slightly higher temperature and is used to protect against overheating of the metal if the control signal fails for any reason. The furnace PID temperature control holds the pot at a constant temperature (less than ± 2 °C). In manual mode, the operator can adjust the inductor power separately.

Wiping, cooling, and measurement of the strip

In manufacturing continuous hot dip metal coating steel, coating wiping techniques are of the most importance for deciding coating qualities. High-quality wiping nozzles are essential for ensuring uniform coating weight and excellent surface smoothness of strip.

At the Thailand facility, a unique Siemens VAI mechatronic air knife system (CLECIM DAK E) has been introduced to replace the BlueScope Steel air knife system. DAK E system allows automatic transversal coating control in addition of the longitudinal coating control by using online dynamic lip-gap profile adjustment. This permits much tighter coating standard deviation for optimum consumption of coating material.

After coating, the strip is cooled to a temperature consistent with its contact with the first roll at the top of the cooling tower. Regular spangling occurs in a natural way during the cooling of the strip and the subsequent solidification of the zinc coating. >>

>> A mobile cooling unit located just above the air knive supports the Zincalume cooling cycle. Two turndown rolls of large diameter allow the strip to smoothly change of direction from upward to downward to the water quench without affecting the metal coating. Then, cooling is completed by air blowing systems, and the strip passes through a quench tank in order to reach the suitable temperature for skin pass operation (< 45 °C).

The coating thickness on both sides of the strip is measured by high-precision X-ray traversing weight gauge. The coating weight control is normally operated in closed loop mode with the coating knives.

The coating gauge is a cold gauge since, after final quenching, a cold location provides the best working environment with the easiest access. However, this also induces a slow response time that is compensated by a Smith predictor in the longitudinal coating regulation of the DAK system.

From coating to coil

The pinch/deflector roll and thread table is positioned prior to the tension reel for feeding the lead end of the strip to the mandrel. A belt wrapper, mounted on the tension reel, is provided to guide the leading end of the strip around the mandrel when starting a new coil. When sufficient wraps have been made on the mandrel, the wrapper retracts and the exit section is accelerated to line over speed.

The tension reel is of the overhung expanding type with a hydraulically actuated traverse cylinder allowing 150 mm traverse either side of the line centerline. This unit will provide the tension required for normal line operation and control the exit section tension. The mandrel is expanded/collapsed by a rotary hydraulic cylinder.

The edge guide equipment controls automatic shifting of the tension reel to maintain a straight coil wall or staggered coil wall. The photoelectric sensor senses the strip position, the signal is processed and hydraulic pressure activates the hydraulic traverse cylinder on the tension reel to align the strip.

Coils are transported from the tension reel mandrel by the coil car, which serves oil saddles positions in the line bay. The coil is circumferentially banded and weighed, then unloaded and transported to the coil storage and packaging area.

Implementation and production ramp up

From the start, the entire project was put on a fast track to start the galvanized and Zincalume production campaigns in 20 and 21 months, respectively, from contract award. BlueScope Steel hired Bilfinger Berger to complete the design and construction of main buildings and equipment foundations as well as the installation of plant equipment and piping systems. Other specialized companies were engaged for electrical cabling, refractory installation, refractory dry out, and hydraulic piping installation.

Normal start-up problems ranging from quality to reliability issues were actively worked on by a multidiscipline team from BlueScope Steel Research and Technology groups with the full support of Siemens VAI and Stein Heurtey.

Entry section – ML21L welder in foreground

Monthly improvements in throughput and quality, as a result of dedicated operational and maintenance teams, enabled MCL2 to run for 12 days without a stoppage in April 2007. During this period, the line produced in excess of 8,800 t at a prime first time (pft) of 99%. Originally designed for an average of 4,000 t/week, MCL2 now exceeds 5,000 t/week on a consistent basis.

From metal coating to metal painting

BlueScope Steel provides product with a one-week lead time for established customers. The dual coating pot provides the flexibility to meet a changing order book, with the changeover from prime galvanized to prime Zincalume product routinely achieved in just 54 minutes.

With the increasing cost of coating metals, the ability to control overcoating has become very important. BlueScope Steel has a long history of development of

coating pot equipment and, through Hatch, has developed IONA pot equipment with servo-control air jets and edge baffles.

Further enhancements, including, in particular, the addition of the CLECIM DAK E air knife system with traverse coating mass control, have meant that metal coating weight deviation is easily halved when compared to classical jet wiping systems. Another feature of MCL2 is the horizontal cleaner section with roll change carts, employed mainly for Zincalume production. Strip cleanliness is of upmost importance for proper coating quality by preventing flaking, cracking, and peeling.

The BlueScope Steel Asia Building division built MCL2 to provide a flexible response to local and regional market demand. The next implementation at the company will involve in-line painting capability within the surface treatment section to serve diverse market needs even better. ■

Coating line technical features

Thickness	0.3 to 1.2 mm for Zincalume and 0.3 to 1.6 mm for galvanized
Width	600 mm to 1,260 mm
Tensile strength	up to 850 MPa in full hard grade
Yield strength	up to 600 MPa maximum
Off Gauge Material	up to 4.0 mm maximum to accommodate feeds from reversible cold mill
Entry coil weight	25,000 kg maximum and 5,000 kg minimum
Exit coil weight	15,000 kg maximum, 5,000 kg average. 1,500 kg minimum
Process speed	150 mpm maximum
Entry & Exit speed	200 mpm maximum
Operating hours	7,048 hours per year

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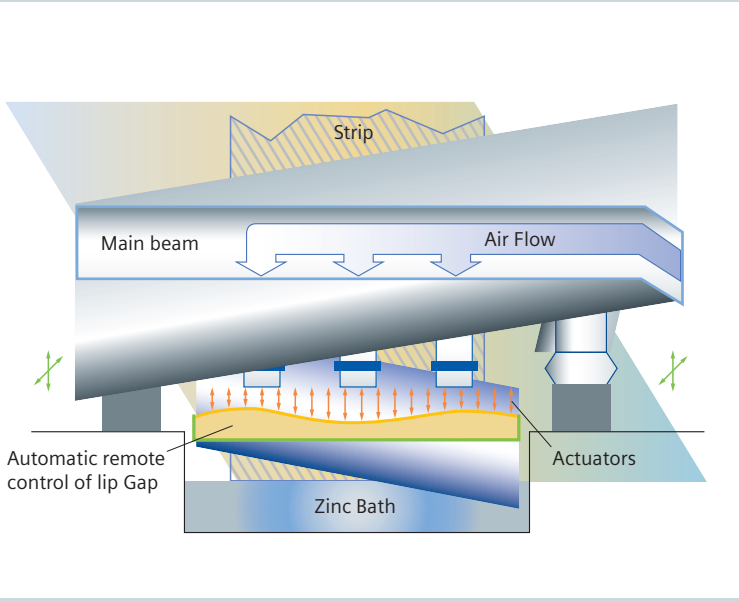

Principle of DAK E – Transverse & longitudinal coating control

VAIS do Brasil extends business to ThyssenKrupp

Maintenance Move

VAIS do Brasil, a company owned by Siemens Metals Technologies and registered in Volta Redonda, Rio de Janeiro State, Brazil recently concluded a long-term maintenance service contract with Thyssen Krupp Companhia Siderurgica do Atlantico (TKCSA). The author explains how VAIS outclassed stiff competition to receive the coveted TKCSA maintenance contract.

VAIS do Brasil was founded in 2000 to execute a caster maintenance contract with the Companhia Siderurgica Nacional (CSN), located in Volta Redonda, Brazil. Having performed its contract duties in an outstanding manner, VAIS was recently awarded a 5-year extension until 2012. This contract is the most comprehensive cost-per-ton contract known in the steel industry so far as it also comprises online maintenance, breakouts, and necessary spare parts.

Besides the caster maintenance for CSN, which comprises online maintenance, the exchange of segments and the refurbishing of caster molds and segments of the 3 slab casters, VAIS do Brasil is providing caster roll refurbishing services to COSIPA and Arcelor Mittal Tubarão (AMT) and nickel plating services to almost all Brazilian steel companies involved in casting of slabs. For the recently operational Continuous Casting Machine No. 3 at AMT, VAIS do Brasil handled the overlay welding of all caster rollers. After the production of more than 500,000 t, the caster rolls of all segments show hardly any wear.

In 2003, VAIS do Brasil started the nickel plating plant. After stabilizing the operation of the plating of the mold coppers with plain nickel, nickel cobalt plating was introduced on the Brazilian market – with great success. Most Brazilian clients now use nickel cobalt-plated narrow faces, whose service life has now been extended to up to 200,000 t.

Meeting TKCSA maintenance needs

In the course of the decision-making process to set up a steel plant for the production of 5 million t of slabs, ThyssenKrupp managers also visited the facilities of VAIS do Brasil. The delegation found a maintenance operation matching European standards, and TKCSA decided to consider outsourcing maintenance activities of the new steel plant. After ordering the equipment for the new steel plant comprising harbor facilities, a coking plant, a sinter plant, two blast furnaces, and a steel melt shop (two BOF converters, two ladle furnaces, two slab casters), TKCSA started an international bidding process for outsourcing maintenance activities. Following a very tough round of competitive bidding, TKCSA awarded the maintenance service contract to VAIS do Brasil.

As the consequence of receiving the order from TKCSA, VAIS do Brasil established a branch operation

in the coastal area of Rio de Janeiro state. To build the workshops VAIS do Brasil has found a local partner, who is erecting the maintenance facilities and will rent them to VAIS do Brasil. To provide a convenient service to TKCSA, the workshop complex will be located adjacent to TKCSA site. The workshop will be equipped with a large number of advanced machine tools of all kinds, giving VAIS do Brasil the capability to manufacture spare parts for all its Brazilian clients, instead of having to import them.

Services on a tight schedule

Services to be furnished to TKCSA per the maintenance service contract comprise mechanical repair for the entire steel complex, manufacturing of spare parts, machining of repaired items, crane maintenance, electrical and automation repair services, refurbishing of molds and segments, and staff training for provision of maintenance throughout the entire steel complex.

VAIS do Brasil must be ready with its service by first quarter 2009. The duration of the contract is 15 years. To comply with the requirements of the service contract and to be able to also service other customers from this maintenance base, VAIS do Brasil will need to increase its staff by more than 600. An intensive training program has already started in order to have sufficient qualified staff available during the erection phase of the steel complex. ■

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Modernizing a ThyssenKrupp Steel continuous casting plant without interrupting operations

Best Time to Modernize

Full order books in the steel industry are denying some plants the time they need to modernize. Shutting down of production facilities during these good market conditions will lead to significant profit loss. But, if the modernization efforts are delayed too long, then even longer downtime can result. The author describes how ThyssenKrupp has overcome this dilemma, using Siemens engineering resources to modernize a continuous casting plant during full operation.

Traditionally, production facilities have been shut down before modernization work was undertaken. Today, downtimes of two to four weeks for the modernization of electrical and automation equipment and its commissioning can now be eliminated with some extra effort at the start of the project.

Aging automation technology

Typically, automation equipment and systems in a production facility are not kept up-to-date on a continuous basis because doing so would mean significant disturbance of operations. Instead, this equipment is upgraded every 10–15 years. The hardware and software are technically obsolete after about 10 years, which means that spare parts are no longer readily available or the interfaces to new equipment in the plant are inadequate or nonexistent. What is more, upgraded core software often cannot be used to its fullest potential with older equipment.

Multi-level modernization concept

Production has top priority in modernization projects. All work on revamping and upgrading automation equipment must be carried out so that production is not restricted or impacted in a negative way. For upgrades to new software, the original architecture and operating masks should be preserved as far as possible to avoid operating risk.

With a multi-level modernization concept, Siemens meets both challenges – no production downtime and same operating structures. But, this comes at the cost of greater effort in the analysis of the system being replaced. The new automaton architecture matches the older architecture as far as possible, enables smooth migration of operator functions into the new system technology.

New approach to continuous casting in Duisburg-Bruckhausen

Siemens is also using this modernization strategy at ThyssenKrupp Steel for a continuous casting plant in the oxygen steel facility in Duisburg-Bruckhausen. The project involves equipping the caster with new basic and process automation, a new control system as well as a new process computer. This advanced automation technology is replacing Simatic S5 PLCs installed in 1996. Project completion is scheduled for May 2009.

Close interaction between the continuous casting plant and upstream and downstream processes will make significant demands on the automation and control system, particularly with regard to availability and operating convenience.

Taking a step up to Simatic PCS 7

The core of the Siemens automation solution is the Simatic PCS 7 control system, into which all applications specific to the Bruckhausen plant are integrated. In addition, the application system includes new functions, such as DynaWidth for fast, online change of the slab width and the hydraulic mold oscillator. The mold level control, which has had fuzzy logic since 1996, will be updated according to the new system. Use of standardized hardware and software components in the basic and process automation enables the realization

Continuous casting plant in Duisburg-Bruckhausen

of a uniform, fault-tolerant and easy-to-use solution, which supports operating personnel fully in all operating modes.

Changeover without production downtime

Modernizing such a large automation system entails significant preparation effort, which actually reduces the risk of production downtime during the commissioning phase. At ThyssenKrupp, only scheduled production downtime will be used for the individual modernization steps. These steps are combined into three large project phases.

The project phases are broken down into individual steps and adapted to the production facilities. These individual steps are then inserted into the maintenance plans for the plant.

All important production functions are implemented in parallel for the basic and the process automation. This redundant implementation of the automation enables changeover to take place without any interruption of actual production. All modernization steps can be carried out during schedule production downtime, eliminating the need for the two to four weeks of production shutdown typically required for a modernization and upgrade project. As a result, the continuous casting plant will retain a high degree of availability through a proven concept combining hardware availability with application functions in a continuously operating process. ■

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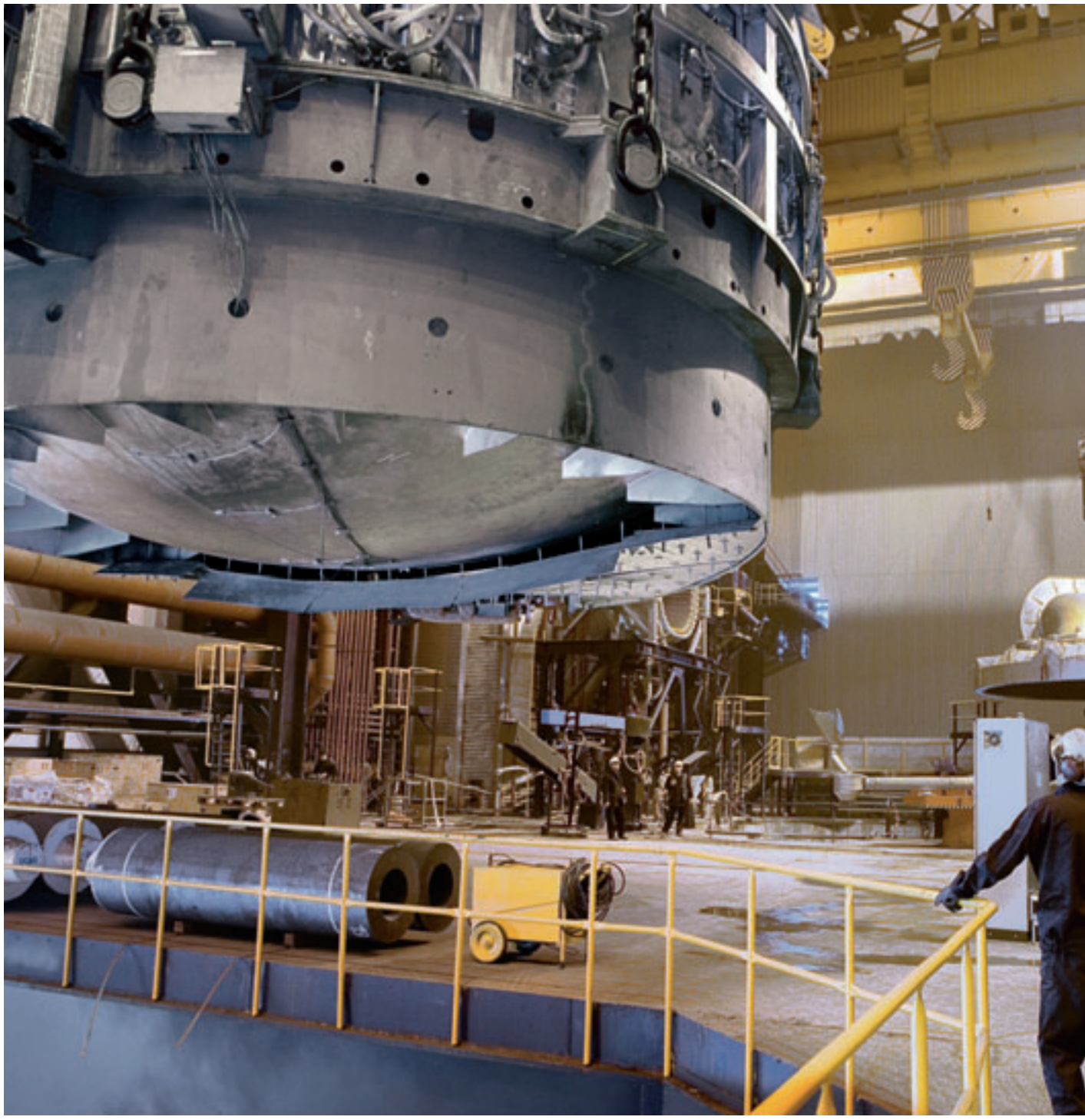

SERVICES >

Next generation services for EAF steelmakers

Taking Support to the Next Level

With steelmakers needing to continuously improve to compete, Siemens VAI has reorganized its regional support services to respond more rapidly and effectively to customer needs for training, maintenance, equipment and turnkey installations.

To remain competitive, steelmakers must continuously improve productivity, reduce conversion costs, reach high plant availability and achieve consistent production. This can be achieved through frequent plant updates and by benchmarking performance against world best practices.

Most steelmakers are boosting productivity and reducing the number of personnel. The best EAF steel mills now have productivities of more than 2,700 t/man/year. This lean production concentrates efforts on the core fields of production, quality assurance and lowest cost, necessitating external service for repairs, spare parts, inspections, studies, technical assistance, training, and technological upgrades.

The typical operating life of new metallurgical plant is about a decade. Continuous development in technology, equipment, processes and systems are needed from external specialists.

As a global service provider, Siemens VAI offers technical solutions and services tailored to the harsh operating conditions of electric steelmaking, as well as methods to achieve best performance throughout the entire life cycle of a plant. All components, systems and services improve plant efficiency through their endurance, ease of access and low maintenance.

New service approach

Siemens VAI provides a complete scope of supplies and services for the steel industry, from raw material to steelmaking. But it is expected that in the next 10 years, revenue from new plant construction will only account for a third of the overall business. As modernization of existing plants becomes more important, so service and revamping business will grow.

Located close to customers, the regional companies (RC) in Siemens global network can provide together with the associated center of competence such modernization service. This allows Siemens VAI in Germany to serve as the world headquarters for electric arc steelmaking, secondary metallurgy, and services for EAF steelmaking.

The RCs' proximity to customers provides rapid response for all operational, maintenance and service tasks. Experienced steelmaking experts together with the RCs can answer specific mechanical, electrical, automation and technology demands and consider constraints linked to the metallurgical process and environment. Metal and Mining Service and Support Centers (MSC), unique to Siemens, support the RCs through close cooperation with Siemens world headquarters. Technicians and engineers can analyze new inquiries and provide tailor-made solutions within the shortest possible time and help implement them on site.

Siemens' reputation for innovative EAF plant design extends to its upgrade services. Major plant improvements can be achieved with relatively small budgets and reasonably priced continuous investment.

New generation soft skills

Siemens VAI can assist with the whole project execution, from first discussion with the customer to turnkey supply of an installation with all peripherals. The main competencies available from Siemens are design and engineering of metallurgical equipment, manufacture, erection, testing, automation/start-up, training (external and on-site), and technical assistance for process optimization.

On-site investigations of steel mill equipment may also include proposals to enable steelmakers to improve efficiency. The Siemens VAI service team can evaluate and diagnose equipment condition, plant operation, and plant performance.

The Siemens VAI service team can identify the problems to be solved through on-site inspections during >>

Transport of the EAF roof

Siemens VAI personnel are present throughout commissioning

>> shutdown, detection of bottlenecks, and analyses of operating practice. Proposed solutions can achieve new milestones within a variety of investment programs, such as short-term improvements not requiring further investment; medium-term measures requiring small investments; and, to achieve maximum output, long-term measures requiring larger investments.

New targets can be determined by identifying development potential, weak points, future plans for the plant, and actions to reach the new targets. Higher efficiency can be achieved by re-engineering for a correct and simple design, and performing layout and metallurgical studies.

Technical assistance and training

The main focus of technical assistance and training is to follow up on new targets, give technical advice, and support the implementation of new operation and equipment. Several technical assistance and training sessions are needed for the customer to set revised targets and assimilate the new technology operation and know-how. Service teams operate fact-finding missions where the required information is collected on-site, evaluated, and discussed, and databases are established for the mission. Teams provide operational and maintenance training in external steel plants using the concept of "show-how". For external training the mini-mill facilities supplied by Siemens VAI are used, which are belonging to the world's benchmark operators.

To increase know-how and "show-how" service, training is performed using Siemens VAI training team and external steel plant staff. Trainees receive theoretical and practical training, during which the group is integrated in the maintenance and production team. On-site training and assistance is given at the customer's steel plant. This includes advising and exchanging best practices to avoid basic mistakes and initiate methods of operation and maintenance. Each development step is driven by recommendations and calculated proposals to set benchmarks for progress. The main consumption and operating figures are reported for each step.

The tap-to-tap time is a key measure of production performance of a meltshop. The evolution of methods of operation, standards of operation, maintenance of equipment, management of spare parts, and control of product quality are most important for successful development. To overcome the peak working load and provide specific expertise, Siemens VAI provides services during weekly maintenance shifts and annual shutdown. During weekly maintenance shifts, the aim is to check actual equipment condition, improve the shift shutdown work, provide support, set action plans and goals, achieve improvements, and boost plant reliability and availability. During the annual shutdown,

Main Benefits

Siemens VAI offers a comprehensive range of tailor-made upgrades for technical solutions and services.

Due to the service portfolio, the customers achieve best performance throughout the entire life cycle of their plants.

Closer proximity to customers due to a strengthened regional support enables Siemens VAI to rapidly respond to provide competent services for all operational, maintenance and service tasks.

Major plant performance and efficiency improvements can be reached with even relatively small budgets through reasonably priced continuous investment programs.

Siemens VAI Service offers: individual, customer-oriented approach combined with a multidimensional problem-solving capability on the basis of a turnkey system supply.

the team explains how to prepare, execute, evaluate, and record the shutdown, and exchanges expertise on how to repair and replace mechanical and electrical works.

New generation hardware supply

Many technological improvements at Siemens VAI metallurgical plants were born from discussions with customers in trying to understand their needs and offering the best answer to their request. This feedback and the aim for continuous improvement are the strengths of the after-sales and service approach. These improvements are integrated into the basic equipment design. All designs and features of a metallurgical plant are available from Siemens' hardware service.

Siemens VAI thus provides a wide range of hardware supply services from spare parts to the most exhaustive revamping project. Siemens can select and procure spare parts for any furnace design. Many components are available from stock or from Siemens' own suppliers or regional companies, with rapid delivery times. Spare parts include components (e.g., valves, cylinders, roller bearings, water cooling element, guiding columns); equipment (e.g., complete roof, lower and upper shell, electrode regulation); and systems (e.g., high current system, hydraulic systems, oxygen technology, etc.). To solve repeated wear problems, Siemens engineers can re-design a particular component to improve lifetime, reliability, availability and specific maintenance costs. For example, a water cooling element could be made of copper instead of steel.

The objective of spare part management is to assure quick procurement when a component has to be replaced. Delays or down times are reduced and inventory cost optimized by storing spares in Siemens workshops or at Siemens' regional companies. This also improves efficiency of spare part replacement and repair. Thanks to Siemens VAI's workshop and service organization, "Rapid Action" response teams can reply in emergency situations. Repair and remanufacturing services are offered on a case-to-case basis.

Revamping and upgrading

Modernization can extend the life of a metallurgical plant at a reasonable cost. The aim of modernization is to explore and use all potential optimizations possible. Solutions suggested are customer-specific but are based on standard products and proven solutions. Siemens experts in engineering, manufacture, erection, operation, and maintenance are available for continuous improvements. Modernization technologies are offered for all furnace types, whether supplied by Siemens or a competitor. Innovative technologies are often included. Most investments have a return on investment of less than a year.

Examples of performance enhancing solutions include improved design, injection technologies, and advanced process models. Facility replacement can be more easily justified by adding cost saving features and improving design to achieve better performance. Most projects include the full scope: design, erection, start-up and process optimization. Significant productivity improvements have been achieved by implementing Siemens VAI's Refining Combined Burner (RCB) technology, in most cases without increasing the total oxygen input. The company offers this technology and all the peripheral equipment, integration in the existing EAF, and complete control, visualization, automation, and fine-tuning.

In conclusion, Siemens VAI's new generation Metal Service offers an individual, customer-oriented approach combined with a multidimensional problem-solving capability on the basis of a turnkey system supply. Thanks to the global Siemens network via the regional companies, a new service approach is possible closer to customers. ■

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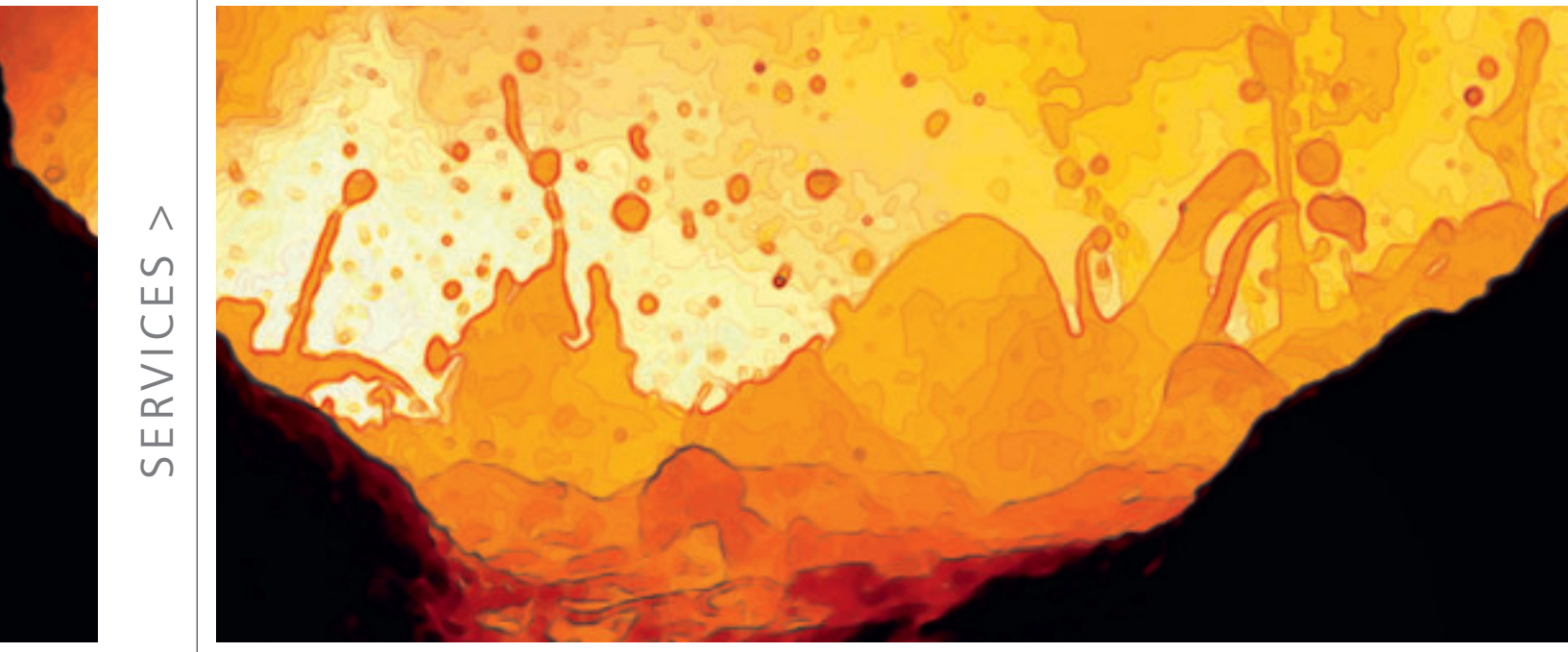
SIMETAL^{CIS} Simelt MDC speeds steelmaking by automated recipe

Right Recipe for Steel



Relentless demands for greater energy efficiency, sophisticated furnace automation, and overall cost reduction in steel production make the SIMETAL^{CIS} Simelt MDC package the preferred solution for standardized meltdown control in electric arc furnace (EAF) operations.

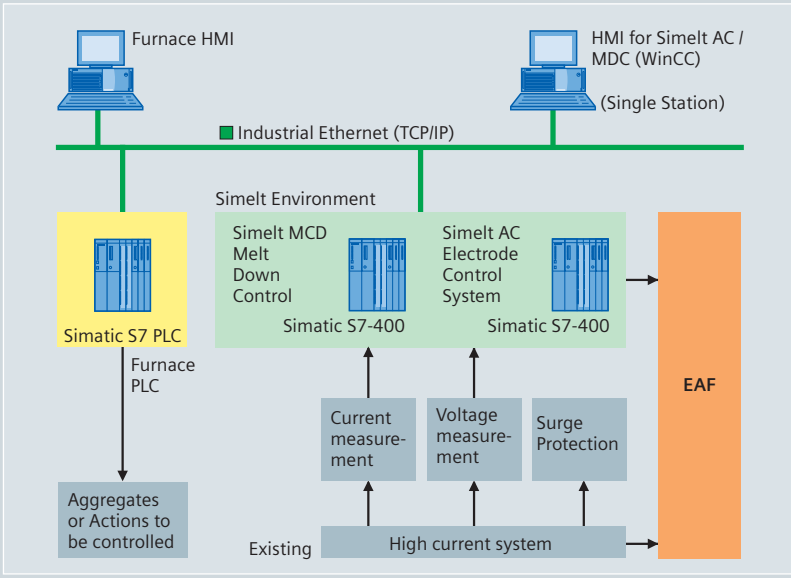
The efficiency of many EAFs depends on the precision and attention of their operating personnel. To melt steel successfully in an EAF, several "ingredients" are needed, along with a number of operational steps and precise timing. A melting specialist needs significant experience, good concentration, and even the proper "good feeling" to provide the same steel quality as competitors on a consistent basis. Errors can and do occur, especially when normal operations are interrupted unexpectedly.

Getting right the first time with SIMETAL^{CIS} Simelt MDC

The melting specialist must pay close attention to scrap and/or DRI composition, quality and quantity, the correct amounts of the right additives, and the appropriate melting energy from an electrical and chemical point of view. He must also turn the melting process on and off at the right time, take temperature and material samples when necessary, adjust transformer and reactor levels, activate the burner, start oxygen lances and carbon injection, and more.

To ensure the reproducibility and the precision of the operational steps as well as eliminate the error potential of the individual operator, Siemens has developed a further module to the SIMETAL^{CIS} Simelt electrode control, which has now been installed in more than 220 EAFs worldwide. The module MDC (Melt Down Control) automates recipes for steelmaking and implements, monitors, reports, or ends actions in defined process

Operator screen SIMETAL^{CIS} Simelt MDC



Concept of SIMETAL^{CIS} Simelt MDC

sequences at predetermined milestones or for selected equipment.

Data and melt now under control

To satisfy the requirements of different steel grades and melting strategies, Simelt MDC provides up to 50 setup profiles. Each profile is divided into a maximum of six melting phases, according to scrap bucket charging or refining period, where each melting phase allows setup of up to 10 program steps. Simelt MDC also controls as many as 50 different tasks, including the setpoint of transformer or reactor tap, melting current setpoints, burner and oxygen lancing modes, DRI feeding rates, and so on. When input data is included correctly and in a timely manner, and the parameters of the recipe are stored, Simelt MDC is able to implement a consistently high-quality melting process for each melt of a particular steel grade.

A dynamic process model ...

The transition from one program step to the next during the melting process is handled by milestones in an energy model and a mass model. Various milestones allow the operator to develop and implement a dynamic meltdown strategy. Fundamental process values, such as elapsed time [s], electric or chemical energy [kWh] and specific energies [kWh/t] as well as harmonic distortion, and the combination of milestones, can be defined to set up the profile best-suited to the technological requirements.

... runs on an advanced automation platform

The Simelt MDC package is implemented on the Simatic S7 PLC using standardized application modules. This facilitates fast commissioning as well as maintenance and upgrade services. Data exchange with the process is handled by standardized communication only between the MDC S7 processor and the superimposed furnace PLC.

The visualization of the system is integrated in the standard WinCC HMI of the SIMETAL^{CIS} Simelt application. Easy-to-read and convenient-to-use screens, diagrams, and trends support the operation and supervision of the Simelt MDC package.

SIMETAL^{CIS} Simelt MDC delivers results

Precise reproducibility promotes no more than marginal variation in the melting times, while delivering steel grades with higher accuracy, which improves production yield. In addition, operating personnel are relieved of routine tasks, allowing them to focus on activities demanding the highest degree of concentration. All this helps to create stable conditions for each melt, resulting in uniform production results. Once identified, deviations can be immediately removed through correction of the parameters.

Wherever it has been installed to date, Simelt MDC has achieved positive EAF results, ranging from shorter tap-to-tap times through reduced consumption values less off times through stable processing to higher reproducibility of heat properties at the time of tapping. The easy-to-upgrade design, in combination with advanced process control, makes the Simelt MDC an ideal tool for electric arc and ladle furnace operation and optimization – now and in the future. ■

Main Benefits

Ensures stable process conditions, improving production yield

Increased flexibility using a wide variety of recipes

Up to 50 setup profiles for easy implementation of consistently good results

Easy-to-upgrade design safeguards the value proposition of the system.

Reduced off times by avoiding singular effects produced by operators, less maintenance time.

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Outsourcing of caster mold and segment refurbishment work to specialists

Caster Maintenance Matters

A growing trend can be noted among steelmakers to outsource the refurbishment of caster molds and segments to outside companies. This is because such specialized service providers have acquired extensive know-how which goes far beyond the maintenance capability of a steel producer. Caster refurbishing is a core business of Siemens VAI Metals Services.

With a mature technology, such as continuous casting, improvements related to the service life and availability of caster components require a disproportionally high effort and cost. For a slab caster operator, expenditures for such improvements are normally not cost-effective – but are feasible for Siemens VAI.

It pays to outsource!

Only an outsourcing partner such as Siemens VAI can afford to invest in the development of new solutions

Training and technical assistance for continuous casting plants

Superior Training, Superior Product

Well-qualified and well-prepared staff is decisive for a fast production ramp-up, high component reliability and minimum caster downtime. Siemens VAI provides comprehensive training programs for both new and upgraded plants to achieve these targets.

Over the course of more than 30 years of caster installations, Siemens VAI has observed that where personnel has been well trained, caster ramp-up was shorter by roughly 35 to 45% compared to projects where the staff was not trained. Furthermore, the frequency of plant standstills due to, e.g., breakouts or component failure, was also much lower. On the basis of long-term experience, it could be shown ideal training results are achieved in training programs comprising three phases: theoretical training, practical off-site training and "on-the-job" on-site training.

Post-start-up training and technical assistance

The increasing demand for high-quality steel, the production of new steel grades and the steadily increasing demand for steel represents a challenge for producers. In addition to the above-outlined training approach, Siemens VAI provides technical assistance covering customer needs related to product quality and yield improvements, higher output, elimination of logistic bottlenecks and the development of new steel grades. In this way, producers can best meet their specific performance targets. ■

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which can significantly improve service life. Thanks to caster refurbishments for customers worldwide, Siemens VAI can spread its R&D costs, which means that it is far cheaper for a caster operator to outsource rather than to do this work on his own.

Additional benefits for greenfield installations

Challenges faced by a customer for a caster installation at a greenfield site include acquiring qualified and experienced staff, minimizing the investment costs for the repair workshop, and to have the right spare part on stock. Outsourcing the caster mold and segment repair right from the start of this type of project is an attractive option for any producer to meet these challenges.

Should the customer decide to conclude a long-term service contract for caster offline maintenance, services on a cost-per-ton basis are provided – when a Siemens VAI caster is installed – which applies right from the start of casting operations. This is because of the proven high reliability of our casters and the immense experience that we have with caster refurbishments. With this type of contract, Siemens VAI thus shares the start-up risk with the customer resulting in a win-win situation. ■

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Thyristor-Controlled Reactors of 257Mvar SVC

Improving power quality in metals and mining

Top-Quality Power

As the largest consumers of electricity in the metals industry, electric arc furnaces (EAFs) are a major cause of system perturbations. These take many forms, including voltage distortions due to harmonics and voltage variations caused by large, abrupt changes in active and reactive power, as well as flicker and voltage unbalances. The article describes what Siemens is doing to help optimize power network conditions.

To reduce the impact of network perturbations and improve production at the same time, Simetal^{CIS} PQ takes a holistic approach to optimize network conditions and to compensate and balance the erratic behavior of the arc furnace with a Static Var Compensation (SVC), a combination of static filter banks and a thyristor-controlled reactor (TCR).

Sophisticated TCR technology

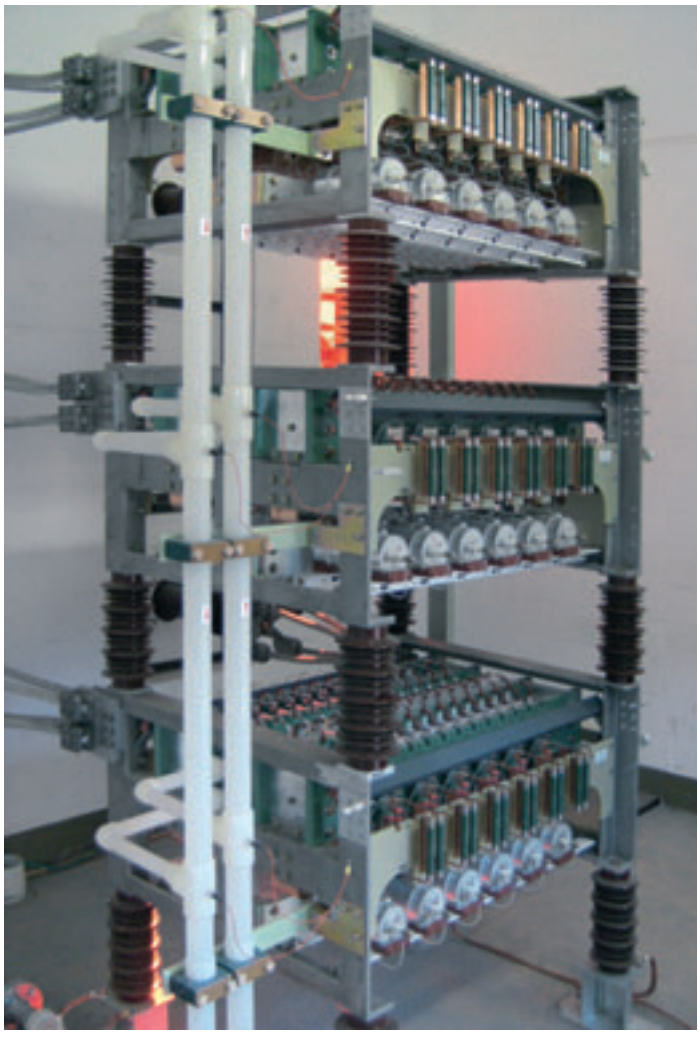
A key component of the TCR is the thyristor controller, based on extremely rugged series connections of LTTs (light triggered thyristors) for direct connection to medium voltage and up to 69kV, combined with the sophisticated Simatic TDC industrial control system that ensures long-term reliability, proven performance, extendability with standard automation components and standard engineering tools, and reliable spare parts availability. Fiber-optic transmission from the control directly into the medium voltage connected LTTs ensures tolerance of trigger signal to interference by high magnetic fields common in this environment, as opposed to the commonly used ETT (electrically triggered thyristor) that relies on combined fiber-optic and electric trigger pulse generation.

Excellent electrical parameters are combined with a clever mechanical arrangement, making maintenance very simple, without risk of misalignment of thyristors and almost without the need for any special tools.

Unsurpassed experience regarding application of the LTT, which Siemens helped to pioneer, has been gathered since 1997 in similar systems, and since 2000 this has been the standard concept for SVCs in the metals industry. The LTT has proven its reliability in countless HVDC systems and in utility and industrial VCs, even in extreme climatic conditions worldwide.

South America's largest steel plant SVC at Acindar / Argentina

Commissioning of the largest SVC project for a steel plant in South America was successfully completed after only 10 months in January 2008 with smooth start-up of the compensation system in Acindar, a plant belonging to the Arcelor-Mittal Group, located in Villa Constitucion (Argentina). In the step-by-step imple-



Thyristor valve

mentation of a plan for capacity increase, Acindar has started to increase the transformer power of two electric arc furnaces by 30–35%, along with the upgrade of the power supply and the facilities for power quality improvement. The original SVC has been replaced by a new 257Mvar SVC, comprising a TCR and four filter circuits, all directly connected to the 33kV furnace busbar – with hardly any shutdown of the power supply to the furnaces. Outstanding performance has been demonstrated with regard to voltage stabilization, power factor improvement, and reduction of harmonics, and flicker caused by the EAFs in operation at the plant. Operating the thyristor assembly, consisting of 4-inch LTTs, at the current limit of 2,600A made it possible to build a TCR with 257Mvar. Flawless operation has demonstrated the robustness of the Siemens thyristor valve concept in the rough environment of a steel plant.

As a new feature, remote access to the Simatic TDC thyristor control system and the HMI screens has been implemented via a secure TCP/IP connection. This feature enables a specialist at Siemens Germany to access the entire software program, making remote online customer support, diagnosis, and troubleshooting or system modification very simple.

PDS to improve nickel matte production at PT Inco, Indonesia

At the beginning of 2008, Siemens received a contract award from PT Inco to supply a modified version of the reliable thyristor controller as a Power Demand Stabilizer (PDS) for one of the four shielded arc furnaces. The thyristors will be controlled by a Smart Predictive Line Controller (SPLC); a technology developed by Canadian companies, one of which is Hatch Inc., who today owns the patents. Hatch has a long-standing history with PT Inco for technology delivery, and is involved in this project as a technology partner. The SPLC is a new approach to improving the furnace operation by reducing the fluctuations in furnace power, thereby increasing furnace production and reducing the impact of the furnaces on the electrical system.

The SPLC stabilizes the arc of an electric furnace by dynamically controlling a series reactor installed between the utility and the EAF. The controlled reactor acts as a dynamic spring to stabilize the arc.

This application of thyristors to control a reactor in the supply to an arc furnace transformer poses a number of challenging tasks different from the SVC application. These challenges include very steep changes in voltage and current, which need to be safely managed. Extensive studies and simulation led to a thyristor valve configuration with additional safety precautions to enable safe functioning within the complete range of expected operating conditions.

The PDS system will be installed at a remote site. To reduce risk and to speed up the commissioning period, the thyristor valve, switchgear, control and protection panels, a water-to-water cooling system, air-conditioning and fire system will all be “packaged” in a modular building, so that the equipment can be tested and the SPLC integrated with the thyristor controls at the factory, before the system is shipped to site.

Once the PDS system is operational and delivers the benefits achieved by furnaces at other smelters equipped with SPLCs, PDS systems will be installed on the other three furnaces at PT Inco. ■

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Dr. Alexander Fleischanderl (Siemens VAI),
Erwin Zwittag (Chief Process Technologist of voestalpine sinter plant) and
Viktor Sigl (Provincial Counselor of Upper Austria)

Honored for Meros Development

For his contributions to the development and implementation of the Meros Process, Dr. Alexander Fleischanderl accepted the "Upper Austrian Innovation Prize" from Dr. Josef Pühringer, Governor of Upper Austria, on October 22, 2007 on behalf of Siemens VAI and voestalpine, which jointly submitted this topic to the evaluation jury.

Meros is a new breakthrough technology for sinter-offgas cleaning in which the emission levels of dust and pollutants are reduced to previously unattained levels in sinter production (see Meros article in this issue). The process has been in operation at the Sinter Plant No. 5 of voestalpine Stahl in Linz since August 2007, resulting in a significant improvement in the quality of the air in the Linz region. ■

Honorary Employee Award

On January 26, 2008, Mr. Ulf Arnusch of Siemens VAI received the "Honorary Employee Award of the Year 2007" from Wuhan Iron & Steel (Group) Co. (WISCO) for his extraordinary efforts and activities in connection with numerous continuous casting projects implemented at Wuhan, China. Mr. DENG Qulin, President of WISCO, as well as other top company managers, representatives from the Ministry of Foreign Affairs of Hubei Province and many other foreign guests were present at the ceremony.

Mr. Arnusch was the technical project leader and commissioning leader for six slab casters comprising nine strands in total at Wuhan, China since 2000.* In his own words, "I am, of course, personally delighted to receive this award, however, I fully know that it is the quality of our products, the dedicated efforts of our casting teams and the excellent cooperation with the customer teams that was decisive for the overall success of these projects." ■

Ulf Arnusch honored by WISCO

*Mr. Arnusch was the technical project leader of previous slab-caster projects at Bengang and Shougang, and is currently in charge of other caster projects under way at these companies as well as at Liuzhou Iron and Steel Co. (LISCO).

More information
You can find further information and more press releases over our online portal at **www.siemens-vai.com**

Events: Upcoming Conferences and Fairs

Jul 04 – 05	12th INT. CONFERENCE ON NON-FERROUS METALS, Nagpur;
Jul 09 – 11	WIM 2008 – 1st International Congress on Water Management in the Mining Industry, Gecamin, Santiago, Hotel Sheraton; *http://www.wim2008.com*
Jul – Aug 28 – 01	63rd CONGRESS ON SUSTAINABLE GROWTH, ABM, São Paulo, Mendes Convention Center; *http://www.abmbrasil.com.br/congresso/2008*
Aug 06 – 08	3rd INT. CONFERENCE ON MINING INNOVATION – MININ 2008, Universidad de Chile, Santiago, Sheraton Hotel & Convention Center; *http://www.minin2008.com*
Aug 18 – 20	3rd BAOSTEEL BIENNIAL ACADEMIC CONFERENCE Baosteel, Shanghai; *http://bac.baosteel.com/baosteel_bac3/index_en.jsp*
Aug 21 – 23	SHANGHAI METAL EXPO – 4th China International Metals Industry_Shanghai_Expo, National Metallurgy Industry Association, CISA, Shanghai, Shanghai International Everbright Convention&Exhibition Center; *http://www.metal1986.com/*
Aug 24 – 27	COM 2008 – Zinc & Lead Metallurgy, University of Manitoba, Winnipeg, Winnipeg Convention Centre; *http://www.metsoc.org/com2008*
Sep	3rd INT. MEETING ON IRONMAKING, Tecnored, Rio de Janeiro;
Sep 03 – 05	STEEL AND COMPOSITE STRUCTURES, TU Graz, Graz; *https://www.eurosteel2008.tugraz.at*
Sep 03 – 05	MAPLA 2008 – IV Mining Plants Maintenance Meeting, Gecamin, Santiago, Hotel Sheraton; *http://www.mapla.cl*
Sep 08 – 10	23rd INT. ALUMINIUM CONFERENCE, Metal Bulletin, Montreal, Fairmont The Queen Elizabeth hotel; *http://www.metalbulletin.com/events/Details*
Sep 08 – 12	ELECTRA MINING 2008, Johannesburg; *http://www.electramining.co.za*
Sep 08 – 12	MINEXPO INTERNATIONAL 2008, Las Vegas; *http://www.minexpo.com*
Sep 09 – 10	STAINLESS STEEL WORLD AMERICA 2008, Houston; *https://www.stainless-steel-world.net*
Sep 10 – 12	THERMOMECHANICAL PROCESSING OF STEELS, AIM, Padua; *http://www.aimnet.it/tmp2008.htm*
Sep 14 – 18	THE 11th INTERNATIONAL SYMPOSIUM ON SUPERALLOYS, TMS, Pennsylvania; *http://www.tms.org/Meetings/specialty/superalloys2008/home.html*
Sep 17 – 18	SIEMENS VAI ROLLING & PROCESSING CONFERENCE – Rolling and Processing of Siemens VAI incl. Arvedi ESP, SVAI, Linz, Design Center;
Sep 17 – 18	MINING WORLD CENTRAL ASIA, ITE Group, Almaty, Kazakhstan, Atakent Exhibition Center; *http://www.miningworld-centralasia.com*
Sep 22 – 24	MINExpo INTERNATIONAL 2008, Las Vegas, Las Vegas Convention Center; *http://www.minexpo.com/*
Sep 22 – 26	INT. CONFERENCE ON ALUMINIUM ALLOY (ICAA11), DGM, Aachen; *http://www.dgm.de/icaa11*
Sep 22 – 26	3rd INT. MEETING ON IRONMAKING & 2nd INT. SYMPOSIUM ON IRONMAKING, ABM, São Luís City, Brazil; *http://www.abmbrasil.com.br/seminarios/ironmaking/2008/*
Sep 23 – 25	156th ISIJ MEETING, ISIJ, Tokyo; *http://www.isij.or.jp/Event/kokusai.htm*
Sep 23 – 25	ALUMINIUM 2008 – 7th WORLD TRADE FAIR & CONFERENCE, Reed, Essen, Exhibition Center; *http://www.aluminium2008.com*
Sep	2nd INT. CONFERENCE ON CLEAN TECHNOLOGIES IN THE STEEL INDUSTRY, Brno;
Sep – Oct 29 – 03	1st INT. CONFERENCE ON "INTERSTITIALLY ALLOYED STEELS," IAS, Bahia, Brazil; *http://www.ias2008.com*
Oct 1st week	4th INT. CONGRESS ON SCIENCE & TECHNOLOGY IN OXYGEN STEELMAKING, ISIJ, Gifu, Japan, N.N.;
Oct 01 – 03	PROCEMIN 2008 – Vth International Mineral Processing Seminar, Universidad de Chile, Santiago, Hotel Sheraton; *http://www.procemin.cl*
Oct 01 – 03	MAINTENANCE CONFERENCE, AIST, Memphis; *http://www.aist.org*
Oct 05 – 09	MS&T 2008 – The Material Science & Technology Conference and Exposition, AIST, ASM, TSM, ACerS, Pittsburgh, N.N.;
Oct 06 – 08	The 4th International Congress on the Science and Technology of Steelmaking (ICS 2008), Nagaragawa, Nagaragawa Convention Center; *http://www.isij.or.jp/ICS2008/*
Oct 08 – 10	ABM AUTOMATION SEMINAR, ABM, Vitoria, ES; *http://www.abmbrasil.com.br/seminarios/*
Oct 14 – 17	10th INT. STEELMAKERS CONGRESS, JSC MMK, Yubilejny; *http://www.mmk.ru*
Oct 14 – 17	ABM 45th ROLLING SEMINAR, ABM, N.N., N.N.; *http://www.abmbrasil.com.br/seminarios/*
Oct 15 – 16	51st INTERNATIONAL COLLOQUIUM ON REFRACTORIES 2008, Eurogress, Dresden International Congress Center – ICC; *http://www.feuerfest-kolloquium.de/*
Oct 19 – 22	8th INT. CONFERENCE ON MOLTEN SLAGS, FLUXES & SALTS, Santiago, Chile, N.N.;
Oct 21 – 24	ABM 45th Rolling Seminar, ABM, Ipojuca – Porto de Galinhas – PE – Brasil, Enotel Porto de Galinhas Resort; *http://www.abmbrasil.com.br/seminarios*

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IMPRINT

Publisher
Siemens AG
Industry Sector
Industry Solutions
Metals Technologies
Schuhstr. 60
91052 Erlangen, Germany

Editorial Responsibility in Accordance with German Press Law
Alfred Baur

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Iron- & Steelmaking, Long Rolling;
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Publishing House
Publicis Kommunikationsagentur GmbH, GWA
Corporate Publishing Zeitschriften
Postfach 3240, 91050 Erlangen

Editorial staff: Dr. Beate Bellinghausen, Heiko Jahr, Kerstin Purucker
Layout: Jürgen Streitenberger, Rainer Degenkolbe
Copy editor: Sabine Zingelmann

DTP: der Döss für Kommunikation, Nuremberg
Printed by Wünsch, Neumarkt
Circulation: 20,000

Order No.: E10001-M10-A6-V1-7600
Dispo No.: 21661 K. No.: 28105

Photo Credits:
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metals & mining is published three times per year.

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