

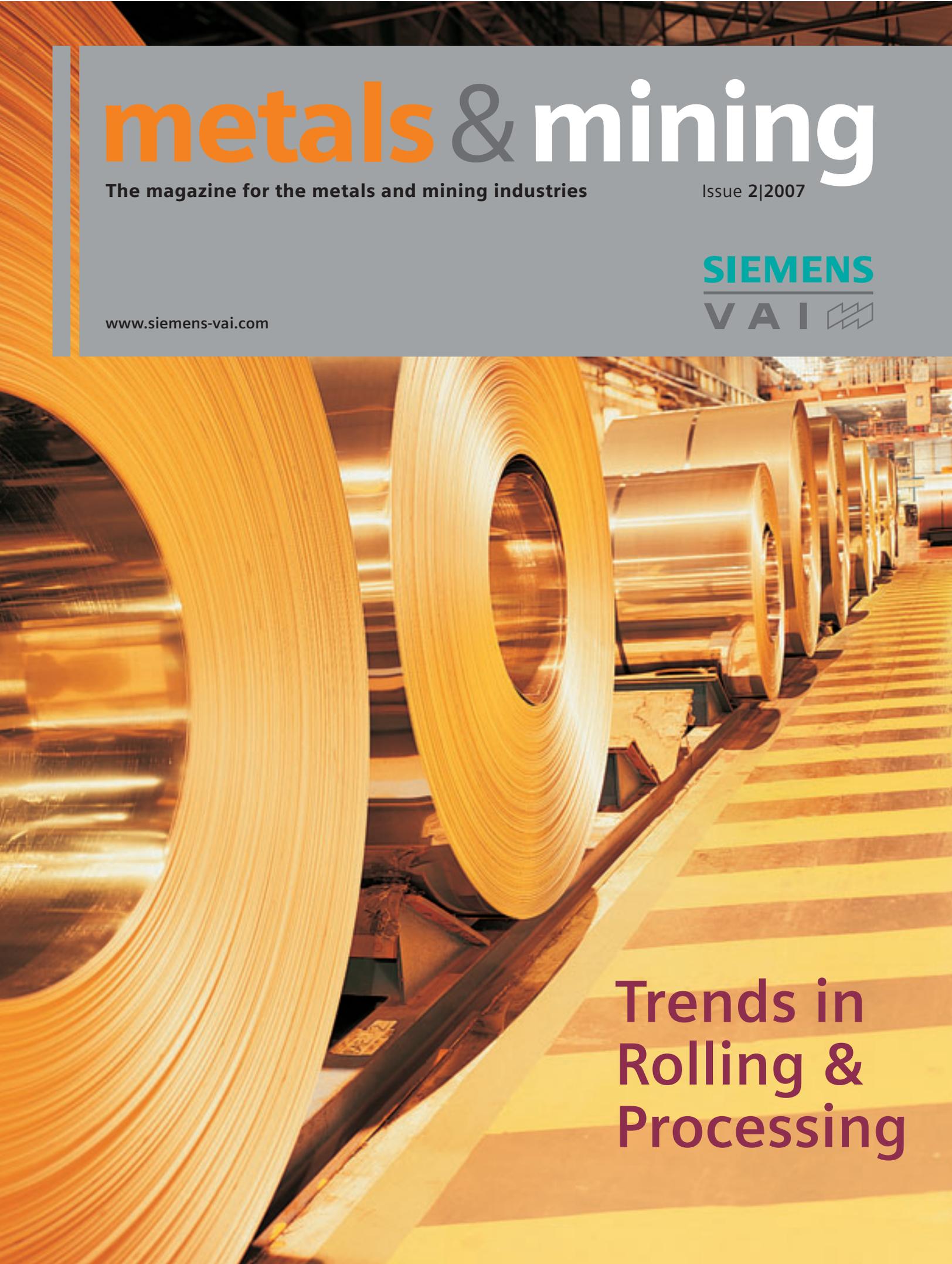
metals & mining

The magazine for the metals and mining industries

Issue 2|2007

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Trends in
Rolling &
Processing



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Metals Technologies

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**Dear Readers:**

Welcome to the second issue of **metals & mining** in 2007. In this issue we will focus on Rolling & Processing.

Over the past few years, the rolling and processing industry has seen significant production capacity increases. This level of growth is expected to continue going forward, but will not necessarily result in only new plants. Many steel producers are also heavily investing in upgrades of existing facilities to meet the growing market demand.

This type of investment is necessitated by recent developments in the steel market. Customers are creating growing demands for new, innovative steel grades, including complex phase steel grades for the automotive industry with equally complex material properties, high-strength steel grades for the ship-building industry, as well as high-strength steel grades with characteristics such as temperature resistant pipes used in the oil and gas industry.

This new market demand is combined with a need for increased production flexibility, consistent and reliable product quality, low production costs, reduced investment and operation expenses, as well as optimal exploitation of raw materials. Moreover, safe production operations that also satisfy environmental protection standards have become the baseline standard.

In this issue of **metals & mining**, we offer viable answers to these and similar challenges facing the rolling and processing industry. For example, we highlight our solution for microstructure target cooling, creating dual-phase, multiphase or high-strength steels along with concepts to improve strip quality. Through selected references, we convincingly demonstrate our extensive solutions expertise for both new plants as well as modernization projects. We also showcase several new products, including our power coiler solution as well as our heavy gauge laser welder.

This issue also covers other aspects of our comprehensive equipment and solutions portfolio for the iron, steel and mining industries, including our broad range of service offerings.

I would like to take this opportunity to invite you to visit us at the Metec, where we will be introducing our latest technologies and solutions for our entire portfolio.

I look forward to seeing you at the Metec, scheduled for June 12–16 in Düsseldorf, and I do hope we can give you some useful insights into *Next Generation Metals* with this issue of **metals & mining**.

Enjoy the articles!

A handwritten signature in blue ink, appearing to read 'Sanjeev Sinha', with a stylized flourish at the end.

Sanjeev Sinha
**Head of the Rolling and Processing Division and
member of the Siemens VAI management board**

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Next Generation ESP

The Arvedi ESP Endless Strip Production Technology will be one of the major highlights at the Metec. Next generation hot-strip production is a breakthrough in the metals industry.

Siemens VAI will show the improvements in technology and electrics and automation since 1990 when the concept of thin slab casting / direct rolling was developed. The technology improvements, such as higher casting speed, process control during casting, induction heating and new rolling mill technologies as well as integrated automation solutions, are the basis for the next generation of this technology. ■

Mining Package

Siemens has received orders from Equinox Minerals Limited, Canada, for the supply of electrical equipment and systems for opencast mine haulage trucks, gearless drives for grinding mills and "in-pit" electrical reticulation, required for the development of its new Lumwana Copper Mine in Zambia. 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.

The Lumwana mine, which is located in the North Western Province of the Republic, will be the single largest copper mine on the African continent. The mine is scheduled to begin production during the second half of 2008. ■

www.siemens.com/mining



High-Performance Hoisting

Siemens has received an order to supply two high-performance mine winder systems for the main production shaft of a new coal mine belonging to Shanxi Gaohe Energy Co. Ltd., China. The goal is to equip the shaft with production winders and so achieve a hoisting capacity of 6 million metric tons of coal per year.

Siemens is equipping the facility with electrical components. For the coal mine in China, Siemens is supplying two high-performance winder systems. The pit conveying systems are scheduled to start operating in the middle of 2009. ■

www.siemens.com/mining

Two New Aluminum Cold-Rolling Mills

Siemens VAI Metals Technologies received orders to supply two new aluminum cold-rolling mills to the Chinese producer, Aluminium Corporation of China Ltd. (Chinalco). The two plants will be built on the premises of two of Chinalco's subsidiaries, namely Chinalco Henan Fabrication Co., Ltd. and Chinalco South West Aluminium Co., Ltd. The new cold-rolling mills are scheduled to start operation by mid-2009.

The two orders follow an agreement signed last year between Siemens and CNPT – Chinalco's mill-building division – and relates to collaboration of the two companies in the design, engineering and supply of technological solutions for aluminum rolling mills for the world market. These two projects underline the leading position of Siemens as a supplier of integrated solutions for aluminum rolling mills. ■

Plant Start-ups and Final Acceptances (January to March 2007)

Company	Country	Project
Aceros Ormazabal	Spain	Slitting Line and a cut-to-lengthline
Acroni	Slovenia	Modernization of withdrawal drive system of competitor slab caster
Acroni	Slovenia	Modernization of Sendzimir cold mill including installation of SIFLAT systems
Ahmsa	Mexico	1-Strand slab caster
Aleris Koblenz	Germany	New main drive for Aluminum Hot Mill
Arcelor Zaragoza	Spain	Relocated and modernized 120-t DC EAF from Belgium and new billet caster started up in Zaragoza, Spain
Arvedi Acciaieria	Italy	1-Strand thin-slab caster
Baosteel	China	1-Strand slab caster
Baotou Steel Union Co.	China	6-Strand finishing train for production of long products; Final Acceptance Certificate
Barrick Gold	Australia	Cowal – gearless drives for grinding mills
Benxi Iron & Steel Co.	China	2-Strand slab caster; modernization
BlueScope Steel Limited	Australia	Installation of Level 2 automation Twin Caster No. 3 and Slab Caster No. 1
China Steel Corp.	Taiwan	Galvanizing Line 2
Corus, IJmuiden	The Netherlands	Modernization of Roughing Mill automation
Corus Teeside	United Kingdom	2-Strand slab caster; modernization
Dragon Steel Corp.	Taiwan	2-Strand slab caster
Erdemir	Turkey	New Divide Shear for heavy plates goes into operation
Gerdau Acominas	Brazil	1-Strand slab caster
Gerlafingen Stahl AG	Switzerland	Long-product rolling mill for large flats; Final Acceptance Certificate
Hadeed	Saudi Arabia	EAF (1.15 million t/a capacity). dedusting facilities. slab caster. Level 1, 2 and 3 automation systems (turnkey project)
Hyundai Steel	Korea	Modernization of downcoilers in Compact Hot Strip Mill
Ilva s.p.a Taranto	Italy	2-Strand slab caster; modernization
Jinan Iron & Steel Co. Ltd.	China	1-Strand slab caster
Lianzhong Stainless Steel Corporation	China	Electrical and Level 1 & 2 automation systems for stainless-steelmaking plant comprising EAF, AOD converter, ladle furnace, twin-station VOD and slab caster
Metallurgica Marcora SpA	Italy	New, innovative roughing group for long-product rolling mill
Novolipezkij Met. Combine	Russia	Two 2-strand slab casters; modernization
Shagang	China	New divide shear for plates
Shougang	China	Final Acceptance Certificate for Plate Mill
Shougang	China	Two 2-strand slab casters
SSAB Oxeloesund	Sweden	Two 1-strand slab casters; modernization
Steel Dynamics Inc.	USA	4-Strand beam-blank caster; modernization
Tangshan	China	Two 2-strand slab casters
Tata Iron & Steel Co	India	1-Strand slab caster; modernization
ThyssenKrupp CSA	Brazil	Two 2-strand slab casters
ThyssenKrupp Steel	Germany	New main drive stand 1 for coupled tandem cold mill BETA
Tianjin Tiantie Met. Group	China	2-Strand slab caster
Ugine & ALZ Genk	Belgium	1-Strand slab caster; modernization
Viraj Profile Ltd	India	Combined bar, wire rod and bar-in-coil mill for rolling of stainless and special steels

Trendsetting technologies in rolling and processing

Global Rolling Boom

The economic situation for the global iron and steel industry is the best that it has been since the 1960s. Yet, this rolling boom has led to bottlenecks in the supply of raw materials, which, coupled with higher prices for energy and ore, represents a downside that rolling and processing innovations from Siemens VAI are helping to ameliorate.

There has been an enormous expansion of iron and steel production capacity worldwide, particularly in China. Between 2000 and 2004, in fact, China more than doubled its steel output from 127 to 280 million tons per year, and the years leading up to 2010 will once again almost double the 2004 figure – all, in a single decade. This enormous increase has gone a very long way toward sustaining the economic development of China. “The previous years have seen major investments in iron and steel production, mainly caused by the boom in China. We expect investment in new rolling mills to continue in China, India, Russia and Brazil,” notes Sanjeev Sinha, head of rolling and processing and a member of the Siemens VAI management board. Sinha adds, “The increasing demand for steel will automatically lead to the need for more – and more-advanced – rolling mills and processing lines.” “Despite

the worldwide steel boom, however, the market for our customers’ business is very competitive. That means, quite simply, that we must really understand customer requirements, in order to offer them profitable solutions and long-term partnerships,” explains Sinha.

A host of new challenges

Besides the mere supply of market needs, a further development has taken place over the past few years: The efficiency and range of steel grades has increased significantly. The automotive industry, in particular, along with the infrastructure industry have boosted requirements for high-strength steels. The need to fulfill these requirements, makes upgrades and expansions of existing plants a special challenge for plant operators and solution providers alike. Decades of experience as a partner of the steel industry covering all





Advanced high-strength steels for the automotive industry require advanced rolling technologies

process phases has put Siemens VAI in the unique position of being able to recognize potential production and quality bottlenecks, to support operators in resolving these problems and bring the plant back to competitiveness.

Firm focus on products and productivity

The fusion of Siemens and VAI in 2005 brought together a multinational group of more than 1,500 specialists, who look back on a proud rolling and processing technology tradition. Aided by the Completely Integrated Solutions (CIS) concept, Siemens VAI has created the basis for a new and innovative product family designed to enhance mill productivity: Siroll^{CIS}.

“Several years ago, we introduced the Siroll^{CIS} product family, which at the time covered our electrical and automation portfolio for the rolling and process-

ing industry. With Siroll^{CIS}, we successfully entered the market, and our customers all over the world appreciated the advantages we offered,” says Sinha. The basis for the Siroll^{CIS} product family not only included the electrical and automation equipment for individual plants: comprising horizontal and vertical process integration (from hot rolling to processing lines and from field devices to management execution systems), as well as the entire life cycle of the plant. “With the integration of VAI, we are extending the Siroll^{CIS} product portfolio to include mechanical and technological solutions as well. The basic strategy is to bring together the best of Siemens and VAI into the new Siroll^{CIS} product family covering process technology, electrical and automation solutions, mechanical equipment, services, and life-cycle support,” explains Sinha.

>>



The bridge over the Tarn valley is one of the most famous examples of innovative architecture with steel



>> Portfolio for hot rolling strip and plate

Siroll^{CIS} HM represents the technological solution for hot rolling mills, and covers mechanical and technological systems as well as electrical and automation solutions. Its flexibility also makes Siroll^{CIS} the ideal solution for retrofitting existing plant facilities. In addition to conventional methods for hot strip production, Siemens VAI is also very active in advancing innovative developments. As a result, Siemens VAI is now building the world's first endless strip production (ESP) plant – the next generation of thin-slab casting and direct rolling technology. The patents and the operational know-how from Acciaieria Arvedi in Cremona, Italy, combined with the technological expertise of Siemens VAI form the basis of this future-oriented production approach. ESP is considered the next generation technology in thin-slab casting and rolling. The unique design and plant configuration of the Arvedi facility, particularly the high casting speeds, will enable continuous, endless rolling of high-quality strip for a wide range of steel grades. A joint venture engineering company called Cremona Engineering srl has been established to coordinate all of the activities surrounding the implementation of this project. The new line will be built at the existing Arvedi premises of Cremona and linked to an extended melt shop. It comprises four main plant sections. The first section consists of a thin-slab caster with liquid core reduction and in-line rolling using three high-reduction stands at the exit of the casting machine. In the second section, the inter-

mediate strip is heated up and equalized in an induction furnace. The third section, comprising a 5-stand, 4-high finishing mill and cooling line, is designed to enable the rolling of strips with thicknesses ranging from 12.0 mm to as low as 1.0 mm at strip widths of up to a maximum of 1.570 mm. The fourth section consists of a high-speed flying shear and three downcoilers.

The 180-m compact line arrangement reduces capital investment significantly over conventional thin-slab casting and direct-rolling plants. The line's capability to produce thin hot-rolled strip eliminates the need for cold rolling in many strip applications. Endless rolling operations will also enable the production of strip with uniform and repeatable mechanical properties along the entire strip width and length.

For heavy plate production, Siemens furtherly improved the Mulpic system for plate cooling, as well as a new plate shear for high-strength materials and massive thicknesses. Both developments are ideal for installation in new plants, as well as for retrofitting older facilities. Siemens thereby once again underscores its leading market position in plate mills technologies.

Innovation in cold rolling and strip processing

Cold rolling is another area of expertise of Siemens. Typically conducted customer requirements analyses ensure that they receive the solution that is best suited for their final products. For example, Siemens is supplying 6-high technology for a new 4-stand tandem mill at the Corus site in IJmuiden, The Netherlands,

The Siroll Product Family

Siroll ^{CIS} HM	Hot strip mills, endless strip production (ESP) plants
Siroll ^{CIS} PM	Plate mills, Steckel mills, plate/Steckel mills
Siroll ^{CIS} CM	Tandem cold mills, reversing mills, skin pass mills
Siroll ^{CIS} PL	Pickling, annealing and coating lines
Siroll ^{CIS} FL	Strip finishing lines
Siroll ^{CIS} ALU	Hot, cold and foil rolling mills for aluminum



Production of heavy plates, which are being used in Oil & Gas and ship-building, is also experiencing a genuine boom at the moment

which will be coupled with an upgraded and expanded pickling line.

For voestalpine Stahl, to offer another example, Siemens is delivering a 5-stand continuous tandem mill with quarto technology for a new cold rolling mill in Linz, Austria, which includes a separate discontinuous pickling line that will be added to the tandem mill at a later date. Both mills were designed specifically for the production of advanced high-strength steels (AHSS).

Siemens VAI's advanced processing lines cover all of the typical processing applications such as pickling and galvanizing, as well as the special equipment. For example, they feature a new laser strip-welding machine, which has been specially designed for the processing of high-strength steel grades. With the development of this laser welder for heavy gauge strip, Siemens VAI is now able to offer an industrial solution designed to meet requirements ranging from conventional mashed lap and flash butt processes to advanced laser welding. A comprehensive portfolio for finishing lines rounds off the Siemens VAI portfolio, creating a link to the downstream metalworking industries.

Dedicated to aluminum rolling

Siemens VAI offers a broad solutions portfolio for aluminum processing for everything from hot and cold rolling to finishing, both for new plants as well as for plant modernization projects. Technical highlights include DSR technology with a hydraulically adjustable backup roll to ensure highest quality under changing

plant conditions. The patented contact-free Siflat flatness measurement technology offers an advanced measurement method that provides outstanding advantages without any risk of surface damages, thus perfectly complementing modern cold rolling mills.

Siemens VAI: the right choice

Whether you are deciding on a new rolling mill, a processing line, or simply searching for a life-cycle partner to stay at the forefront of modern strip production, Siemens VAI is a recognized supplier of the finest quality mill technology for steel and aluminum processing. As full liner, Siemens VAI optimizes and supplies solutions for the entire process chain, including mechanical, hydraulic and technological applications as well as energy distribution, drive technology, automation, process models. Siemens VAI's project management ensures a smooth project execution by reducing the number of external interfaces and streamlining all of the processes. These management capabilities, coupled with advanced products and global resources, make Siemens VAI the right choice for steel and aluminum processing projects, wherever they may be located. ■

Authors

Gerald Hohenbichler
Günther Winter

Contact

rollingandprocessing.metals@siemens.com

Christophe Cornier on steel trends and their influence on process and equipment design

Stronger, Thinner, Wider

“One key issue will be the ability to deliver products with consistent properties from coil to coil and within the body of a single coil.”

Christophe Cornier

Executive vice president of Arcelor Mittal and CEO of Flat Europe



In the next five years the automotive market for steel will see the industrialization of advanced high-strength steels such as dual-phase TRIP (transformation-induced plasticity) steels and multiphase steels, in terms of both volume and mechanical characteristics. We spoke with Christophe Cornier, executive vice president of Arcelor Mittal and CEO of Flat Europe, about how this will impact steel manufacturing.

Mr. Cornier, advanced high-strength steels seem to be the market of the future.

Christophe Cornier: Everybody is talking about automotive right now, but high-strength steels will also be required for applications such as crane manufacturing and freight transport, with yield strengths up to 1,300 megapascals in a thickness range of 3 to 12 millimeters, excellent flatness, and warranted toughness down to -40° Celsius. These characteristics can be ensured by tightly controlling the steel cleanliness, followed by mastering the segregation phenomena, such as control of the superheating, electromagnetic stirring, and softer reduction. Another major demand will be API tubes for heavy-gauge X80 to X100 grades, which require more sophisticated processes from the steel shop and hot-roll facilities.

So manufacturing these steels will be different from what we see today?

Christophe Cornier: One key issue will be the ability to deliver products with consistent properties from coil to coil and within the body of a single coil. In the steel plant, tight control of the chemical composition must be achieved without lowering productivity. Development of a “dynamic routine” of steels, including in-line process adaptation, is a tool that will help meet these objectives. As the steel contains higher quantities of alloying elements, secondary metallurgy – for example, RHOB or ladle treatment – is also becoming more important.

And what about other mechanical properties, such as strip width and gauge?

Christophe Cornier: Along with increased mechanical strength we see the production of thinner and wider strips, which require more powerful hot strip mills, especially in the finishing stands, as well as more powerful cold strip mills. Another alternative we will consider is heavy warm rolling. Downstream, welding and shearing need to be adapted. However, one major concern is obtaining consistently good geometry, with a defined flatness and crown. This requires more stringent

temperature control at the hot strip mill, such as coil box, tunnel reheating, and edge reheating. And to obtain the targeted mechanical properties, tight temperature monitoring of the soaking and cooling must be ensured in the continuous annealing and hot-dip galvanizing lines. For advanced high-strength steels, we can obtain a good coating quality only if the gaseous atmospheres in these lines are controlled as well.

How will you achieve these tighter control regimes?

Christophe Cornier: Generally, there will be an extension of in-line controls, for example, magnetoscopy, eddy currents, Lamb waves, and automated surface-inspection systems. As the process will rely on the accurate measurements of process parameters, physical models, and actuators, we need integrated solutions to close the loop in real time.

Where do you think these developments will take you?

Christophe Cornier: Right now, we primarily need greater process flexibility. For instance, induction heating can be introduced at different process steps: before soaking or after continuous annealing to get tempered high-grade dual-phase steel. We need process designs that offer this flexibility. We are also considering process variations such as physical vapor deposition, which allows the processing of any coating onto any steel, even with thicknesses of several nanometers. We also need to have additional treatments or coatings such as thin organic coatings on existing coating lines. In hot-dip galvanizing, being able to precisely control the zinc thickness is very important, even at high speed and down to 7.5 microns.

Over the longer term, classic carbon steel metallurgy could reach a limit in terms of product development, so we are considering new metallurgies such as steel matrix composites, highly alloyed carbon steels, TWIP (twinning-induced plasticity) steels, intermetallic-containing steels, ultrafine-grain steels, functionally graded materials, and so on. Corresponding processes to be developed include ceramic injection, co-casting of two or three grades, significant power increases at the cold mill, and the capacity to introduce nonmagnetic steels (for example, TWIP) along the process.

Such metallurgical developments will allow more flexibility in the process and create fewer scheduling constraints, reducing lead time and improving service to our customers.

Thank you for speaking with us. ■

Contact
www.rollingandprocessing.metals@siemens.com

Precise strip property control in hot-rolling mills

Targeted Cooling

One of the most important processes in steel production is the cooling of hot-rolled steel on the runout table in hot strip mills. New developments in the physical modeling of the steel transformation process and in control technology make it possible to compute temperature and phase fractions along the entire cooling section in real time and enable precise control of any strip point's temporal cooling course.

The successes of new materials have been accompanied by an increase in the requirements placed on classic steel. The properties of new dual-phase,

control the cooling process. The physical model enables calculation of phase equilibrium and generated transformation heat, as well as microstructure properties.

This makes it possible to describe all steel grades with a unified concept, especially modern complex steel grades such as dual-phase or TRIP steels, and also to describe their behavior and phase and microstructure changes as they travel through the cooling section. In addition, this innovation supports the design of new materials. The ability to specify temporal cooling courses simplifies the procedure of establishing new steel grades. With a sophisticated water flow and heat flow model, which takes into account the different water cooling techniques, it is possible to model the heat transfer at each point in the strip in the mill at any given time. The predictive controller concept enables the temperature course calculation to be performed at a point in time before the relevant strip point enters the mill.

The adaptation with the pyrometers in the mill enables the close monitoring and adjustment of the model computations.

Mechanical and automation concepts from a single source

In addition to models and control, Siemens VAI offers the related mechanical cooling-section equipment and automation equipment. With its experience in building new mills and cooling sections, combined with extensive knowledge of revamps, Siemens VAI can offer all the solutions required to enable a cooling section to handle both current and future demands. ■

Author

Klaus Weinzierl

Contact

rollingandprocessing.metals@siemens.com

COVER STORY >



Key Benefits

- Physical models for all types of steel
- Advanced control for high flexibility
- Precise cooling for highest-quality products
- Broad range of cooling equipment
- Flexible automation systems

The Microstructure Target Cooling package for Siroll^{CIS} HM can precisely control the cooling process

multiphase, or high-strength steels such as TWIP and TRIP are strongly influenced by the cooling section. Precise and highly flexible control of the cooling process is therefore extremely important.

Sophisticated models supply control with microstructure information

Siemens VAI has developed a new cooling-section control system that uses the Gibbs free energy to calculate the steel transformation very precisely on the basis of a thermodynamic model. By means of a model-predictive control function, the stipulated time curve of cooling in the cooling section is optimally adhered to for the entire steel strip within the limits of the plant in question.

With the Microstructure Target Cooling package for Siroll^{CIS} HM, Siemens VAI offers an automation and control solution for the cooling section that can precisely

Advanced high-strength steels require new cold-rolling technologies

Cold-Rolling Precision

COVER STORY >



Coupled Pickling Line and Tandem Cold Mill, Tangshan Iron & Steel Co, China

Cold rolling becomes more difficult as the strength of the steel grade increases. With proven 4-high and 6-high mill stand configurations for continuous tandem cold-rolling mills, Siemens is able to meet the growing demand for advanced high-strength steels in the steel industry.

Today, new continuous tandem cold-rolling mills must be capable of rolling strip with a tensile strength of up to 1,300 MPa. In future it will be necessary to process an extremely broad range of steel grades including a considerable proportion of advanced high-strength steel (AHSS) grades such as multiphase steels. Key factors to be solved for a successful production of AHSS grades are:

- The higher reduction capability of the mill stands which influences the general performance of the mill

- The stiffness of mill stand housing and roll stack which is important to reach the required thickness performance
- The right choice of the flatness actuators which influences the flatness performance
- And finally the mill setup especially for AHSS grades which leads to a smooth operation

Other significant requirements on a modern tandem cold mill include:

- The sensitivity to strip surface quality (a key characteristic for all products produced for the automotive industry)
- The need to keep thickness reduction at the strip edges (edge drop) within close tolerance limits, which is particularly important for electrical sheets.
- Short off-gauge lengths:

In continuous mills, the so-called “flying gauge change” is a higher order sequencing and control function that secures the transition from one strip to the other at optimized speed and length parameters. It requires fast control systems, a high accuracy segment tracking and process models that perfectly fit together.

Key Benefits

A comprehensive offering for the entire cold-rolling process

4-high and 6-high mill stands for high mill flexibility for all products

Tight tolerances for strip thickness, shape and high surface quality

Low costs for operation, maintenance and minimum downtimes

6-high and 4-high technology

Siemens VAI is currently on the way to install new continuous cold-rolling mills using proven 4-high and 6-high mill stand technology for the production of AHSS grades. Work rolls of 4-high mill stands and intermediate rolls of 6-high mill stands are equipped with the SmartCrown roll contour which enables the control of higher order flatness defects. Compared to the 4-high mill stand technology, the 6-high mill stand technology offers a more flexible flatness-adjustment behavior in the fourth and sixth order for very wide strips and allows therefore a better control of edge drop. However, it has about 10% higher investment and higher operating costs.

Latest Siemens VAI references in the field of AHSS rolling are the new tandem mills for voestalpine Stahl in Austria (5-stand, 4-high) and for Corus Staal in The Netherlands (4-stand, 6-high). ■

Authors

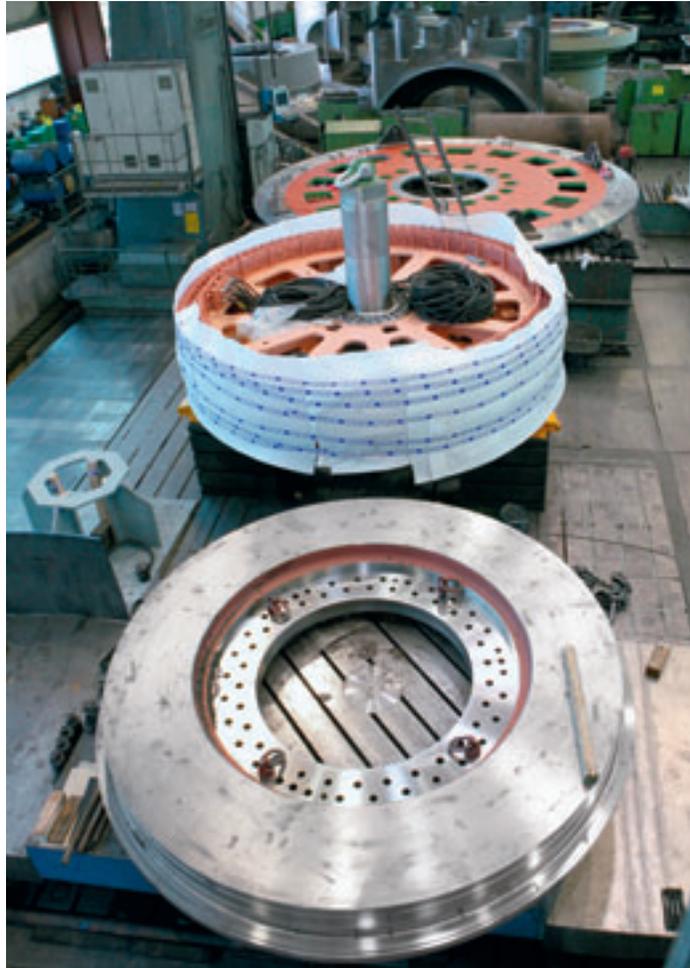
Gerlinde Djumliia, Georg Bytowski

Contact

coldrollingmill.metals@siemens.com



The rotor for the new minewinder motor was built at the Siemens factory in Berlin



Minewinder replacement at K+S Kali in record time

18 Days and Done

At the K+S Kali GmbH, the large minewinder had to be modernized and Siemens and Siemag were contracted to deliver and install the new drive. In just 18 days, the project team with experts from both companies took out the existing unit and installed a completely new drive system.

The K+S Kali GmbH operates six mines in Germany for potassium and magnesium. The company is one of the world's leading providers of potassium and magnesium products with a production capacity of 11 million tons. This is approximately 13

percent of the world's potassium requirements. Potassium is required both in agriculture and building.

At the potassium salt mine in Hattorf, Germany, the old Siemens winder had been in operation since 1961. The production shaft Hattorf in Philippsthal has two



Siemag at Netphen manufactured and assembled the winder drum and mounted parts of the minewinder

The mounting rig for the drive is brought into position at K+S Kali GmbH in Philippsthal



winders. One of these units, the north winder, which had been automated by Siemens already in 1982, had been in continuous operation 23 hours a day and had transported 150 million tons of salt. After more than 45 years in service, the friction wheel, gear and motor were showing signs of wear. Consequently, there was an increased risk of unexpected machine failure – a risk the K+S Kali GmbH did not want to take in view of the high facility workload, and it was therefore urgently necessary to replace the drive.

Finding the right partner

To ensure continuing operation of the winder, the owners were looking for the right partner to replace the large drive. “The contract was awarded to Siemens and Siemag because they were the best suppliers to come out of the invitation to tender and technical and economical assessment,” Manfred Armbrust, head of electrical engineering underground at the K+S Kali GmbH Werra plant explains.

Siemag with its headquarters in Netphen offers logistic systems for the mining, steel and metal industries. The company offers comprehensive logistics system solutions from planning via project management,

delivery, installation, maintenance to service. With Siemens as a general manager, the two companies formed a fine team which was able to solve the problem at K+S Kali GmbH competently.

The customer’s demands were high. The replacement of the old drive and the complete commissioning of the new system had to be completed within a maximum 18 days during a summer shutdown. An essential reason for awarding the contract to Siemens and Siemag was their concept of the integrated winder, which enables short-time conversions such as required for this case. After a detailed analysis of all basic conditions and specifications, the project experts chose a drive design with motor integrated in the friction drum. This solution with an integrated motor can be implemented with a minimum interruption of production because the winder can be installed as a completely preassembled set. The winder drum has a diameter of 6.5 meters. It will drive two skips each with a load capacity of 15 tons at a speed of 16 meters per second. The hoisting distance is approximately 700 meters long. The hoisting capacity amounts to 665 tons of untreated potassium salt per hour. Over the last 20 years, Siemens has installed 16 of these integrated drives. >>



Siemens also supplied the medium-voltage system



>> With a nonintegrated system, which Siemens also has in its portfolio, the conversion would have taken twice as long.

The minewinder is put into operation

Siemens delivered a drive system with an integrated drive solution from the Simine^{CIS} Winder family. The system consists of the external-rotor synchronous motor with a power of 3,000 kW including the corresponding 12-pulse cyclo converter of the Simovert D type. The motor and the converter are air-cooled. The heat loss is dissipated through a heat exchanger and a chiller. A filter and compensation system ensures compliance with the quality specifications of the feeder network and the trouble-free operation of the existing ripple control system. Control and safety technology, shaft signaling system and a new brake with control unit were also supplied. The machine manufacturer Siemag GmbH contributed the mechanical components: the drive wheel, axle, bearing and the new brake system.

While the rotor for the motor was being put through the final tests at the Siemens factory in Berlin, Siemag was manufacturing the winder drum and the addition-

al units. Precise project management and the optimum coordination of the individual subcontractors were essential aspects in keeping the tight schedule. A crucial factor for the trouble-free pre-assembly of the large drive was that all of its parts are manufactured with high precision. After pre-assembly, the drive weighs an impressive 130 tons and has a diameter of more than 7 meters.

Transport and installation – supersized

Transporting this huge unit to the K+S Kali GmbH in Philippsthal by road took several days. This service which was also coordinated and carried out by Siemens in cooperation with specialist companies.

In the meantime at the Hattdorf facility, the project team prepared the site for the installation of the new machine. The old drive was disassembled and the roof of the building was removed. Two special heavy-duty cranes specially certified for this load were necessary to install the minewinder drive. The transport frame of the drive had to be replaced by the assembly frame to be able to lift the drive through the open roof. The “supersized” drive was lifted high above the heads of the team and placed into its final destination in the build-



A heavy-duty crane lifted the minewinder into an upright position and transported it through the roof to its designated place of installation. The entire project was completed in a mere 18 days

ing by the special crane. This intricate work demanded maximum precision. With combined forces and great care, the motor was installed in its place, where it will perform its duties for the next forty to fifty years until the mine's salt deposits are exhausted. "The coop-

eration with Siemens as general manager was excellent. All jobs were very well coordinated," Manfred Armbrust recalls.

All important components of the winder are redundantly designed to guarantee a high safety and availability of the system and to comply with mining authority safety standards. For example, the system

can continue to operate with full load and at full speed even when a transformer fails. The control system is designed redundantly as a standby system. The three-channel controlled safety brake has a fourth connectable channel which can fully replace any of the three active channels in the event of a system fault.

The conversion took place in the summer of 2006 during the regular 18 day production shutdown peri-

od. The new winder system is operating trouble-free, and the customer's expectations have been fully satisfied. The extremely short conversion time has minimized production downtimes.

Moreover, the integrated high-tech drive offers additional benefits: Intelligent control algorithms, increased performance due to shorter cycle times, lower maintenance costs, increased availability due to gentle handling of the mechanical components, optimization of the drive times and thus an increase in the hoisted volume due to intelligent drive controls, maximum safety due to redundant tested safety system, security of investment due to the use of standardized industrial components. ■

Main Benefits

- Higher performance
- Shorter cycle times
- Less wear and tear
- Greater reliability
- Higher output
- Greater investment security

Author
Winfried Schmitt
Contact
mining@siemens.com

Operations Research improves opencast mining process

Making Optimum Use of Resources

The individual parts of the opencast mining process chain, from storage facilities to handling of the excavated materials, have been continuously improved over the course of the past few years by several measures. However, there is more potential in the optimization of the entire process. Based on an integrated IT landscape, Siemens offers methods for operations research that can be implemented as control technology functions at planning and control level.

MINING >

The optimization steps at equipment unit level have improved the process in three respects: First, they have reduced downtimes caused by maintenance and operational malfunctions. Second, they have increased the availability of conveyors close to the limit of their capacity, and third, they enabled improved diagnosis of both process and system management.

In modern opencast mines, a reliable supply of diverse types of data has to be made available to the automation devices and the mine operators at all times, in some cases covering considerable distances. This asks for powerful data networks. Thanks to considerable efforts in this area, a basis has been created on which the entire process of lignite mining and power generation can be optimized.

Analysis of the process chain

Analyzing the process chain in opencast mining has to cover the process steps and their interaction including both commercial and technical aspects. The model that results from this analysis forms the basis for optimization solutions based on operations research methods.

These methods have already proven their value in many industrial sectors. They are aimed at analyzing and structuring entire complex scenarios and making them accessible to mathematical modeling. These models provide the basis for predicting system behavior and developing numerical processes that can propose optimized (partial) plans to the production scheduler and even perform control functions online.

Utilizing synergies

When optimizing the entire process, opencast mining can profit considerably from the experiences of other industries. There are a number of analogies between

the conveying process and the supply chain in the water supply and distribution industry. There, processes can already be optimized by means of the Siwa-Plan tool. With this tool, it is possible to minimize energy costs through optimum scheduling of pump operation and stocks on the basis of regional requirement forecasts.

In opencast mining, the conveyor is the equivalent of the wells and springs in the water supply industry. Bulk transport in opencast mining is performed via conveyor belt systems instead of pipelines. The pumping stations that ensure the flow of water through the pipes correspond to the belt drive systems in opencast mining, which require a supply of electric power for operation and for which the costs must be minimized. In the water supply industry, large reservoirs are used for stock management, whereas in coal mining that function is performed by bunkers, for example outside the power plant. At the end of the supply chain, the local consumers are equivalent to the power plants or processing plants. The aims are also similar: reduction of system management costs and low-stress operation of equipment. In opencast mining that means, for example, using conveyor equipment just under the load limit.

Five-step phased concept

A five-step phased concept provides a practical means of developing and integrating suitable methods and

Five steps to an optimized process

- Initial review, feasibility study
- Modeling and prototyping, optimization potential assessment
- Development and implementation of tools as a stand-alone solution
- Field test in opencast mining
- IT integration



When it comes to optimizing the entire process, opencast mining operators can profit considerably from the experiences of other industries

tools to optimize the entire opencast mining process. In order to develop a successful solution, both the supplier of the optimization solution and the opencast mine operator have to cooperate closely during this process.

First of all, a detailed process review has to be performed. All relevant data and contributing factors have to be recorded. This phase also includes conducting interviews with representatives of the mining company as well as with electrical and mechanical engineers and suppliers on site.

This is followed by careful mathematical analysis and modeling. Prototype calculations can also be car-

ried out to provide quantitative data to back up the optimization potential. In the third phase, the tools are developed and made available as stand-alone tools which are then tested in detail in a field test. Once the field test is successfully completed, the tools are integrated in the control system and in the corresponding IT system. ■

Authors

Norbert Becker, Michael Hofmeister

Contact

mining@siemens.com

Another major project under way in South America

New Greenfield Steel Mill

IRON & STEEL >



Schematic Overview of the Steel Mill

A new integrated iron and steel works is now under construction for ThyssenKrupp CSA Companhia Siderúrgica near Sepetiba on the Brazilian coast in the state of Rio de Janeiro. Siemens VAI will supply an LD (BOF) converter steelmaking plant, including the secondary metallurgical plants, environmental facilities, two slab casters and the associated electrical and automation systems. Following the start-up scheduled for March 2009, five million tons of steel slabs will be produced each year for export to the NAFTA (North American Free Trade Agreement) market as well as for processing at the rolling mills of ThyssenKrupp Steel in Germany.

September 28, 2006 marked the start of yet another major project to be implemented by Siemens VAI in the Latin American region. In order to participate in the expected continued growth of the glob-

al steel market and to utilize regional cost advantages as well as the geographic proximity to raw-material sources, ThyssenKrupp Steel decided to build a new integrated iron and steel works near Sepetiba, Brazil. The mining giant Companhia Vale do Rio Doce (CVRD), the world's largest producer of iron ore, will hold a 10 percent stake in this project. The contract was signed between ThyssenKrupp CSA Companhia Siderúrgica – a Brazilian company of ThyssenKrupp Steel – and Siemens VAI on the occasion of the groundbreaking ceremony for this monumental project. For the new steel mill, Siemens VAI will supply two LD (BOF) converters with a capacity of 330 tons each, two secondary metallurgical facilities, one primary and one secondary dedusting system and two 2-strand slab casters. Included in the project scope are the basic and detail engineering for the steel mill and caster equipment;

**Site of Future
Thyssen Krupp
CSA Steel Plant,
Sepetiba, State of
Rio de Janeiro,
Brazil**

all of the associated mechanical, media, and electrical equipment; Level 1 and Level 2 automation systems; training of customer personnel; services for construction, start-up, and commissioning; and project management services.

ThyssenKrupp will carry out the civil design and construction, engineering and services relating to the erection of the steel structure for the steel mill building. They will also supply selected operational plant items such as the material-handling system, hot-metal desulphurization, cranes, ladles, and ladle preparation equipment.

LD (BOF) Converters

The converters will be outfitted with maintenance-free VAI-CON Link converter-suspension systems, quick-change oxygen lances, pneumatic slag stoppers as well as sublances and bottom-stirring equipment. The secondary metallurgical facilities will comprise two ladle-stirring stands for steel-bath homogenization and a station for the chemical heating of the liquid steel. An RH vacuum degassing unit will be equipped with a T-COB (Technometal-Combined Oxygen Blowing) lance for decarburization and precise adjustment of the steel chemistry and quality.

Environmental Facilities

In order to satisfy the stringent environmental regulations, primary and secondary offgas treatment systems will be provided to minimize dust and

harmful gaseous emissions. The primary offgas-treatment system includes the offgas cooling, dry-type offgas cleaning and gas recovery. The secondary offgas-treatment facility with pulse-jet-type filters will collect and separate the dust and fumes emitted during the charging and tapping of the converters as well as the emissions from the ladle-treatment stations, desulphurization, deslagging, ladle and tundish wrecking and from material handling at the storage bins.

Slab Casters

Two 2-strand slab casters will be provided to enable an annual production capacity of 5 million tons of slabs. The slab widths will range from 800 to 2,000 millimeters with thicknesses varying between 200 and 260 millimeters. In order to ensure the highest standards of product quality, reliable casting operations and an



Contract Negotiation Teams. From left to right: Christian Laimer (Siemens VAI), Wilhelm Fingerhut (Siemens VAI), Norbert Petermaier (Siemens VAI Brazil), Heinz Steinmair (Siemens VAI), Ulrike Höffken (TKS), Manfred Jäger (TKS), Peter Steiner (Siemens VAI), Burkhard Donnepp, (TKCSA), Peter Höfer (Siemens VAI)

efficient production flow, the slab casters will be equipped with state-of-the-art design features and technology packages.

The technology packages include LevCon (for automatic mold-level control), DynaWidth (for online mold-width adjustments), MoldExpert (for online automatic breakout prediction and strand-shell friction monitoring), and the DynaFlex mold oscillator (for the flexible and online adjustment of the oscillation parameters). The bow zone, the straightening zone, and the horizontal casting section will be provided with low-maintenance SmartSegments, which allow rapid slab-thickness adjustments and dynamic soft reduction to be carried out. This is made possible through the remote adjustment of the roller gaps with the DynaGap SoftReduction technology package. A long service life for the strand-guidance system is ensured by I-Star rollers (intermediately supported strand-guide rollers) and DynaJet cooling nozzles (featuring a flow-adjustable air-mist spray). The casters will also be installed with the Dynacs secondary-cooling system and with a slab quality-control system for quality assurance. Other systems include YieldExpert (for optimized yields) and CC Explorer (for comprehensive caster information and documentation).

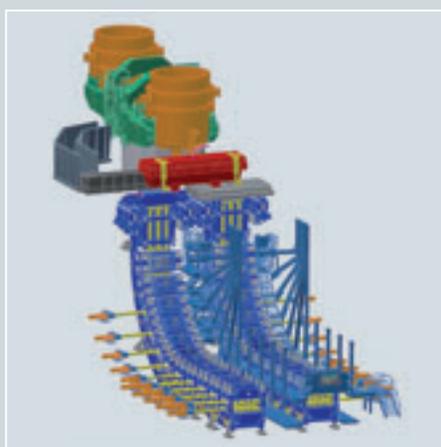
Since the start of the project, the ThyssenKrupp CSA and Siemens VAI teams have been working closely together at a very high professional level and overall progress is highly satisfactory. Both teams and the management are dedicated to the success of this challenging project. ■

Authors

Peter-Horst Höfer, Richard Kasmader, Georg Stadler

Contact

peter-horst.hoefler@siemens.com



General Design of the 2-Strand Slab Caster

With more than 170 new blast furnace references in addition to many more blast-furnace rebuilds, Siemens VAI today is the leading supplier of blast furnace technology in the world. Efficient, cost-effective and environmentally friendly operation is achieved by extending the furnace campaign life, by producing consistently high product quality, and by conserving energy and resources to the greatest extent possible. The steadily increasing size of blast furnaces to improve performance and reduce costs and the impact on plant equipment and furnace design has been investigated by Siemens VAI.

Furnace design

With the use of sophisticated design practices and finite element techniques, a fully optimized “free-standing,” “thin-shell,” and “lightweight” design can be implemented that withstands cracking, even toward the end of a furnace campaign. The key issue in the design of large-sized blast furnaces is that the additional stresses and necessary plate thicknesses must be carefully considered to ensure the structural integrity of the furnace vessel. There are no insurmountable design issues to be overcome relating to the furnace proper as the hearth size increases.

Casthouse operations

As the blast-furnace hearth diameter increases, the casthouse size must also be increased. Large blast furnaces should be designed with four tapholes, with provision for a fifth taphole taken into consideration. Flat floors and fully covered runners that are flush with the floor level allow for easier use of mobile vehicles in the casthouse area. With radio-controlled equipment and effective emission-control systems, considerably improved and safer working conditions exist for operators today. There are no complex design issues to be solved associated with an increase in the size of the casthouse (in terms of the floor plan) to accommodate a larger blast furnace.

Furnace cooling systems

As the furnace hearth size increases, the size of the water-cooling system and the number of required staves – now standard in blast-furnace cooling systems

Key design issues associated with large blast furnaces

The Bigger the Better?

A key reason for the improved operational efficiency of blast furnaces over the years has been the continuous increase in the furnace size. Since the late 1800s, the average furnace hearth diameter has grown from three meters to over 14 meters today. The largest blast furnaces in the world now boast hearth diameters in excess of 15 meters! Is there a limit in the size that a blast furnace can be built? In this article, the impact that large hearth diameters can have on the ancillary blast furnace equipment is discussed.

– also increase proportionally. The circulation flow rate is a function of the number of staves and their specific water demands. Water flow rates in excess of 5,000 cubic meters per hour, if required, may necessitate the use of larger pumps and/or the splitting of the water system into more than one circuit. The design of the cooling elements (staves) is not sensitive to the furnace size. The number of elements is simply increased to adapt to a larger furnace hearth. Adequate instrumentation and monitoring systems are, of course, necessary to ensure careful heat-flux monitoring.

Gas cleaning

The removal of dust from the blast-furnace offgas is important for the subsequent use of the gas as a fuel



Corus Redcar No. 1 Blast Furnace – 14-m Hearth Diameter (Siemens VAI supply)

for stove heating and elsewhere in the plant. The proposed Siemens VAI dedusting solution, also for large-sized blast furnaces, foresees the use of a cyclone followed by a two-stage cone-type wet scrubber. In comparison with a traditional dustcatcher solution, the cyclone considerably reduces the load at the scrubber and at the effluent treatment plant. The proprietary Siemens VAI cone-type wet scrubber cools the blast-furnace gas, which is then saturated with water sprays in the conditioning tower part of the plant. The gas is then passed through a movable cone assembly, which allows the top pressure of the furnace to be accurately and consistently controlled in support of good furnace operation. The saturated offgas passes through a demister to remove the free water and also the dust contained

within the water. This results in a dust-removal efficiency of about 99.9 percent.

With an increased furnace size and the resulting increase in the volume of the gases flowing to the top of the furnace, it may be necessary to install more than one cone unit within the scrubber vessel.

Hot-blast stoves

As the blast-furnace size increases, the required blast volume and corresponding stove size is also larger. External-combustion-chamber stoves are particularly suitable for the ultra-high-temperature operation of large-sized blast furnaces. There are also no limits to the stove size (as opposed to internal-combustion stoves) due to dome-structural reasons. The well- >>



China Steel No. 4 Blast Furnace – External Combustion Chamber Stoves (Siemens VAI supply)

>> proven ceramic burners are high-combustion efficiency units with low CO, SO_x, and NO_x emissions. Increased stove efficiency and recovered waste heat help reduce the need for expensive enrichment fuels.

With the use of modern stove valve systems, particularly those with hydraulic actuators, a high level of stove availability can be assured. A three-stove system will be adequate even for large blast furnaces; however, provision should be made for a fourth stove installation in the event that parallel blast/gas patterns are desired or to ensure a sufficient hot-blast quantity in the case of a stove outage.

Tuyere injection systems

Coal injection is currently preferred today to reduce the blast furnace's coke consumption and the related

costs. With an increasing furnace size and hot-metal production, a greater coal-grinding and injecting capacity is required. This can be easily achieved by employing larger grinding mills and injection vessels or by foreseeing parallel coal-grinding/injection streams.

Process automation and control

Large-sized blast furnaces will obviously be equipped with a wide array of probes, sensors, and other monitoring equipment to gather and evaluate information on burden profiles, refractory conditions, cooling systems and many other parameters. VAiron represents a particularly effective and well-proven process optimization solution that is highly suitable for use in large blast furnaces. It is based on the application of advanced process models, artificial intelligence and a



Posco Gwangyang No. 4 Blast Furnace – Flat Casthouse Floor (Siemens VAI supply)

closed-loop expert system capable of performing blast, injectant and charging set-point changes without operator interaction. Corrective actions are continuously determined and executed in a closed-loop cycle. This is a prerequisite for stable furnace operation, lower production costs and constant hot-metal quality.

Concluding remarks

From an engineering point of view, it is definitely possible to design a large-sized blast furnace. However, large blast furnaces operate at higher pressures, are more susceptible to burden-distribution irregularities and are in need of constant monitoring. It is also the case that downtime – for whatever reason – inevitably means a major interruption in iron production. Considering the anticipated operational and equipment

difficulties, the question remains whether an investment in a large-sized blast furnace can be justified from an economic and production point of view, or whether an investment in multiple smaller-sized units would be the more pragmatic decision. Whichever philosophy a producer adopts, whether “the bigger the better” or “small is beautiful,” the decision will ultimately depend, as always, on the specific site situation, applied technologies and market conditions. ■

Authors

Martin Smith, Ian Craig

Contact

blastfurnace.metals@siemens.com

Turn-key steel plant modernization at Nizhny Tagil

A Monumental Challenge

Nizhny Tagil. At the borderline between Europe and Asia in the Sverdlovsk region. Winter temperatures down to minus 40 °C. A harsh and forbidding site in the heart of the Ural Mountains. And a steel works modernization project to be implemented under extreme time constraints which also includes the demolition and reinstallation of steel structure and equipment equivalent to the weight of more than two Eiffel towers!

Nizhny Tagil Iron & Steel Works (NTMK), located on the outskirts of the city of Nizhny Tagil, is part of the Evraz Group S.A. – Russia's largest company in the vertically-integrated steel and mining business. In 2006, the Evraz Group produced around

16 million tons of crude steel and ranks today among the top twelve metallurgical steel producers in the world. The steel is primarily used for railway products, seamless pipe blanks and for structural products.

Project scope

As part of an investment program to increase NTMK's steel production from 3.8 million t/a to 4.2 million t/a, Siemens VAI was awarded a major turn-key project in 2006 for the modernization of the company's steel plant. The project includes the engineering, supply and start-up of four new 160-ton converters, the replacement of the outdated offgas treatment system, modifications to the bunker system and the installation of a new feeding line for converter and ladle charging. In addition to the climatic and logistic hurdles to be overcome, the most challenging factor of this project is that the installation work has to be performed during full steel production operations within a very tight

timeline of only 90 days for each converter replacement.

The converters will be designed with a higher reaction volume to considerably improve the oxygen-blowing efficiency in comparison with the existing facilities. A specially designed quick-change-type blowing-lance system with high oxygen-blowing rates will increase productivity, and the possibility to carry out slag splashing inside the converter will contribute to an extended converter-lining lifetime. The converters will be outfitted with new trunnion rings in combination with the well proven VAI-CON Link suspension system, powerful 4-pinion tilting drives for quick converter tapping, inert-gas bottom-stirring systems for an enhanced steel-bath agitation, and the well known VAI-CON Stopper system with an integrated infrared-camera-based slag-detection system for an optimized slag retention in the converter. The existing hard- and software systems will be replaced by the latest generation of Siemens VAI Level I electric and basic automation systems. These solutions will enable an increased steel output and a maximum recovery of vanadium slag from the vanadium-rich titaniferous ores melted in the blast furnace.

Furthermore, the additive bunker system will be upgraded and expanded in accordance with the higher steel-production requirements. The new and upgraded dosing and weighing systems, coordinated with the converter automation systems, will ensure a far higher accuracy of the quantity and rate of additives to be fed to the converters and ladles.



View of the NTMK Steel Works, Nizhny Tagil, Russia

Enormous environmental improvements

The existing primary offgas-cooling and wet-dedusting system will be replaced by a newly designed dedusting system comprised of venturi cleaning scrubbers. This will result in a far superior cleaning efficiency in comparison with the existing facility and will enable NTMK to meet existing and future environmental regulations. A highlight of the new dedusting system is its capability to cope with different blowing rates applied during de-vanadization-, duplex- and mono-converter operation modes.

Strict project implementation

The permissible time window of only 90 days for the replacement of each converter during full production operations demands the strictest planning of all project activities. A three-dimensional computer model of the existing plant was therefore prepared at the start of the engineering work to enable on-line simulations of the required demolition activities and equipment installations. Potential time and installation bottlenecks could be identified in advance to avoid delays in the project completion. Furthermore, a detailed and continuously updated time schedule defines all activities and material deliveries to be carried out on an hourly basis.

Contract work started in the summer of 2006. The first converter exchange is scheduled for the second half of 2007. This will be followed by two converter replacements in 2008 and a fourth converter installation in 2009. With the completion of this project the following main benefits will result for NTMK:

- Higher production output and improved steel quality
- Dramatic reduction of environmental emissions
- Increased output of the highly lucrative vanadium slag production

Prepared for the challenge

Of the hundreds of converter projects implemented by Siemens VAI since the introduction of the oxygen steel-making process in 1952, this project represents one of the most difficult challenges ever faced by Siemens VAI. Expert project management, technological know-how and unparalleled turn-key project experience – all backed by a reservoir of highly skilled and experienced engineers – are the factors which will be decisive for the ultimate success of this project! ■

Authors

Joachim Schnalzger, Horst Brenneis

Contact

convertersteelmaking.metals@siemens.com

Next generation electric steelmaking boosts performance to new benchmarks

The Ultimate EAF Solution

Siemens VAI is the world's leading supplier of electric steelmaking equipment. A complete range of powerful and cost-saving solutions are offered for electric arc furnaces, ladle treatment stations and secondary metallurgical facilities, including fully integrated automation and environmental systems. Technological highlights include the introduction of water-cooled panels and equipment, current-conducting electrode arms, single-point roof lifting, shaft furnaces, twin-shell EAFs and vacuum degassing plants as well as refining combined burner systems for enhancing productivity. To date, Siemens VAI has supplied more than 100 electric arc furnaces of AC and DC design worldwide. The most recent developments and applications of the next generation EAF technology, referred to as Ultimate, are outlined in this article.

IRON & STEEL ^

The Ultimate EAF combines all of the latest electric steelmaking technologies in the product portfolio of Siemens VAI. These include ultra-high-power input (up to 1,500 KVA/ton liquid steel) controlled by Simelt^{ciS} Automation, Refining Combined Burner (RCB) technology for enhanced EAF performance through oxygen, gas and carbon injection, and improved furnace and equipment design features. This combination has led to the implementation of an electric arc furnace where the heat-cycle times can be extremely short and the corresponding productivity comparable to larger-sized furnaces. For example, a 120-ton Ultimate EAF is capable of a capacity increase by up to 50 percent for an annual production of approximately 1,800,000 tons per year – roughly equivalent to an EAF with a steel-tapping weight of 180 tons. Thanks to the enlarged EAF shell volume to allow for single-bucket scrap charging, the Ultimate furnace is ideally suited for varying charge mixes, from 100 percent scrap to combinations of scrap/DRI/HBI and hot metal.

Operational results of Ultimate installations

A 120-ton EAF supplied to the Russian steel producer NSMMZ (Nizhny Sergi Metalware-Metallurgical Plant), part of the Maxi Group, started operation with Ultimate technology. The first heat was tapped in January 2005. A record of 40 heats per day was already achieved during the first year of operation in the single-bucket-charge mode. After several months of operation, the

customer decided to equip all future EAF installations with Ultimate technology.

Another example for high productivity levels and the highest electrical power input is the 300-ton EAF supplied to a steel producer. This furnace employs the largest transformer in AC EAF applications with a rated power of 240 MVA. Because of the large tapping weight and the availability of mostly only light scrap, the EAF is charged with two to three scrap baskets per heat. After tapping the first heat in mid-January 2007, a production of 5,950 tons of liquid steel per day and a productivity of over 40,000 tons per week was reached by mid-March 2007. The achieved melting power during this short period of time was an impressive 160 MW with 1,550 volts.

Features of the next Ultimate EAF installations

The key data of Ultimate electric arc furnaces that will be installed in 2007 and 2008 are shown in the table below. Single-bucket charging, high electrical power inputs and the latest oxygen-management tools will be employed.

Main Benefits

- High degree of flexibility with respect to charge materials (scrap, DRI/HBI, hot metal)
- Proven low-consumption values for energy, electrodes and refractories, etc.
- High productivity and corresponding low conversion costs
- Proven and profitable technology for any steel route (long and flat products) and for the production of carbon- and stainless-steel grades



Key Data of the Next Ultimate EAF Installations

	Revda Beresovsky, Russia	Atoun Steel, Saudi Arabia	Revda Togliatti, Russia
Tapping Weight	120 tons	80 tons	165 tons
Furnace Diameter	7.7 m	6.5 m	8.6 m
Transformer	150 MVA	105 MVA	195 MVA
Injection Tools	5 RCB + 2 burners 4 post-combustion and 4 carbon injectors	3 RCB + 2 burners 2 post-combustion and 2 carbon injectors	5 RCB + 3 burners 4 post-combustion and 4 carbon injectors
Tap-to-Tap Time	36 min	36 min	36 min

Concluding remarks

With the use of inhouse technologies which include the electrode control system, the electrical power supply system, RCB technology, the Foamy Slag Manager as well as all engineering and supply competence for the entire range of EAF equipment, Siemens VAI has developed a new generation of electric arc furnaces referred to as Ultimate. With this solution the demand of

steelmakers for increased productivity, low conversion costs and safe and reliable operations are met for the production of both carbon and stainless steels. ■

Authors

Bernard Villemin, Uwe Wilhelm

Contact

electricsteelmaking.metals@siemens.com

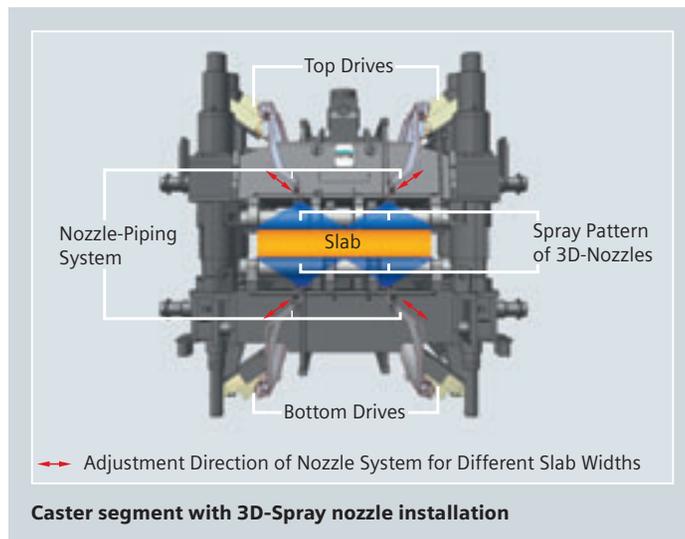
Flexible spray-width adjustment using the new 3D-Spray nozzles

A “Cool” Solution for Changing Slab Widths

The formation of transverse corner cracks during continuous casting frequently occurs as a result of overcooling in the strand-corner areas where the heat transfer is two dimensional. Siemens VAI has developed a new dynamic solution to overcome this problem. The first industrial application took place in July 2006 at a newly commissioned slab caster for a Korean steel producer.

The main function of a continuous casting machine is to transform the liquid steel coming from the steel plant to solid intermediate products. These must satisfy strict dimensional and quality criteria to enable their subsequent processing for the foreseen product applications. Thus, an optimized heat removal from the strand is a key issue in the continuous casting process.

Following primary cooling of the liquid steel in the caster mold when the strand shell forms, heat is continually removed from the strand by means of water-spray nozzles during the secondary cooling process. The target is to achieve a uniform water distribution and thus a homogeneous temperature profile over the slab width. However, the casting of variable slab widths complicates the cooling process when a conventional spray-nozzle arrangement is used. Conventional systems are characterized by rigid nozzle positions and by two separate nozzle-control loops, i.e., one for the central slab-surface area and one for both slab-margin areas. A separate flow control enables the water spray in the margin zones to be decreased with a smaller casting width to avoid excessive cooling of the slab corners. However, this means a reduced water flow at the slab margins compared with the slab center and an inhomogeneous temperature profile and varying mechanical properties of the slab may result. Such systems are therefore always a compromise between the ability to control the slab corner and slab center temperatures. Furthermore, since the nozzle positions are fixed, only a step-wise cooling control is possible.



A simple, yet elegant solution

As a solution to this problem, Siemens VAI has developed a moveable nozzle arrangement which allows the nozzle position in relationship to the slab width to be adjusted. This is accomplished by raising or lowering the nozzle arrangement in a slanted direction according to the spray angle (about 110°) or, in other words, at an angle of 35° from the slab surface. If the casting width is decreased, the two opposite nozzles (above each slab half) move closer to the slab surface and nearer to the slab center. This creates a smaller spray width. In the case of increasing slab widths, the opposite occurs (see figure). The nozzle positioning is carried out in such a way that the slab center is adequately sprayed and cooled and that a defined distance to the slab corner is maintained to avoid overcooling of the corners. Each strand segment is controlled by its own spray-width adjustment controller.

The 3D-Sprays are linked with the Siemens VAI Dynacs secondary cooling model which enables an online determination of the strand temperature

Main Benefits

- Homogeneous temperature profile across entire slab width
- Major reduction in frequency and severity of corner cracks for a wide range of steel grades
- Optimized water/air consumption due to variable nozzle positioning and spray density
- Quick and easy maintenance with connect & cast system design

profile with respect to the actual water flow rates, casting speed, steel grades, casting sizes and superheat temperature. In this way, the water setpoints related to the nozzle position and the spray density can be calculated.

First industrial application

In July 2006 the 3D-Spray nozzles were industrially applied for the first time at a newly commissioned slab

caster for a steel producer in Korea. Compared with other slab casters in operation by this producer, a significant improvement of slab quality was observed. ■

Authors

Helmut Wahl, Paul Pennerstorfer, Klemens Hauser, Karl Mörwald

Contact

casting.metals@siemens.com

First slab caster for Gerdau Group allows expansion into the flat-steel sector

The Ticket to New Market Opportunities

An order for the supply of a new state-of-the-art slab caster is now being implemented by Siemens VAI for the Brazilian steel producer Gerdau Açominas. With the completion of this facility scheduled for December 2008, Gerdau Açominas will be able to produce 1.5 million tons of high-quality slabs for the growing flat-product market.

The Gerdau Group is the leading producer of long products in the Americas and produced more than 15.5 million tons of steel in the year 2006 at its production sites in Argentina, Brazil, Canada, Chile, Colombia, Peru, the United States, Spain and in Uruguay. An expansion program is currently underway at its Brazilian works Gerdau Açominas in Ouro Branco in the State of Minas Gerais where the goal is to increase the annual steel production output by fifty percent from three million tons to four and a half million tons. For this project Siemens VAI will supply an RH degassing plant and a slab caster which will enable the production of one and a half million tons of slabs for the highly attractive expanding flat-product market. The caster is designed to allow for the installation of a second strand which would then double the casting capacity. The majority of the slabs are foreseen for sale on the international market.

The slabs will be produced in widths from 800 to 2,100 mm and at thicknesses of 220 and 250 mm. The caster will be equipped with the latest technological

packages from Siemens VAI to ensure the highest product quality, reliable production operations and flexible slab-width and thickness adjustments. Included are LevCon automatic mold-level control, DynaWidth on-line slab-width adjustment, MoldExpert automatic breakout prediction and strand-shell friction monitoring in addition to the DynaFlex mold oscillator for flexible adjustment of the oscillation parameters. The strand-guide system is provided with Smart® Segments to allow dynamic soft reduction and fast slab-thickness adjustments to be carried out. This is made possible through the remote adjustment of the roller gaps using the DynaGap SoftReduction technological package. The caster will also be equipped with the Dynacs secondary-cooling system and with a slab quality-control system for quality assurance. Additionally, Siemens VAI will supply the automation and process control systems for the slab caster, allowing all operational parameters to be optimally harmonized with one another throughout the entire production process.

Among the reasons for the contract being awarded to Siemens VAI were the company's reputation as the leading supplier of slab casters in the world, the comprehensive range of technological packages offered and the close contact to the customer by Siemens VAI Metals Technologies Ltda. in Brazil. ■

Authors

Cesar Lapuerta, Karl Pirner, Heinz Steinmair

Contact

casting.metals@siemens.com

LONG-PRODUCT ROLLING



Sizing Group of Bar-Rolling Line, Shijiazhuang Iron & Steel Company, China

View of CCR Stands of the New Bar Line, Villares Metals S.A., Sumaré SP Works, Brazil

Recent major Siemens VAI mill start-ups in the long-product sector

Go Long – Go Strong!

The uninterrupted series of new mill orders and start-ups in the long-product-rolling sector continues unabated for Siemens VAI. Innovative solutions providing increased customer benefits is the reason why.

Thanks to advanced design and the latest technology packages from Siemens VAI, producers benefit from improved rolling operations, minimized mill downtime and strict product tolerances. In the following, five examples of project start-ups are presented in which the benefits of innovative solutions are outlined for the rolling of specialty steels, high-quality applications, increased operational flexibility and for the production of unique steel products.

Villares Metals S.A., Sumaré SP Works, Brazil

Villares Metals, a company of the Austrian group Böhler-Uddeholm, is the largest producer of non-flat, highly alloyed, specialty-steel long products in Latin America. At the company's Sumaré plant near São Paulo, Brazil, the most sophisticated steel grades are rolled, including tool, valve, stainless, high-speed, and spe-

cialty alloys. In late 2006, Siemens VAI started up a new state-of-the-art finishing rolling mill at the Sumaré site, which featured a multiline arrangement comprising the following:

- Straight bar line with 16 rolling stands
- Wire rod line with two finishing monoblocks
- Large flat line with a single flat-rolling block
- Cooling and handling areas

The bar line produces rounds up to 76 millimeters squares, and hexagons. The rolled wires have diameters of 5 to 13.5 millimeters and the flat-block line finishes flats in dimensions up to a maximum of 250 millimeters in width and 63 millimeters in thickness. The CCR (compact cassette rolling) stands of the bar line, equipped with precision and automatic settings, provide the high degree of rigidity required for the precise rolling of special steel grades.



Hangzhou Zijin Industry Co., China

In May 2006, the final acceptance certificate was issued by Hangzhou Zijin Industry Co. for a new Siemens VAI-supplied SBQ (special bar quality) line. The mill, with a yearly capacity of 800,000 tons, includes an innovative two-roll multigroove sizing group (three stands) and a four-roll PRS (precision rolling sizing) stand in addition to thermoprocessing equipment.

Already in the second month after start-up, the mill topped its nominal capacity by rolling in just one month over 67,000 tons of bars with dimensional tolerances as tight as 1/6 DIN.

Shijiazhuang Iron & Steel Company, China

In February 2006, a Siemens VAI bar-rolling line supplied to Shijiazhuang Iron & Steel Company Ltd., located in Shijiazhuang City, the capital of Hebei Province, was successfully started up. Shijiazhuang is the largest producer of high-quality steel in China. The new mill is capable of rolling a total of 900,000 tons of bar products comprising rounds (14–50 millimeters), rebars (10–50 millimeters) and flats (45–100 millimeters). The steel grades produced range from carbon to SBQ steels, with a special focus on the requirements of the automotive industry.

The rolled products are characterized by their excellent dimensional tolerances and metallurgical properties. For example, immediately following the mill start-up, 14-millimeter-diameter bars could be consistently rolled with an ovality of less than 0.1 millimeter from the bar head to tail. These results were even better than the contract-guaranteed value of 1/4 DIN.

This project represents a major milestone for the new generation of long-product rolling mills catering particularly to the automotive industry. The equipment supplied included a multigroove sizing group with four stands, the controlled cooling equipment and an online gauging station.

To date, over 20 Siemens VAI installations of the multigroove sizing group make it one of most successful sizing technologies on the market.

Changwon Special Steel Co. Ltd., Korea

The Korean steel manufacturer Changwon Special Steel Co. Ltd. produces up to 100,000 tons of tool steel per year in a wide range of dimensions and shapes. In September 2006, Siemens VAI successfully started up a two-line rolling mill for the production of large rounds, squares, and flats. The rounds and squares are finished in a continuous bar line equipped with six CCR stands, while the flat-rolling line features a three-stand flat block where flats in widths of 150 to 510 millimeters are produced. Discharge and handling areas for the finished products complement the mill.

The entire project was completed within a very short time frame, and the contract performance guarantees were quickly fulfilled. In particular, the flat block was able to immediately roll flats that met all required dimensional and shape tolerances, and the final acceptance certificate was issued in November of the same year.

Corus Scunthorpe, UK

In July 2006, seven new Red Ring universal stands went into operation at the medium-section mill at the Scunthorpe works of the British steel producer Corus. The mill, with an annual capacity of 600,000 tons, is designed to process rails, angles and beams in widths of up to 360 millimeters. The universal stands are characterized by special design features that allow a rapid automatic changeover to a two-high horizontal roll configuration for conventional rolling operations. Installation of the mill equipment was carried out with only 14 days' shutdown of the existing line.

The project scope also included state-of-the-art marking, hot-sawing, precambering, cooling, dispatch, and handling equipment required for the continuous production of rails in lengths of up to 120 meters. ■

Author

Luigi Giacomini

Contact

longrollingmill.metals@siemens.com

Modernization of Corus Hot Strip Mill No. 2

Special Automation Upgrade

Corus in IJmuiden, The Netherlands required a new automation system in its Hot Strip Mill No. 2. Siemens VAI was asked to supply and install a very special solution, based on Siroll^{CIS} HM.

Corus Strip Products IJmuiden (formerly Hoogovens) is an integrated steel mill located at IJmuiden, The Netherlands with an annual production output of over 6 million tons of high quality strip. Equipped with 4 reheating furnaces, 5 roughing mill stands, a 7-stand finishing mill as well as 3 down coilers, the company's Hot Strip Mill No.2 produces more than 5 million tpy of coils.

Ambitious project targets

Under its program to revamp the Level 1 automation and HMI of the mill as well as parts of the main drive controls, Corus awarded a contract to Siemens in 2005 that entailed performing of all modernization work with only minimal production downtime. Together with Corus, a revamp strategy and time schedule were elaborated involving a switchover to the new automation equipment in parallel shadow mode to avoid the risk of lost output.

Continuous upgrading and expansion had evolved the existing automation arrangement into a heterogeneous system landscape. That made increased demands on the operating and maintenance teams while maximizing spare part inventory needs. To overcome this growing and unnecessary system complexity, the con-

tract called for the replacement of most basic automation components and the HMI as well as the speed controllers for the main drives and their commissioning.

Advanced automation technology

One of the requirements for the new automation system was the need to replace proprietary communication systems of the existing automation solution by an open communication system based on Profibus and Ethernet. The new configuration features Siemens VAI Siroll^{CIS} HM products, comprising proven modules that have been developed for rolling applications. The Simatic PCS 7 process control system based on the Simatic TDC hardware offers the performance that is required for technological controllers in rolling mills as well as a wide range of interfaces and adapters, needed on this project to connect with an equally wide array of older components. These interfaces and adapters include TCP/IP; Profibus (including some with C bus transducers for adaptation to the legacy drive system); RS232 and RS485 protocols; and direct hardware I/Os. In replacing and upgrading the IJmuiden automation system, Siemens installed 27 Simatic TDC PLCs, 90 CPUs, 27 operator panels, 4 HMI server, and around 17,000 hardware I/Os.

Rigorous contract fulfillment

All automation and visualization components were subjected to rigorous integration testing at the Siemens VAI testing facility in Erlangen. Customer personnel also participated in the testing phase, giving them advanced training on the operation of the equipment.

The Hot Strip Mill is a core production unit in the IJmuiden plant. Therefore, as the risk of production losses had to be minimized, Corus paid high attendance on fast switch-over possibilities and extended shadow operating mode. To realize shadow operation mode on site, Siemens VAI duplicated some 6,000 signals through optocouplers or buffer amplifiers and made them switchable. The required switching devices were installed in 61 Simatic ET200 cabinets, boxes, on 25 mounting panels, and in 101 small groups on busbars (called "switchover units" or SOUs) built into the drive cabinets and wired for operation. This arrangement enabled operators to switch back and forth between the two automation systems in just 25 to 30 minutes (from strip to strip). Particularly the SOUs tasked with signal duplication required significant detailed engineering knowledge, as they had to be adapted individually to the operating environment. Siemens engineers provided that knowledge.

Minimal downtime – early ROI

The project's conversion and upgrade concept foresaw a ramp-up of the new plant in two phases. The furnace and roughing mill were placed into operation in the fall of 2006, following routine semi-annual maintenance work. The finishing mill and the coiler will go into operation following routine maintenance work in the spring of 2007. During each phase, the contractually-



The complex project required not only solid engineering expertise, but also extensive re-wiring of signals

fixed ramp-up curve had to be followed or exceeded. The Corus IJmuiden project was the largest of its kind for Siemens VAI in the last 15 years and underscores Siemens VAI recognized strength in plant and mill modernization. As a complete provider, able to handle mechanics, drives technology, automation, and technological models from a single source, Siemens VAI project management minimizes the interfaces among all project parties and ensures a swift return to production and an early return on investment for all customers. ■

Author
Jan Lübbers
Contact
hotrolling.metals@siemens.com

New combination inline inspection and sampling station

Double Performance

Siemens VAI has developed a combined inline inspection and sample-cutting station for hot-rolled steel strip, which can be integrated into existing transportation systems of hot-strip mills for automatic sample cutting.

Sample taking has become an important factor in steel plants, especially for flat products. Developing the new inspection and sampling station from Siemens VAI involved process simulation using 2D-type finite element methods to investigate uncoiling and recoiling operation. The results were used to specify the drive requirements and to optimize the positioning and adjustment of pinch rolls.

Three important features

The new Siemens VAI station for hot strip combines inline operation, inline strip inspection, and sample-cutting of heavy steel strip.

Inline operation ensures that there is no need for a separate transportation system or intermediate coil storage. The systems can be installed in new mills or retrofit to existing transportation systems. Cost-effective installation is based on the combined equipment that allows the use of only one shear for sample cut and for inspection cut featuring a quick knife-exchange system. The cut samples are automatically marked and can be visually inspected on both sides using integrated turning table. The special design (patent pending) of the hydraulic bending and pinch-roll unit in combination with the leveling rolls ensure that the strip head is perfectly flat. The position of the bottom roll is automatically adjusted in accordance with the incoming strip thickness.

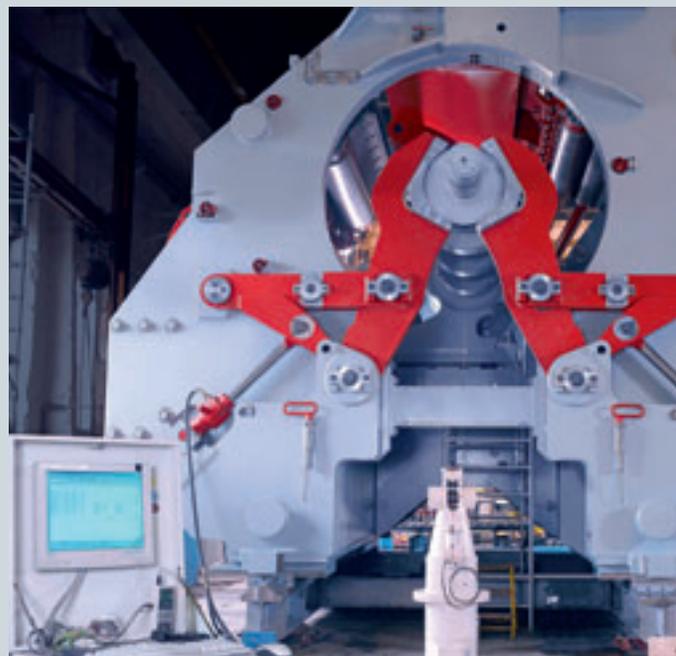
Strip up to 6 mm thickness can be inspected on the inspection table. The winding and rewinding operation is done in the same way as with the mode test piece cutting. For cutting, the heavy gauge shear is used. The test strip can be scraped into the basket by a light gauge

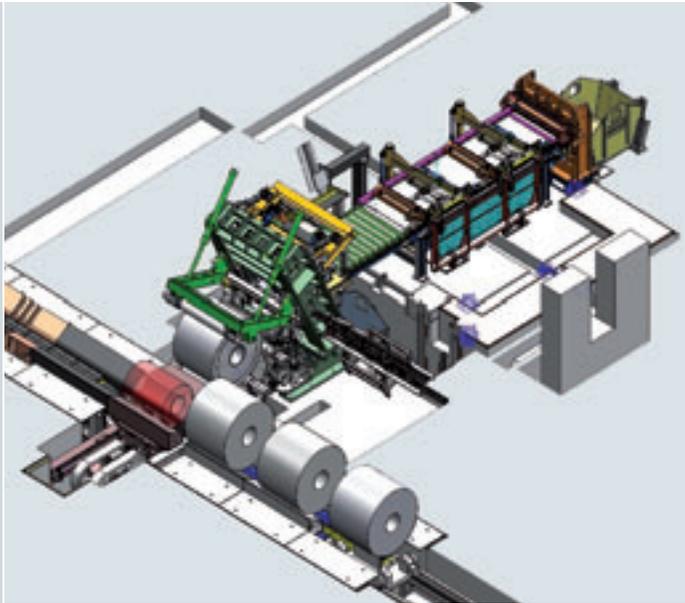
PowerCoiler start-up at Arcelor

Finely-Tuned

The new Siemens VAI PowerCoiler was installed for the first time in a revamping project at the hot-strip mill (HSM) at SOLLAC Fos sur Mer, France, (Arcelor-Mittal Group). According to the authors, this project is currently in its final phase, after completion of commissioning and receipt of the customer acceptance certificate.

A primary motivation behind this project was Arcelor's intention to extend the product mix of the plant and to include thicker tubular steels in the program, such as 25.4 mm thick API X70 steels, which was beyond the capacity limits of the installed





Combined inline inspection and sample cutting station



Overview of the combined inline inspection and sample cutting station at Hadeed

shear. Strip up to 16 mm thickness can be cut to test samples in the heavy gauge shear. The movable top and side rolls provide that the movable bottom roll can be lowered during the threading operation. The strip is clamped and the swiveling table is moved into the threading position. This procedure assures that no residual deformation of the strip occurs.

Station in operation in Saudi Arabia

The combined inline inspection and sample-cutting station was first installed in the hot strip mill at

Hadeed, Saudi Arabia, and started operating in May 2006. This equipment makes it possible to automatically cut samples of high-strength API X70 pipe steel in thicknesses of up to 16 mm and in lengths of up to 300 mm. ■

Authors

Gerald Mousek, Berta Haring, Albert Angerbauer, Roland Schuster

Contact

hotrollingmill.metals@siemens.com

coiling equipment. An additional requirement was that the existing drives were to be re-used for the coiler mandrel and wrapper rolls.

The project included the manufacturing and erection in our Montbrison workshop and the subsequent function tests. The PowerCoiler was delivered to the site in April 2006, erected offline the plant, and tested up until the end of June.

Inline installation on schedule

Inline installation (including civil engineering work) of the PowerCoiler was carried out in the scheduled downtime (12 days as per contract). Coiler start-up took place after cold and hot tests with the HSM restarted using new bridging table and sideguides. The first strip was successfully coiled on the PowerCoiler on August 16, 2006. The PowerCoiler was ramped-up to its nominal maximum output value after 10 days of production. Coiling on the product range (thickness up to

18 mm) was validated in the weeks following start-up. The thinnest gauges on this coiler are 2.25 mm. During the first weeks of production, the machine was extensively used for thin gauges.

Fine-tuning and final acceptance

During last quarter of 2006, fine-tuning of coiler was completed for thicker gauges. Until the end of December 2006, thick format tests were performed successfully for thicknesses up to 24 mm. To date, more than 350,000 tons have been coiled on the PowerCoiler in all steel grades and formats used in SOLLAC Fos with up to 25.4 mm thickness. Final customer acceptance was achieved in February 2007. ■

Authors

Albert Angerbauer, Sebastien Maillard

Contact

hotrollingmill.metals@siemens.com



Preassembled PowerCoiler at the Siemens VAI Montbrison Workshop

voestalpine upgrades its HSM in Linz

Equipped for the Future

ROLLING & PROCESSING >



voestalpine Stahl is a producer of hot, cold, and galvanized strip for high-end market segments. The hot-strip mill (HSM) produces a total of 4.2 million tpy, with 40 percent of this output sold as hot strip and the remainder being converted into cold rolled and partly coated in the downstream facilities in Linz. Built between 1951 and 1953, the HSM has undergone a number of upgrades over the years.

Relentless demands for better products at lower prices has forced voestalpine to seek equipment improvements and more efficient rolling operations on an ongoing basis. Since the early 1990s, voestalpine Stahl has been working on a series of improvements steps, resulting in productivity increase, yield improvement, reduction of the depreciation rate, and an extension of the product mix.

Making the grade in 2007

As the latest stage in the continuous upgrading process of the voestalpine facility, Siemens VAI received an order from voestalpine Stahl to equip its HSM in Linz with a new automation system. The automation solutions are to be installed at the same time as the roll stands are replaced. This is to be done in four stages, with 2010 as the completion date. The aim of the conversion proj-

ect is to increase the annual production and add steel grades of a higher quality to the range of products the company offers.

Siemens VAI is responsible for replacing the entire basic automation of all seven finishing stands of the hot-strip mill, including the higher-level functions of the instrumentation and control system. The automation system to be used is part of the Siroll HM solution, which was specially developed for hot-strip mills. Simatic PCS7 will serve as the system platform.

time, and Siemens VAI broad experience in modernizing the roughing mill and the finishing train drive systems at the Linz site.

Implementing Linz 2010

The voestalpine HSM in Linz, which has been continually undergoing a process of modernization in which Siemens VAI has played a major role, is the heart of the flat steel production facility. As part of its Linz 2010 expansion program, voestalpine is renewing the rolling



7-Stand hot-strip mill at voestalpine Stahl, Linz, Austria

HSM Upgrades at voestalpine

- > **Descaler** (1991)
- > **RF Upgrade** (1992)
- > **New Laminar Cooling** (1992)
- > **L1+L2 Automation Systems** (1994)
- > **Crop Shear Modernization** (1996)
- > **FM Edger** (1996)
- > **Flatness and Thickness Gauges** (1996 + 1998)
- > **Microstructure Monitor** (1998)
- > **Lubrication and Water Systems** (1998)
- > **Surface Inspection System** (1998)
- > **New Edger (E1)** (1999)
- > **Slab Yard Management with GPS** (2000)
- > **RM + Edger – Main drive** (2001)
- > **RF Automation** (2002)
- > **RM + FM – Drives** (2002)
- > **FM – Drives** (2003)
- > **Mill Stand Housing F1** (2003)
- > **Down Coiler No. 4 and No. 5** (2003 – 2005)
- > **New Roughing Mill** (2004)
- > **FM Automation** (2004)
- > **New Coil Handling System** (2004)
- > **RM, Mill Pacing – Automation and Drives** (2005)
- > **FM – Drives** (2005)
- > **FM – HAGC cylinders** (2007)
- > **Additional Reheating Furnace** (2007)
- > **FM, RF, Laminar Cooling – Automation** (2007)

New components and systems will replace older installations. As the work is to be carried out in stages, the interim phases will be used to temporarily integrate parts of the old systems in the new automation setup.

The uniform, universal automation system for voestalpine is characterized by a high degree of standardization. Thanks to the open communication protocols, future expansion will not present any problems. The diagnostic functions integrated in the system will ensure a high level of transparency, uncomplicated operator control and fast reactions of the operating personnel to any problems that may occur.

Siemens VAI is also supplying the cylinders for the hydraulic adjusting equipment of the roll stands. Reasons for the order being given to Siemens VAI included the modernization concept, the minimum down-

stands of the mill. The automation systems will also be upgraded with a standardized and expandable solution based on the latest technological advances. Once the modifications have been completed, the HSM will have a capacity of 4.9 million tpy of high-quality steel strip with thicknesses between 1.4 and 20 mm. ■

Author

Albert Angerbauer, Berta Haring, Reinhold Fogel

Contact

hotrollingmill.metals@siemens.com

ROLLING & PROCESSING >



Production starts at Shagang 5-meter-wide plate mill

Massive Rolling Machines

Recent years have seen unprecedented investment in new plate mills. To date, most of these new projects have been in China and are aimed at producing plates for shipbuilding and pipeline stock. Among the new mills are 5-meter-wide versions representing a class of machines that are the largest and most powerful ever built to roll metal. These massive rolling machines are pushing equipment design and manufacturing to their limits.

The Shagang plant is located in the eastern Chinese province of Jiangsu. With the start of production, the new 5-meter plate mill enables Shagang to compete directly with Baosteel, whose own 5-meter mill nearby started production in 2005. These two mills are the first 5-meter-wide plate mills to be built in the last 30 years, as well as being the first ones ever built outside Japan and Western Europe. The Shagang 5-meter plate mill line has a throughput capacity of 1.5 million tons per year and can produce plates from 5 to 150 millimeters in thickness.

Siemens VAI has been responsible for the engineering of all the process equipment, from the primary descaler (the first line process after slab reheating) to the final operations of plate piling and cold leveling. Design work was done in the United Kingdom. The equipment manufacture was split between imported and local supply, with key components such as the mill's hydraulic gap-control cylinders being manufactured at Siemens VAI facilities in France. During the manufacturing phase, Siemens VAI was responsible for quality-control supervision of local production. Comprehensive plate-mill training for the technicians and operators at Shagang was also part of the project package.

High strength and superior toughness

The heart of the plate mill line is the mill stand. At Shagang, a unique four-piece bolted housing was used, making both manufacturing and transportation easier. The assembled weight of each mill housing is 450 tons, and the 2,200-millimeter-diameter backup rolls each weigh in excess of 200 tons. The mill stand has a maximum rolling load capability of 10,000 tons and is equipped with heavy work-roll bending and bottom-mounted hydraulic automatic-gauge-control cylinders. The mill is powered by a pair of 10-megawatt motors.

A vertical edger is attached to the exit side of the mill stand, improving yield by consolidating plate edge quality as well as by tightening width tolerances. Beyond the mill is a Mulpic plate-cooling machine. This technology was developed by Siemens VAI in cooperation with one of Europe's leading steel research institutions, CRM. Precisely controlled cooling at high rates can produce uniformly high strength and superior toughness in low-alloy plate products. This is the first Mulpic system to begin operation in China, and the technology is central to Shagang's aim of becoming a leading supplier in the quality-critical marketplaces of ship plate and pipestock.

After passing through the fully hydraulic nine-roll hot leveler, the plates cross the cooling beds and move into the shear line. This line incorporates a crop shear, a double side-trimming shear, a slitting shear, and a divide shear. The design of this new generation of heavy plate shears is the result of extensive research and development work carried out by Siemens VAI in response to the modern market requirement for cutting at tensile strengths up to 1,200 megapascals and at thicknesses up to 50 millimeters.

In addition to designing and supplying the mechanical equipment, Siemens VAI developed and supplied the complete Level 1 and Level 2 automation system for >>

Scope of delivery

Design and supply of the mechanical equipment

Development and supply of the complete Level 1 and Level 2 automation system for the mill line

Automation System for adaptive set-up models for the plate mill stand and edger, Mulpic machine, and levelers.



Rolling on the Shagang 5m plate mill



Mulpic accelerated cooling machine on the Shagang 5m plate mill

- >> the Shagang mill line, including adaptive set-up models for the plate mill stand and edger, Mulpic machine, and levelers.

Installation of the mill equipment began in March 2006. This was followed in October 2006 by cold commissioning, during which the dynamic operation of individual pieces of equipment was demonstrated in the unloaded condition. Equipment groups were then brought together to complete an integrated dynamic trial on a simulated production cycle. These tests proved the readiness of the new mill to roll its first plate, which was accomplished on December 18, 2006.

Production of 3.5-meter-wide plates was achieved after just two weeks, and full-width plates (4.9 meters wide) were being rolled to salable quality within the first month of production. Trial rolling of high-strength ship plate and pipe steel is currently under way. The rapid progress in rolling capability has al-

ready allowed Shagang to accept orders from four major Korean shipbuilders.

Siemens VAI automation in all new Chinese plate mills

It is a source of great pride within Siemens VAI that all new plate mills built in China during the last five years feature Siemens VAI automation. This project continues a long history of excellent collaboration between Shagang and Siemens VAI – collaboration that includes Siemens supplying continuous casters and revamping a hot strip mill relocated to Shagang from Germany. ■

Author
Jim Everitt
Contact
platemill.metals@siemens.com



Rotary shear
multiblanking line with
side strip

The Perfect Cut

In late 2004, Siemens VAI Metal Technologies S.A. Spain finalized the commissioning of a new multiblanking line for the steel-service center of Planos F3rricos S.A., located in Madrid, Spain.

The line is designed to uncoil, level, slit, and cut to length steel strips from coils, and place them in up to four well-stacked rectangularly shaped sheet piles. The new line is equipped with two heavy-duty levelers installed in a tandem arrangement in order to cover the complete range of strip thicknesses (0.5 to 4 millimeters) and mechanical properties (ultimate tensile strength [UTS] = 700 megapascals). Following leveling, the strip is slit into narrower strips by a slitter head installed in the line. In order to ensure a high degree of flexibility and short tool-change times, the slitter tools are set up beforehand in an offline turnstile, allowing for a fast and completely automatic change within 5 minutes.

Prior to the final transversal cut, the individually slit strips drop into a pit in order to facilitate their separation and the guidance required to achieve adequate tolerances during both cutting and stacking. This separation and guidance is performed by separator discs mounted on two pneumatically inflatable shafts at the exit basket of the pit.

A very interesting and innovative feature in this type of multiblanking line with a rotary shear is that if for any reason one of the slit strips must not be cut into sheets, it can be re-coiled for further use while at

the same time the other strips are being cut to the required lengths, providing high operating flexibility. To enable this, the exit pinch roll out of the pit includes a pneumatic press to provide the required back-tension against the re-coiler mandrel, thus ensuring a perfectly tight wound coil.

The strips are then cut to length in continuous mode by a high-performance Siemens VAI eccentric rotary shear, allowing for maximum production rates and optimum final product quality and tolerances. During the stacking of the cut sheets, potential damage from dropping is minimized by an air cushion generated by a turbofan. ■

Main Benefits

Heavy-duty levelers to achieve high plastification rates (maximum 80 per cent)

Fast and automatic tool change within 5 minutes

Possibility to re-coil unsuitable slit strips during simultaneous cutting and stacking of product strips

High degree of line flexibility as required by steel-service centers

Author
Cesar Mart3n
Contact
finishingline.metals@siemens.com

Baosteel is one of China's – and the world's – leading manufacturers of steel strip products. The ongoing modernization of its plant in Baoshan, to the north of Shanghai, aims at improving thickness and flatness tolerances and ensuring product quality, especially for the automotive industry. A second objective is to increase productivity in the plant and to install advanced automation equipment.

Originally built in the late 1980s by a consortium with Siemens as a member, the Baosteel five-stand tandem cold rolling mill is one of the largest of its kind anywhere. At that time, the 5-stand, 4-high mill represented the state of the art, featuring hydraulic gap

Automation and drive upgrade at Baoshan Tandem Cold Mill No. 1

Improved Strip Quality

The Baosteel Continuous Tandem Cold Mill No. 1 went back into operation in November 2005 after an extensive upgrade of its automation and drive systems. The project was started to keep Baosteel's flat steel products on a world-class level and to create a foundation for meeting future product and market requirements.

control, work roll bending, a process computer with Siemens Type R30, set-up models, and fully-automatic operation. The mill was built for discontinuous and mainly continuous operation.

Automation upgrade improves product quality and productivity

The Siemens automation upgrade concept focuses primarily on improving product quality at the mill. Siroll CM for cold mills from Siemens formed the core of the automation concept. Other improvements included better dynamic response and better support of the thickness control through digitalization of the drive speed control; laser-based speed measurement; additional tension measurement before Stand No. 1 for Siemens advanced mass flow control (optional dancer



Key Mill Data

Entry Thickness:	1.8 – 6.3 mm
Exit Thickness	0.3 – 3.5 mm
Strip Width (max):	1,890 mm
Capacity:	2,400,000 tpy
Coil Weight (max):	max. 45 t
Exit Speed (max):	1,900 m/min

The Baosteel five-stand tandem cold rolling mill is one of the largest of its kind

roll control); new basic automation equipment and operator pulpits; new process automation; interface to existing thickness gauges and tension measurement devices; integration of the existing Siemens VAI flatness control; and the integration of the new Laser welding machine.

Project management through the first strip to mill start-up

Project management and engineering were handled by Siemens in Erlangen and by Baosight in Baoshan, with significant participation by Baosteel itself. Trained on Simatic automation systems, customer personnel were responsible for the realization of important functions, such as parts of the HMI, basic automation, and process automation. Extensive onsite system testing lasting over six weeks before the main shutdown concluded the engineering phase. During this test, all important functions were simulated, including the HMI and all operation modes and sequences. The operators were trained on the new system as well.

Prior to main shutdown, the control and thyristor power units for all the smaller strip transporting drives were replaced and commissioned during regular maintenance work using existing cubicles and wiring. Testing of the firing pulses for the main drives and larger strip drives to the remaining thyristor units and the software of the auxiliary function was also carried out at this time.

Cabling and installation of the cubicles included the connection of new terminal boxes to the Profibus field network, installation of an Industrial Ethernet network, and the removal of old cables and equipment.

Main shutdown of the mill was scheduled in two phases. The first phase called for restarting the mill in discontinuous mode within 21 days and additional 7 days for the installation and commissioning of the new laser welding machine and the continuous operation.

After the cold commissioning, the first strip was rolled after 19 days in discontinuous mode. The mill

then rolled 90 coils on its first day in continuous operation.

Thanks to experienced Baosteel and Siemens commissioning personnel, cold commissioning of the basic automation, the HMI and the process automation was completed on schedule, including all finalization work. In preparation for the restart, the process automation was prepared with a careful check of all set-point values by the specialists. Then, the first strip was rolled with the new automation, already under full control of process automation and the basic automation thickness control, with only secondary control functions disabled. In days that followed, optimization was performed on the operational sequences and the technological systems.

After 28 days, nominal production went to 6,800 t/day. In the first three months, a total of 500,000 t was produced. Even at this very early stage of production ramp-up, all grades were put on the production schedule.

Minimum equipment replacement, maximum strip quality

Additional improvements were carried out on the automation. One was the implementation of the newly-developed REC (roll eccentricity compensation) system, which was installed into automation of Stands 1 to 4 and compensates periodical disturbances of the MORGOIL bearings with up to 120 µm eccentricity.

In March 2006, the mill passed its performance test successfully. It has now met all project targets and produces better strip quality thanks to the modernization project that has delivered a wide range of electrical and automation improvements with minimum replacement of mechanical equipment. ■

Authors

Tomaso di Paolo, Josef Hofbauer

Contact

coldrolling.metals@siemens.com



Siemens VAI enhances POSCO pickling capabilities

Pickling Projects

Following the successful rebuilding and coupling of the Pohang No. 1 coupled pickling line, South Korea's POSCO, in 2004 and 2005, awarded Siemens VAI three major contracts covering pickling lines, which included the complete rebuilding of Gwang Yang No. 1 coupled pickling line, the complete rebuilding of Pohang No. 2 coupled pickling line, and supply and installation of the process section and key equipment for the Gwang Yang No. 3 POL. The author recounts how Siemens VAI has helped to enhance pickling capability at POSCO.

The POSCO Gwang Yang No. 1 coupled pickling line was built to replace the old pickling line, utilizing the existing concrete structure. This project has doubled production of the PLTCM No. 1 from 1.1 to 2.2 million tons per year. The line is designed to process high-strength steel with a yield point up to 1100 Mpa.

Overcoming the challenges of pickling high-strength steel

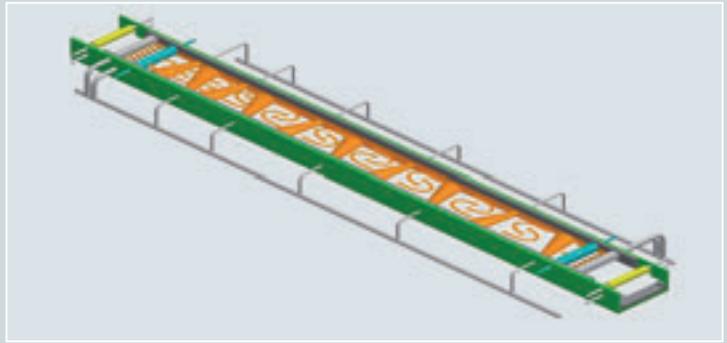
The entry of the new line includes two uncoiling sections and a new welder. Entry, intermediate, and exit loopers are designed to match high tension required for high-strength material. The process section includes turbulent polypropylene pickling tanks. The coupling equipment up to the mill entry are part of this project. Entry equipment, including automatic and strapping unit and a preparation station, load the coil on the pay-off reel and thread the strip up to the welder in fully automatic mode. This entry section includes

two pay off reels to minimize the entry downtime and enhanced flexibility.

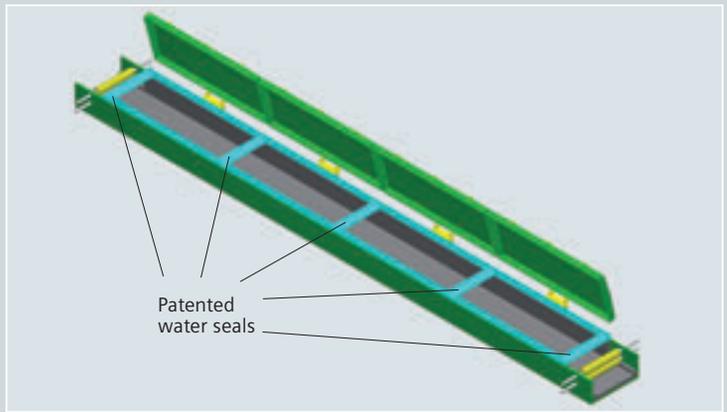
The (4 x 26 meters) turbulent pickling tanks have a contour design to avoid any contact between the strip and any fixed part, ensuring high strip surface quality. High turbulence in pickling tanks is given by side jets located both sides all along the tank and spray headers for high pickling efficiency. This injection system is fed by variable flow acid pumps that enable the turbulence to be adjusted independently of the strip speed. The strip length in contact with acid can be reduced by reducing the acid level in the first three tanks. In this configuration, the process section is able to run at ultra-low speed (15 to 20 mpm) without over-pickling giving high operation flexibility. The water seals on the four sides of the covers minimize the fume exhaust connection on the tanks, limit energy lost, and provide a convenient and clean section. Demineralized high-pressure spray headers give perfect strip surface cleanliness.



High turbulence in pickling tanks is given by side jets located both sides all along the tank and spray headers for high pickling efficiency



The water seals on the four sides of the covers give perfect tank tightness



This line is also equipped with the latest Siemens VAI Pickle Liquor Control System (FAPLAC). FAPLAC is a fully-automatic continuous iron content measuring device that ensures the optimal composition of the pickling baths. High pickling efficiency is the result, along with pickling at minimum temperature, which saves energy. This phase of the POSCO project was implemented with a very aggressive schedule. Demolition and erection work were performed from February to March 2006, followed by a mere six weeks of commissioning. The first commercial coil was produced on May 15, 2006, and full production was achieved two months later.

Processing carbon, silicon, and stainless steels

The POSCO Pohang No.2 coupled pickling line replaced the old pickle line. The new line is very similar to the Gwang Yang No. 1 coupled pickling line in term of layout, complexity, and technology. The production of the No. 2 Pohang PLTCM has been increase to 1.7 mil-

lion tons per year. The line is used for carbon steel, high silicon steel, and stainless steel. These last two grades are pickled on different units and conditioned in the process section before rolling.

Limited space required the entry end length from the pay off reels to the welder to be reduced by 6 m compared to the Gwang Yang No. 1. This was achieved by a new compact and innovative section in front the welding section. An aggressive schedule was followed during this phase of the POSCO project as well with demolition and erection work being performed in just three months from December 2006 to February 2007. Commissioning took place during the subsequent six weeks, followed by the first commercial coil on March 22, 2007.

New pickling and oiling line with combined skin pass and scale breaker

After the success of the POL No. 2 installed at Gwang Yang and the CPL No. 1 installed at Pohang, POSCO re- >>



POSCO Gwang Yang – Pickling & Oiling Line No. 3

>> cently awarded VAI the order for the new Pickling & Oiling Line No. 3 of Gwang Yang works.

This line is dedicated to pickling and oiling high quality product that is shipped after packing on the packaging line. Part of this equipment is reused from the CPL No. 1 rebuilt by POSCO. The entry accumulator, process section, and exit equipment are new. This line runs in fully automatic mode. Entry equipment including automatic and strapping unit and a preparation station load the coil onto the pay off reel and thread the strip up to the welder in fully automatic mode.

Installed after the entry accumulator, the combined skin pass – scale breaker significantly improves the strip flatness and the pickling time. The (3 x 20 meters) turbulent pickling tanks have a contour design in order to avoid any contact between the strip and any fixed part, ensuring consistently high strip surface quality.

In addition to these three projects, POSCO has also awarded Siemens VAI a contract to revamp the Gwang Yang No. 4 coupled pickling line where the entry section will be upgraded, and a scale breaker will be in-

stalled in the process section. To date 6,500,000 tons per year of carbon flat product are processed at POSCO through pickling section technology provided by Siemens VAI.

Anticipating POSCO's future needs

In keeping with the Siemens VAI commitment to anticipating future needs at POSCO, project teams are assessing the requirements for upgrading and retrofitting at the Pohang and Gwang Yang plants. All parties are making a concerted effort to sustain the Siemens VAI – POSCO success story for many years to come. ■

Author

Jacques Leroyer

Contact

processingline.metals@siemens.com

Automatic surface inspection system (SIAS)

On-line surface control is an on-going field of development at steel makers. If the value of a steel piece is to be broken down, the three major components one would probably identify would be: metallurgical properties, geometry and surface quality. Whereas the two first areas are rather well-known and gauges or systems to measure and control them in a repeatable manner have been available for decades, surface quality was, until recently, a rule-of-thumb area which required expert knowledge from trained inspectors who built their know-how over years. Thus, as the first so-called automatic surface inspection systems (SIAS) appeared in the 90's, expectations were great as to their ability to solve any surface-quality-related issue.

It is important to determine precisely what will be the aim of introducing an SIAS. There are four main reasons to proceed to such an investment:

Objective 1: Prevent defect crisis. Sometimes a single defect can by itself justify the introduction of a surface inspection system. The role of this system will be, in this case, to alert the line/mill operators of this defect's presence as early as possible, in order to allow for immediate action to be taken. The system is used as a production watchdog.

Objective 2: Protect the production tool. This is another fairly basic requirement of automatic surface control. Some defects may indeed be the cause for major problems in the downstream production processes if they are not detected early enough. An example is the presence of edge cracks on pickled product. If the strip is cold rolled, these defects may lead to the strip breaking while under tension in the rolling mill, causing an outage and a corresponding loss in productivity. Once again, the system will here be used as a watchdog, warning the operator early enough in case such a harmful defect is present so that he may react and prevent any problem from happening.

Objective 3: Qualify the product for delivery. A third well-identified requirement is for the system to verify that the product meets the specifications in terms of surface quality. In its most challenging form, this requirement turns into assessing the product's quality level: instead of just saying whether the coil meets surface quality specifications or not, the system allows deciding for which application it would be optimal.

Objective 4: Improve defect knowledge and comprehension. Finally, the data collected by the system over sever-

al months of production can, when correlated with various production parameters, allow a better understanding of defect origins or causes. This will in turn orientate the efforts around the defect-generating conditions, to reduce or eliminate the defect's occurrence.

Siemens VAI SIAS tools for powerful surface inspection

Inspection of surface steel strip is a challenging task from an image processing point of view:

- the steel's texture is the cause for a noisy image where it is uneasy to look for information;
- some defects are very subtle and would be difficult to pick-up even for a trained inspector;
- finally, the diversity of defects aspect makes it challenging to automate their identification.

Siemens VAI SIAS' expertise in the field of image processing has allowed the company to develop a system based on highly elaborate techniques and algorithms, which essentially match or exceed the requirements from a purely technical standpoint.

A critical aspect was to make these techniques accessible and configurable by the end-user alone, without having to rely on an expert in such techniques. Siemens VAI SIAS always includes as part of the supply of its system, the tools that allow easy interfacing and configuration of the system's various parameters. These include, among others, a state-of-the-art image-based classification builder, follow-up indicators and image archiving capability that allow for maximum efficiency at commissioning stage.

Supplier's full support until final acceptance

In parallel to these tools, Siemens VAI SIAS can provide an actual technical assistance to accompany the system's user throughout the tuning phase. In addition to providing a particular attention to the specificities of a given project for a given user, this approach offers the benefit of ensuring a smooth know-how transfer that eventually results in the end-user being completely autonomous and comfortable with using and optimizing the use of the surface inspection system. Also, it establishes a partnership between the system's supplier and user, who join their efforts to reach the best performance with regards to the project's objectives.

This approach has been applied by Siemens VAI SIAS successfully in the frame of various surface inspection projects, for both hot mills and processing lines. In each case, it has led to a fruitful cooperation that has helped perform efficient commissioning with controlled validation steps and a visible progression through time.

High-performance laser welder for heavy-gauge steel strips

Laser Welding Power

ROLLING & PROCESSING >

Siemens VAI has been developing welding equipment for the iron and steel industry for more than a decade. Now the company is expanding its welder range to meet the requirements of automatic welding machines, increased reliability of welds, perfect welding quality criteria (weld robustness, overthickness, welder reliability over 99 percent), and the emergence of new high-strength steel grades (dual phase, TRIP, TWIP).

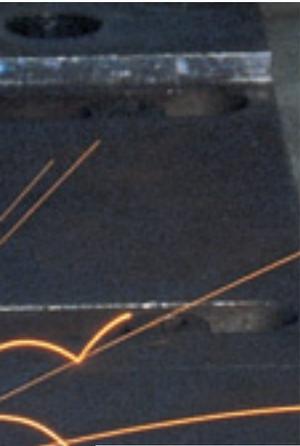
In its earliest stages, the Siemens VAI welder program was dedicated to perfecting the flash-butt welder concept for the pickling section and the fully continuous rolling mill and the mash lap welder concept for galvanizing line entry, continuous annealing, and inspection lines. Development of the laser welding process actually began in 2000. The first laser welder was installed in 2004.

Benefits of laser welding

Prior to laser technology, flash-butt technology for welding heavy-gauge strips on pickling lines and tandem mills was the only option available to steel suppliers. Laser technology now provides an alternative with a number of benefits.

For the production of high-strength and sensitive steel (silicon, manganese steel), for instance, the laser process ensures perfect quality. Another benefit is that superior performance can be achieved on a wider range of products. The laser process is able to weld from 0.5 to 7 millimeters reliably, while for the flash-butt process the thickness is limited to 1.2 millimeters. According to the evolution of the product mix for pick-





ling lines and tandem mills, this will represent a main advantage. Finally, compared with the flash-butt process, the laser operates cleanly, without flashing parts, fumes, or trimming.

High-performance LW 21 H laser welder

The LW 21 H welder comprises a fixed shear for tail- and head-strip fine cutting, a clamping system, and a welding carriage and optical path.

The shearing operation was one of the main concerns in the development of the heavy laser welder, as the quality of the shearing operation is one of the most

Clamping is done by raising the lower welding die. The position of the strip's upper face is independent of the strip thickness. For added operating convenience, there is no need for the line control to stop the strip head and tail precisely, as the welder is equipped with an integrated shield, which is placed in position for the arrival of the incoming strip head and tail.

Welding carriage and optical path

A welding carriage (C frame) is located on the motor side and is moved from the motor side to the operator side for the welding, planishing, and postheating operations.

This welding carriage is built around a double-focus welding head. The follower rolls actuated by hydraulic cylinders keep the strips perfectly in position during the welding operation. Planishing rolls are used to avoid any over-thickness during weld rolling at the tandem mill, while high-strength and sensitive steels are normally treated by postheating.

To optimize its reliability, the laser source is fixed on the motor side. This design provides a very simple beam path with easy access

to the components traveling on only one axis. All optical components can be removed and/or reinstalled without affecting the beam's final impact point.

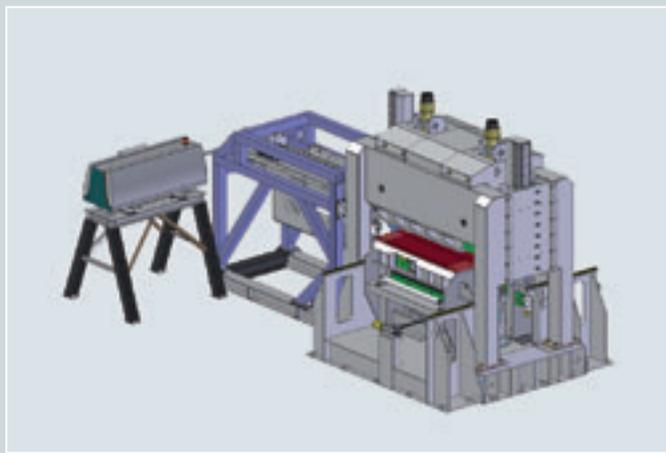
A world leader in strip-welding technology

Welding a strip head with a strip tail may not seem like a complex operation. But doing it quickly, without breaking the strip in the line, and achieving more than 99 percent line availability makes the task rather more complicated. Extensive R&D efforts have given Siemens VAI the ability to perform this and other complex tasks, making it a world leader welding machines.

With the development of a laser welder for heavy-gauge strips, Siemens VAI can now offer customers industrial solutions ranging from conventional but proven processes (mashed lap or flash butt) to advanced laser welding. ■



Laser welding operation



Principle design of the Heavy Laser Welder

important factors in achieving consistently perfect welding quality. The shear was designed to cut steel up to 1,500 megapascals, from 0.5 to 7 millimeters thick; to avoid any impact on shearing quality due to bad adjustment, shear displacement, or guiding wear; to adjust the shearing gap automatically based on the strip thickness; and to be easy to maintain.

To meet these performance criteria, an innovative design was defined with a completely stationary shear always in the same position on the line axis. The shear is not moved from a parked position to its working position at the risk of losing cutting quality due to wear or bad guiding adjustment. It has been calculated to cut steel up to 1,500 megapascals. Shearing parameters are automatically adjusted according to the welded thickness to optimize the cutting quality and the shear-blade service life.

Clamping system

The clamping system of the LW 21 H laser welder features two movable frames with high rigidity for steel up to 1,500 megapascals. The large (1 meter) opening of the welder provides easy maintenance access.

Author

Hervé Thomasson

Contact

processingline.metals@siemens.com



Dr. Christoph Dax, Fototechnik

Baotou's new fully integrated galvanizing line in Mongolia

High-Speed Hot Dip

ROLLING & PROCESSING >

At Baotou Iron & Steel Co. in Mongolia, commissioning of the new high-speed hot-dip galvanizing line was completed in April 2006. Siemens VAI integrated the mechanical equipment, the mechatronics package, the electrical equipment, and the automation technology.

The Baotou hot-dip galvanizing line includes the entry and exit sections, two loopers at each side of the process zone, one cleaning section, one furnace, one coating area, the temper mill and tension leveler, and the chromating unit. Downstream of the chromating unit, a free place is dedicated to the future anti-finger tower.

The entry section comprises two entryways (saddles), two pay-off reels to change the product on the fly with continuous production at rated speed, and one mash lap welder (ML 21). The exit section consists of two inspection areas (one vertical and one horizontal), the oiler, the shear, and two tension reels to permit the creation of pup coils as well as two exit ways with weighing positions.

The shearing functions have been optimized to produce coils according to the customer's weight and length requirements. Four tanks make up the cleaning section: the hot alkaline tank, a brush scrubber, the electrolytic cleaner, and a second brush scrubber. The furnace includes the NOF (non-oxidizing furnace) for the preheating of the strip, the RTF (radiating tubes furnace) for the main heating, and a cooling part to obtain the required temperature for the coating process. The coating section begins with two zinc pots to give clients a choice of coating, the Dynamic Air Knives (DAK), one cooling tower, and finally the cold coating gauge.

Sophisticated automation package

At Baotou, the automation system comprises a Level 1 process control for movements, sequencing, temper mill and tension leveler control, line drives, and utilities as well as process data acquisition and strip seg-

ment tracking. Full integration of the distributed process control system for the annealing furnace, zinc pot, and special instrumentation and package units (DAK, Skin Pass Mill and Tension Leveler) is also included.

One highlight of the automation system is Level 2, which includes optimal setpoint generation, traceability of the process applied to the strip, data collection, alarms, downtime management, and reporting functions.

In contrast to the current HUB technology, in which all data is distributed to all receiving subsystems, the switching technology transmits specific data to the selected subsystem only. All messages between Level 2 and the PLC master pass through a fiber-optic cable between the computer room and the entry electrical room. A fast Profibus network automatically detects whether a station has dropped out or a new one has joined the network.

One highlight of the automation system is the level 2, which includes optimal setpoints generation, traceability of the process applied to the strip, data collec-

The Baotou hot-dip galvanizing line





House integrated test: Before shipment the automation system is subjected to extensive testing

tion, alarm, downtimes management, and reporting functions.

Even zinc coating with DAK control

With the DAK system, the air-jet distribution across the strip is automatically controlled by continuously modifying the lip gap profile. This allows the appropriate wiping pressure to be applied, taking into account the data received from the coating gauge.

The zinc thickness control system allows computation of the wiping system presets according to the line speed and zinc thickness target. The horizontal nozzle position and the wiping pressure are adjusted to control the zinc deviation along the strip. The skewing of the nozzles is also adjusted. Finally, the lip gap profile is corrected to control the zinc deviation across the strip. The zinc thickness control in longitudinal mode and zinc thickness control in transverse mode with lip profile control enable the coating distribution deviation across the strip to be reduced to just 2 percent.

Operating convenience on Levels 1, 2, and 3

Primary data input on each coil is provided by Level 3 equipment. At the end of the process, Level 2 creates primary data output (PDO) and sends it to Level 3 for storage and use. As soon as a coil is identified in the entry section, set-up data is transmitted from Level 2 to Level 1 for this coil. The set-up data for all strips are stored in a buffer and applied depending on the strip

locations triggered by the tracking system. These data can be displayed on the HMI and modified there as needed.

Strip defects can be tracked throughout the plant and identified on a local control station in the exit section. Online data from Level 1 are stored for a short time in the database, while PDO data are archived for three months or more.

Exhaustive factory testing, smooth on-site commissioning

Before shipment to the project site, the automation system underwent extensive testing. The functions of each automation component were tested, followed by the components of the process control. The HMI, control desks, peripheral devices, drivers, and motors were then assembled and connected at the Siemens VAI facility and subjected to exhaustive inhouse testing. The Baotou project benefited directly from this preliminary testing work, both in terms of the technical training of customer operating personnel and through the smooth on-site commissioning of all equipment and systems. ■

Authors

Pierre-Jérôme Borrel, Philippe Podda

Contact

processingline.metals@siemens.com



Water treatment plant at the Mittal Steel Poland hot-strip mill

Water for Steel

Water and wastewater treatment are critical to every industry and are becoming an increasingly important – and often increasingly costly – resource for the steel industry as well. Siemens is ready to support customers in the steel industry to exploit this resource effectively and economically.

One example of Siemens' water-treatment expertise can be found at the Mittal Steel Poland hot-strip mill, where Siemens implemented a new system for treating the water from four different cooling circuits: a direct cooling system with a flow rate of approximately 8,700 cubic meters per hour, a laminar cooling system with a flow rate of approximately 4,000 cubic meters per hour, a furnace cooling system with a flow rate of approximately 900 cubic meters per hour, and an indirect cooling system with a flow rate of approximately 2,800 cubic meters per hour.

Challenging plant layout

The new water-treatment plant had to be integrated into the existing structures of the steel plant. Space was very limited, so the layout and process design of the water treatment plant had to be adapted and optimized. For example, free space in the rolling mill bay was used for the laminar cooling pump station and sludge treatment. In addition, during the project legacy foundations were discovered that had not been documented, so further adaptations became necessary.

Proven concepts and new approaches

The scale pit, which is the lowest part of the water-treatment plant, was constructed with an elliptical footprint for reasons of structural statics, a concept that had already proven its benefits in several projects.

To save as much space as possible, a newly designed and developed treatment stage was used for the direct

cooling water system. For the first time, Siemens implemented a lamella clarifier system directly after the longitudinal clarifier, which minimized the footprint required for the clarifiers. Scale from rolling process is eliminated by using a double stage filter with a small footprint. Piping between the water-treatment plant and the rolling mill is routed in a pipe tunnel with a walkway.

Minimal footprint

Not least due to the innovative clarifier process design, the footprint requirements of the new water-treatment plant were minimized so that the plant could be integrated into the existing units of the steel plant, allowing the cooling water required for the steel plant to be processed without major adaptations in the plant. ■

Key Figures of cooling circuits

- Direct cooling: flow rate approx. 8,700 m³/h
- Laminar cooling: flow rate approx. 4,000 m³/h
- Furnace cooling: flow rate approx. 900 m³/h
- Indirect cooling: flow rate approx. 2,800 m³/h

Author

Wolfgang Leitner, Head of Department
BoP U - Piping / Utilities / Water Treatment

Contact

balanceofplants.metals@siemens.com

A recipe for profit with 18 new steel grades at AZE Egypt

Steel Cookbook

On October 21, 2004, Siemens VAI was awarded a contract by the Egyptian state-owned Abu Zaabal (AZE) steel mill, which operates an electric arc furnace (EAF) steel mill, a forge, and a specialty steel shop. The contract called for Siemens VAI to provide the metallurgical "cookbook" to implement 18 new steel grades.

contract value with revenues from selling this steel in Europe.

This has been achieved with the help of the Siemens VAI consortial partner Salzgitter Trading. The prime responsibility of the Siemens team is to guide AZE staff to produce steel conforming to the European purchase orders received through Salzgitter Trading. The team also helps to operate the production planning software that keeps Salzgitter Trading abreast of production



Project Meeting

Electric Arc Furnace at AZE Egypt

Starting February 1, 2005, the time projected to fulfill the contract was 60 months. To provide the steelmaking expertise called for in the contract, documentation was created including all important theoretical basics as well as a metallurgical cookbook containing all the data required to produce 18 new steel grades. A very important part of this cookbook involves the heat-treatment requirements (temperature versus time), which ultimately ensure the physical properties of the steel produced. In addition to documenting its expertise, Siemens VAI had to develop a business plan addressing profit potential, sales revenues, and the production costs of the new steel grades.

Several contract milestones

Siemens VAI is currently fulfilling several milestones set down in the AZE contract. In addition to handing over the documentation and the business plan, small quantities of the 18 steel grades must be produced and analyzed for their steel properties. Siemens VAI is also obliged by the contract to finance 33 percent of the

output on a weekly basis. To prepare this information, a database was created that counts all the heats, cast ingots, and forged bars and issues a quality certificate to confirm that the bars meet the purchased properties and are ready for shipment.

Profitable implementation strategy

Excellent collaboration among all parties is leading to highly successful contract fulfillment. More than 3,000 tons of alloyed steel have been produced, generating substantial revenue for AZE. In fact, the implementation strategy has been so successful that discussion has now been initiated on a long-term profit-sharing contract. Under the terms of this proposed agreement, Siemens will assist AZE in increasing production from 15,000 to 100,000 tons per year. ■

Author

Rainer Wawrina

Contact

service.metals@siemens.com

VAI.safe for improved production and plant maintenance

Tireless Assistant

VAI.safe is a modular software package that improves plant reliability and availability with supporting tools for the maintenance and production crews. The key modules of this software package – MaintenancePlanner, IncidentAnalyzer, and DiagnosticsServer – cover a wide range of activities, from corrective to preventive to predictive maintenance.

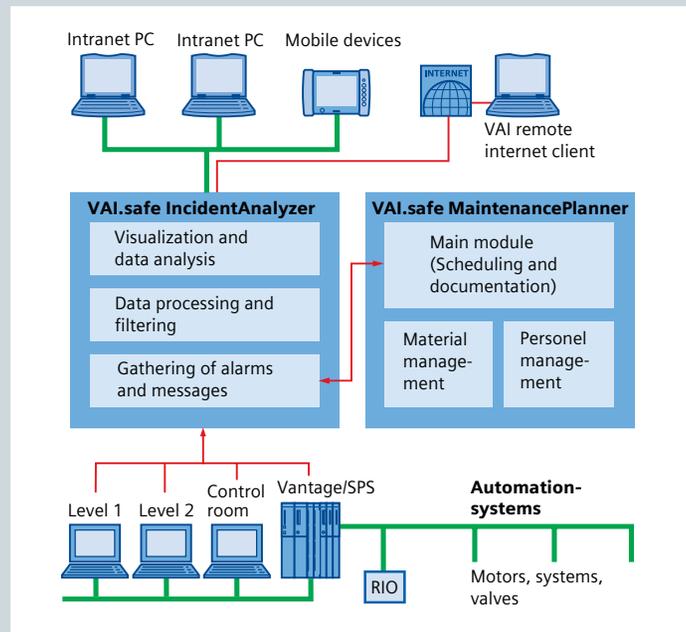
The MaintenancePlanner module documents and schedules repair, service, and inspection jobs as well as other modifications for all plant equipment. It is thus a knowledge database containing relevant information about past problems and their solutions. It represents a perfect tracking tool for past and future maintenance jobs with an easy-to-use interface. All tasks related to the maintenance of plant equipment are covered, including material management (ordering and reservation of spare parts, administration of suppliers, warehousing, etc.), capacity management (workload, available personnel, generation of work plans, etc.), reporting (weakness analyses, cost reports, etc.), resource management, interfaces with commercial software (SAP, etc.), and an interface to IncidentAnalyzer.

The IncidentAnalyzer is a tool for the efficient and methodical analysis of alarms and production inci-

dents. It offers immediate support for the repair of a malfunction and ultimately reduces plant equipment downtime. It stores and structures generated alarm messages from the automation systems as the first step in analyzing the cause of production incidents. It gathers alarm messages from the HMI without interfering with or interrupting the HMI control task. This is the basis for implementing corrective maintenance measures. The following information and functions can be accessed from any Web browser:

- Analysis of long-term alarm history with a range of filters
- Structured reports of alarm occurrences, including an integrated calendar view
- Display of hit lists and “meantime between alarms” as the basis for a systematic approach to reducing malfunctions
- Troubleshooting support through the recommendation of repair strategies
- Incident response
- Interface to MaintenancePlanner

The DiagnosticsServer – currently under development – applies data-based methods for modeling and diagnostic analysis of process measurement data. Important characteristic of the analysis methods incorporated in DiagnosticsServer is that they can efficiently cope with large measurement data sets from complex production processes. The DiagnosticsServer combine two



VAI.safe Main Modules

Main Benefits

- Holistic maintenance solution based on existing data
- No or minimal modifications required for installation in existing plants
- No risk of interference with ongoing production
- Compatible with automation equipment from all major suppliers

modes: the configuration mode followed by the diagnostic mode.

The configuration phase relies on historical measurement data from the analyzed process. During the configuration phase different analysis methods are applied to raw measurement process data describing ideal production periods with the goal first to prepare them for data-based modeling and then to use them in the data-based modeling, optimized for the diagnosis.

Generated models of the production process under analysis are input for the diagnosis mode. Beside the models, the configuration mode is able to give a valuable additional insight in analyzed process uncovering redundancies, time delays or even unknown interconnections between the process variables.

Switching over to the diagnosis mode, DiagnosticsServer uses data-based models to detect abnormalities in the process by comparing the output of the process models with the actual process measurement data, and then to isolate process elements (sensors, process parts, etc.) which actually cause the detected abnormalities. Furthermore, the process failure identification can be achieved through IncidentAnalyzer or (when required) through use of a custom-made expert sys-

tem. The diagnosis mode is can be used either in real time or offline (on prerecorded process measurement data).

In spite of the fact that the prior knowledge about the analyzed production process in DiagnosticsServer is not needed, existing expert knowledge can be used, for which purpose an appropriate interface is provided. This way a powerful combination of existing knowledge and data-based analysis serves to identify irregular production situations in their early stages.

Original features of VAI.safe

The originality of the VAI.safe software package lies in interconnection between its modules. Hierarchical organization of the modules permits that hierarchically higher modules, beside its own functions, enhance the feature of the others. DiagnosticsServer, for instance, will automatically provide alarms to the IncidentAnalyzer. IncidentAnalyzer can immediately create repair jobs in MaintenancePlanner as soon as a certain alarm occurs. As a result, VAI.safe fully integrates process information from the automation systems into a holistic maintenance solution. ■

Authors

DI Hajrudin Efendic, DI Arnold Wollschlager

Contact

service.metals@siemens.com



Advanced caster maintenance in Brazil

Superior Maintenance Services

The Volta Redonda workshop of the Siemens VAI group has been providing offline maintenance for the three slab casters of Companhia Siderurgica Nacional (CSN) since 2000. This workshop is an excellent example of how a Brazilian workforce can deliver world-class maintenance services.

The Siemens VAI Services workshop occupies two different locations within CSN's Volta Redonda plant. The workshops refurbish slab caster molds and segments, overlay the welding of caster rolls and the nickel coating of mold coppers, and repair hydraulic cylinders. There is a total of six strands to be maintained with an average annual production of 5.4 million tons. In addition to these activities, Siemens VAI Services in Volta Redonda also changes the segments in the plant and provides regularly scheduled maintenance services.

Qualified maintenance technicians

A team of expatriates and Brazilians manages 160 staff members plus seven apprentices. The Brazilian workforce receives ongoing training in courses and on the job. Convinced of their acquired skills and knowledge, the craftsmen decided to undergo the Abraman (Associação Brasileiro de Manutenção, or the Brazilian Maintenance Association) certification process. Ninety percent of the staff passed the examination the first time, and the remainder the second time. Having achieved well above the average examination results, all of them are now proudly certified maintenance craftsmen. The strong identification with the company made this professional qualification possible.

Specialized workshop facilities

The two Siemens VAI workshops are specialized. In Workshop 1, molds and segments are disassembled; cleaned by shot blasting; reassembled with new, refurbished, or old parts; and tested. For this purpose, there are three assembly and testing stands. The average refurbishing time for caster molds is 5 days and for caster segments between 8 and 10 days, depending on the complexity of the caster segments.

Workshop 2 is organized into four sections. Welding machines with 11 overlay welding heads are located in the welding section for refurbishing the caster rolls. Nine machine tools are installed in the machining section to machine the caster roller and other parts. The nickel-plating section has three galvanizing basins in which the mold copper plates are coated with nickel and with alloyed nickel. The milling section has two machines dedicated to mill the cold and hot faces of the broad and narrow faces as well as one planner and one boring mill.

Low material and production overhead

The Volta Redonda workshop keeps 1,700 spare parts in stock, and some spare parts are quite expensive. Because capital costs are very high in Brazil, spare parts are ordered for just-in-time delivery. Parts that must be changed every time a mold or segment is refurb-



Abraman certified craftsmen

ished are called Plano de Troca parts. Parts that are changed from time to time, as required by their condition, are called min-max parts. A Plano de Troca, or change plan, is established, with the client specifying when segments are to be exchanged as they reach the end of their service life. Based on this Plano de Troca, the net material requirements are calculated and the material is ordered. This approach keeps material inventories low.

Superior service quality

CSN does not pay Siemens VAI for the work itself, but for the performance of the refurbished molds and segments. Performance for the customer means the quality of the slabs, the service life of the molds and segments, and trouble-free operation.

Siemens VAI achieved two records recently at CSN. On Machine No. 4, a VAI caster installed at CSN, more than 800 days were achieved without breakdown, and 207,899 tons of material were cast in January 2007 on the same machine (average slab width: 1,300 mm). This success is the result of ongoing efforts to improve the casting machines, excellent work performed by the service staff, quality spare parts installed, and, of course, firm operational control by CSN.

A systematic analysis of faults and wear is the basis for continual maintenance engineering aimed at implementing improvements in all areas. Since 2000, the service life of the non-VAI casters (Machines 2 and 3) was increased by 230 percent on the segment zero. Even on the VAI caster, which has been designed for a long operational life, the service life of the bender has been extended by 50 percent. ■

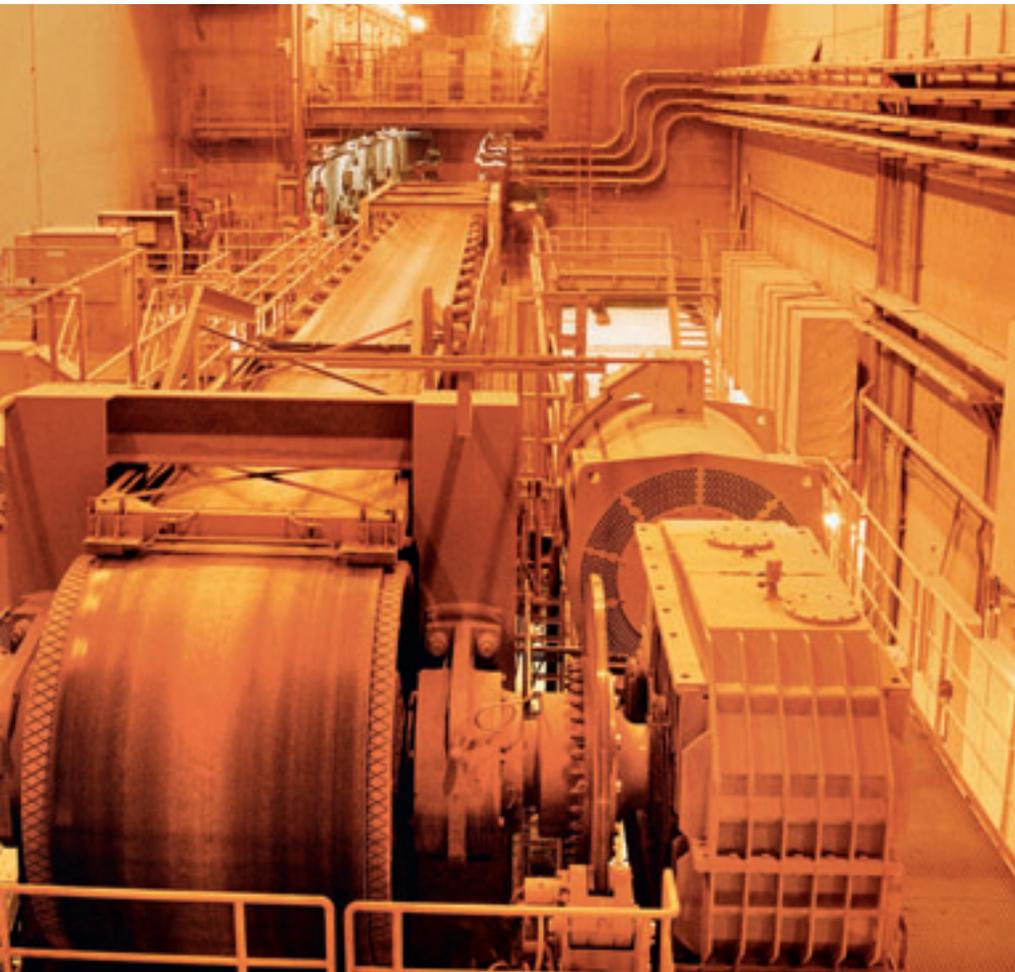
Author
Dr. Erhard Reichel
Contact
service.metals@siemens.com



Partnership with Minera Los Pelambres extended for another five years

Successful Service Relationship

The service contract between Minera Los Pelambres, Chile, and Siemens Industrial Solutions and Services (I&S) has been extended for another five years. This partnership with the Chilean copper producer was entered into in 1999 and has turned out to be highly successful. Within the framework of the contract, Siemens is responsible for maintaining the primary crusher and the entire conveyor-belt system between the ore-crushing section and the plant. This involves ensuring that setpoints regarding availability and reliability are adhered to. The service contract includes maintenance management, planning as well as spare-parts and contractor management.



Maintenance contract:

Maintenance management
Maintenance services for E&M
Material handling
Performance-based contract
Payment: Price per ton
KPIs: availability, reliability, cost, asset condition
Win/Win partnership
Duration: since 1999, prolongation until 2011

Around 200 kilometers to the north of Santiago de Chile in the Los Pelambres copper mine, copper ore is extracted at an altitude of 3,200 meters above sea level. A conveyor-belt system, which is approx. 13 kilometers long, connects the ore-crushing section, which lies at an altitude of 3,000 meters, to the beneficiation plant, located at 1,600 meters above sea level. The conveyor belts transport up to 8,700 metric tons of ore per hour at a speed of six meters per second. Eight motors with outputs of 2,500 kilowatts each operate the belts. Due to the steep incline and the rough surroundings, the electrical and mechanical components are exposed to considerable stress. The system generates about 15 megawatt electrical power by breaking the belts conveying the load downhill.

In 1999, Siemens signed an agreement to take over responsibility for preventive and corrective maintenance of the primary crusher and the entire conveyor system. Siemens is responsible for all the mechanical and electrical equipment, the automation systems and the instrumentation as well as for materials and spare-parts management.

A glass-fiber network links together all parts of the installation, whereas sensors detect important status

parameters of all the components. This enables the installation to be monitored all round the clock, irrespective of where the service personnel are stationed. Faults can be detected at a very early stage and, over the Internet, experts can examine the conveyor-belt system and its peripheral equipment from anywhere in the world. Any faults detected can thus be analyzed and the installation can be restarted, if necessary, as well.

Payment for this maintenance service includes performance-related components: The level of success is measured in price per ton, which is trendsetting in the industry, and on the basis of key performance indicators. Setpoints for the installation's availability and reliability are therefore defined in the contract.

Moreover, Siemens and Los Pelambres agree on a maintenance budget each year whereby Siemens is responsible for adherence to this budget. ■

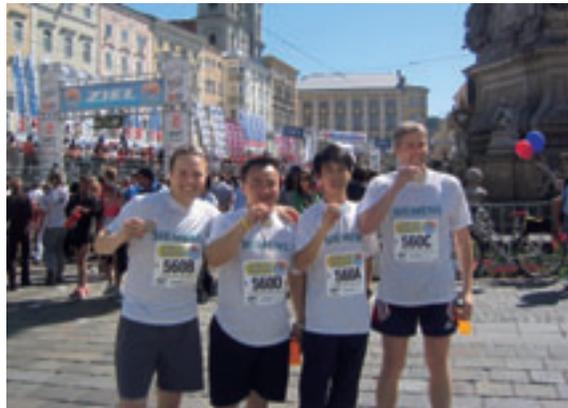
Author
Joachim Krämer
Contact
service.mining@siemens.com

The Baosteel/Siemens VAI Marathon Team

On the occasion of the spectacular Linz Marathon on April 15, 2007, members of the Baosteel and Siemens VAI "Vertical Caster Team" combined forces to run in the fast-pace relay-race event. The formidable distance of 42.2 kilometers was easily mastered by the four team members in a respectable time of 3 hours, 49 minutes und 46 seconds!

This feat took place following technical meetings in Linz related to an exceptional slab-casting project for Baosteel's Special Steel Branch in Shanghai, China. A vertical slab caster will be installed to cast highly critical steel grades that cannot be cast in conventional bow-type casters. Two runners each from the Chinese and Austrian project teams joined forces to participate together and succeed in the Linz Marathon relay race.

TEAMWORK, whether in sports events or in plant projects, is always the decisive factor for success! ■



Successful Completion of the Linz Marathon

From left to right: **Stefan Hofmayr** (Commercial Project Manager/Siemens VAI), **Zhang Jin** (Mechanical Engineer/Baosteel), **Li Jian Cheng** (Utilities Engineer/Baosteel), **Olaf Schwarze** (Technical Project Manager/Siemens VAI)

Shanxi Foreign Expert Friendship Award

Each year the People's Government of Shanxi Province, China, presents an award to a foreign expert who has made outstanding contributions to the development of Shanxi Province. On February 14, 2007, Mr. Peter Mit-



Peter Mittag of Siemens VAI Receives Shanxi Award from Mr. Xue Yanzhong, Vice Governor of Shanxi Province, China

tag, Project Manager of Siemens VAI, received the Shanxi Foreign Expert Friendship Award for the year 2006 from the Vice Governor of Shanxi Province, Mr. Xue Yanzhong. The text on the plaque reads:

"You are hereby honored with the Shanxi Foreign Expert Friendship Award in recognition of your contribution and dedication to the social development and economic construction of Shanxi Province. The People's Government of Shanxi Province. December, 2006"

Mr. Mittag, the plant-commissioning leader, received this award as the representative of the commissioning team for a three-million t/a carbon-steel production line, which was started up in August 2006, and for a 1.5-million t/a stainless-steel double-production line which was started up in September of the same year for Taiyuan Iron and Steel Co. in Taiyuan. All three production lines are installed under the same roof which enables the highest flexibility with respect to logistics and productivity. As a particular highlight, the capacity of the combined stainless-steel facility is the highest in the world. ■

Siemens VAI Metals Symposium

The Siemens VAI Metals Symposium was held in Sanya, the famous resort city of south China, on March 19–21, 2007. More than 200 customers from major steel companies all over China as well as around 80 Siemens staffs participated in this conference. In total, over 20 lectures and key-note speeches were delivered showcasing the whole portfolio of Siemens VAI technologies for metals and mining industry. The symposium was well received by the audience. ■

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

- JUN 3-5** 2nd STEEL TUBE & PIPE CONFERENCE, Düsseldorf, Hilton Hotel, SVAI Seuthe www.metalbulletin.com/events
- JUN 4-6** CLEAN STEEL 7, Balatonfüred www.mvae.hu/cleansteel
- JUN 4-6** FUNDAMENTALS OF METALS TRADING & RISK MANAGEMENT (Training Course), Metal Bulletin, London, The Guoman Tower, Tower Bridge www.metalbulletin.com/events/risk
- JUN 4-7** STEEL MILL OPTIMISATION & MAINTENANCE ASIA 2007, Terrapinn, Bangkok, Grand Hyatt Erawan www.terrapinn.com
- JUN 5-7** 35th IRON & STEELMAKING SYMPOSIUM: "Optimization of the EAF Process Using Injection Technology", McMaster, Hamilton, Canada, Sheraton Hotel <http://mcmasteel.mcmaster.ca/Training>
- JUN 6-8** 3rd ASIAN STAINLESS STEEL CONFERENCE, Metal Bulletin, Hong Kong, Kowloon Shangri La Hotel www.metalbulletin.com
- JUN 10-12** WORLD WIRE & CABLE CONFERENCE, CRU, Paris, Rive Gauche Hotel www.cruvents.com
- JUN 10-14** 2nd INT. CONFERENCE ARCHAOMETALLURGY IN EUROPE, Grado www.aimnet.it/archaeometallurgy2.htm
- JUN 11-13** 20th INT. COPPER CONFERENCE, London, Hyatt Regency, The Churchill
- JUN 11-13** 11th WORLD ALUMINIUM CONFERENCE, CRU, Montreal, Hotel Omni Mont-Royal www.CRUMonitor.com
- JUN 12-16** METEC InSteelCon 2007, VDEh, Düsseldorf, Congress Center Düsseldorf www.stahl-online.de
- JUN 13-15** SOUTH EAST ASIAN STEEL CONFERENCE, Hanoi, Hilton Hanoi Opera www.metalbulletin.com/events/seas
- JUN 18-20** STEEL SUCCESS STRATEGIES XXII, AMM, MT, New York, Sheraton <http://amm.com/events/2007/steelsuccess/>
- JUN 18-20** DUPLEX 2007, AIM, Grado www.aimnet.it/duplex2007.htm
- JUN 27-28** 5th CHINA INT. COKING TECHNOLOGY & COKE MARKET CONGRESS 2007, CCPIT, Taiyuan City, Yingze Hotel www.coke-china.com
- JUL 17-19** INT. CONFERENCE ON IMPROVING THE PRODUCTION, FABRICATION & PERFORMANCE OF MICROALLOYED STEEL AIST, Pittsburgh, Soldiers & Sailors Hall www.aist.org
- JUL 23-27** ABM ANNUAL CONGRESS, ABM, N.N., Laser welder for high thickness for steel industry, Vitoria www.abmbrasil.com.br
- AUG 21-23** IFAC MMM ,07 - 12th IFAC SYMPOSIUM ON AUTOMATION IN MINING, MINERAL & METAL PROCESSING, IFAC, Turning Scrap into Steel, Quebec www.qch.ulaval.ca/ifacmmm07
- AUG 25-30** COPPER IN STEEL, Metall. Soc. Of CIM, Toronto, Fairmont Royal York Hotel www.cu2007.org
- AUG 28-30** ALUMINIUM CHINA, Reed, SVAI UK R&P Alum., N.N., Shanghai, N.N. www.aluminiumchina.com
- SEP 5-7** *STEXPO 2007 - 5th CHINA INT. STAINLESS STEEL CONGRESS, N.N., Shanghai* www.stexpo.com.cn
- SEP 9-11** ALUMINIUM 2007 - 22nd INT. ALUMINIUM CONFERENCE, Dubai, Grand Hyatt www.metalbulletin.com/events
- SEP 10-14** EXTEMIN 2007, Arequipa/Peru
- SEP 12-14** INT. CONF. ON MODELLING & SIMULATION OF STEELMAKING, Graz, Austria, N.N. www.asmet.at
- SEP 17-20** MATERIALS SCIENCE & TECHNOLOGY 2007 Detroit, Michigan, Cobo Hall Convention Center www.aist.org
- SEP 25-27** 6th INT. NICKEL, STAINLESS & SPECIAL STEEL FORUM, Helsinki, Radisson SAS Seaside Hotel



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Contact Address

Headquarters:

Siemens VAI Metals Technologies GmbH & Co, Austria

P.O. Box 4, Turmstr. 44 · A-4031 Linz, Austria

E-mail: contact.metals@siemens.com

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