

# metals & mining

The magazine for the metals and mining industries

Issue 1|2011

**SIEMENS**  
**V A I** 



**Innovation**  
**Creating the Future**



## Can we measure temperature – fast, safe and without interrupting the process?

### With SIMETAL RCB Temp contact-free temperature measurement.

Steelmaking is all about knowing the exact temperature at any given time – and not just at the surface, but directly inside the melt. Until now, this was accomplished through time-consuming and dangerous sampling. With its supersonic oxygen injection technology, SIMETAL RCB Temp offers an innovative new approach. The burner preheats the scrap during power-on time, accelerates the melting process and provides a supersonic oxygen stream during the refining phase. As soon as the defined homogenization level is reached, the system switches to temperature mode for analyzing the temperature at short intervals. Compared to manual sampling, this allows for a sooner determination of the right tapping time. The result: shorter tap-to-tap times, higher productivity – and no operator risks whatsoever.

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Answers for industry.

**SIEMENS**  
**V A I** 



Werner Auer

## Dear Readers,

Technological innovation and development has always been a driving force in the metals and mining industries. The origin of Siemens – today the world's largest engineering company – and the metallurgical plant builder Siemens VAI can be traced to spectacular inventions and their subsequent applications that have changed the industry forever. Our tradition and reputation as pioneers of innovation continue to this day.

We aim to find answers to the present and future challenges confronting the steel industry. A major focus of our activities is therefore placed on the development of products and technologies that lower the consumption of natural resources and energy, reduce environmental emissions, improve the quality of steel and make the most of capital expenditures. Innovative services from Siemens VAI also provide opportunities to maximize the performance and operational lifetime of the plants we supply.

Our international centers of competence and our global setup ensure that we are close to the market. This allows us to better orient our research work both to regional requirements as well as to the individual needs of our customers. Siemens VAI researchers, specialists and process engineers work closely together with industrial partners, research institutes and universities to develop and implement state-of-the-art solutions. Our research activities are holistic in that all aspects of a product are taken into account that include technology, mechanical equipment, media supply, electrical and drive systems, all automation levels and environmental solutions.

This issue of metals&mining presents examples of recent innovation highlights across the entire value-added iron and steel production chain. Our innovation activities are not only limited to technologies and products, they also include innovative consulting, financing and maintenance services, examples of which are presented in this issue.

Innovation is a fundamental pillar of the business activities of Siemens VAI. In this way we can ensure that a maximum of benefits are derived for our customers.

Yours sincerely,

A handwritten signature in blue ink, appearing to be 'W. Auer', written in a cursive style.

Werner Auer

CEO of Siemens VAI Metals Technologies

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## Start-up of New Steel Mill at TK CSA, Brazil



Slab removal from the run-out area of the slab caster

In November 2010, Siemens VAI started up the LD (BOF) converter and continuous slab caster of the second production line of the ThyssenKrupp CSA (Compan-

hia Siderúrgica do Atlântico) steel mill located in the outskirts of Rio de Janeiro, Brazil. The first slab had already been cast on the first line in September. "The efficiency and safety of the plant configuration are impressive. Even the slabs produced immediately after commissioning were already of extraordinarily high quality," said Dr. Herbert Eichelkraut, CEO of ThyssenKrupp CSA. The steelworks is designed to produce some 5 million tons of slabs per annum. Siemens VAI supplied two basic oxygen furnace plants, secondary metallurgical facilities, primary and secondary dust-cleaning systems, two continuous slab casters, and the associated electrical and automation equipment. Around 40% of the produced slabs are to be rolled at ThyssenKrupp locations in Germany. The remaining 60% are foreseen for further processing at the new U.S. ThyssenKrupp works in Calvert, Alabama. ■

## Modernization Project at Kennecott Mine

The Kennecott Bingham Canyon Mine in Utah, U.S.A., operated by Rio Tinto, is one of the world's largest copper mines. Gold, silver and molybdenum are also extracted at the mine. Three SAG (semi-autonomous grinding) mills installed with twin-pinion DC motor systems in 1988 will be equipped with new control and automation technology. The system is based on Simatic S7 for the general control of the mill and a Sinamics DCM converter for the drive-specific control of the rec-

tifier. The modernization ensures enhanced diagnostic features as well as operational reliability and availability of the plant. Maintenance costs are also reduced. Retaining the power section of the rectifier is the key feature of the modernization concept developed by Siemens, a step that significantly reduces investment costs for the modernization. Commissioning will start in early 2011 and is scheduled for completion for all three mills by early 2012. ■

## Ore Mill Drive Modernization at Quadra FNX

Quadra FNX Mining, one of North America's leading copper producers, commissioned Siemens to modernize the drive system in a SAG mill in its Robinson open-pit copper mine in Nevada, U.S.A. This will be the first time that an ore mill will be equipped with a Sinamics SL150 cycloconverter. The modernization concept for Simine Mill GD enables analogue or early digital control systems to be substituted without also having to replace existing electrical equipment such as the motor and transformers. This approach significantly reduces conversion costs. Modernization work is scheduled to be finished in the summer of 2011. ■



First installation of Sinamics SL150 cycloconverter control system in an ore mill

# Selected Start-ups and FACs (June 1 to Oct. 31, 2010)

Company	Country	Project
AG of Dillinger Hüttenwerke	Germany	Start-up secondary dedusting plant for 160-ton converter
Baoshan Iron & Steel Co., Ltd	China	Upgrading of EAF No. 2 with RCB technology comprising three RCBs, valve stand, electrics and Level 1 automation
Dragon Steel Corporation	Taiwan	FACs received for Sinter Plant No. 1, Blast Furnace No. 1, and Slab Casters Nos. 1 and 2
Hunan Valin Lianyuan Iron & Steel Co., Ltd.	China	Start-up of dry-type dedusting system for two 210-ton converters
Hyundai Steel Co., Ltd	Korea	Start-up of 2-strand slab caster at Dangjin Works (CCP 2)
Indian Steel Corporation Ltd. (Gandhidham works)	India	Start-up of new 6-high reversing cold mill with a capacity of 450,000 t/a
Jiexiu Xintai Iron & Steel Co. Ltd	China	Start-up of 3-strand beam-blank caster
Jinan Iron & Steel Co. Ltd	China	FAC received for VAiron process-optimization system for sinter plant
Nanjing Nangang Industry Development Co. Ltd	China	FAC received for VAiron process-optimization system for blast furnace Start-up of 1-strand thick-slab caster (CCP 3)
OJSC Novolipetsk Steel	Russia	Start-up of 330-ton converter in LD1 steel mill, including dry-type primary dedusting system. Modernization of 4-strand bloom/beam blank combi-caster (CC3)
Pohang Iron & Steel Co, Ltd (Gwangyang)	Korea	FAC received for a vacuum pump system and T-COB lance system for 270 t and 280 t RH-VDT facilities. Start-up of 2-strand thick slab caster (CCP 3)
Pohang Iron & Steel Co, Ltd (Pohang)	Korea	Replacement of 2-strand thick-slab caster (CCP 2/CCM2)
Qinhuangdao Shouqin Metal Materials Co., Ltd.	China	Start-up of 1-strand ultra-thick slab caster (CC3). Start-up of 4,300 mm plate mill with an annual capacity of 1,800,000 t/a – extension project (includes E/A and drives)
RWE Power AG	Germany	FAC received for modernization of conveyor system comprising 40 conveyors at the Inden lignite mine in the Federal State of North Rhine-Westphalia
Saudi Iron & Steel Co. Ltd. (Hadeed)	Saudi Arabia	Revamping of 150 t EAF No. 1 with new hydraulic unit, new electrode arms, electrics and Level 1 automation
Shagang Wide Plate Mills Co. Ltd.	China	Order received to provide service support for 5 m Plate Mill No. 1
Shandong LaiGang Yongfeng Iron & Steel Co., Ltd.	China	Start-up of 8-strand billet caster
Shandong Loften Aluminum Foil Industry Co., Ltd.	China	First aluminum coil rolled at Foil Mill No. 3 at Qingdao. First coil rolled in cold mill at Boxing, Shandong Province
Shinsho Corporation (Kobe Steel Group)	Japan	Start-up of Siroll Fara electrostatic oiler for aluminum strip protection
Shouqin Metal Materials Company Limited (Shougang Group)	China	Start-up of E/A systems, main and auxiliary drives, shear line and cold-plate leveler for 4,300 mm plate mill (extension project)
Siemens WLL	Bahrain	Start-up of new metallurgical service center for electric steelmaking and long rolling in the Middle East
Steel Dynamics Inc.	U.S.A.	Start-up of 4-strand bloom/beam blank combi-caster (CC 2)
Sumitomo Metals Industries (Kashima)	Japan	Start-up of Mulpic accelerated plate-cooling system on an existing plate mill
ThyssenKrupp CSA (Companhia Siderúrgica do Atlântico) S.A.	Brazil	Start-up of two 330-ton converters equipped with dry-type dedusting systems; secondary metallurgical facilities; and two 2-strand slab casters.
Xiangtan Iron & Steel Co. Ltd (XISCO)	China	Start-up of 4-strand billet caster; first plate rolled on roughing and finishing mills

AOD = Argon Oxygen Decarburization  
 CC = Continuous Casting  
 CCM = Continuous Casting Machine  
 CCP = Continuous Casting Plant

E/A = Electrics & Automation  
 EAF = Electric Arc Furnace  
 FAC = Final Acceptance Certificate  
 RCB = Refining Combined Burners

RH = Ruhrstahl Heraeus  
 RH-VDT = Ruhrstahl Heraeus Vacuum Degassing Tank  
 T-COB = Technometal Combined Oxygen Blowing

POSCO, Pohang Steelworks, Korea –  
a long-term partner of Siemens VAI  
for the introduction of many  
innovative technologies

COVER STORY >





# **Innovation:** Creating the Future With Today's Technologies

Innovation is not only a fundamental pillar of Siemens VAI strategy, it is decisive for providing our customers with a unique competitive edge and for meeting the challenges of tomorrow.

The roots of the metallurgical plant builder Siemens VAI can be traced to the invention and implementation of the LD (BOF) steelmaking process in Linz, Austria, and the subsequent marketing of this revolutionary technology worldwide. Oxygen steelmaking processes account for more than 60% of all steel produced today. This tradition of innovation at Siemens VAI has been decisive for the company's success and will continue to serve as a cornerstone of company policy and strategy in the future. Gerald Fliegel, head of the research and development department at Siemens VAI, writes about the role of innovation in company policy, and the trends and factors that will affect the steel industry of tomorrow.

**W**hat do I get for my money?" With this question, Werner Auer, CEO of Siemens VAI, continually confronts our company's R&D department, which I have the to honor to lead. In answering this question there are three main aspects that need to be considered:

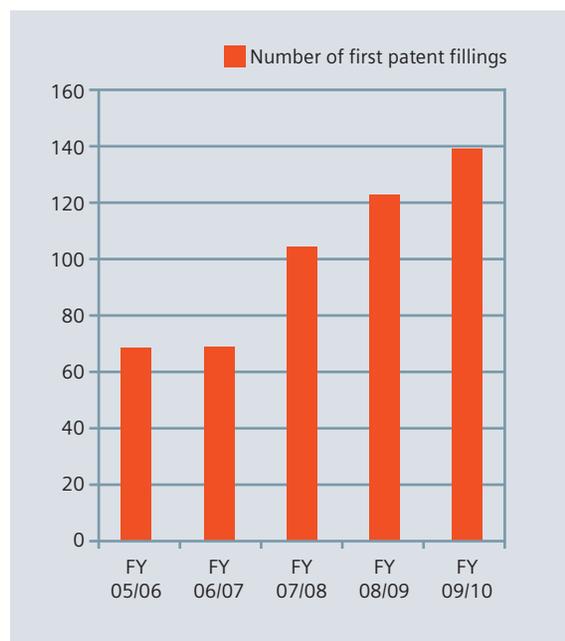
- 1) Investments in R&D are huge and have a direct impact on profit. This fact alone justifies a CEO asking to be regularly informed about innovation activities and their progress.
- 2) The mid- to long-term influence of R&D results on the economic success of a company cannot be overestimated. The R&D activities of today have to generate a substantial portion of a company's sales volume within a few years. Therefore, innovation has a profound influence on sustainable success.
- 3) The money allocated to R&D must be clearly focused on marketable products, solutions and technologies. These commercial goals are documented in business plans and serve as the basis for R&D projects. The targets can only be met if the innovation strategy is implemented as an essential part of the business strategy.

An effective innovation approach is carried out on different levels: An internal organization supplies the innovation pipeline with new ideas. Patents are registered to protect the considerable investments made in R&D. An innovation strategy must be strictly organized and enforced to ensure successful commercialization.

**Internal idea factory**

To permanently provide our customers with beneficial and cost-saving innovations, promising ideas must be carefully evaluated and implemented in a professional manner. This calls for the establishment of an "internal idea factory." An open-minded and fault-tolerant atmosphere prevails within Siemens VAI, where managers encourage staff to actively participate in the ongoing innovation process. An innovation process must have the full support of motivated and dedicated employees to be successful. The idea factory at Siemens VAI generated nearly

200 invention disclosures in fiscal 2010 – twice as many as four years ago. This increase in submitted ideas is also reflected in the continuous growth in the number of first filings for patents during the past five years (Figure 1).



**Fig. 1: First patent filings from 2005 to 2010**

**Patents**

Patents are not filed just to demonstrate an efficient corporate innovation system. The ultimate strategic goal for filing patents is to enable a long commercial exploitation of R&D results without being threatened by nonauthorized and inferior copies. The creation of own intellectual property rights (IPRs), mostly in the form of patents, ensures regional or worldwide exclusivity to use and commercialize the results from R&D efforts. Patents protect products or technologies from illegal copying and ensure that revenues from innovations are kept at a consistently high level to generate sufficient ROI to finance future R&D activi- >>



Demonstration of Gimbal Top Distributor at the Taicang Workshop of Siemens VAI, China

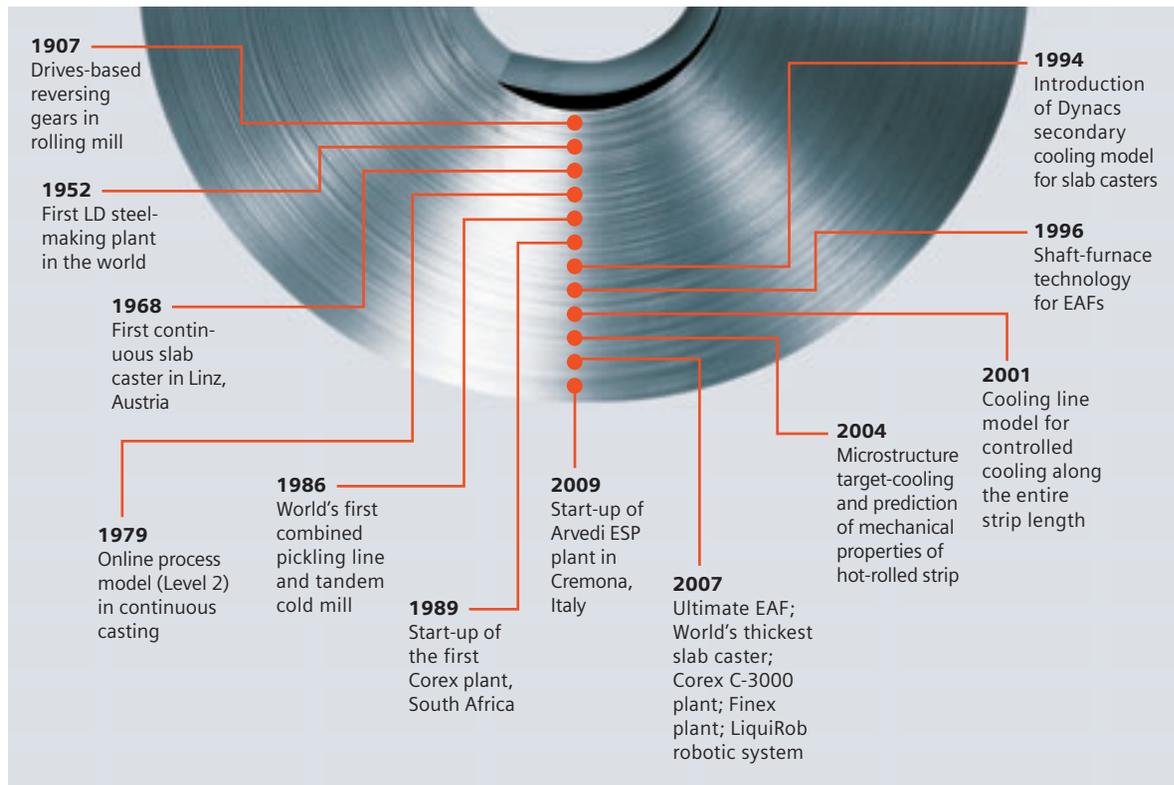
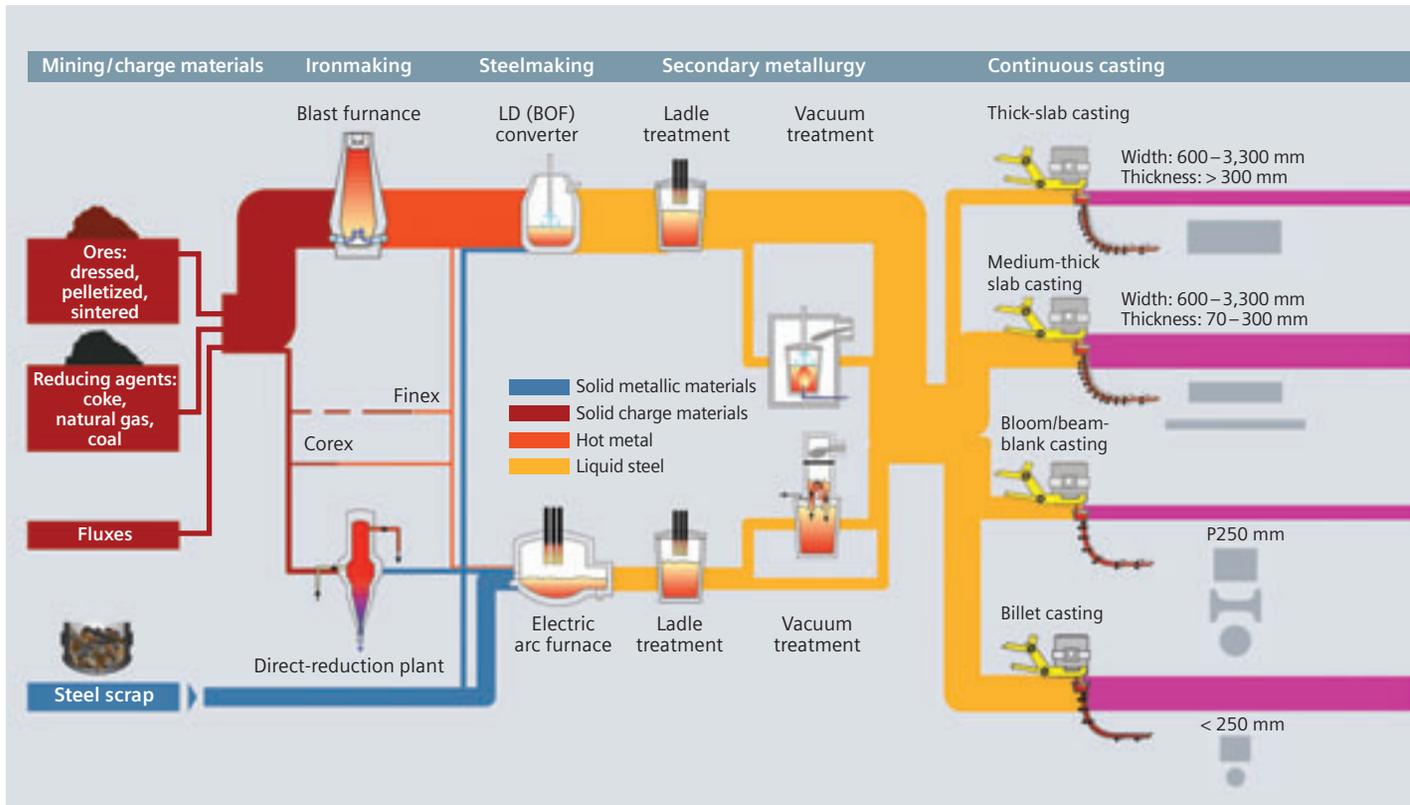
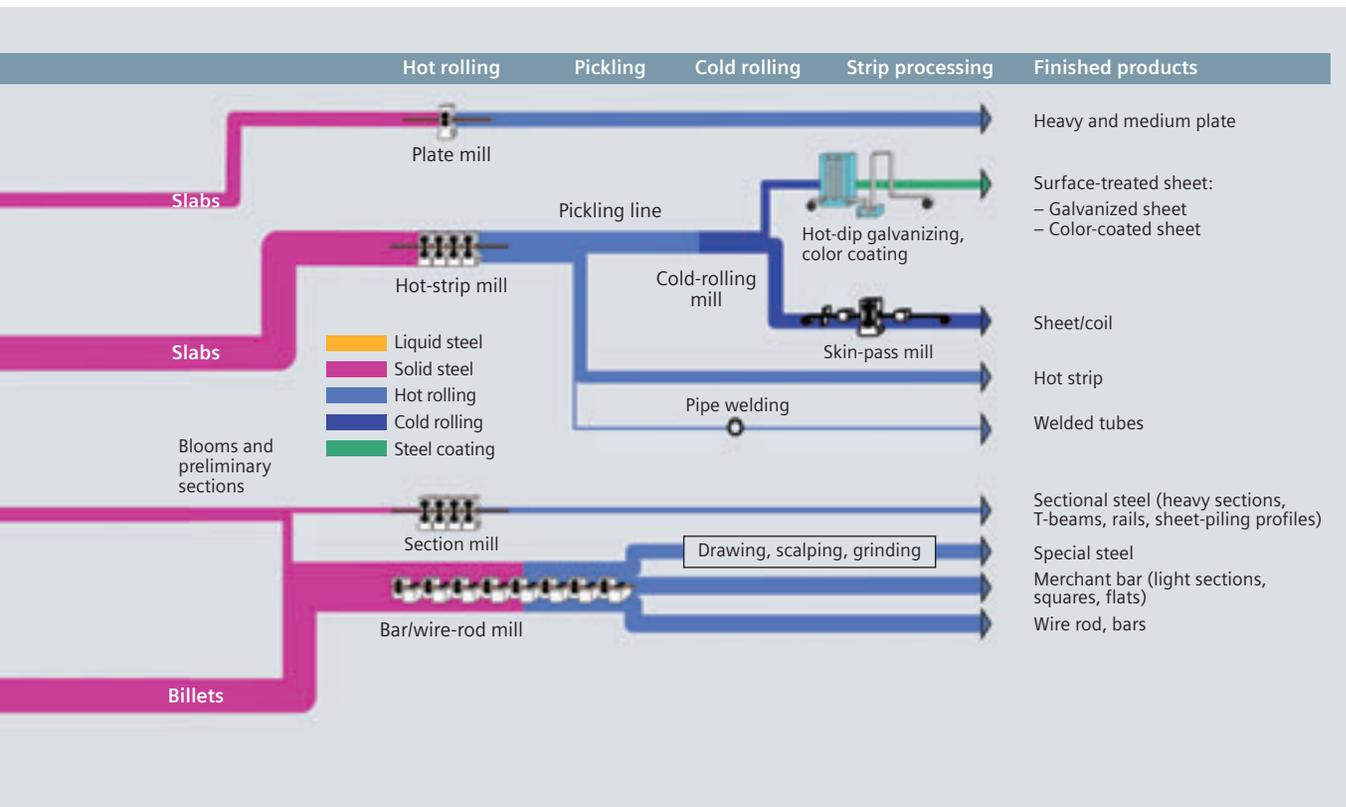


Fig. 2: Examples of important innovative developments in the history of Siemens and Siemens VAI



**Fig. 3: Selected examples of Siemens VAI innovations along the iron- and steel-production chain that were introduced to the market during the past five years**

	Plant/Technology	Product
<b>Mining</b>	Open-cast mining	SIMINE Pump – world's largest slurry pump
	Open-cast mining	SIMINE Drag – first gearless drive system for draglines
	Open-cast mining	SIMINE MES – first mine with complete communication and control system with WLAN
	Open-cast mining	SIMINE SH – AC drive system for small shovels in emerging markets
	Beneficiation	SIMINE Flot – mobile hybrid flotation
<b>Ironmaking</b>	Coking plant	Pumas camera-based coke-oven monitoring system
	Sinter plant	Intensive Mixing and Granulation System
	Sinter plant	Twin-Layer Charging System
	Sinter plant	Selective Waste-Gas Recirculation
	Sinter plant	Meros – offgas-cleaning system
	Sinter plant	Sinter VAiron – optimized process control
	Blast furnace	Gimbal Top Distributor
	Blast furnace	Sub-burden gas-analysis probe
	Blast furnace	Hydraulic taphole drill
	Blast furnace	Classifier inlet cyclone
	Blast furnace	Merim – offgas-cleaning system
	Finex	Waste-heat recovery system, dry-dedusting system
<b>Steelmaking</b>	LD (BOF) converter plant	Horizontal sublance for semi-automated measuring and sampling
	LD (BOF) converter plant	Conlink suspension system
	LD (BOF) converter plant	LiquiRob robot-aided measuring and sampling system
	EAF	LiquiRob robot-aided measuring and sampling system



	Plant/technology	Product
Continuous casting	Slab caster	LiquiRob robotic applications in liquid-steel areas
	Slab caster	LevCon (precision mold-level control and stabilization)
	Slab caster	Smart Bender (thickness-adjustable bender)
	Slab caster	EcoStar (new generation of cost-saving, long-life rollers)
	Slab caster	3D Sprays (dynamic spray-width adjustment)
	Slab caster	New Dynacs 3D cooling model
	Slab and bloom casters	DynaGap Soft Reduction (3D roll-gap control)
	Slab caster	Ultra-thick slab caster (400 mm slabs)
	Beam-blank caster	Significant reduction in web thickness
	Billet caster	Record-speed billet caster
Arvedi ESP	Linked slab casting & hot rolling	Endless strip production from liquid steel to hot-rolled coils
Rolling	Plate mills/plate-Steckel mills	Extended lift bend and shift block
	Plate mills/plate-Steckel mills	SmartShear – hydraulically operated divide shear
	Plate mills	Plate leveler for faster cassette change
	Hot-strip mill	Power Coiler – coiling of highly rigid and thick-gauge strip
	Hot-strip mill	Roll-gap lubrication
	Hot-strip mill	Microstructure target cooling for hot strip
	Aluminium hot mill	Fully hydraulic mill stand
	Long rolling, rod mill	Vertical compactor
	Long rolling, rod mill	Dual-diameter laying head
	Long rolling, rod mill	Intelligent pinch roll
Long rolling, rod mill	SIAS Q-B – surface-inspection system for long products	
Processing	Pickling line	Faplac – optimized control of pickling process
	Pickling line	Silica-removal system
	Strip processing	Fiber laser welder

>> ties. Furthermore, patents are often a good starting point for industrial or academic cooperation in R&D, as IPRs officially document the knowledge that is submitted by each partner. Siemens VAI has substantially contributed to the global Siemens patent portfolio comprising more than 55,000 patents. Figure 2 highlights some of the main innovative developments in the history of Siemens and Siemens VAI. Figure 3 presents examples of successfully introduced innovations at Siemens VAI during the past five years.

**Innovation strategy**

Ultimately, the number of ideas we create and the number of patents we file is not the decisive factor. In the end, it is the market that decides how many of our inventions will become successful products. Internal innovation management as well as the patent program must be focused and channeled by an innovation strategy. This strategy is derived from the business strategy and takes external trends into account, such as global and local economic developments, emerging technologies, future market and customer demands, and competitor activities.

Green plants and technological packages are two of the main cornerstones of the Siemens VAI innovation strategy.

**Green plants**

Substantial improvements have been made during the last decades to reduce the environmental impact of iron- and steelmaking processes. Nevertheless, customers are interested in solutions that save energy and reduce emissions without sacrificing plant performance.

An innovation process must have the full support of motivated and dedicated employees to be successful.

Examples of green and innovative solutions in the Siemens VAI portfolio that have been recently introduced to the market include Meros (Maximized Emission Reduction of Sintering); Selective Waste-Gas Recirculation; ongoing improvements to the Corex and Finex processes, which are clearly superior to the blast furnace route from an environmental standpoint; and the Arvedi ESP (Endless Strip Production) process, which results in approximately 40% energy savings compared to conventional casting and rolling

COVER STORY >



Customers are interested in solutions that save energy and reduce emissions without sacrificing plant performance.

180-ton LD (BOF) converter at voestalpine Stahl, Linz, Austria

processes. Reducing the energy required to produce a ton of steel is further supported by process control incorporating continuously optimized Level 2 online models; the integration of energy-consumption monitoring systems; and the introduction of power-saving models in Siroll and Simetal products.

Current developments are focusing on improving the use of waste heat from major energy consumers within a steelworks. In the ironmaking process blast furnace slag offers a huge potential for recovering heat energy that would otherwise be lost. In the steelmaking process R&D activities are focusing on utilizing waste heat from the converter and EAF. New solutions from Siemens VAI will make their market debut soon.

#### Technological packages

The integration of process models and mechatronic solutions into technological packages offers customers significant advantages, such as standardized and defined interfaces; quick installation and implementation, especially for revamping and modernization projects; and fast machine ramp-ups to required production output. The availability of knowledge-based maintenance schedules that combine preventive and predictive maintenance schemes together

with online and remote condition monitoring can help to ensure continuously high plant performance and an optimized equipment service life (see pages 94 and 95). Siemens VAI can offer its customers these advantages with a steadily growing portfolio of technological packages for each step of the iron and steel production route. An integrated approach is applied in R&D to support the cooperation between different technological disciplines in order to design optimized packages that meet the requirements of the foreseen application.

It is our main task to provide our customers with innovations that offer notable added-value benefits and a unique competitive edge.

#### What do customers get for their money?

Our customers also ask what they get for their money when we introduce new innovations. Simply because a product or solution is new is obviously not >>



Torchcutting of 400 mm thick slab at Qinhuangdao Shouqin, China

>> enough to convince a customer to invest in it. Innovations must support customers in meeting their own strategic and economic targets. Successful innovation happens where the technology push meets the market pull. It is our main task to provide our customers with innovations that offer notable value-added benefits and a unique competitive edge.

## The development of new process technologies for the iron and steel industry often takes 5 to 15 years.

It is also not enough to understand the current needs of customers. In the plant-building business the development of new process technologies for the iron and steel industry often takes 5 to 15 years from the concept phase to the construction of an industrial-scale plant. Therefore, various scenarios for the plant of the future have to be developed in time and the direction of long-term research projects has to be carefully charted. This overview of market developments also helps our customers to adapt their product portfolios to meet future market requirements.

Various trends that are expected to shape the metals and mining business 20 years from now are reviewed in the final section of this article.

### Importance of energy and environmental care

Undoubtedly, the overall trend is moving in the direction of increased environmental awareness. However, an assessment of the situation two decades from now does not reveal a consistent picture. Instead, there are a number of scenarios that will presumably exist side by side depending on local conditions such as environmental regulations, the availability of different sources of energy and the quality of raw materials.

The topic of CO<sub>2</sub> will play a decisive roll, especially in ironmaking. Although carbon capture and storage (CCS) is technically applied today in connection with the processing of natural gas, and also for enhanced oil recovery (EOR) in Canada, it will not offer a viable solution on a broad scale to the underlying CO<sub>2</sub> problem. A number of technical and logistical problems must be addressed before CCS can be extensively applied in the industry.

Among the iron-ore smelting technologies, the Finex process, which operates on the basis of fine iron ores, will become established as the preferred technology.

The broad use of H<sub>2</sub> as a substitute for coal to reduce iron ore, or the industrial implementation of radically alternative technologies in ironmaking (such as the electrolysis of iron ore), are not anticipated within the next 20 years. Nonetheless, a number of interesting scientific findings can be expected as an outcome of the research done in these areas.

With regard to waste-material reprocessing and improved energy efficiency and recovery, all process steps in a steelworks will be optimized. Auxiliaries and additives will be introduced into closed cycles to reduce the environmental impact. CO<sub>2</sub> taxation (such as the Emission Trading Scheme in Europe) and ever-stricter emissions regulations will change the rules of the game. Complex and more ecological technologies will become competitive under these new circumstances. All types of waste energy and materials must be recovered, reused in the process or marketed in order to optimize the economics of the complete system. Together, these developments will open the door to new business opportunities, in particular in those areas that do not belong to the core business of steelmakers.

### Flexibility

In order to optimize business performance, customers will increasingly buy raw materials on the spot markets, including energy. Metallurgical plants will have to be capable of flexibly using a wide range of raw-material qualities (for example, ores rich in phosphorous, silicon or titanium) and energy sources (such as coal, gas and hydrogen) without adversely affecting performance or availability. Depending on the quality of steel being produced, especially in the case of widely used commodity steels, increasingly cheaper and lower-quality raw materials will be employed. The application of these materials in traditional processes will require new methods of treatment and preparation, or modified processes will have to be developed to cope with the poorer input material qualities.

Looking downstream, the operating ranges of many facilities will have to be considerably expanded to broaden the spectrum of steel grades produced or the range of product dimensions that can be manufactured on a given line. Additionally, producer's customers will expect significantly shorter response times and greater flexibility in the case of order changes. Fully integrated processes and steelworks logistics and higher-performance components – for example, thoroughly integrated mechatronic packages combined with optimized Level 2 process models – will help operators meet these challenges. >>

Finex plant at Posco Pohang Steelworks, Korea



Horizontal link of the Vaicon Compact Link converter suspension system

Noncontact temperature measurement of liquid steel in EAF with expanded RCB (Refining Combined Burner) application



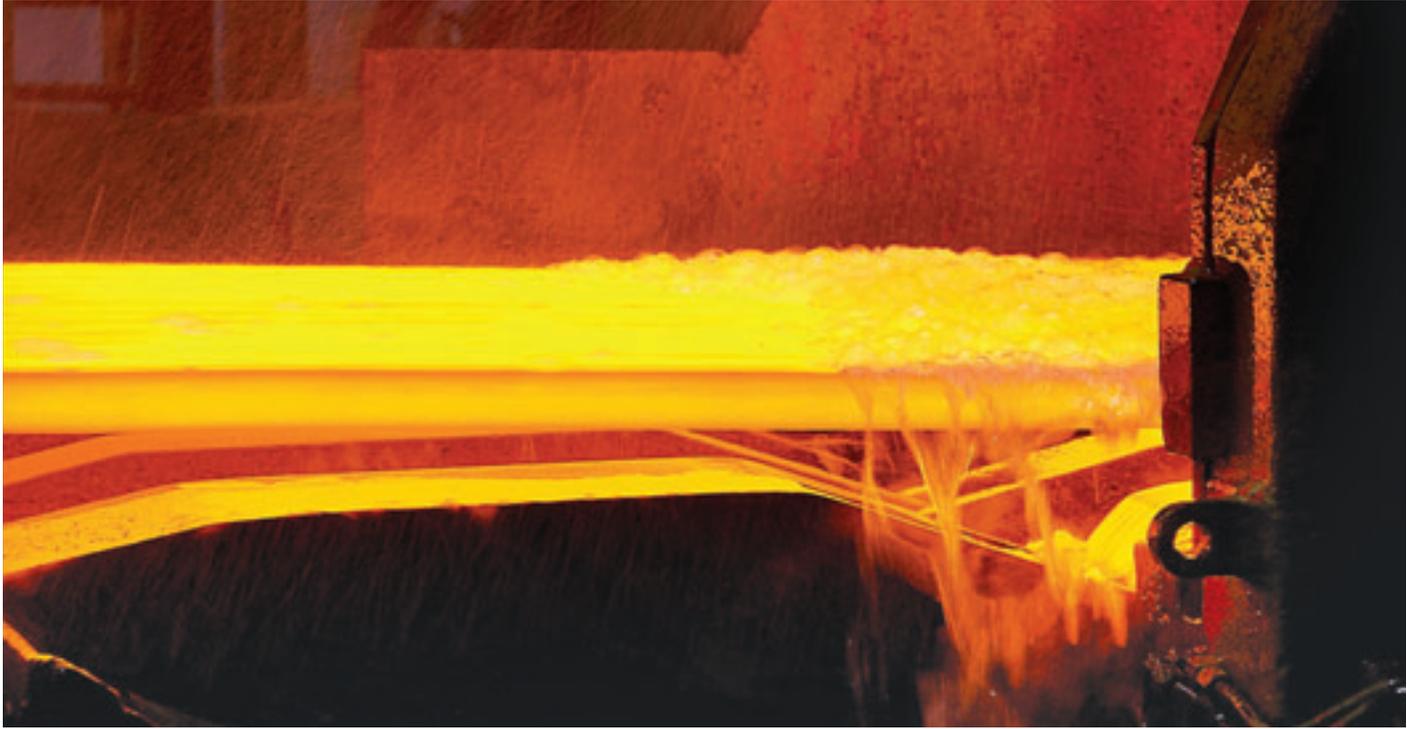
Tandem cold-rolling mill of voestalpine Stahl, Austria, incorporating Smart Crown roll technology and other innovations from Siemens VAI



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



Hot-strip mill at MittalSteel Poland equipped with numerous technological packages



Hot-strip mill at Jiangsu Shagang Group Co. Ltd., China

Hot-rolled coils at the hot-strip mill of Hadeed, Saudi Arabia

Siemens VAI is committed to providing decisive and long-term benefits for metals producers with trendsetting innovations.



- Responsibility
- Excellence
- Innovation

Along with the commitment to ethical and responsible actions and the pledge to achieve high performance and excellent results, innovation is the third pillar of the core values of Siemens VAI.



“I believe that one of the main reasons why our factories are flourishing is because most of the products they produce are based on our own inventions.”

Werner von Siemens – founder of the company that eventually became Siemens AG

## >> Performance

From today’s perspective, two developments in particular will help increase plant performance in the future:

- 1) Three-dimensional simulations (digital imaging) and optimization that will be used even for the most complex process steps in iron- and steelmaking. These tools will be employed throughout the entire life cycle of a plant such as during the proposal phase, for plant design and as a possible training simulator. It will therefore become possible to make a realistic assessment of the state or condition of a facility throughout its entire lifetime.
- 2) Comprehensive optimization involving the linking of process steps – such as in the Arvedi ESP process where casting and rolling processes are linked. This all-embracing optimization will also be introduced at the production-control level and extended even beyond company boundaries. Ideal performance in the iron and steel industry will not be attained until the entire value chain is optimized, from raw materials to the finished products. Customers’ processes and those of the suppliers must also be taken into account.

The above will take place simultaneously with a continuous increase in the degree of process automation. To avoid human error, and in many cases to increase safety, automation will be increasingly applied for mechanical and manual procedures, for instance, with the use of manipulators and robots. In parallel, full automation in the form of more complex and closely linked Level 2 online models in combination with a new generation of three-dimensional sensors will bring us closer to the goal of no-man operation.

## Innovation strategy: setting the trends

To maintain its leading technological position for the next 20 years and beyond, Siemens VAI has adopted a trendsetting strategy that includes the best of two innovation strategies: the “first-mover strategy” (The early bird catches the worm) and the “fast-follower strategy” (The second mouse gets the cheese). These strategies mean that we need to recognize and understand the relevant trends and to be familiar with customer needs. This knowledge is necessary to decide which trends are the most important and where investments should be made. Being a trendsetter does not mean merely following a trend; it also means actively influencing and steering a trend.

Most of the trends cited in the 20-year vision above are already the focus of R&D projects at Siemens VAI. Others will be addressed as soon as the required technologies are available and their economic application is foreseeable.

## Concluding remarks

Siemens VAI is committed to providing decisive and long-term benefits for metals producers with trendsetting innovations. The numerous examples of innovative technologies, processes and services that are presented in this issue of metals&mining show the central role that innovation has at Siemens VAI and, in particular, how our customers profit from our ideas. ■

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Producers benefit from the expertise of Siemens VAI as a full-line supplier of metallurgical plants

# The Right Investment Decision



Modernized converter steel mill at Nizhny Tagil Iron & Steel Works, Russia

COVER STORY >

During the past few years, Siemens VAI has conducted a number of plant investigations and studies with the aim to boost the productivity and competitiveness of a producer's steelworks. Thanks to its broad expertise in supplying integrated plants on a worldwide basis, Siemens VAI is in an ideal position to enhance the value-added production chain from ironmaking to rolled products. Customers are provided with expert consultancy services to determine which investment measures will lead to an optimum technological and economical solution in the long term. This article outlines two examples of consulting studies carried out for planned plant investments in new and existing steelworks.

**S**iemens VAI is a leading plant-engineering and construction company for the iron- and steel-making industry. The company is capable of supplying not only the complete mechanical equipment for metallurgical plants but also all systems and solutions for electrics and automation, environmental compatibility, media supply, drives, energy recovery, and the generation, transmission and distribution of power. For these reasons, numerous steel producers

have turned to Siemens VAI in connection with plant-wide modernization and optimization projects. Proposed solutions are based on detailed plant investigations and studies that are carried out by experienced engineers who work closely together with the customer. Existing production capacities, product portfolios and future extensions are taken into account. The integration of all technological, ecological, logistical, managerial and economical aspects are ad-

dressed in detailed technical specifications for the project phase. The subsequent modernization and optimization activities are implemented in such a way to minimize the downtime of ongoing production operations.

Several Russian and Ukrainian steel enterprises have recently emerged on the market with the vision to become multinational, integrated steel and mining groups. These companies are typically dedicated to profitable and sustainable production of high-quality products for local and international markets. As a consequence of rapid expansion through mergers and acquisitions, there is often the need to improve coordination between the group companies as well as the necessity to restructure and modernize. The consultancy services of a highly experienced plant builder are therefore called for to assist producers to make the right restructuring and investment decisions. The Evraz Group and Metinvest are two companies that requested the services of Siemens VAI to find optimized long-term solutions for planned investments in steelworks in Russia and the Ukraine.

Thanks to its broad expertise in supplying integrated plants, Siemens VAI is in an ideal position to provide expert consultancy services.

#### Evraz Group – striving for excellence

The Russian steel producer Nizhny Tagil Iron & Steel Works (NTMK), part of the Evraz Group S.A., is one of the country's largest, vertically integrated mining and steel companies. In late 2008, Evraz Group awarded Siemens VAI a contract for the preparation of a study for the construction of an additional steel mill at NTMK. Siemens VAI submitted 15 plant-configuration and production-output variants. In December 2009, the customer chose one of the proposed options that foresaw two project phases: At the conclusion of the first project phase the new mill will be capable of producing 1.7 million tons of steel per year. This will be followed by a subsequent plant extension to achieve an annual steel output of 3.4 million tons. When phase 2 of this project is completed, the total annual steel output of all steelmaking facilities at NTMK will be approximately 7.8 million tons. This new high-performance converter steelmaking plant will allow the remaining energy-intensive open-hearth, ingot-cast-

ing, blooming-mill production route to be shut down.

The Siemens VAI study addressed the integration of the new mill facility within the existing iron and steel complex at NTMK. Special attention was placed on optimizing the overall material flow and on selecting the ideal installation site for the new continuous casters in relationship to the existing rolling mills. The best locations of all new auxiliary plants were specified and provisions were made to ensure a reliable supply of water, gas, additives, etc., for both project phases.

It was recommended to equip the new converters with dry-dedusting systems and to enable CO-gas recovery. This would be the first installation of a CO-gas-recovery system in Russia and would be an important step towards reducing the energy consumption at the NTMK steelworks.

The generation of waste materials from the existing and new production line was carefully investigated. A recycling concept for ferrous waste materials was proposed. Vanadium-bearing dust and sludge – NTMK uses Kachkanar vanadium iron ore – would be processed and recycled separately from other wastes in order to improve the vanadium yield. Finally, a “zero-waste” steel production concept was introduced for the treatment and utilization of all other wastes from the steelworks.

The new production plants previously installed by Siemens VAI at NTMK have strengthened the company's reputation as supplier of high-quality steel products. Implementation of the proposed modernization and optimization activities will further contribute to improved profitability, energy efficiency and environmental compatibility. >>



Siemens VAI-supplied slab caster for Nizhny Tagil Iron & Steel Works

>> Profile of a successful cooperation

During the past 15 years, Nizhny Tagil Iron & Steel Works and Siemens VAI have jointly implemented a series of highly successful metallurgical plant projects. These include the supply of high-tech equipment for Blast Furnaces Nos. 5 und 6; replacement of four converters in the company's steel mill with new 160-ton-capacity converters to increase the steel output from 3.8 million t/a to 4.4 million t/a; and the modernization of outdated converter offgas-treatment systems. Furthermore, ladle-treatment furnaces, a single-strand slab caster and a two-strand beam-blank/bloom combi-caster have been installed. Siemens VAI is currently extending the combi-caster to enable four bloom strands to be cast simultaneously in order to meet increased market demands for rail steel.

Metinvest Group – focusing on the Master Plan

In mid-2007, Siemens VAI was commissioned by Metinvest Group to prepare a so-called Master Plan in connection with foreseen investments in three of the Group's Ukrainian steelworks: Makeevka Iron and Steel Works CJSC (in Makeevka), a producer of long products, including rebars, wire rod, angles and

rounds; Yenakievo Iron and Steel Works (in Yenakievo), a producer of billets, sections, structures and bars; and Azovstal Iron and Steel Works (in Mariupol), an integrated producer of plates, heavy sections and other long products. The general plant configuration of these steelworks can be seen in Figure 1. Several plant modernization variants were requested to take into account varying market requirements or changes in the Group structure. Accordingly, Siemens VAI prepared an "action portfolio" that elucidated the strategic objectives of Metinvest and the activities required to meet the objectives. The main activities included:

- Replacement of unfeasible production lines or individual plant sections with state-of-the-art facilities
- Harmonization of the capacity of individual plant sections
- Installation of new or the modernization of existing facilities to increase production capacity and improve product quality
- Installation of best available technologies (BAT) to minimize environmental emissions
- Evaluation of the consequences of the proposed investments on the existing infrastructure facilities
- Examination of the material flow and logistics, and the identification of bottlenecks and rectification measures in order to increase the avail-

COVER STORY >

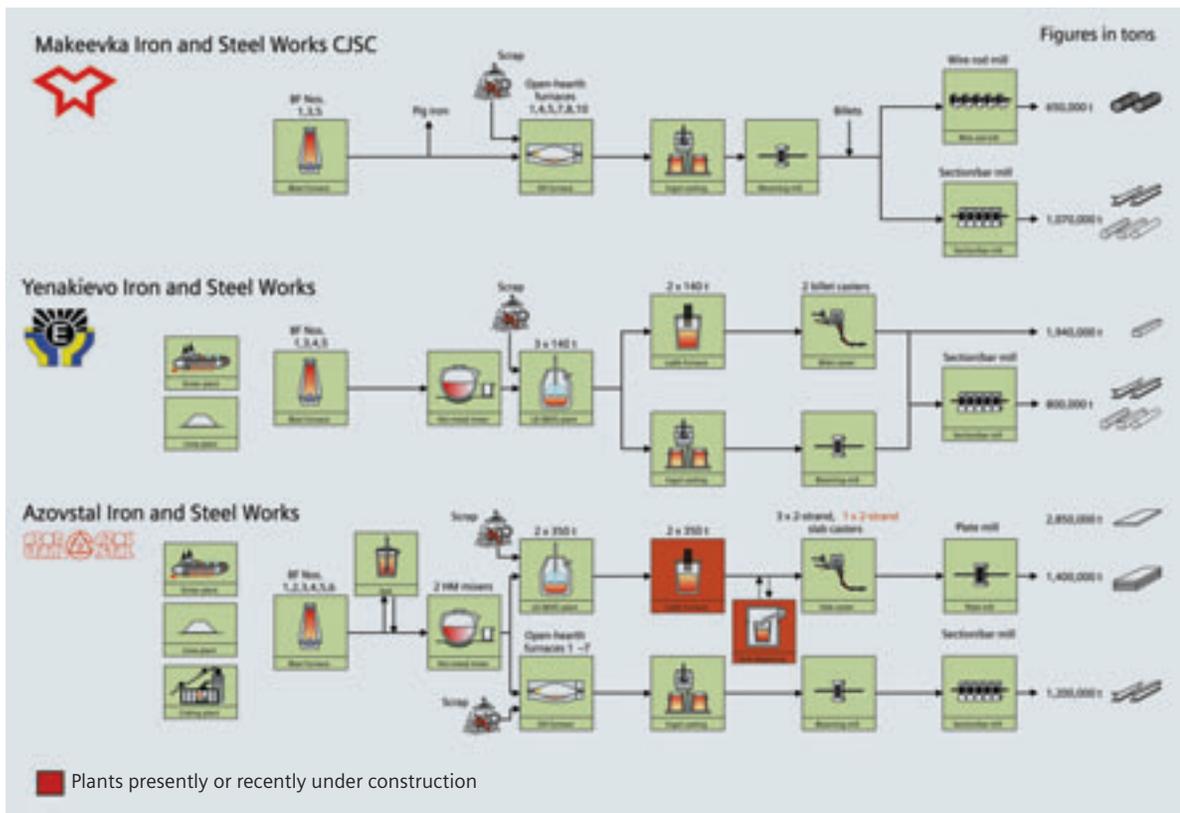


Fig. 1: General plant configuration of the Metinvest steelworks as of 2007

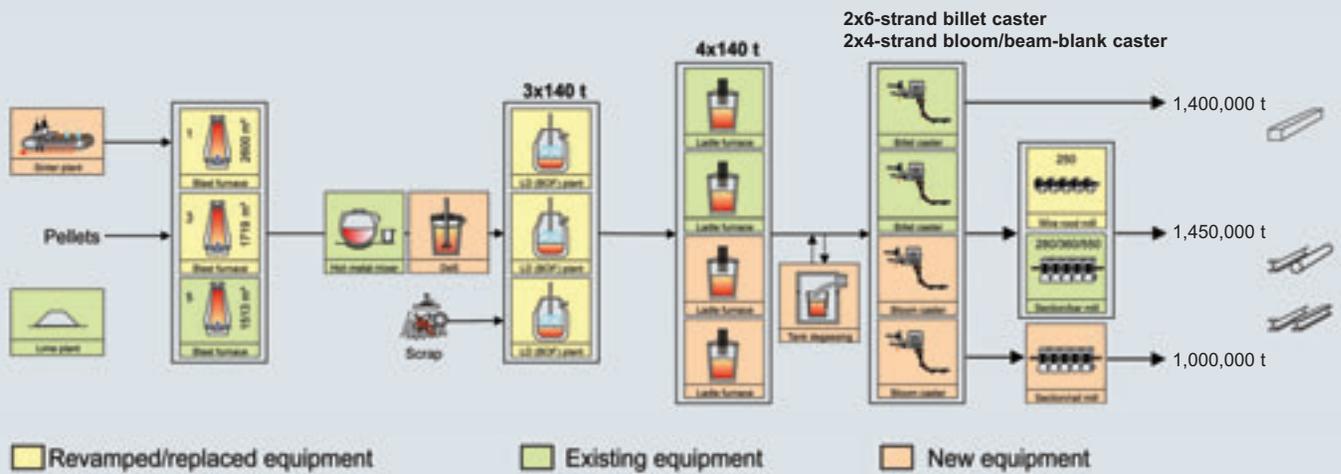


Fig. 2: Proposed new plant configuration for Yenakievo Iron and Steel Works, Ukraine

ability and productivity of the steelworks

- Technical advice for the production of new steel products
- Investigation of a possible interdependence between the individual steelworks and recommendations to optimize the raw-material supply and product mix
- Definition of benchmarking figures for productivity, production costs and energy consumption
- Improvement of overall energy efficiency

In the subsequent fact-finding missions, the existing production structure, the infrastructure, plant performance, equipment condition, etc. was analyzed in depth. For each steelworks location an investment plan was prepared that foresaw a completely new plant configuration and production structures. Details were specified related to plant design, consumption figures, manpower requirements, project-implementation schedules, capacity increases over the long term, scope of investments and required budgets, a waste-recycling concept and an integrated energy system. Benchmark figures were also cited for cost, productivity and energy efficiency.

The following main improvement steps were recommended for Yenakievo Iron and Steel Works (Figure 2):

- Replacement of existing sinter plant for economic and environmental reasons
- Reduction in the number of operating blast furnaces
- Installation of hot-metal desulfurization facilities
- Shut-down of open-hearth steelmaking plants
- Increase in the steel output to four million t/a
- Installation of CO-gas recovery systems
- Application of 100% continuous casting
- Construction of new medium (rail) section mill and upgrading of existing mills
- Installation of new integrated automation systems (Levels 1, 2 and 3)

At the Makeevka Iron and Steel Works it was clear from the beginning that the open-hearth steelmaking route had to be shut down. To enable Metinvest to

determine the optimum solution for its long-term strategic intentions, three new plant configurations were engineered and integrated within the overall steelworks environment. These plant variants feature an integrated plant setup for the production of long and/or flat products; application of 100% scrap- or scrap/hot-metal-based electric steelmaking for the production of billets or blooms; and decommissioning of the liquid-steel production phase with only onsite rolling of billets supplied from other Metinvest production sites.

At Azovstal Iron and Steel Works the open-hearth, ingot-blooming mill route was also to be shut down. Liquid steel would only be dedicated to the casting of slabs followed by rolling and processing to plates, hot strip and sheets.

Following the finalization and presentation of the Master Plan in March 2008, Metinvest and Siemens VAI signed an agreement for the continued support by Siemens VAI in connection with subsequent project planning, technical and organizational matters, and to implement specific technologies.

### Concluding remarks

Investments in metallurgical plants are not only expensive, the decisions made with respect to the production route, plant configuration, plant capacities, product mix and a host of other factors profoundly affect a steel producer's competitiveness and long-term viability. Expert advice from an experienced plant builder in the form of in-depth, on-site investigations, consultancy services and detailed studies is paramount for making the right investment decisions. ■

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Innovative financing solutions for metals and mining projects

# Expert Financial Engineering Too



Marcos Boskamp Alexandre, head of the export and project financing department at Siemens VAI

COVER STORY >

For investments in the metals and mining sector, financial risk protection is possible through private or state export credit schemes, conservative contractual provisions and creative financing solutions. Emerging countries such as Brazil, Russia, India and China are demanding overall project packages that include investment-specific financing. For these and other scenarios, the export and project financing department at Siemens VAI is ready to help.

**A**t Siemens VAI, an internal department for export and project financing integrated within the network of Siemens Financial Services (SFS) provides a solution for financing and risk management, and helps with customer negotiations when the focus is on structuring payment terms or financing. “We can offer a whole range of financing and export-risk protection instruments,” reports department head Marcos Boskamp Alexandre. “We always strive to find a financing instrument that meets the needs of all those involved in a project.” To reach that goal, Alexandre and his team take an in-depth look at how a project is processed, the timeline for implementation, how financing is ensured, and how the requirements of the export credit agencies such as Österreichische Kontrollbank (OeKB), Euler Hermes, etc., are met. In addition, the export and project financing department

helps with the preparation of Letters of Credit (L/C) and bonds in accordance with the contract.

These services are available from Siemens VAI to support sales and project execution worldwide for all customers who wish support or need to finance their projects. "It pays off that we work in close cooperation with our customers to develop creative solutions and that we have access to the strong, global Siemens Financial Services network," explains Alexandre. As a result, Siemens VAI can offer its customers global solutions.

"We always strive to find a financing instrument that meets the needs of all those involved in a project."

Marcos Boskamp Alexandre

To cite an example, Alexandre refers to the service and maintenance outsourcing project for the Thyssen-Krupp CSA (Companhia Siderúrgica do Atlântico) integrated steel works in Sepetiba, Brazil. The 15-year service contract covers maintenance of all electrical and mechanical systems involved in the production processes. "Complex financial engineering played a decisive role in lowering the customer's capital expenditure," says Alexandre. "With political risk backing by OeKB, the banking consortium took over the economic risk and the residual value of the investment. During the financial crisis we could find excellent banks and partners interested in participating, and we set up long-term financing and volume so the facilities were implemented exactly within the time schedule."

Another example is a hot-rolling mill project for Jindal Stainless Ltd., India's leading producer of stain-

less steel. Unlike many other projects where a governmental export credit agency was chosen to hedge risks, in this case the private insurance market in London insured production and payment risks (e.g., the non-opening of letters of credit and fair and unfair calling of the advance payment bond). The insurance coverage also extends to the local scope of the consortium partner Siemens India. The new 1,800 mm hot-rolling mill will produce 1.6 million tons of austenitic and ferritic stainless steel strip in the first stage as well as a small amount of heavy plate.

As a third example, Alexandre points to the construction of the steelworks LISCO 2 at Lianzhong Stainless Steel Corporation in Lianzhong, China. For this classical multi-sourcing project, Siemens VAI is delivering an electric arc furnace and AOD converter for the production of stainless steel as well as a ladle furnace and a continuous casting plant. Under the leadership of the OeKB, the foreign delivery packages were reinsured by Euler Hermes of Germany and SACE of Italy, which greatly simplified processing and financing of the entire project. "This is the first structured financing of a Taiwanese project in China that was ensured by export credit agencies," says Alexandre. A total of five parties from different countries with different legislation and cultures were involved in the financing, which added to the complexity of the project.

"Financial engineering played a decisive role in lowering the customer's capital expenditure."

Marcos Boskamp Alexandre

Siemens has filed an application with the German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin) for a license to conduct banking business. The authorities have already approved the application. With the help of a licensed credit institution, Siemens aims to expand the product portfolio of its financial services unit, particularly in the sales finance area, to add flexibility to Group financing and to optimize its risk management. ■

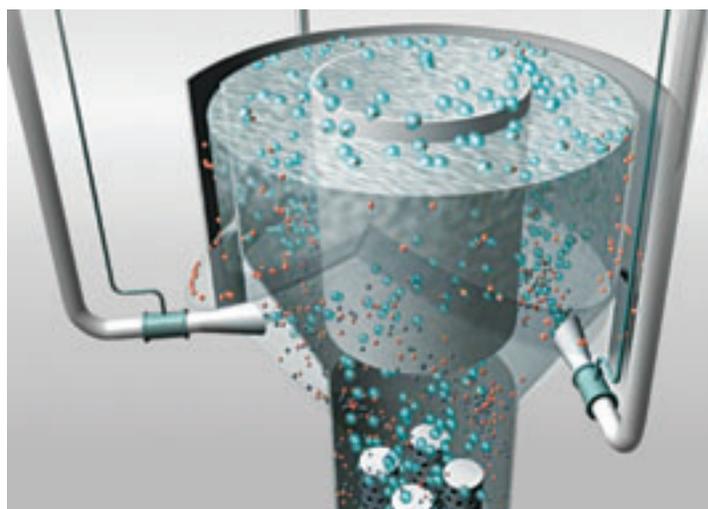
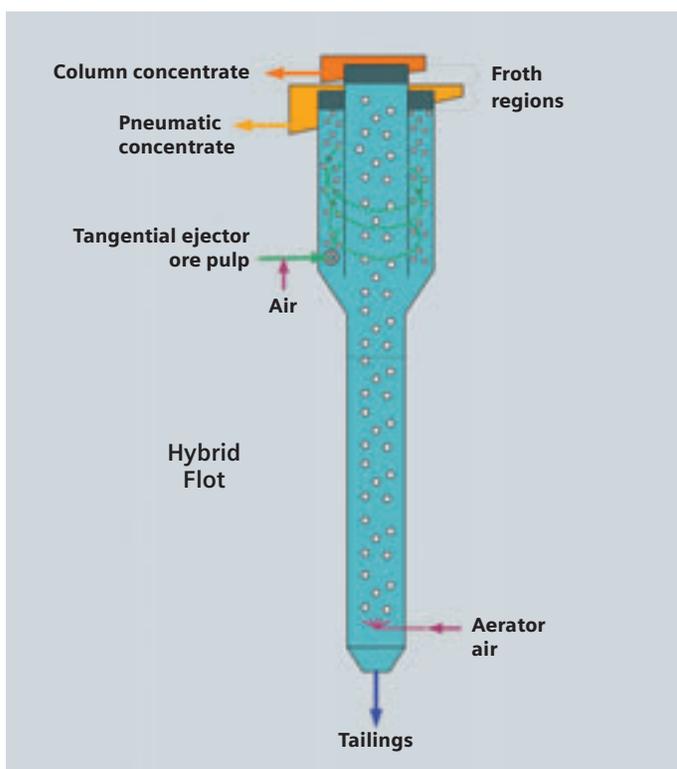
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Simine Laboratory Hybrid Flotation Cell for testing flotation behavior

# The Same in Small

Today's challenges in processing low-grade ores require a rethink of conventional methods and investment in more creative and cost-effective approaches to flotation cells. The Simine Hybrid Flot technology combines a pneumatic spray-in principle with a column method. This process results in a higher concentration of valuable minerals in the generated froth product. A new addition to the 2 m<sup>3</sup> and 16 m<sup>3</sup> tanks is the 0.03 m<sup>3</sup> laboratory cell; with this small cell, operators can perform a quick and versatile evaluation of flotation processes for different ores and flotation chemical recipes.

MINING ^



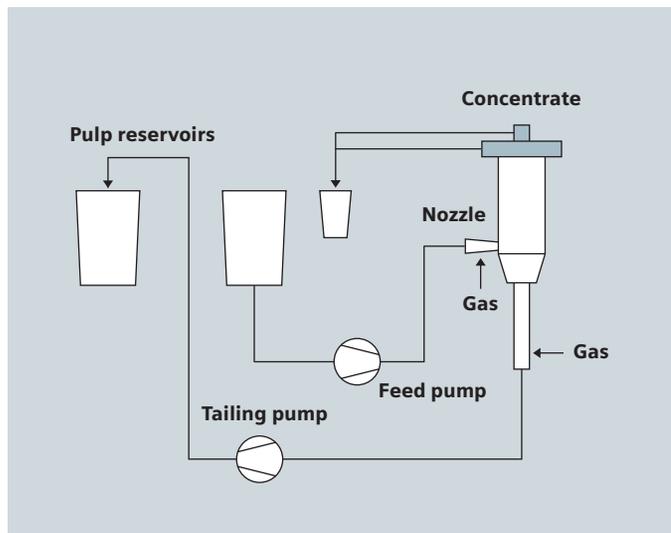
Simine Hybrid Flot technology is adaptable for base metals, precious metals and even industrial minerals

**T**he flotation process is the heart of many mines, and it determines the profitability of the mine. During the beneficiation process, valuable materials in raw ore are separated using gas bubbles. By adding collectors, sulfide ore particles are selectively hydrophobized, and these particles are much more likely to attach to the gas bubbles.

The Simine Hybrid Flot technology combines a pneumatic spray-in principle with a column method. The pneumatic component creates very small gas bubbles and inserts high kinetic energy. Feed pulp and gas are mixed inside the mixing chambers of the ejector system before being sprayed into the cell. This results in the increased recovery of fine particles. The



The 0.03 m<sup>3</sup> Laboratory Hybrid Flotation Cell



Schematic diagram of the technology

column system creates bigger bubbles combined with lower kinetic energy insertion to capture coarser particles. An agitator apparatus as used in conventional cells is not required. The froth produced flows over the edge of the flotation tank and drains off. The short retention times of the pulp in the machine and additional launders reduce the risk of losing the particles already captured. This process results in a higher concentration of valuable minerals in the generated froth product.

Simine Hybrid Flot technology is adaptable for base metals such as copper, molybdenum, nickel and zinc; precious metals such as platinum, gold and silver; and even for industrial minerals. The Hybrid Flot flotation cell operates with a significantly reduced power requirement compared with conventional systems. Gas and water demands are also significantly reduced.

#### Application of Simine Hybrid Flot

At the Chilean Minera Los Pelambres mine, the Simine Hybrid Flot cell showed in a selective copper-molybdenum process an increase of molybdenum recovery of more than 2% of the total process. The recovery increase is shown especially in the fine particle fractions (particle sizes smaller than 10 µm), but also in coarser particle size fractions (greater than 75 µm). The molybdenum concentration could be enriched from a typical concentration in the molybdenum plant in the feed pulp by close to 40% in the concentrate product of the Siemens cell.

#### Quick evaluation for different ores and new recipes

In addition to the 2 m<sup>3</sup> and 16 m<sup>3</sup> cells for production, Siemens developed the 0.03 m<sup>3</sup> Laboratory Hybrid

## Improvements in the flotation process result in increased profits and more efficient use of natural resources

Flotation Cell. Due to the natural variability of ores, it is very often necessary to test flotation behavior to elaborate the decisive parameters for flotation circuit design and optimization. The new laboratory cell is integrated into a continuous, closed-cycle flotation circuit where all fluid flows are recycled in order to minimize the circling amount of ore and chemicals in a single test. However, it can also be used in an open-circuit continuous or batch mode, if required. Hence, this cell is particularly well suited for a quick and versatile evaluation of flotation processes for different ores and flotation chemical recipes. The Laboratory Hybrid-Flotation Cell can also be used as an additional flotation module and can be integrated into existing continuous flotation circuits if required during test-work projects. ■

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The 26-foot ball mill of Minera Los Pelambres in Chile with gearless drive systems from Siemens. Simine services are geared to specific maintenance- and production-related processes

Simine Services – life-cycle support for mining

# The Key to Sustainable Success

On the one hand, maintenance of mining machines and systems is a sizable cost factor. On the other hand, the costs incurred by unscheduled downtimes can significantly reduce the profitability of an entire mining company. The goal: minimize risks while keeping expenditures as low as possible. The answer: Simine Services as the key to reliable operation and maximum protection against equipment failure. The Simine maintenance strategy is tailored for each mining company and for the individual mining processes, and covers the life cycle of the entire plant.

**T**wo years ago Simine Services became an integral part of the mining group within Siemens. The main driver for this decision was to improve the life-cycle support for the mining business. As a globally operating service provider, Siemens supports the mining industry with a unique combination of industry-specific experience and mechanical and electrical engineering know-how. This competence, together with a wide portfolio of customizable solutions, enables Siemens to ensure optimum operation of mining plants and equipment, even under difficult conditions. Simine Services covers numerous technical functions for every phase of operation, from rapid provision of necessary maintenance and operating materials right up to comprehensive life-cycle management.

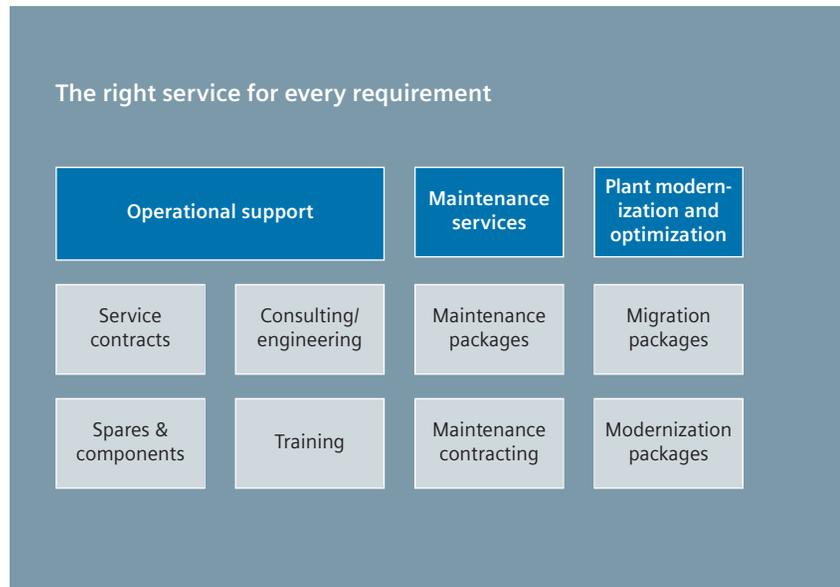
Siemens is represented globally at 250 locations in over 190 countries. More than 40 of these locations offer Simine Services to assist the mining industry with all service, maintenance and modernization assignments. To be even closer to the mining companies, Siemens has recently opened new service centers in Calama, Chile; Arequipa, Peru; Monterrey and Zacatecas, Mexico; and Belo Horizonte, Brazil. Additional service centers in India and Russia will be established within the year.

Simine Services provides optimum support for all maintenance work. Various services can be individually combined to meet the requirements of the specific mining plant. The offering begins with operational support and maintenance services and ends with plant modernization and optimization.

## More than 40 Siemens locations offer Simine Services to assist the mining industry with all service, maintenance and modernization assignments.

### Service contracts to minimize downtime of technical faults

A core element of a service agreement is the development of effective maintenance programs and the implementation of preventive maintenance measures – all established jointly with the customer to provide reliable protection against faults and equipment failures. Our service technicians and engi-



neers have practical experience combined with in-depth technical expertise in automation and drive technology, measurement and control technology, process and production control systems, and energy technology.

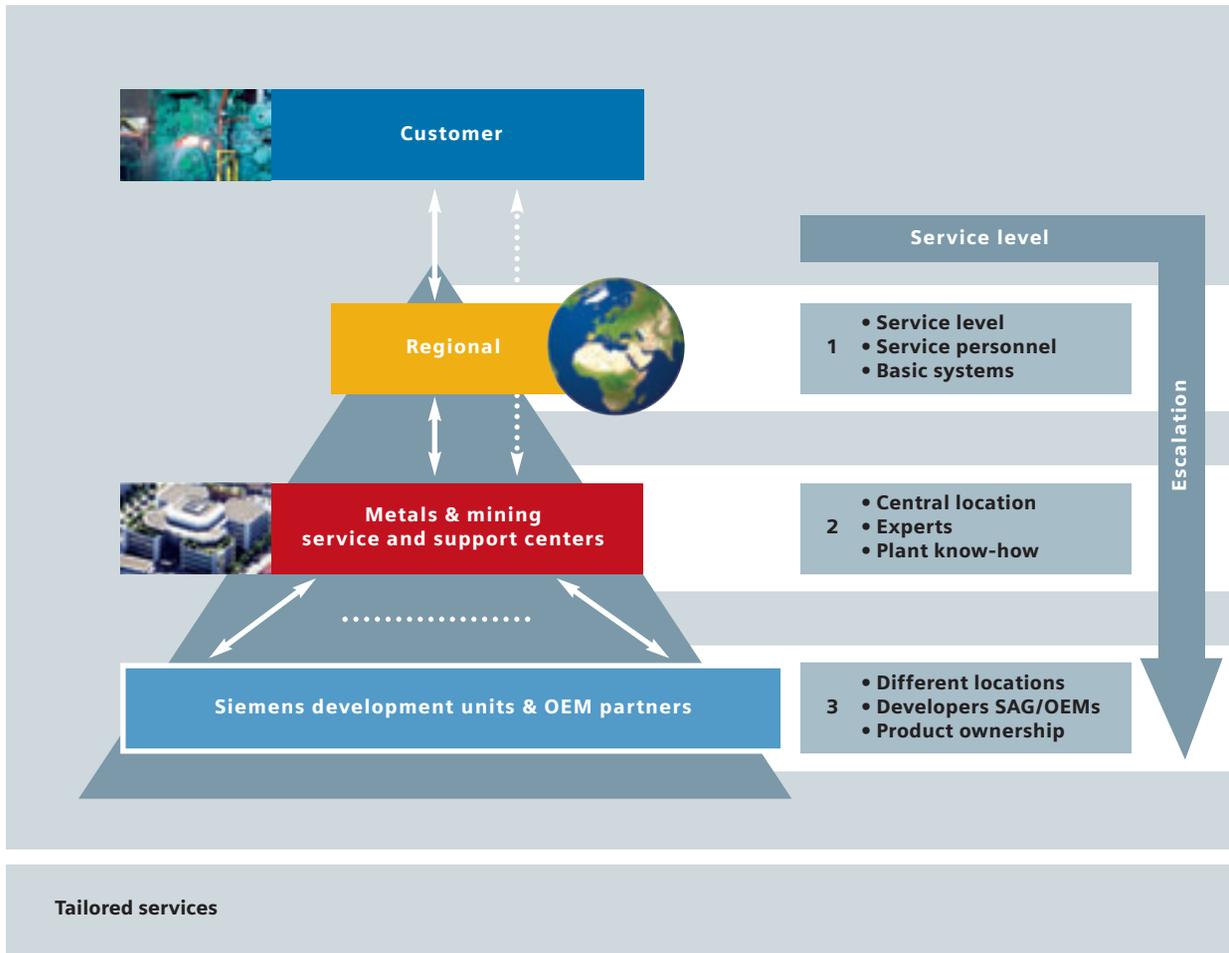
In the case of faults, the service technicians and engineers ensure that errors in electrical systems are cleared quickly and reliably on site. A rapid reaction is guaranteed by a 24/7 service hotline. Individualized agreements relating to technical specifications and response times ensure that problems are resolved quickly and directly. Remote monitoring of mining systems and equipment, such as teleservice for electrotechnical components, is also available. This allows technical problems to be identified and corrected even faster, and faults can be avoided from the outset.

Service contract references for customers with mine winder and gearless mill drives include the Süd-Westdeutsche Salzwerke AG in Germany; Somincor in Portugal; Iberpotash in Spain; Olympic Dam, Cowal and Cadia in Australia; Minera San Cristobal in Bolivia; Lumwana Mining Company in Zambia; Rio Paracatu Mine in Brazil; and Penasquito (Goldcorp) in Mexico.

### Material and spare-parts supply

We assure the availability of required materials and spare parts at a reasonable cost – for everything from inventory and process analysis to optimization of purchasing processes. Our offering also extends to the ordering of materials. We carry out any repairs in our certified services centers or in cooperation with the manufacturer.





>> **Consulting and engineering**

In the framework of a plant performance audit, we analyze the condition of plants and processes. Our engineers also identify bottlenecks in the production process and develop suitable countermeasures. Furthermore, on the basis of process parameters we examine the degree of automation in the production process as a whole in order to find possible ways to increase yield through optimized control loops and fewer manual operations. Based on an investigation of the plant's entire energy consumption, engineers make suggestions to boost energy efficiency and reduce consumption peaks.

**Training**

Qualification of the customer's own employees is a key task. Simine Services offers comprehensive training courses in the areas of technology, equipment, operation, management and maintenance.

**Maintenance services**

Simine Services maintenance packages cover defined maintenance activities with a guaranteed life-cycle

performance for electrical systems, drives and automation, switchgears and motor management, as well as ready-to-use solutions for the management of secondary processes and general overhauls.

**Maintenance contracts**

For those companies that outsource plant maintenance, Siemens offers a win-win partnership. Apart from carrying out scheduled proactive and preventive maintenance, daily maintenance work, repairs and special assignments during general overhauls, we can also take over maintenance management. Together with the customer we define the performance metrics such as plant reliability and availability as well as actual performance figures for the plant or machinery in question.

This data is laid down in a success-related contract. On the basis of these metrics it is possible to establish key performance indicators. According to your requirements we perform maintenance either for complete plant sections or for individual components and systems such as conveyor systems, electric motors and power-supply systems.

Maintenance contract references include Minera Los Pelambres and Radomiro Tomic Mine (Codelco), both in Chile; Vattenfall Europe Mining AG in Germany; and Minera Peñasquito in Mexico.

### Plant modernization and optimization

With our mining-specific and standardized modernization solutions, we replace the systems used in machines and equipment with state-of-the-art solutions that ensure the overall availability and reliability of production. The investment generally pays off after a short time through increased availability, improved production quality and reduced maintenance requirements. In addition, our modernization activities usually target the main electrical and mechanical parts of the installation. By doing so, the downtime needed for modernization is reduced to an absolute minimum.

Our comprehensive range of modernization solutions for mining covers complete large-scale solutions, the modernization of Simine parts, and mining equipment from other suppliers.

## Faster, better, more productive – Simine modernization measures pay off.

### Newly developed modernization solution for mills

Siemens developed new modernization packages to improve the life cycle and availability of Simine Mill GD installations. Along with bringing the automation system up to the latest version of Simatic S7 and Simatic PCS7, the new modernization solution for gearless or twin-pinion mills also includes a newly developed retrofit solution for the drives control system. This solution makes it possible to replace analogue or early digital drive control systems like Simadyn C/D without the having to replace the motor, transformers or even the power section of the existing cycloconverter. Together with new diagnostics and remote-service features, the modernization solution helps increase reliability and availability of the plant while reducing necessary maintenance.

Only a short shutdown of less than ten days was needed to implement the highly standardized modernization solution at the SAG mill of Codelco Andina in Chile. During the modernization in March 2010, Siemens migrated the control system of the mill into Simatic S7 and Simatic PCS7. Another reference project is the migration of an early version of the digi-



Servicemen at work

tal drive-control system Simadyn D at the Robinson open-pit copper mine in Nevada. The twin-pinion drive of the SAG mill is equipped with a new control system based on Simatic S7 and a new drive-control system based on Sinamics. ■

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Pumas – improved productivity and safety in cokemaking

# The Coke-Oven Watchcat

Progress of the pusher ram during coke pushing from a coke oven

A new camera-based coke-oven monitoring system originally developed by Finnish steel producer Ruukki (Rautaruukki Oyj) and a technology partner was first implemented at the coke-oven plant of Ruukki's Raahe Steel Works. This innovative solution, referred to as Pumas (PUshing MAManagement System), contributes to improved productivity and safety in cokemaking. Various coke-oven criteria and parameters are measured, examined and documented during the coke-oven pushing sequence. The system incorporates an optimized battery-machine positioning and interlocking system from Siemens VAI, which now offers Pumas technology on a worldwide basis.

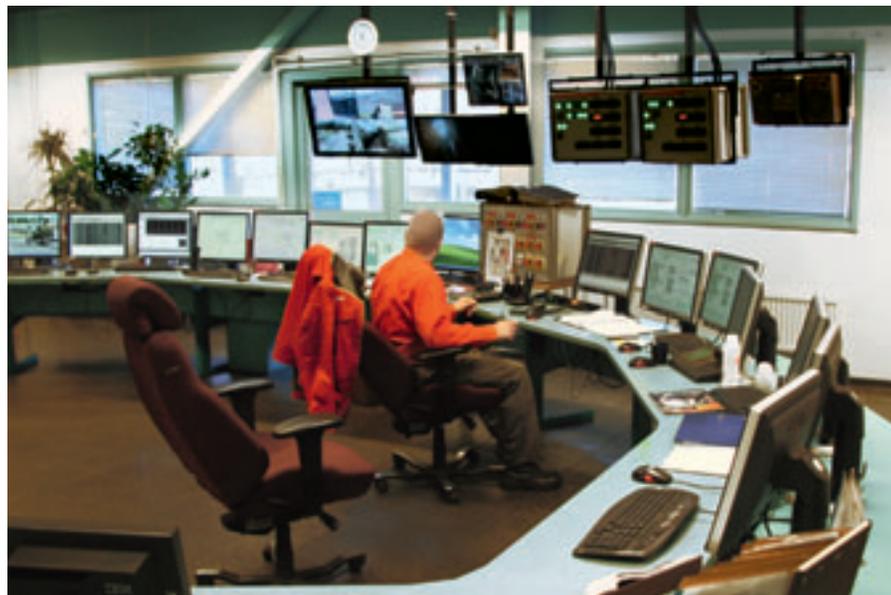
**D**uring the cokemaking process, coking coal is heated in the absence of oxygen at temperatures typically ranging from 1,000°C to 1,300°C for 15 to 30 hours to remove volatile components. A high-quality coke product is thereby generated that satisfies the chemical, energetic and physical properties required for use in a blast furnace. Cokemaking takes place in gas-fired coke-oven batteries comprising 30–100 individual ovens per battery. The ovens are exposed to enormous thermal and mechanical wear and require regular monitoring and maintenance to ensure high productivity, long service life and an optimized product quality. Visual inspections of the inner oven conditions are typically carried out by operators during coke pushing when the coke-oven doors are open. However, this activity, which is not usually performed on a regular basis, is subject to an operator's experience and interpretation, and involves working in an unsafe and harsh environment. The Pumas system was therefore developed to counter these problems as well as to improve the accuracy and reliability of coke-oven monitoring.

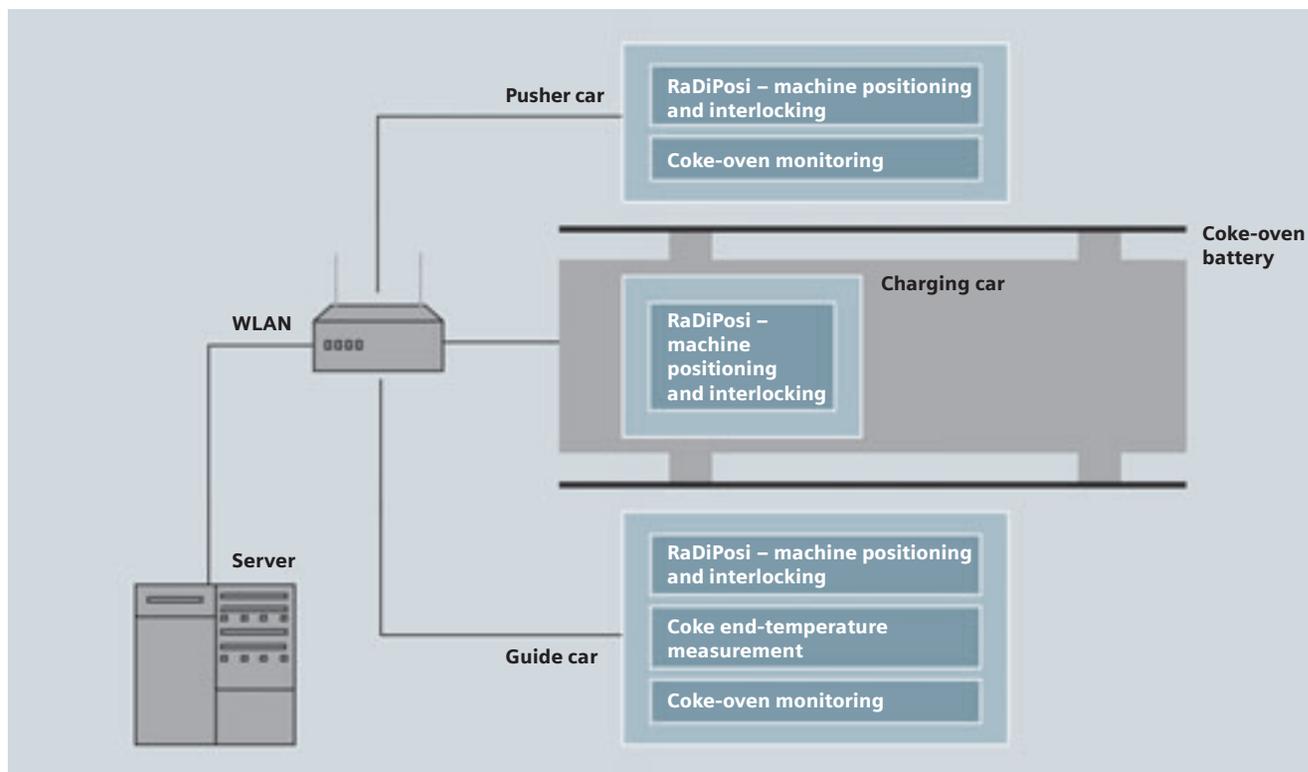
### Seeing is believing

During the pushing of hot coke from the oven, important data should be registered without interrupting the charging and pushing schedules of coke production. With the use of specially developed video cameras mounted on the coke guide car and pusher, Pumas remotely inspects the inner condition of an oven during the coke-pushing sequence. Continuous coke-temperature measurements are simultaneously carried out as an indication of the efficiency of wall heating and heat transfer to the coke. Data transfer to a server takes place via a high-capacity and fast WLAN, which allows operators to systematically evaluate coke-oven conditions online from the safety and convenience of the control room. It is thus no longer necessary for operating personnel to manually inspect coke ovens in a hot and dangerous area when the oven doors are open. Selected photos and videos are stored in a database for reference as well as to improve evaluation and interpretation skills. Data monitored by Pumas relates to the following:

- Brickwork conditions of oven walls and sole
- Degree and location of oven-wall graphitization >>

**Cokemaking control room at Ruukki, Raahe Steel Works, Finland**





Basic functionality of the Pumas system

- >> • Degree of oven filling
- Profile of coke-cake level
- Coking status
- Status of oven-gas space
- Abnormal pushing- and pulling-force trends

With the Pumas system, badly worn oven soles can be identified and repaired before potential coke-oven damage can occur. Maintenance intervals can also be better defined and coordinated. These steps lead to an improved heat transfer to the coking coal, notable heat-energy savings, reduced electrical energy requirements for coke pushing, increased oven productivity and prolonged battery service life.

Pumas not only performs dependable coke-oven monitoring, it also features the state-of-the-art Radio Digital Positioning System (RaDiPosi) control system from Siemens VAI. This well-proven Level 1 application ensures fast, reliable and accurate positioning and interlocking of mobile coke-oven machines such as the pusher car, charging car, coke guide car and quenching car. Smooth and disturbance-free operation of the coke-oven machines is a key factor for efficient and economical cokemaking operations.

#### Pumas in action

First-generation system elements of Pumas were installed in Ruukki's Raahe plant in 2009 and continuous

improvements have been carried out since that time. A total of 70 coke ovens in two battery sets is carefully monitored by the system, which has been continuously operating since that time. According to Timo Vierimaa, Raahe's coke-oven plant manager, "We are very satisfied with the reliability and results achieved with Pumas since its installation. This monitoring system has made our maintenance work easier, especially for locating and removing harmful graphite formations in some of the ovens. As a result, we have increased the productivity, operational reliability and lifetime of our coke-oven batteries while improving safety conditions for our battery-machine operators."

#### Outlook

Emphasis is increasingly being placed on operational safety and production efficiency in the industry, which calls for new solutions. Pumas helps increase productivity, the lifetime of coke-oven batteries, and considerably enhances personnel safety. These benefits have been proven by the highly successful application of Pumas technology at Ruukki's Raahe Steel Works in Finland. ■

#### Authors

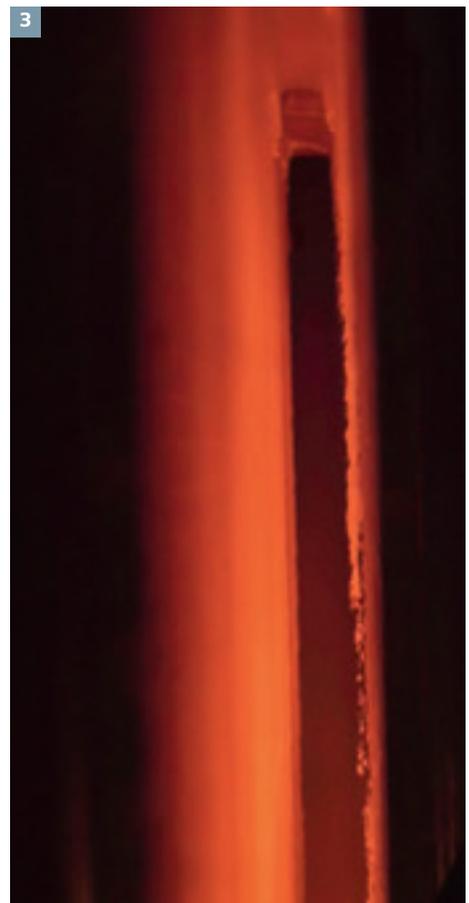
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“We are very satisfied with the reliability and results achieved with Pumas since its installation.”

Timo Vierimaa, coke-oven plant manager at Ruukki



- 1 Pushing of coke into the quenching car
- 2 View of coking chamber prior to pushing
- 3 State of the coke-oven chamber after coke pushing (normal graphite accumulations can be seen at top of the coke oven)

Start-up and one year of operation of a highly innovative sinter plant

# Baptism by Fire

As part of a major program to expand its portfolio of long products to also include high-quality flat products, Dragon Steel Corporation decided to build a completely new greenfield steelmaking complex in the harbor area of Taichung. For Phase 1 of this major investment program, which was completed in the first half of 2010, Siemens VAI supplied the sinter plant; a blast furnace with a diameter of 12 m and an inner volume exceeding 3,200 m<sup>3</sup>; and two 2-strand slab casters. This article focuses on the design features and operational results of the sintering plant.

IRONMAKING >



Discharging of sinter  
from the sinter strand

Following three and a half years of intensive planning, engineering and installation work, the new Sinter Plant No. 1 at Dragon Steel Corporation – a subsidiary company of China Steel Corporation, the largest steel producer in Taiwan – was finally ready for its baptism by fire. In the early morning hours of December 7, 2009, Karl Czermak, Siemens VAI commissioning manager, gave the signal to start the preheating of the ignition furnace. The heat slowly ascended through the furnace chamber, drying out and warming the refractories to operational temperature. Two days later, when all process and operational preconditions were met, the order was given to start with the charging of the sinter raw mix onto the sinter strand and to ignite the furnace. “Tension was high,” recalls Stefan Hötzing, head of the sinter technology department at Siemens VAI. “The start-up of the entire steel plant depended on the sinter plant and the quantity and quality of the sinter product.” At temperatures in excess of 900°C, a mixture of fine iron ore, additives and coke burned intensively. A coarse, agglomerated iron-ore product was formed, exactly as required by the blast furnace. “When we saw that the plant operated as designed, we were all relieved and proud to have been part of this challenging project,” said Hötzing.

“Tension was high. The start-up of the entire steel plant depended on the sinter plant.”

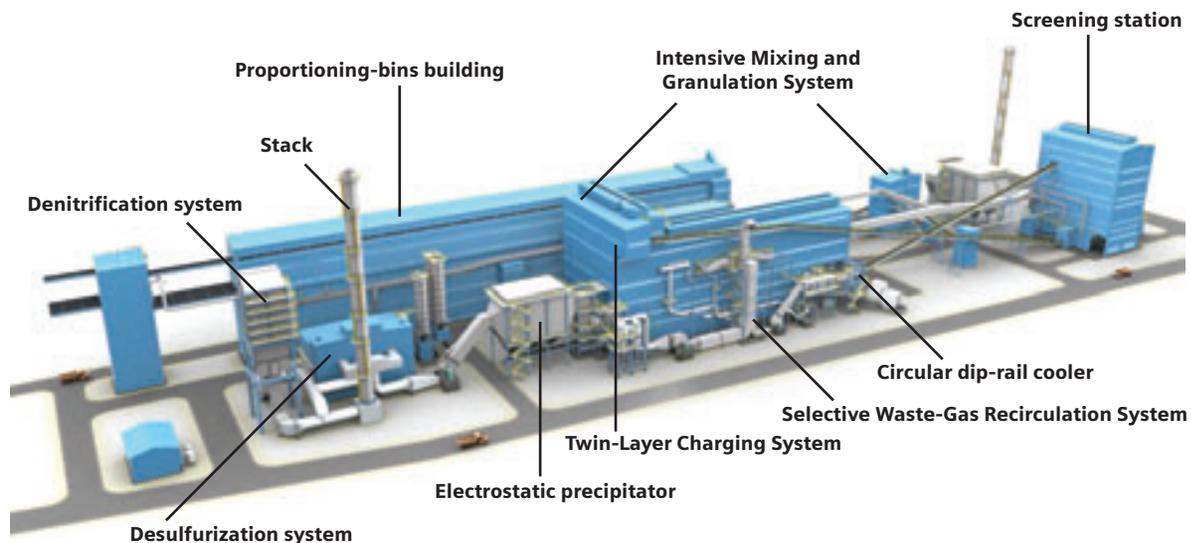
Stefan Hötzing, head of the sinter technology department at Siemens VAI



General view of Sinter Plant No. 1

#### Overview of special design features

Sinter Plant No. 1 at Dragon Steel, supplied by Siemens VAI in cooperation with consortium partner CTCI Machinery Corporation, is designed with a suction area of 248 m<sup>2</sup> and a nominal production capacity of 7,440 tons of sinter per day. The plant incorporates the latest sintering technologies and technological packages from Siemens VAI to ensure a high and constant sinter quality, low operating costs and minimum environmental impact. Examples include the Intensive Mixing and Granulation System; the Twin-Layer Charging System; the Selective Waste-Gas Recirculation System to reduce the volume of sinter waste gas and pollutants released to the environment; integrated desulfurization, denitrification and dioxin-removal facilities; a circular dip-rail sinter cooler with a >>



Schematic diagram of Sinter Plant No. 1

>> number of unique design features, including offgas recovery; and the Sinter VAiron process-optimization system. With a footprint of only 43,020 m<sup>2</sup> (478 x 90 m), the sinter plant is one of the narrowest facilities of its type in the world. Table 1 lists the main technical features of the sinter plant.

## The sinter plant is one of the narrowest facilities of its type in the world.

### Sinter raw-mix homogeneity and agglomeration

At Dragon Steel the materials used for the mixing and preparation of the sinter raw mix are stored in a total of 26 bins (16 for iron ores and revert materials, 4 for fluxes, 2 for coke breeze, 2 for dust, 1 for burnt lime, 1 for in-plant return fines) with storage volumes up to 380 m<sup>3</sup>. This setup provides a high degree of flexibility with respect to the selection of materials and charging ratios during ongoing operations. The raw-mix recipe and the ratios of the various materials extracted from the bins are controlled by dosing belt scales with accuracies of  $\pm 0.5\%$  of the set feed rate. The material is deposited in layers onto a conveyor belt and then transported to the mixing station.

**Table 1: Main technical features of Sinter Plant No. 1**

Plant data	
Sinter-plant area	478.5 x 90.5 m $\approx$ 40,000 m <sup>2</sup>
Start-up	December 7, 2009
Suction area	248 m <sup>2</sup>
Width	4.5 m
Length	55 m
Bed height	700 mm
Suction pressure	-1,650 mm WC
Sinter cooler	264 m <sup>2</sup> (effective cooling area)
Diameter	22 m
Width	4.5 m
Bed height	1.5 m
Offgas volume to stack	$\sim$ 400,000 Nm <sup>3</sup> /h
Recirculation-gas volume	$\sim$ 260,000 Nm <sup>3</sup> /h
Hot air from cooler	$\sim$ 100,000 Nm <sup>3</sup> /h
Mixing & granulation	High-intensive mixer and granulation drum
Screening & crushing	Scalping screen, roller crusher, hearth layer and return fines screen (+ standby line)
DeSO <sub>x</sub>	Coated bag filter process operating with hydrated lime
DeNO <sub>x</sub>	Dual-functional catalyst process operating with ammonia

To eliminate the need for blending beds as well as to reduce the investment costs for preparing an optimum sinter raw mix, Siemens VAI installed the Intensive Mixing and Granulation System. This highly compact system consists of an intensive mixer (Eirich vertical shaft-type mixer) and a granulation drum. With its high-speed mixing tools and rotating shell, the intensive mixer creates a very homogenous raw mix. The raw mix is then transferred to the granulation drum, where it is agglomerated using hydrated lime prior to charging onto the sinter strand. In order to reduce the number of transfer points, the granulation drum is mounted directly on top of the sinter-charging system.

Installation of the Intensive Mixing and Granulation System meant that blending yards were not necessary at Dragon Steel – a major benefit for the company considering the limited available space in the harbor area of Taichung.

### Twin-Layer Charging System – improved porosity

High permeability of the sinter bed is a decisive factor for ensuring high sinter-plant productivity. Siemens VAI developed a simple yet elegant solution to improve the porosity of the sinter bed by taking advantage of the natural size segregation of the raw materials in the charging hopper. In the Twin-Layer Charging System the raw mix is deposited onto the sinter strand in two separate layers with different size fractions. The first coarser layer (approximately half of the total raw-mix volume) is fed directly onto the sinter strand. The second layer, which includes an increased portion of the solid-fuel content, is charged onto the first layer by means of a conventional drum-feeder system.

The Twin-Layer Charging System was installed for the first time worldwide at Dragon Steel. In comparison with conventional charging systems, this solution increases the permeability of the sinter bed, results in a greater fuel efficiency, and allows a more intensive and uniform ignition of the sinter layer.

## The Twin-Layer Charging System was installed for the first time worldwide at Dragon Steel.

### Selective Waste-Gas Recirculation

The Selective Waste-Gas Recirculation System was implemented at Dragon Steel in which approximately 30% to 40% of the sinter offgas is recirculated back to the process. Contrary to other offgas recirculation

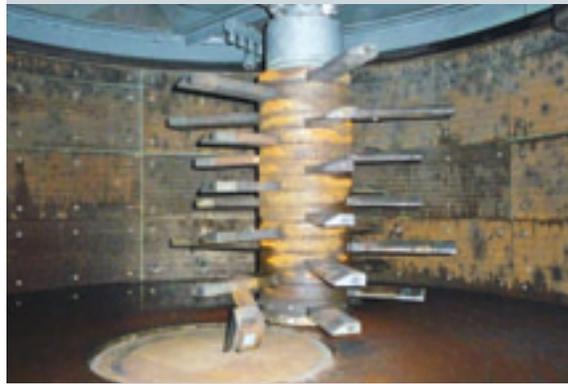
systems in which a portion of the total offgas quantity is recirculated back to the process (with a relatively low mean temperature and CO content), in the Siemens VAI solution only the offgas from selected wind boxes is recirculated to the sinter strand. At Dragon Steel the wind boxes designated for offgas recirculation were chosen primarily on the basis of the heat, CO and O<sub>2</sub> contents of the offgas. The heat and CO content of the recirculated waste gas help reduce solid-fuel consumption. In addition to the positive impact on the sintering operations, the offgas volume directed to the stack is also lowered. This means that the dimensions of the downstream offgas-cleaning facilities could be reduced, leading to a decrease in the related installation and operational costs. For more information on the operational and environmental benefits offered by the Selective Waste-Gas Recirculation System, please see *metals&mining* 3|2009, pages 36–37.

#### Environmental-protection systems

A sinter plant is one of the largest sources of emissions in a steelworks. Thanks to the installation of advanced environmental-protection systems, the sinter plant at Dragon Steel is a notable exception. The sinter waste gas flowing to the stack is first dedusted in an electrostatic precipitator, followed by the injection of hydrated lime into the waste-gas stream to bind the SO<sub>x</sub> compounds. The gas is further cleaned in a flat bag filter where the concentrations of dust and SO<sub>x</sub> are brought down to the required levels. In a subsequent catalytic NO<sub>x</sub> and dioxin-removal system, NO<sub>x</sub> compounds are reduced to nitrogen and water using ammonia (NH<sub>3</sub>) as a reducing agent. Furthermore, dioxin is decomposed to carbon dioxide, water and hydrogen chloride. The sinter plant at Dragon Steel is exemplary with respect to its unique assembly of environmental-protection systems and low emission values.

#### Cooler and off-air recovery

The hot sinter is cooled in a circular dip-rail cooler. A special mechanical construction of the cooler charging chute ensures optimum particle-size distribution within the cooler bed. Coarser sinter pieces are first deposited at the bottom of the cooler bed where there is a greater abundance of cooler air for cooling. The fine sinter fraction is then deposited onto the initial layer followed by charging of the mid-sized sinter fraction at the top of the sinter bed. By sandwiching the finest sinter fraction between the coarser lower layer and the mid-sized upper layer, dust emissions are minimized. >>



Inside view of the Intensive Mixing and Granulation System showing the vertical shaft-type mixer



Entry of sinter raw mix into ignition furnace



View of the sinter strand showing the ignition furnace and waste-gas recirculation ducts and hood

>> The sinter plant at Dragon Steel is exemplary with respect to its unique assembly of environmental-protection systems and low emission values.

Furthermore, the charging chute is designed in such a way that the sinter deposited onto the cooler pallets requires no leveling (Shuster principle). As a result, mechanical abrasion of the sinter is reduced, avoiding an unnecessary generation of fines.

Hot off-air from the sinter cooler is recovered and subsequently used for a variety of purposes:

- Replenishment of the oxygen content of the recirculated sinter waste gas
- Predrying and preheating of the lower sinter raw-mix layer prior to the ignition furnace, thereby reducing the amount of coke breeze required for the sintering process
- “Thermal protection” of the ignited surface of the sinter raw mix within an annealing hood
- Combustion air in the ignition furnace to reduce the amount of coke-oven gas necessary for the ignition of the sinter bed

**Sinter VAiron – total process control and optimization**

The latest generation of the Simetal Sinter VAiron process-optimization system was installed in the sinter plant at Dragon Steel. This system covers typical

Level 2 functionalities such as data exchange with the basic automation system; data storage and recall; data visualization incorporating a user-friendly, freely configurable trending tool; and a sophisticated reporting facility. Process models allow an ideal raw-mix composition to be calculated to achieve a high-quality sinter product. A recipe calculation model assists the operation team in administering raw-mix recipes. If there is a change in the raw-material composition, the process engineers can already calculate the new recipe in advance.

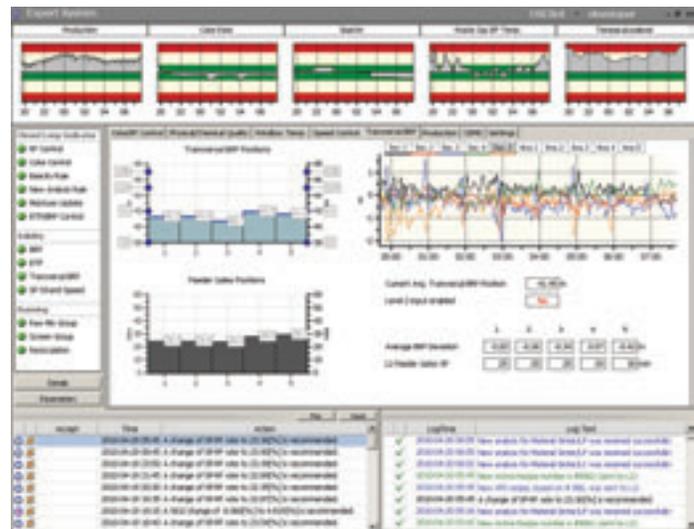
A unique, closed-loop expert system from Siemens VAI is the heart of the Simetal Sinter VAiron Level 2 automation system. This expert system cyclically evaluates the sintering process and displays the results in the form of process diagnoses. As soon as deviations from optimal process conditions are recognized, the expert system generates counteractions that can be executed fully automatically without operator interaction. The expert system optimizes the sinter process with respect to:

- Longitudinal and transversal burn-through point control
- Supervision of the return fines balance
- Basicity and SiO<sub>2</sub> control
- Coke-rate control

The expert system closely interacts with the recipe calculation model. If changes in the recipe are required due to changed process conditions or a different chemical composition of the raw materials, the expert system automatically triggers a new calculation in the background and activates the new recipe in the basic automation system.



Circular dip-rail sinter cooler



Sinter VAiron Expert System (XPS) – transversal burn-through-control display



Aerial view of the new integrated iron and steelworks of Dragon Steel Corporation, Taiwan

**Table 2: Overview of performance figures of Sinter Plant No. 1**

Production data	Target values	During normal operation
Sinter production	7,440 t/day	7,440–8,432 t/day
Discharge temperature	max. 120°C	40–60°C
FeO content	max. 7.5%	8%
Under 5 mm	max. 6%	2%
Over 50 mm	max. 5%	3%
TI (ISO)	min. 76%	77–79%
RDI	max. 38%	28%
Consumption of coke-oven gas	max. 2.5 Nm <sup>3</sup> /t sinter	2.3–2.5 Nm <sup>3</sup> /t sinter
Dust content at waste-gas stack	max. 20 mg/Nm <sup>3</sup>	< 20 mg/Nm <sup>3</sup>
SO <sub>x</sub>	max. 50 ppm (~15% O <sub>2</sub> )	25–50 ppm (~15% O <sub>2</sub> )
NO <sub>x</sub>	max. 70 ppm (~15% O <sub>2</sub> )	40–70 ppm (~15% O <sub>2</sub> )
Dioxin	max. 0.5 ng-TEQ/Nm <sup>3</sup> (~15% O <sub>2</sub> )	< 0.5 ng-TEQ/Nm <sup>3</sup> (~15% O <sub>2</sub> )
Plant dedusting efficiency	max. 20 mg/Nm <sup>3</sup>	< 20 mg/Nm <sup>3</sup>

### Project completion and new orders received

Since the start-up of the sinter plant in December 2009, output has continuously increased to a current production level of 7,600–8,200 tons of sinter per day, commensurate with the downstream demands of the blast furnace and steel mill. In recognition of the fulfillment of all guaranteed performance figures, Siemens VAI has already received the Final Acceptance Certificate from Dragon Steel for the sinter plant.

Currently, Siemens VAI is installing a second sinter plant, a second blast furnace and a third 2-strand slab caster for Phase 2 of the steelwork expansion project at Dragon Steel. The suction area of the sinter strand of Sinter Plant No. 2 will be 387 m<sup>2</sup>, which will allow an additional sinter output of 3.8 million tons per year. The

plant will be equipped with the same technologies and systems that are installed in Sinter Plant No. 1. The start-up of the second sinter plant is scheduled for October 2012. When Phase 2 of Dragon Steel's ambitious expansion project is completed, the company will be capable of producing approximately 5.2 million tons of steel per year. ■

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VAiron Productivity Control System installed in Linz, Austria

# Bringing the Parts Together

The VAiron Productivity Control System is a joint development by Siemens VAI and voestalpine Stahl to implement a new automated production-control system that networks the various plants involved in the ironmaking process. The sinter plant, blast furnace, coke-oven plant and raw-material yard are automatically linked by a superordinate expert system. The result is an overall optimization of the complete plant network instead of independent optimization of separate process steps.

**A**t voestalpine Stahl in Linz, Austria, hot metal is produced by three blast furnaces using sintered iron ore, coke and additives. The production plants are equipped with enhanced Level 2 software automation systems based on advanced process models and closed-loop expert systems. To tie the network of the plants involved in the ironmaking process together, a superordinate system was implemented – the VAiron Productivity Control System (Figure 1). An expert system featuring fully automated online processing is the kernel of this system:

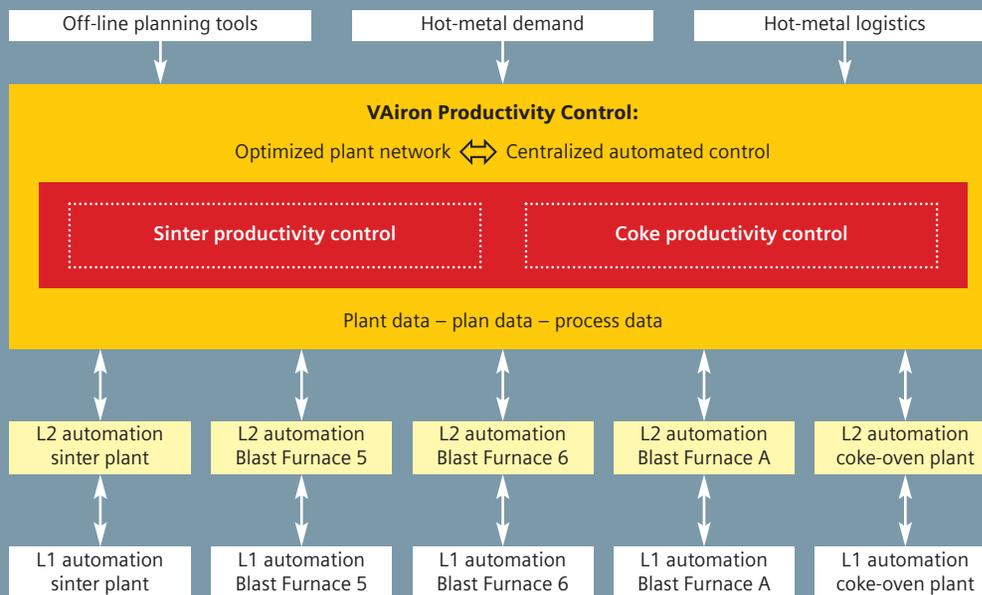
- The overall optimized target figures are evaluated automatically by the expert system based on the plan data, the actual process data of the involved plants and the material stockyard situation. These setpoints are preset online to the underlying Level 2 automation systems of the individual plants.
- Local expert systems, which are part of the Level 2 automation systems, apply the setpoints received from the VAiron Productivity Control System for further processing. Based on the setpoints, more detailed corrective measures are evaluated to be preset to the Level 1 automation systems.
- In case of closed-loop operation of the local expert systems, the setpoints are preset to the Level 1 automation systems automatically; in the case of open-loop (advisory) operation, the operator performs this step manually.

A modular structure allows the system to be extended in defined steps during further development. Two modules are already integrated in the expert system: the production control of sinter and the production control of coke.

**The overall optimized target figures are evaluated by the expert system based on the plant data.**

The target of the production control for sinter is the coordination between the sinter production by the sinter plant and the sinter consumption by the blast furnaces. Basically, for the operation plan, the material mix of the sinter burden and the blast furnace burden is calculated so that the produced amount of sinter minus process losses equals the amount of sinter consumed by the blast furnaces. In real operation, however, there are deviations of the sinter production as well as of the sinter consumption. These deviations are buffered by the sinter stock. To ensure operation with a defined sinter stock level, control of the sinter consumption of the blast furnaces is implemented by evaluating and presetting the target sinter basicity figure for the sinter plant.

Fig. 1: VAiron Productivity Control System concept



Target of the production control of coke is a defined stock level of coke produced in the coke-oven plant. Therefore, this module evaluates the optimum ratio of the coke brands charged at the blast furnace and readjusts the setpoint (Figure 2).

### Conclusions and outlook

A first version of the VAiron Productivity Control System with the functionality described above is already in use at voestalpine Stahl in Linz. At the moment, the implemented modules are being fine-tuned and optimized. For the future, the gradual integration of further modules into the existing expert system is planned. Ideas for future modules include optimized distribution of the available oxygen between the blast furnaces, control of the slag quality for better utilization, and control of the amount of hot metal.

### Blast furnace and sinter plant optimization systems

The Simetal BF VAiron and Simetal Sinter VAiron systems are based on advanced process models, artificial intelligence, a closed-loop expert system as well as enhanced software applications and operational expertise. These optimization systems continuously perform complete diagnosis of all process conditions during operation, while built-in, closed-loop control systems execute corrective actions as



Fig. 2: Visualization of the Productivity Control Expert System

needed. Detailed descriptions of the decision-making process ensure transparent operating conditions. The systems enable fully automatic and stable blast furnace and sinter-plant operations with consistent product quality at significantly lower production costs. ■

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## Heat-recovery system for Finex plants

# You Can Have It All

In the past, environmental measures were synonymous with higher costs. Not any more. New process technologies are helping producers of iron and steel to make a significant contribution toward environmental protection – and save money. A case in point is the new heat-recovery system for Finex plants, as developed in cooperation with POSCO.

**F**inex is an environmentally friendly smelting-reduction process for the production of liquid hot metal from non-coking coal and fine iron ore. The solution was jointly developed by Siemens VAI and the South Korean steelmaking company POSCO. Since completion in April 2007 of the first commercial Finex plant capable of producing 1.5 million tons of hot metal per year, further developments and improvements for Finex plants have been made in close cooperation with POSCO. Among these developments is the implementation of a commercial heat-recovery system. Besides increasing the energy efficiency of Finex, the waste-heat reduction system is an important step for the economic recycling of dust from the process gases.

### The best concept

With the goal of using waste heat from Finex offgas, several concepts for heat recovery were investigated. To decide on the preferred concept, an economic feasibility study was carried out together with POSCO. The result showed that a heat exchanger producing steam would be the most economic alternative. A test facility based on thermo-oil was built at the existing Finex demonstration plant to determine heat transfer coefficients and accretion behavior.

The challenges of heat recovery include high dust load, possible accretions due to hydrocarbons and other gas constituents, a reducing-gas atmosphere comprised of mainly carbon monoxide, and a heat exchanger pressure vessel with high design pressure of 600 kPag. The test facility was operated from October 2008 to March 2009.

### Improved energy efficiency

Based on the good operating results from the test



Fig. 1: 3-D model and picture from industrial heat-recovery system at the Finex 1.5M plant

facility, the design and engineering of an industrial waste-heat-recovery system for a Finex 1.5M plant was started in July 2009. The project was implemented in close cooperation between POSCO and Siemens VAI (see Figures 1 and 2).

The heat-recovery system consists of a pressure vessel and gas ducts supported by a steel structure, main process gas valves including a hydraulic system, heat exchanger bundles, a steam drum, boiler recirculation and feed-water pumps, a feed-water storage tank with a deaerator, and a chemical injection and blow-down system.

Heat recovery prior to dry dedusting of the main process gas streams is also favorable due to lower investment costs. In addition to the energy gained from the heat-recovery system, the main advantages of dry-dedusting systems are generally as follows:

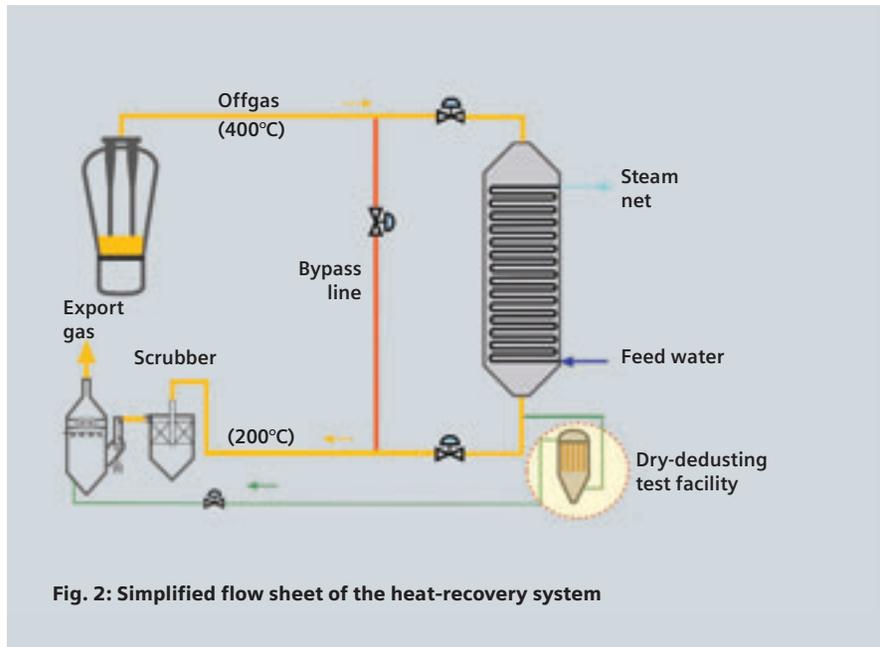


Fig. 2: Simplified flow sheet of the heat-recovery system

- Lower volumes of process cooling water
- Less investment costs and space requirement for water/sludge systems
- Cheaper utilization of dust compared to sludge
- Higher power generation by implementation of TRT (higher pressure and gas temperature)
- Lower operating costs
- Less emissions

#### Successful start-up

After construction was completed, commissioning was executed from April 2010 to June 2010. The waste-heat-recovery system was started up on June 30, 2010, and enables approximately 40 tons/h of superheated steam (260°C/ 12.5 barg) to be generated from hot Finex offgas. The produced steam is used within the existing steam network of the integrated steel plant. In addition to the favorable economics, some 97,000 tons of CO<sub>2</sub> emissions (compared to the same quality of steam produced by a coal-powered boiler) per year can be saved thanks to the system. These important improvement steps in combination with other developments make the Finex smelting reduction technology from Siemens VAI and POSCO even more economical and environmentally friendly. ■



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# One Step Closer To Fully Automatic Steelmaking

Siemens VAI electric arc furnaces combine high capacity with maximum availability, process a variety of charging materials, and produce a wide range of steel types. New innovations focus on optimizing consumption parameters, reducing tap-to-tap times and fulfilling the requirements of maximum automation.

**W**ith 40 years of experience in electric steel-making, Siemens VAI focuses on continuous improvements, especially when it comes to optimizing energy usage to melt steel. Siemens VAI also helps improve the characteristics of the steel produced, with special attention given to efficiency and minimal interruptions. Refining Combined Burner (RCB) technology is one of the most important parts of our approach to optimize the EAF process. The product family consists of the Simetal RCB injection technology for gas and Simetal RCB Oil for oil – both with supersonic oxygen injection – and Simetal RCB Temp for temperature measurements. The elements in the product family are implemented in a new modular panel design marketed under Simetal RCB Modular Injection Panel. These components, especially in combination, are highly efficient and boost productivity, save energy and help protect the environment.

## Simetal RCB

The use of advanced RCB technology and the application of post-combustion promotes high bath turbulence and, consequently, a high heat transfer and scrap-melting rate. Since 1995, worldwide up to 100 furnaces – shaft furnaces and conventional EAFs operating on both AC and DC power for the production of carbon steel, stainless steel and specialty steels – have been equipped with Simetal RCB technology. Designed for low maintenance, Simetal RCB is made of two parts: a water-cooled copper front part and a rear part that supports the injection nozzles and quick me-

dia connections. The rear part can be easily dismounted by removing a coupling strap.

The oxygen mixing chamber is built inside the burner mouth to improve flame stability, and it is supported by central oxygen injection that leads to a more powerful flame compared to a conventional burner. Multipoint supersonic oxygen injection results in strong bath stirring as well as in compositional and temperature homogeneity. Due to the angle and length of the laminar stream, oxygen injection is far more efficient compared to other systems, which enables a very low carbon content to be achieved quickly with favorable oxygen consumption rates. In addition to the shorter power-on time, the bath and slag oxidization levels can be carefully controlled.

The RCB family provides the basis for different injection and analyzing technologies.

## Simetal RCB Oil

Until now, RCB technology was available for natural gas, LPG and even coke-oven gas. The latest development is Simetal RCB Oil, which increases flexibility in energy resources and even allows light diesel oil to be used if natural gas is not available. A special designed spray nozzle mixes oil and oxygen to pro- >>

>> vide an optimized spraying and a special molded burner flame. This layout leads to an improved heat transfer to scrap and a most efficient use of this type of injector. Safety aspects have been integrated in the injector – including easy-to-operate control – for the highest level of on-the-job safety.

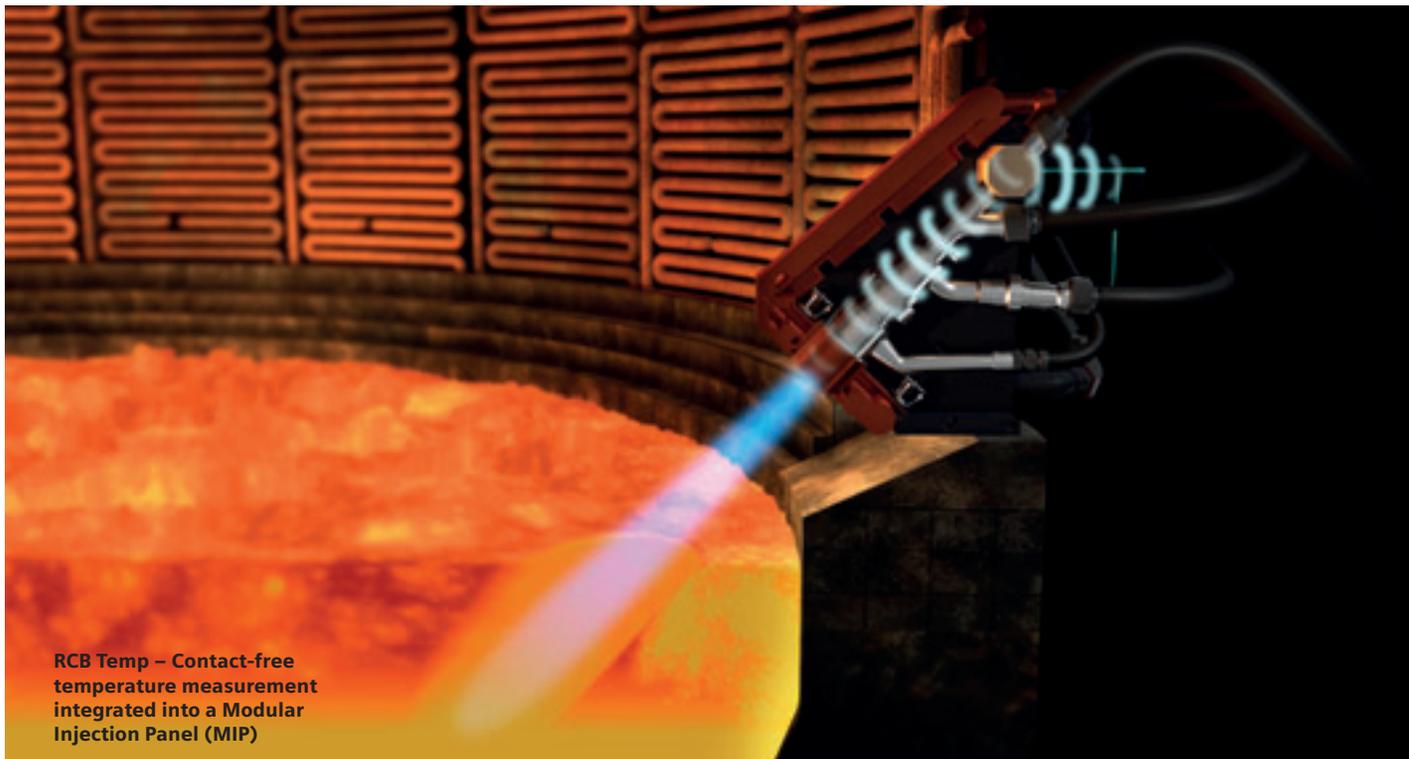
#### Simetal RCB Modular Injection Panel

Siemens VAI has developed a new, easy-to-maintain injection panel in a fully modular structure that combines side pieces with a front and cover plate. Wear-prone parts can be easily replaced. The front plate in particular can be removed quickly using an exchange

Thanks to modern weld techniques and high manufacturing standards, the lifetime and availability of the nose-shaped panel are significantly increased.

#### Simetal RCB Temp

Steel production in an EAF depends heavily on temperature control. Precise and reliable temperature measurements are required, especially before tapping the steel in the ladle. Measurements are usually taken through the open slag door, either manually or with manipulators fitted with conventional cartridges. Simetal RCB Temp offers EAF operators a precise, contact-free method to measure steel-bath



RCB Temp – Contact-free temperature measurement integrated into a Modular Injection Panel (MIP)

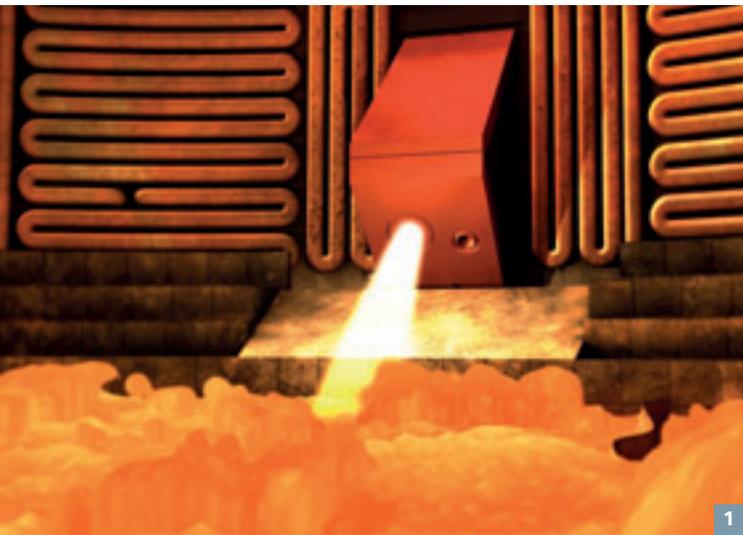
STEELMAKING >

device attached to a crane. This setup allows the front plate to be lifted quickly and easily towards the center of the furnace so that a new front plate can be inserted and connected. Furthermore, there is no need to cool down the furnace before initiating the procedure.

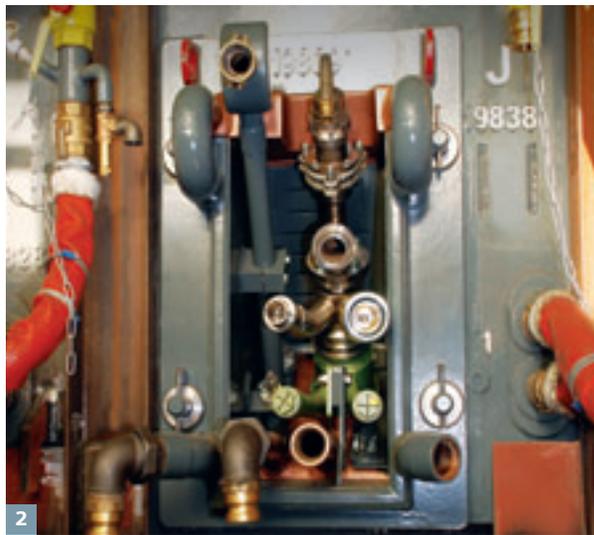
Additionally, a temperature sensor can be installed directly into the front plate for better thermal control and safety. The newly designed front plate has optimized water circulation, which allows safe and efficient cooling and ensures optimal heat discharge.

Siemens VAI has optimized the established injection in a coherent, innovative design concept.

temperatures. At the heart of Simetal RCB Temp is the Refining Combined Burner system equipped with an optical sensor and analyzing unit. In contrast to conventional processes, the temperature can be measured at short intervals, so the best time to tap can be determined more exactly. As a result, power-on and power-off times are reduced for an increase in overall furnace productivity. Costly measurement cartridges are also no longer required, further lowering operating costs. Simetal RCB Temp also improves operator safety by eliminating potentially hazardous work near the furnace.



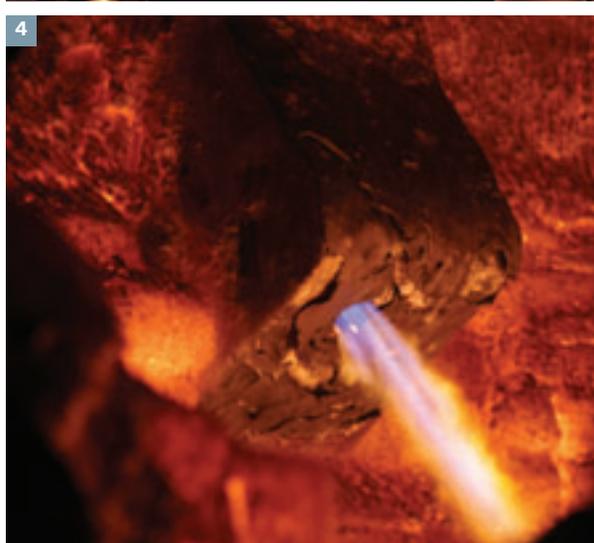
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- 1 Modular injection panel installed in EAF wall
- 2 Modular injection panel – the new design concept
- 3 RCB Oil application
- 4 RCB system in operation

The new Simetal RCB Temp uses supersonic oxygen-injection technology combined with analyzing and control units for contact-free temperature measurement. After preheating and cutting the scrap with the burner's powerful flame, the lance mode is used to decarburize the molten steel and to support foaming slag technology. In order to measure the steel-bath temperature, a measuring gas is blown in instead of oxygen. An optical sensor integrated into the back end of the lance picks up the measuring signal. This measuring signal is amplified and further processed in an analyzing unit. The temperature is then calculated by

means of an algorithm especially developed by Siemens VAI. The unit allows precise measurement of the temperature at short intervals during power-on and with a closed door. The measuring process can be initiated manually by the operator or automatically following given operation profiles from Level 1 or Level 2. The results are far more accurate, with fewer unstable measurements, and allow monitoring of the steel temperature until the target tapping temperature is reached. Simetal RCB Temp brings the operators one step closer to fully automatic steelmaking under safe and reliable operating conditions. ■

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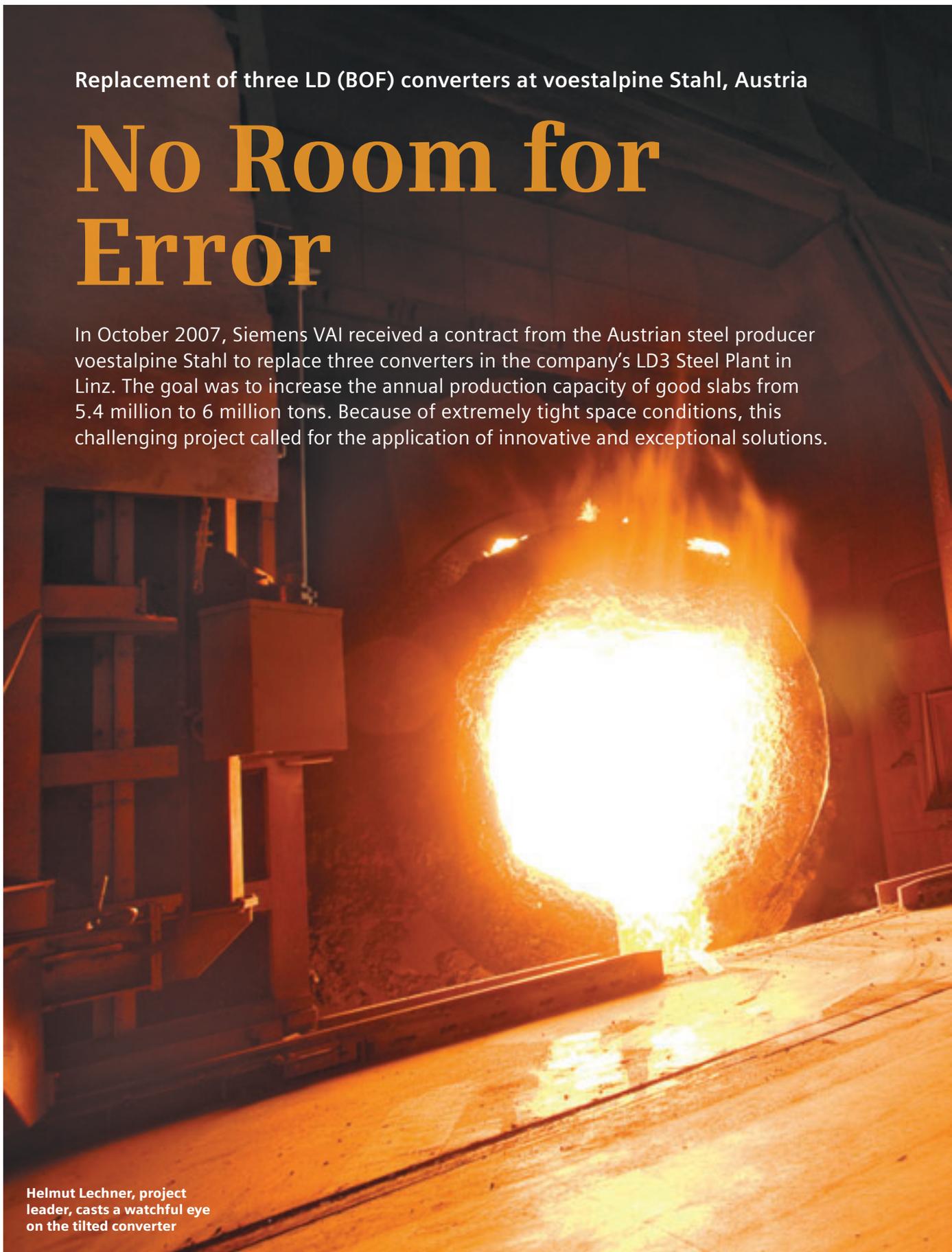
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Replacement of three LD (BOF) converters at voestalpine Stahl, Austria

# No Room for Error

In October 2007, Siemens VAI received a contract from the Austrian steel producer voestalpine Stahl to replace three converters in the company's LD3 Steel Plant in Linz. The goal was to increase the annual production capacity of good slabs from 5.4 million to 6 million tons. Because of extremely tight space conditions, this challenging project called for the application of innovative and exceptional solutions.

STEELMAKING >



Helmut Lechner, project leader, casts a watchful eye on the tilted converter

**W**hen Siemens VAI was awarded the project for the replacement of the three converters, Helmut Lechner, project leader, knew that this was going to be one of the toughest jobs he would ever face. The steel plant built in the early 1970s was originally designed for the operation of just two 110-ton converters. Over the years, the converters were replaced with larger and larger units and a third converter was added. Finally, three 160-ton converters

had to be dismantled and exchanged with three 180-ton converters. "Not only was the available space extremely tight," says Lechner, "the customer demanded that all replacement work for each converter be carried out during ongoing production of the other two converters. Furthermore, a tight time period of only seven weeks was foreseen for each converter exchange that had to be coordinated with the scheduled shutdowns of two blast furnaces in the steelworks." >>





**At the front – dismantling of the old converters**



**Transport of the preassembled converter by bay crane to the installation site**

#### >> Project implementation

A Siemens VAI crack team of specialists worked closely together with the customer's project team. A highly detailed installation schedule, precise logistics coordinated with onsite and operational conditions, and strict

project management were absolutely essential for the success of this project. A total of more than 500 pre-assembly, dismantling and installation steps had to be carefully timed and carried out. The equipment and systems to be installed included the converter shells, trunnion rings and bearings, converter suspension systems, pedestals, tilting drives, rotary joints, ladle alloy and additive systems, pneumatic slag stoppers, doghouses, off-gas hoods, and electrical and Level 1 automation systems.

**Table 1: Chronology of converter-replacement project**

Contract signing	October 17, 2007
Official site opening	January 7, 2009
Delivery of 1 <sup>st</sup> converter to site	January 8, 2009
Shutdown of old Converter No. 1	March 2, 2009
First heat	April 27, 2009
FAC	July, 20, 2009
Delivery of 2 <sup>nd</sup> converter to site	March 30, 2009
Shutdown of old Converter No. 2	June 7, 2009
First heat	August 21, 2009
FAC	December 14, 2009
Delivery of 3 <sup>rd</sup> converter to site	September 3, 2009
Shutdown of old Converter No. 3	January 11, 2009
First heat	February 26, 2010
FAC	April 26, 2010

**“Production and metallurgical expectations were fully met, and even partially exceeded.”**

Herbert Moser,  
head of converter steelmaking during the project,  
now head of continuous casting at voestalpine

The manufactured converters were shipped to the harbor facilities adjacent to voestalpine Stahl via the Rhine-Main-Danube Canal. The trunnion ring was delivered in four parts and the converter vessel in three sections. In order to keep converter downtime to a minimum, onsite preassembly work had to be maximized to the greatest extent possible. The weight of the pre-assembled converter unit was kept under 250 tons so that it could be safely transported by the bay crane to the installation site.

**Table 2: Comparison of operational performance**

	Old converters	New converters
Comparison time	May 2008	April 2010
Steel output (good slabs)	467,087 tons	464,753 tons
Number of heats per month	2,951	2,742
Average heat size	158.3 tons	169.5 tons*
Heats per day	95.2	91.4
Average tap-to-tap time	31.5 min	33.7 min
Blowing time	13.4 min	13.8 min
C content in steel at end of blow	0.032%	0.026%
O <sub>2</sub> content in steel at end of blow	670 ppm	636 ppm
Fe content of slag	21.7%	17.5%
Metallic yield	90.5%	91.6%

\*Converter heat sizes will be gradually increased to nominal capacity, coordinated with the start-up of the new CC7 Caster scheduled by September 2011

The existing converter foundations had to be partly renewed to provide space for the increased converter size. In a special technique applied for the first time, the top section of each foundation was sheared off with a diamond-studded cable saw and replaced with a new reinforced foundation cap. A special trunnion bearing was also installed to support the increased horizontal forces of the new converters. With these solutions, total renewal of the foundations was not necessary.

In consideration of the extremely restricted space, a new, highly compact and maintenance-free converter suspension system – known as Simetal Compact Link – was developed to allow the use of converters with the largest possible reaction volume. This innovative solution features two horizontal links and eight vertical lamellas that accommodate thermal deformations of the converter and trunnion ring.

In addition to increasing the converter size, another key factor for boosting productivity in the LD3 Steel Plant was the extension of the converter lining life from 3,000 up to 4,000 heats per campaign. This increase was made possible by the application of an improved lining concept.

Simetal Slag Stoppers were installed on the converters to minimize slag carry-over during tapping. New ladle alloy and additive systems were also installed to ensure optimized charging techniques and steel deoxidation.

### Start-up and operational results

Converter No. 1 was started up on April 27, 2009, Converter No. 2 on August 21, 2009, and the last of the three 180-ton converters was put into operation on February 26, 2010 (Table 1) – a total of 30 heats were tapped from Converter No. 3 on the start-up day. Ramp-up of each of the converters to required production output was quickly reached.

Table 2 shows a comparison of the operational performance of the old converters with the new converters. Nearly the same monthly production figures were attained with 209 fewer heats.

### Successful project completion

“The entire project was characterized by the close and excellent cooperation between our company and Siemens VAI,” says Herbert Moser of voestalpine Stahl. “Production and metallurgical expectations were fully met, and even partially exceeded.”



**Converter ready for the first heat**

The steel mill of voestalpine Stahl is one of the world's most productive plants of its size. On May 16, 2010, a total of 18,162.74 tons of steel were produced at the LD3 Steel Plant – an all-time daily high for the company! ■

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The future of steelmaking with bottom-blowing techniques

# Highest Flexibility In Steelmaking

Strongly fluctuating prices for raw materials and energy, and pressure on productivity and energy efficiency are the challenges in steelmaking for the next decade. Flexibility is the key word: flexibility in maintaining or even increasing production levels when hot metal and fluctuating scrap or direct-reduced iron is in limited supply; flexibility in the raw material mix if the price of scrap, direct-reduced iron or hot metal becomes unsteady; and flexibility to replace expensive raw materials for stainless steel production with cheaper oxides or ore concentrates. Siemens VAI provides solutions for flexible steelmaking.

**B**y the mid-1970s, more than 50% of world crude steel was being produced by the LD (BOF) process. Nonetheless, at that time a decision was made at Maxhütte in Germany to further examine development of the bottom-blown Thomas process. After many trials, a process utilizing annular tuyeres installed in a converter bottom was developed and received the designation Oxygen Blowing Maxhütte (OBM). Later, an oxygen lance was also applied and the technology was named Klöckner Oxygen Blowing Maxhütte (K-OBM).

The K-OBM process combines advantages of bottom blowing and top blowing with the benefits of pure oxygen steelmaking. Only part of the oxygen is blown through the bottom tuyeres while the remainder is supplied through a top lance. This technology shows very good bath mixing and effectiveness of in-blown materials such as lime. Among others, better desulfurization, dephosphorization and higher yield in comparison to BOF is obtained. Also, higher blowing rates are possible in LD (BOF) steelmaking.

## Flexibility in production

In the Klöckner Maxhütte Steelmaking (KMS) process, provision is made for injecting powdered coal or coke through some of the bottom tuyeres. The extra carbon is first dissolved in the metal and removed by the blown oxygen, which provides further heat to the process. The blown coal therefore allows increased amounts of scrap or direct-reduced iron to the melt according to the quantity of coal injected. The main advantage is the flexibility to increase the proportion

of scrap or direct-reduced iron (DRI) even up to 60% of the charge, or up to 100% scrap or DRI utilizing KS technology. By doing so, operators can take advantage of favorable scrap prices and are less dependent on the supply of hot metal from the blast furnace.

## Flexibility in energy consumption

A by-product of these processes is CO gas that is generated in higher quantities than in LD (BOF) and K-OBM technologies. This offgas can be recovered and used within the steelmaking plant or for power generation. Longer periods of valuable CO-gas generation make gas recovery more economical compared to LD plants.

The KMS/KS (Klöckner Steelmaking) technologies are very good solutions to achieve a capacity increase and decrease of primary energy while the hot-metal rate decreases. Especially for regions with limited access to electrical energy, unstable power grids or limited availability of raw materials, KMS is an attractive steelmaking route.

## Flexibility in stainless steel production

Currently, most stainless steel is produced in argon oxygen decarburization (AOD) converters. Flexibility is one of the advantages of this technology. Until ten years ago, liquid metal for production in AOD converters was delivered only from electric arc furnaces. Now there are several references where dephosphorized hot metal is used for the production of stainless steel. Not only economical, this route is for some producers the only possible way to produce stainless steel in



Charging of hot metal into the converter

countries with limited stainless steel scrap availability. With KMS/KS technologies, stainless steel can be produced with the same equipment that is used for the production of carbon steel.

The flexibility of the AOD converters enables the use of alloying materials containing nickel, molybdenum, vanadium and tungsten as well as ferroalloys, oxides, ores and ore concentrates. In particular, the charging of oxides and ore concentrates into the converter results in decisive economical advantages. Siemens VAI has several references with AOD converters for the production of stainless and special steels where oxidic alloys were used. Industrial experience was gained by using molybdenum, vanadium and nickel oxides. Materials containing tungsten (tungsten ore concentrates such as scheelite, wolframite and tungsten trioxide) are expected to yield similar performance in the production unit and help achieve even higher profits.

#### Main features of the bottom-blown converter

Siemens VAI is one of the world's leading suppliers of bottom-blown converter technology. Innovative solutions for flexible steelmaking allow highest operational flexibility in situations of fluctuating prices for energy and raw materials, including scrap, DRI and hot metal. General key performance parameters of K-OBM/KMS converters are:

- Blowing times in K-OBM processes are short – 8–12 minutes mainly due to blowing rates of 3–5 Nm<sup>3</sup> O<sub>2</sub> per ton and per minute
- A very high steel yield about 1%–2% above that of

the BOF can be achieved mainly by the very low iron oxide content of the slag, by the smaller amount of slag, by reduced vaporization of iron and by less steel splashing or spitting

- Bottom blowing of powdered lime into the melt promotes a controlled blowing behavior and improves desulfurization conditions
- Substantially improved dephosphorization and much higher residual manganese content compared to other oxygen-steelmaking processes
- More efficient treatment of hot metal charges with high contents of silicon and manganese, etc.
- Extremely low carbon contents of approximately 0.005% in the melt can be achieved with a relatively low iron oxide content in the slag
- Low oxygen activity in the steel bath increases the yield of the charged alloying elements and decreases the required quantity of deoxidation agents – the result is cleaner steel
- The oxygen tuyeres act as a cutting torch, and extremely efficient stirring allows even large scrap pieces to be melted
- Production of stainless and carbon steels using the same equipment. ■

#### Author

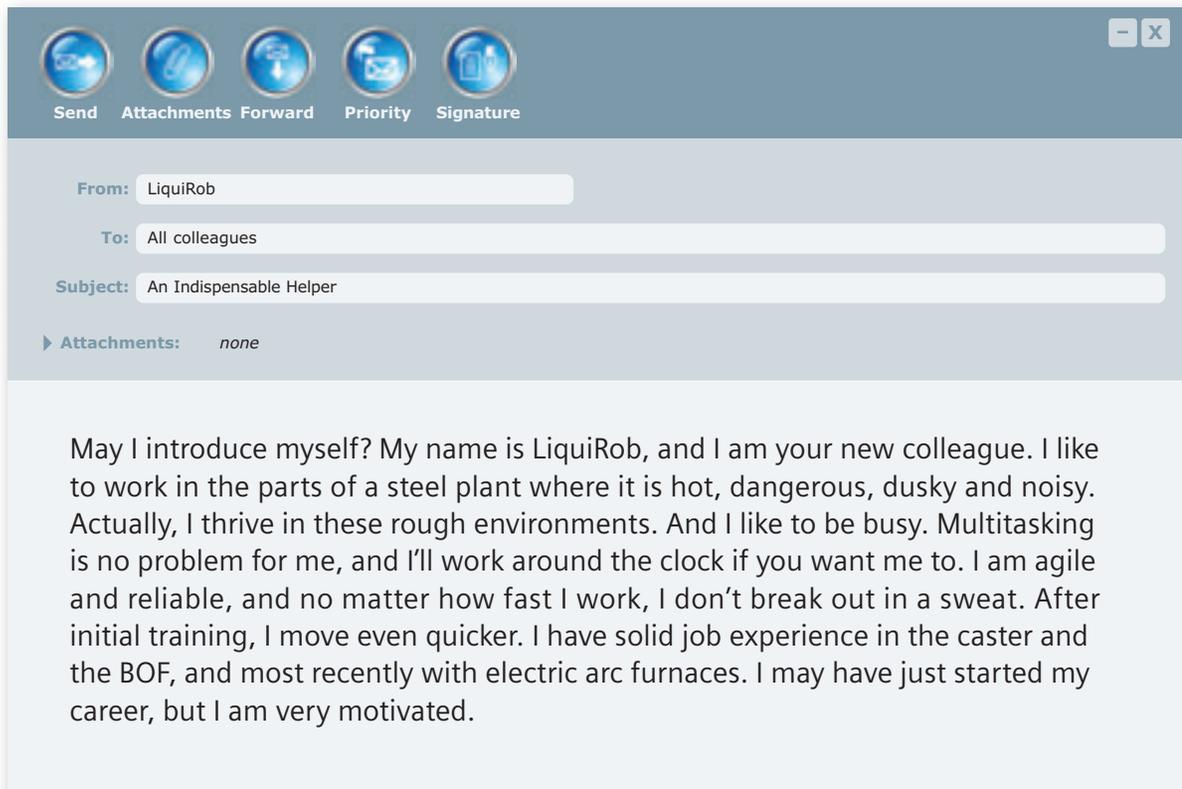
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An unusual helper

# LiquiRob: Simply Indispensable



**L**et me tell you why I am predestined for steel plants: There is no doubt that a steel plant can be a very dangerous place! One of my goals is to improve the safety of work conditions. Even if fatal incidents are relatively rare today in most steel plants, minor injuries like burns take place on a daily basis.

The layout of modern steel plants is optimized for smooth product flow with minimal manual interaction. There are a few areas, though, where human interaction in the vicinity of hot metal is necessary: Typical examples include taking temperature measurements and sampling liquid steel in the furnace, the ladle, the tundish and the mold, or opening of ladles with oxygen lances. In the past, manipulators were designed to carry out these jobs. However, these manipulators are too slow and not reliable enough, and they require intensive maintenance and can only perform a single job.

## Details about my origins

Siemens VAI developed LiquiRob technology as a universal approach to carry out dangerous jobs in a steel plant. LiquiRob consists of a construction kit with several modules: a highly reliable six-axis industrial robot with protective "clothing" and a sturdy tool changer, a position-detection system as the "eyes" of the robot, a force torque sensor that serves as the sense of "touch," a robot moving unit and safety installations. The "brain" is the LiquiRob controller, which provides synchronization between different components, allows flexible work sequences and acts as an interface to other automation systems. With these components it is possible to design LiquiRob installations for a variety of tasks and plant layouts.

## Work experience at continuous casters

The diagram shows a single strand caster where all tundish and ladle operations are carried out by two

robots. I work in the ladle area and connect the slide gate cylinder, a shroud-clamping system and the electromagnetic slag-detection system (Ampera). I also introduce argon for soft bubbling in the ladle. The robot in the tundish area takes tundish samples, measures temperature as well as oxygen and hydrogen in the tundish, opens ladles with burning lances, applies tundish powder and handles the ladle shroud.

The robot system was implemented for the first time in 2008 in the Gwangyang Steel Works of the Korean company POSCO. There I am used for sampletaking, temperature measurement within the distributor, and for casting powder dosing on the casting platform of a two-strand slab caster.

### Work experience with EAFs and converters

In the RIVA Neuves-Maisons plant in France I replaced a manipulator for temperature measurement, oxygen measurement and steel sampling through the EAF slag door. The system is designed for fully automatic operation and enables precise and reliable measurements to be made at frequent intervals. The implemented solution also includes installation of three automated magazines to store the sample and measurement, which can be safely filled by the operation personnel once per day outside the dog house. The sampling and measuring procedures can be run completely automatically. I offer a number of advantages over the use of manipulators. For one, I require only a small window in the slag door and my cartridge reaches further into the furnace and dives deeper into the steel bath. As a result, incorrect measurements are eliminated and the measured data is considerably more accurate. Shorter measuring intervals can also be achieved thanks to the automated cartridge selection. This, in turn, provides a more precise picture of the temperature and composition of the steel.

I also have some work experience at the two LD (BOF) converters at ThyssenKrupp CSA in Brazil. In a very similar setting as in Neuves Maisons, I attached T, TSO and TSC probes to the subplance.

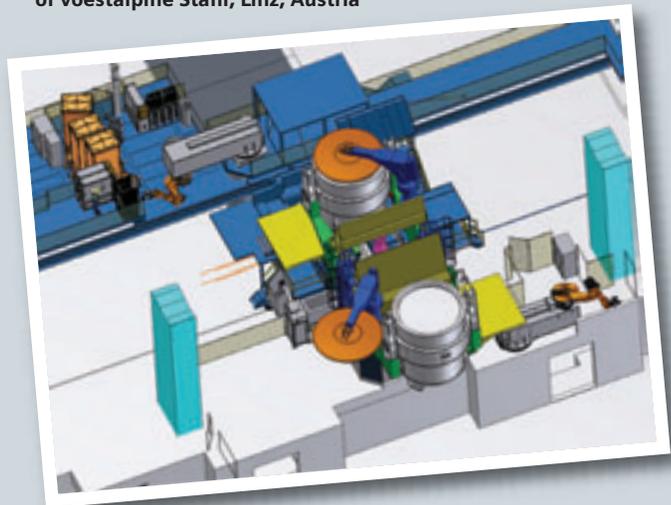
### The beginning of things to come

The development of LiquiRob technology is just the starting point for establishing robots in steel plants. In the future, robots will carry out many different applications in steel plants. As a result, the layout of the plants will change dramatically, since humans will only need to access plant components during maintenance shutdowns. The duties assigned to plant operators will also undergo considerable changes.

I hope I've made you curious. If you'd like to find out more, don't hesitate to get in touch with my agent, Siemens VAI.

Yours sincerely,  
LiquiRob

My future workplace at the CC7 slab caster of voestalpine Stahl, Linz, Austria



Picture of me during a measurement at the EAF

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#### Simetal LiquiRob for LD (BOF) converters

- ThyssenKrupp CSA, Brazil
- JSC Zaporozhstal, Ukraine

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Advanced process models for 400 mm ultra-thick slab casters

# Making Casting History

In June 2010, Siemens VAI started up its newest jumbo continuous casting machine at the Qinhuangdao Shouqin Metal Material Co. steel plant in China. The caster is designed to produce heavy slab sections, typically 250–400 mm thick and 1,600–2,400 mm wide.

**T**op-quality jumbo slabs are essential for high-grade pipe and plate steels. Siemens VAI is the first anywhere to cast ultra-thick slabs of 400 mm on a straight mold machine with the proven concept of bending and unbending during the liquid state while keeping the strand temperature above the critical ductility trough. The machine with its straight mold has an extremely long metallurgical length of 45 m. The 11 m bow radius is an essential aspect of the machine's design and contributes to product quality. The single-strand machine is designed for a yearly capacity of 1.1 million tons.

Siemens VAI and long-term partner Pohang Iron & Steel Co. (POSCO) of South Korea have developed an alternative to the machine concept described above for the production of similar ultra-thick slabs measuring 250–400 mm in thickness and 1,100–2,200 mm in width. POSCO has followed the idea of liquid core bending but with solid core unbending. A straight mold, substantial height and a 16 m radius are beneficial for the separation of nonmetallic inclusions.

This concept requires extensive cooling in the bow segments to shift the strand temperature below the ductility trough. After full solidification of the cold strand in the segmented casting bow, unbending is

performed in heavy straightener units. Due to the rather short metallurgical length of 24 m, two strands are necessary to reach a yearly capacity of 1.3 million tons. The unique POSCO caster will go into operation in early 2011.

#### Simetal Dynacs 3D cooling automation

Application of proven technological packages stabilizes operations and helps to meet the growing demand for top-quality slabs. For these reasons, the machines have been equipped with cutting-edge Simetal Dynacs 3D automation software from Siemens VAI.

Both the Siemens VAI and the POSCO ultra-thick slab caster concepts place extensive technical demands on the temperature control of the strand. In particular, the temperature near the slab corner and the prediction of heat transfer below the Leidenfrost temperature have been the two pivotal areas in these projects involving the application of the Simetal Dynacs 3D secondary cooling system.

Efficient implementation of a three-dimensional heat transfer equation has enabled Simetal Dynacs 3D to provide the full three-dimensional thermal image of the strand in real time. Based on this new three-dimensional calculation, the target strand temperatures can be defined in the casting direction and the

transverse temperature distribution (target corner temperature) can also be tuned.

Calculation precision is further enhanced by incorporating the main heat transfer mechanisms, including enhanced spray-cooling heat-transfer modeling below approximately 700°C, when the Leidenfrost phenomena disappears. Radiation, roller-heat transfer and natural convection also contribute to calculation precision. Since the surface-temperature distribution strongly depends on the nozzle arrangement of the caster, the spray-cooling heat transfer also takes the spray-distribution pattern of the individual nozzles into account. Additionally, Simetal Dynacs 3D is used not only as online automation software control for the continuous caster but also months before commissioning as an off-line simulation tool to determine the optimal cooling setup.

### Simetal DynaGap Soft Reduction

When it comes to the inner quality of the slab, optimum machine protection and a reduction of roller wear – the main requirements for the roller gap control when operating ultra-thick slab casters – Simetal DynaGap Soft Reduction is the right choice. To ensure a proper inner quality of the strand, Simetal Dynacs 3D provides dynamic roll-gap adjustment based on online calculated thermal information.

Simetal Dynacs 3D takes the actual roll gap as well as steel shrinkage into consideration and provides online information about the segments and the actual shrinkage reduction of the strand. Thus, shrinkage feeding flow in the liquid or mushy strand center, as a main contributor to macrosegregation, can be reduced along the entire solidification length.

Simetal DynaGap Soft Reduction also takes responsibility for machine protection, thus helping to avoid the costs associated with downtime as well as roll damage. The system also defines start-up and tailing strategies based on casting thickness, steel grade and casting events. In areas where the strand is rather stiff, usually at the end of the cast due to low speeds, the segments are switched from position to force control to make them softer and to avoid equipment damage.

### Simetal Mold Expert

The Simetal Mold Expert mold monitoring system is one of the most successful continuous casting technology packages from Siemens VAI. In fact, Simetal Mold Expert was installed for the 100<sup>th</sup> time at Shouqin's ultra-thick slab caster. The system collects all relevant data around the mold (thermocouples, hydraulic oscillator piston pressures and strokes, temperatures and flow of primary cooling water, mold level signals, etc.) and provides a detailed look

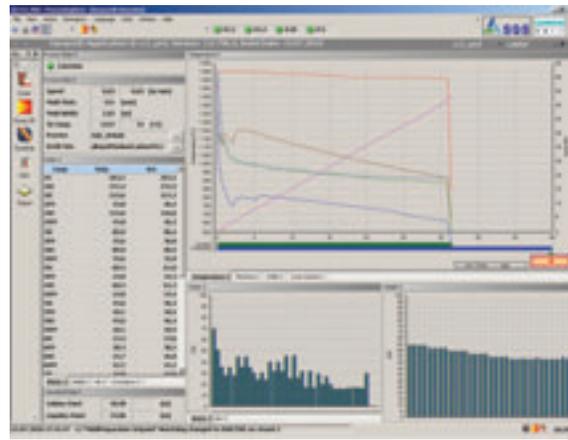


Fig. 1: Calculated temperature profile by Dynacs 3D

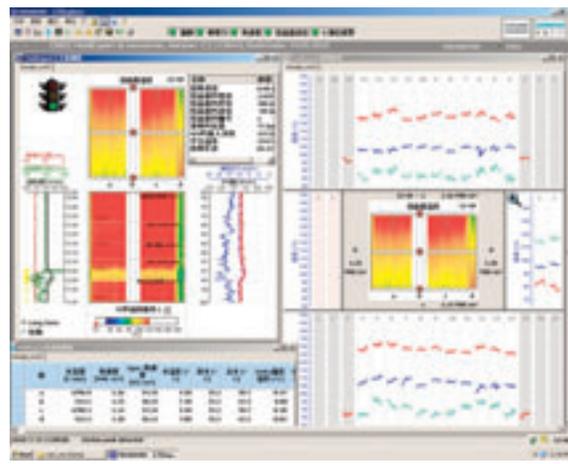


Fig. 2: Thermal mapping by Mold Expert

into the mold. As a result, lubrication and solidification conditions can be interpreted in real time. Critical situations are automatically recognized and alarms are released. A reliable sticker-detection system avoids costly breakouts.

During commissioning, Simetal Mold Expert is an indispensable tool to push targets such as high casting speeds, new sensitive grades and extreme formats. The monitoring system is an excellent tool for process engineers and metallurgists to understand, develop and stabilize the mold process. Simetal Mold Expert data is integrated into the overall automation system, making it available anywhere at any time. Analyzing tools for understanding complex relations ease the daily data processing routine. ■

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Siemens VAI tester for technological packages

# OsciBoy Gets the Job Done

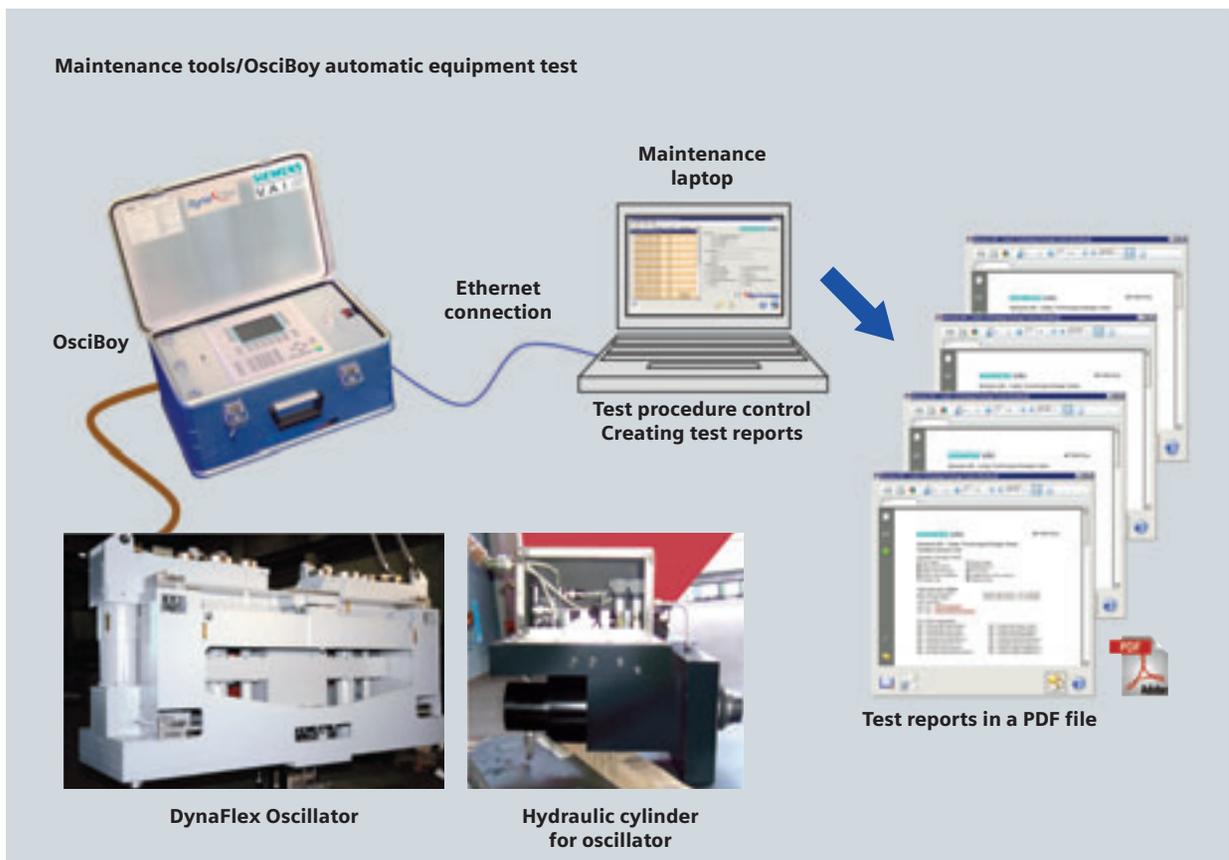
The DynaFlex hydraulic oscillator from Siemens VAI allows online adjustment of stroke, frequency and oscillation patterns during casting, which leads to substantial operational and metallurgical improvements. OsciBoy, the mobile version of the DynaFlex controller, is used to perform test runs of the DynaFlex oscillator on the test stand in the caster maintenance area, as the authors explain.

**T**he DynaFlex hydraulic oscillation drive system enables dynamic adjustment of frequency, stroke and waveform during casting. Installation of this advanced technological package optimizes the performance of the casters to meet demands for productivity, product quality, production flexibility and economic operation.

Additional operational benefits can be achieved

with an integrated mold-friction measuring system to optimize the casting process even further. Rapid coupling of all media supplies facilitates mold and oscillator exchange, and the alignment of the mold and the oscillator is completed automatically.

Far superior to other systems based on bearings, the leaf-spring guiding system ensures wear-free mold oscillation, outstanding operational safety



and low maintenance costs. To increase productivity, a retractable version has been developed that allows mold exchange during casting on another strand.

### Meet OsciBoy

The OsciBoy unit features an operation panel with graphic display and function keys (touch sensitive) for local operation. All operation modes on DynaFlex, except Automatic Remote, are also available on the OsciBoy controller. Test and diagnostic routines include single-cylinder testing in stand-alone mode; all operation modes (manual, positioning or automatic local mode); operation, manual positioning and automatic oscillating of one or two oscillators; and a function check of electrical oscillator equipment.

OsciBoy is connected to the cylinders of the oscillators. Via Ethernet the package tester receives and sends data to OsciBoy, which is responsible for the execution of the tests.

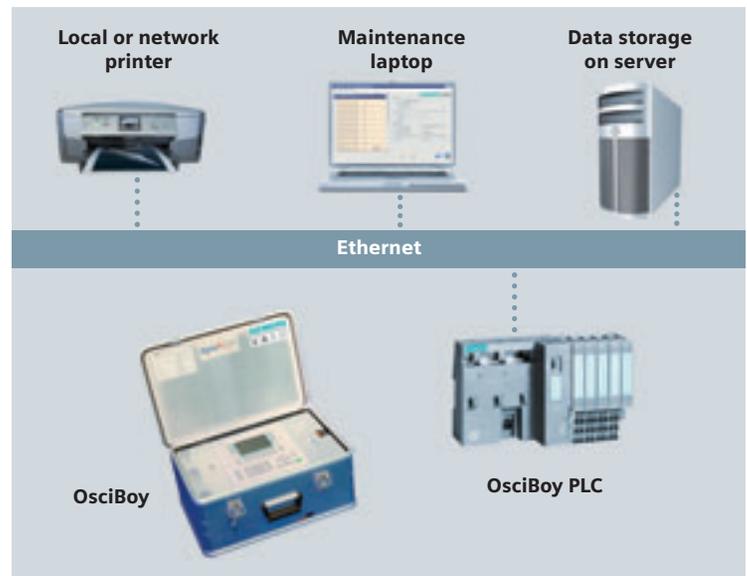
OsciBoy controls all movements of the cylinders and checks interlocks for correct operation of the hydraulic oscillation cylinders, mechanical assembly tolerances and automatic run of oscillator units. OsciBoy communicates with the package tester PC from which the maintenance technician can intervene in the testing process.

### Standard tool for custom testing

The main features of this standardized tool to test technological packages include an advanced functionality check of equipment (position sensors, pressure transmitters); monitoring of all measurements; an intuitive user interface; easy operational handling due to the operator-guided menu; automatic test of complete functionality (repeatable); test certificate for maintenance to assure proper work for operation; and informative test reports in a PDF file.

The package tester tool was designed for suppliers as well as for customers as an add-on feature to the new OsciBoy (not for OsciBoys issued prior to 2010). One of the most important features of this add-on package is its standardized documentation of tests, including all protocols of test routines and results. The reports are compiled in a secure PDF file so that the test results cannot be altered.

Predefined test sequences for single hydraulic cylinder or complete oscillator units give maintenance personnel a quality-assured and reproducible test in the maintenance area. A test for electrical connection and function of equipment, a pressure test, a sensor-calibration function, measurement of break-away force and friction work, and oscillation at various setpoints are included in the package tester software.



Maintenance Tools/OsciBoy

With a few simple clicks the user can select the test sequences, which then run automatically.

To aid both on-site and online troubleshooting, signal and error logs are attached to the protocols. The package tester software is available in a wide variety of languages. Also included is a user-guided off-line calibration function for maintenance personnel, which can be used for training. A pack-and-send function for customer support and feedback is also part of the package.

The package tester tool provides predefined test sequences to give quality-assured and reproducible test results for maintenance.

### Easy software upgrades

Package plug-ins allow easy upgrading of the software on the maintenance PC for future extensions of the OsciBoy package tester software and the possibility for extension to other technological packages. Although the package tester is compatible with the new OsciBoy only, the OsciBoy with package tester is available for all hydraulic oscillator types delivered by Siemens VAI in the past. ■

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Interview with Dr. Karl Mörwald, "Siemens top innovator"

# An Island in The Caribbean

PANORAMA >

During his distinguished career, Dr. Karl Mörwald submitted numerous metallurgical and technological patents that have had a profound impact on the long-term success of Siemens VAI. It was primarily for this reason that he was nominated "Siemens top innovator" in 2009. In an interview with Dr. Lawrence Gould, editor for metals&mining, Dr. Mörwald spoke about his life and experience and the outlook for innovation in the iron and steel industry.

*Dr. Mörwald, you are considered to be one of the most innovative persons at Siemens VAI, and you have submitted a large number of patents. Which of your developments has had the greatest impact on our company's success?*

**Dr. Mörwald:** Looking back, I would say that it was the development and market introduction of technological packages in continuous casting technology that contributed most to our company's marketing and sales successes. For example, the technological package featuring Smart segments combined with Level 2 Dynacs and DynaGap automation has been installed in hundreds of caster strands worldwide – a figure that is ten times higher than what our competitors can refer to. As a direct result of the market introduction of these packages, we were able to recruit and coach dozens of young and outstanding engineers and technicians who are continuing this tradition of innovation at Siemens VAI to this day.

*Please tell us something about your background. Did you always have a knack for innovation? What inspired you to pursue a technological career?*

**Dr. Mörwald:** I grew up on a farm in the countryside and was orphaned at a relatively early age. I wasn't aware that I had any special innovative talents or inclination, only that I really wanted to attend an HTL [Höhere Technische Lehranstalt – technical high school]. I don't know why, I just had this strong desire to go there. My university achievements would have allowed me to pursue an academic career, but I eventually decided to join a technical company where I could work in research at a very challenging level.

*Is an innovative nature something that one is born with, or is it something that can be learned or acquired, through, for example, motivation or training?*

**Dr. Mörwald:** Many people are born with a curious nature. If they are properly motivated and guided by the right mentors under favorable circumstances, then there is a good chance that not only will they have worthwhile ideas as an inventor, they will also be able to develop these ideas as an innovator to successful, marketable products.

*What could be done or what conditions should prevail to foster and promote an innovative climate within a company?*

**Dr. Mörwald:** Two things have to be emphasized here: First of all, you need a culture that tolerates mistakes or unsuccessful product developments without criticism. There is always a certain element of risk in the development process and that has to be accepted. A researcher must be able to work in a supportive environment without the fear of failure. The second important condition is that researchers should be able to spend most of their time doing research – not filling out forms or doing administrative work.

*You served both in research and management positions at Siemens VAI. Can a person be a good innovator and manager at the same time?*

**Dr. Mörwald:** No. If someone is a top innovator and a top manager at the same time, then there's something wrong with the R&D department. A top manager simply doesn't have the time to develop and implement ideas to marketable products. On the other hand, a manager with an innovative nature can extend the meaning of innovation to include new and improved approaches for business processes, customer access and sales activities.

*What are the decisive factors for successfully introducing an innovative product to the market?*

**Dr. Mörwald:** For me, the most important thing is to maintain a permanent focus on the customer's interests and needs. This is true for the development of new products as well as for the improvement of existing solutions. An innovation must be fit for use and offer tangible advantages for the customer, such as the integration of new process technologies, cost savings or easier maintenance.

*Can we still expect breakthrough innovations ahead that have the potential to revolutionize the iron and steel industry, similar to how the LD steelmaking process changed the way we make steel?*

**Dr. Mörwald:** Core processes will be enhanced by supporting technologies such as robotics, automation and informatics. For example, the Arvedi ESP (endless strip production) process would not have



**Dr. Karl Mörwald (center) was nominated as "Siemens top innovator" on October 15, 2009, by Prof. Dr. Hermann Requardt, Member of the Board of Siemens AG (left), and Peter Löscher, CEO of Siemens AG (right)**

been possible 20 years ago because we simply did not have the required fast and affordable computer capability for process control. Other developments will take place in the areas of raw materials, such as the increased use of low-grade raw materials; the environment, especially in connection with reduced pollution and increased recycling; and the efficient utilization of alternative energy resources. However, in the foreseeable future I do not anticipate developments on the scale of the LD steelmaking process, which truly revolutionized the industry.

*If you had unlimited funds available for research & development and a large staff of creative people around you, what would you do?*

**Dr. Mörwald:** (half joking) I would buy an island somewhere in the Caribic where we could do serious research work in a creative and free environment without being disturbed. ■

## Personal background

Dr. Karl Mörwald studied mechanical engineering at the Technical University of Vienna in Austria, where he received his doctorate in 1988 with the prestigious title "sub auspiciis praesidentis" from the Federal President of Austria. This distinction was awarded in recognition of consistently outstanding scholastic achievement during his secondary education and university studies. After joining Siemens VAI in 1990, he initially worked as a research engineer and was subsequently appointed head of the continuous casting technology department. After serving in other research and management positions, he was eventually placed in charge of Siemens VAI R&D in 2008, a position that he held until February 2010.

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# Going Vertical

## New vertical compactor for bar-in-coil and rod-coil products

Compacting and tying coils of rod and bar products – a task that has been performed in long-rolling mills since the late 19<sup>th</sup> century – is a simple task that has evolved into an important part of overall production. Development efforts are now concentrating on improving coil-handling technology.

One of the more subtle aspects of product quality in a long-rolling mill that produces bar or rod in coil form is the quality of the finished coil. The features of coil quality include the orderliness of the rings within the coil, uniformity of the inner and outer diameters, and compactness of the coil package for efficient shipment.

Coil-handling systems in most long-rolling mills throughout the world are principally horizontal systems in which the majority of coil transport time takes place with the coil hanging on a hook. The coil is placed on the hook either immediately after coil formation in a rod mill reform tub or after a bar-in-coil mill pouring reel. Transport of the coil on a hook offers advantages in regard to trimming and inspection. But there are disadvantages: sagging if the coil is very >>



Vertical coil-handling system



>> hot and loosening of the coil package, and there are limits on the size of the coil that can be handled.

With attention turned to improving coil quality and producing larger coil sizes, the trend in recent years has been the application of vertical coil-handling systems. Vertical systems have several advantages over horizontal hook systems: vertical systems use pallets transported on a simple floor-mounted support system and do not require large foundations, like horizontal hook systems that involve substantial structural steel for the support and transport of the hooks.

### Key role of the compactor

The compacting stage of the coil-handling process involves pressing the coil to form a dense package suitable for shipping. The compactor ties the compressed

coil with either wire or steel strap, depending on customer preference and the required product-quality level.

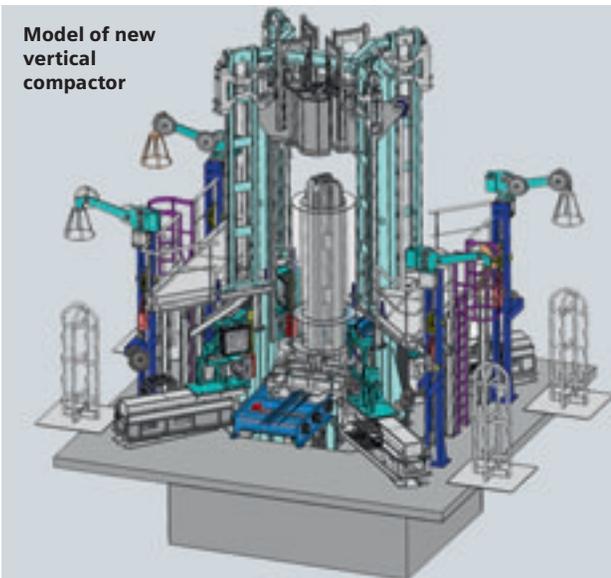
For consistency in the coil-handling system, compactors have been horizontal in most installations, with the hook system path through the compactor. The compaction occurs with the hook stationary within the compactor, allowing the same hook to deliver the loose coil and receive the compacted coil. Vertical compactors have been marketed over the years but with limited capability and capacity.

### A new generation

Several years ago, Siemens VAI developed a new generation of vertical coil-handling systems with stemmed pallets to transport coils. Compared with



Model of new vertical compactor



Horizontal compactor

more conventional horizontal systems, these new systems are more installation-friendly for existing mills due to decreased overall size layout requirements. The new vertical system weighs less and can be installed more quickly with a simple interface to the coil reforming station and to the compactor area. The vertical system is capable of handling larger coil weights without much engineering effort or added equipment costs, thereby making it attractive for new markets.

To complete the product line, a new vertical compactor was developed over the last two years. This new generation will be installed for the first time in a North American rod mill.

The new compactor has been designed to improve the rolling mill's return on investment through lower installation costs and increased reliability for reduced maintenance times. It has a smaller footprint than previous designs, thus making it more suitable for retrofit applications and minimizing space requirements in new mills. Through compacting and vertical tying, the coil packing is disturbed less than in horizontal compactors. This results in a better package for shipment, with greater security during both compacting and shipping.

The compactor has a number of features designed to make the system highly functional and able to consistently deliver high-quality coil:

- Twin centering arms to align the coil
- An elevator to position the coil on a rigid base for compacting
- Twin vertical posts to guide the press plates in a smooth vertical motion during compacting
- Four robust, independently driven guide assemblies and binding machines to tie or strap the coil

In addition, mechatronic systems provide automation for the entire compacting process to ensure control of compression, wire or strap feeding, and tying. Mechatronic systems also offer the ability to handle different recipes for press-forcing settings for various products. ■

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Gerdau Açominas expands its portfolio with technology from Siemens VAI

# Investment Opens Doors to a New Market

Gerdau Açominas placed an order with Siemens VAI in June 2010 for a plate mill and a Steckel mill. The order is part of a large investment intended to launch the company as a flat carbon steel producer in Brazil. After completion at the end of 2012, the mill will be capable of producing some 1.1 million tons of heavy plate and over 800,000 tons of hot-rolled coil annually.

ROLLING >



Plate-Steckel mill at Nanjing Iron & Steel Co. Ltd., China

**T**he Gerdau Group, the parent company of Gerdau Açominas, is currently the largest long-product steel producer in the Americas and the second largest worldwide. With a total capacity in excess of 20 million tons per annum, the Gerdau Group is the 14<sup>th</sup> largest steelmaker in the world. Gerdau is also the largest recycling company in Latin America, processing 16 million tons of scrap metal every year.

The two new rolling lines will be installed at the company's steelworks in Ouro Branco, in the state of Minas Gerais in Brazil. Under the investment program, Siemens VAI has already supplied a single-strand continuous slab caster with a capacity of 1.5 million tons per annum, which was put into operation in May 2009. As part of the current order, a second strand with the same capacity is to be added.

#### A complete package

Under the contract valued at \$290 million, Siemens VAI will supply complete engineering, mechanical and electrical equipment as well as automation systems for the two rolling lines. Also included in the contract are technological control systems and process models, which enable fully automatic thermomechanical rolling with batch rolling. Further elements of the contract are supervision services for erection and commissioning. Finally, a comprehensive training package for plant operators, production managers and maintenance personnel will ensure quick and successful entry of Gerdau Açominas in the flat-products market.

The plate-rolling line consists of a 4-high plate-mill stand, a pre-leveler, a Mulpic plate-cooling machine, a hot leveler, a cooling bed, a cold leveler, and a shear line constituting a double-side trim shear and divide shear. For the Steckel mill, Siemens VAI is supplying, a 4-high Steckel mill stand, coiler furnace, a crop shear, laminar cooling, a downcoiler and coil-handling equipment. Siroll SmartCrown technology will be installed on both mill stands to provide significant benefits in terms of enhanced shape control and increased throughput. Furthermore, Siemens VAI will supply the water-treatment plant for both lines along with plant-utility systems and complete power supply, including high-, medium- and low-voltage switchgears.

The solution for the two rolling lines is based on the integrated Siroll concept for plate and Steckel mills. The main drives of both rolling mills are to be equipped with non-salient pole synchronous motors powered by Sinamics SM150 voltage source converters. The scope of supply covers complete instrumentation and measuring systems. Siroll

microstructure monitor (MSM) is also included in the plate-mill automation for online quality assurance.

The plates produced in the mill will have a thickness of between 4.5 mm and 150 mm and a width of between 900 mm and 3,600 mm. The length of the plates will vary between 3 m and 18 m. The coils will range in width between 900 mm and 2,100 mm, and the strip will have a thickness of between 2 mm and 20 mm. The end products include not only high-grade plates for API (American Petroleum Institute) line pipes, but also for shipbuilding, the construction industry and pressure vessels.

## Siemens VAI convinced operators at Gerdau Açominas with its comprehensive technical concept.

#### An ambitious timeline

Start-up of both lines is planned for the end of 2012. An experienced and qualified team is at work to ensure execution of the project on time, within budget and in accordance with the highest quality standards. Effective project management and close cooperation with the customer help support these efforts.

The mills have been planned with an eye to the future: the combined production of coils and plates can be expanded to three million tons per annum with the installation of a roughing mill stand with an attached edger on each line, additional finishing stands after the Steckel mill stand, a second downcoiler in the coil-production line, and an additional cooling bed and a second shear line in the plate-production line. The civil works will already make provisions for future installation of additional equipment.

Siemens VAI convinced operators at Gerdau Açominas with its comprehensive technical concept and the ability to offer not only the mechanical and electrical engineering but also technology packages and technical support from one source. Siemens VAI's local presence in Brazil also ensures that qualified support will continue to be provided during the operational phase. ■

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On June 17, 2010, Siemens VAI received a contract from Allegheny Technologies Incorporated (ATI) to design, engineer and supply a new, totally integrated hot-rolling mill on a process-turnkey basis. The mill will be capable of rolling a wide range of highly diversified stainless steels and specialty alloys at widths exceeding 2,000 mm. The rolling forces will be the highest ever to be applied in a hot-strip mill.



The Siemens VAI next-generation hot-rolling mill is the critical part of ATI's new hot-rolling and processing facility

## World's Most Powerful Hot-Strip Mill

As part of a strategic investment to enhance its production capabilities, ATI Allegheny Ludlum decided to invest in an advanced specialty metals hot-rolling and processing facility that is now under construction at ATI Allegheny Ludlum in Brackenridge, Pennsylvania, in the United States. The new facility is designed to produce a unique product mix that includes flat-rolled austenitic, ferritic and martensitic stainless steel alloys; grain-oriented electrical steel; titanium and titanium alloys; nickel-based, corrosion-resistant and high-temperature alloys; zirconium alloys; and other specialty alloys. The rolled and processed products will be used in the aerospace, automotive, defense, petroleum, chemical, construction, mining and power industries, as well in various medical, food-equipment, machine and cutting-tool applications.

### Project scope

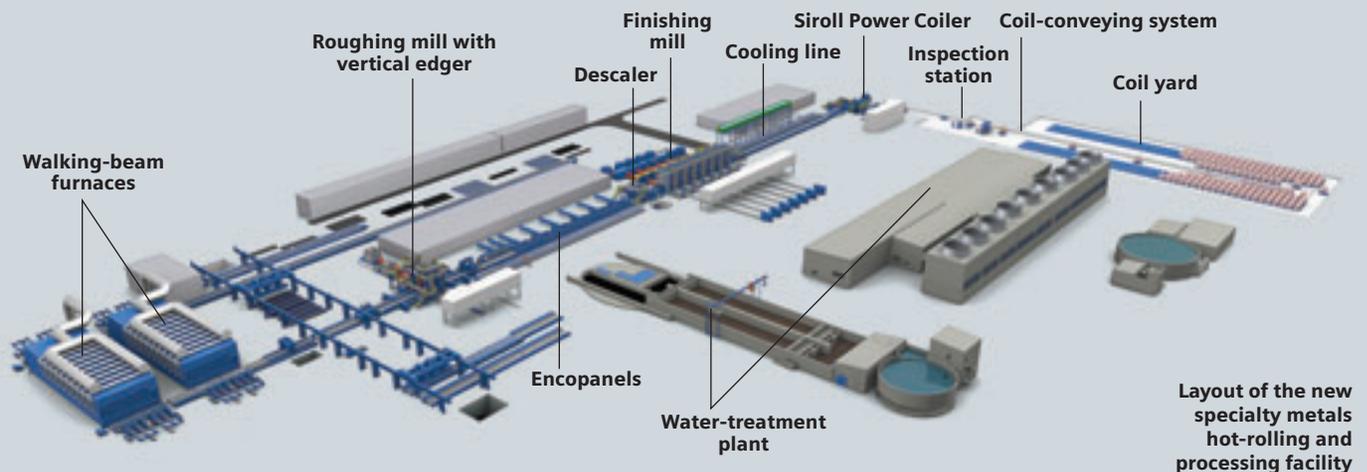
For this challenging project, Siemens VAI will supply the hot-strip mill in addition to the water-treatment

plant. The project scope includes engineering, manufacture of special components, and the supply and installation of mechanical equipment as well as electrical and automation systems.

The hot-strip mill will be comprised of a roughing stand with an integrated heavy edger, a slab shear, a crop shear, a 7-stand, 4-high finishing mill, and two Siroll Power Coilers designed to coil highly rigid steels and metallic alloys in thick gauges. The electric and automation systems include the main and auxiliary motors, drives, basic automation, process automation, a manufacturing execution system (MES), instrumentation and the Siemens VAI Siloc yard-management system.

### Technological packages and other features

In order to ensure that the highest technological demands will be met for rolling the extremely sophisticated product mix at ATI Allegheny Ludlum, the mill will be outfitted with numerous technological packages. For example, SmartCrown rolls will be installed



in the finishing stands, which will work in conjunction with L-type bending blocks. This technology will serve as the basis to achieve excellent strip profile and flatness control. Other highlights include the application of long-stroke hydraulic cylinders for automatic gauge control (HAGC), and advanced work-roll cooling and lubrication. Encopanel installed between the roughing stand and the finishing mill will minimize heat loss of the transfer bar. The laminar cooling section will be equipped with cooling headers that can be flow-controlled on the basis of the output from the Siemens VAI microstructure target-cooling model.

Additional features of the mill include its capability to roll both slabs and ingots in the roughing stand. Supervisory services for erection, start-up and commissioning in addition to customer training round off the project scope of supply.

### Concluding remarks

According to Werner Auer, CEO of Siemens VAI, "This is an outstanding opportunity for Siemens VAI to work with ATI on this next-generation, totally integrated hot-rolling mill. We know of no other facility like this one in the world. We believe this will be the most powerful and most technically advanced hot-rolling mill ever built."

Project progress is proceeding smoothly, and the new mill and processing facility is scheduled to be started up in 2013. ■

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ROLLING >



Siroll Power Coiler – the ideal solution for the coiling of high-strength and advanced steel grades

# A New Generation Of Downcoilers



Siroll Power Coilers installed at ArcelorMittal Poland

In response to ever-increasing demands by the steel industry for high-strength steels and other advanced steel grades, Siemens VAI has introduced a new generation of downcoilers that are capable of coiling high-strength steels in thick gauges. Marketed under the brand name Siroll Power Coiler, four such units are already in operation and orders have been received for the supply of five more.

The reliable and efficient coiling of advanced steel grades extending from soft thin-gauge strip to thick-gauge high-strength steels is often an insurmountable challenge for conventional coilers in hot-strip mills. More powerful coiling equipment is required to allow the product mix of a hot-strip mill to be extended to assure, for example, the coiling of high-strength steels with thicknesses up to one inch (25.4 mm), structural steel grades with yield strengths up to 1,100 N/mm<sup>2</sup>, or tubular steels such as API X80 or X100.

To meet these requirements, Siemens VAI has developed a powerful solution known as Siroll Power Coiler. This new coiler type was implemented for the

first time in 2006 in the hot-strip mill of ArcelorMittal in Fos-sur-Mer, France. This development was in response to the company's need to coil thicker-gauge, high-strength strip grades, which was beyond the capacity limits of the previous coiling equipment.

#### Technical description

As opposed to conventional coilers with three wrapper rollers, the Siroll Power Coiler is normally equipped with four wrapper rolls for strip coiling. A key focus in the development was to enable prebending of the incoming strip, which is accomplished by the pinch rolls and the first wrapper-roll unit. This setup significantly reduces overall power demands for the initial coil windings and simultaneously decreases the friction between the strip and coiler aprons.

Coiling can be performed in two modes: the classic mode with step control and the heavy-gauge mode. The coiling mode to be applied depends on the coilability index, which is a function of strip thickness, width and yield strength at the coiling temperature. Advanced control systems are installed to enable dynamic step control and force control of the wrapper rolls; non-linear hydraulic gap adjustments; hydraulic pinch-roll control; hydraulic side-guide control; and strip-tension control. Other system functions that contribute to improved strip-coiling quality include variable pinch-roll forces for different strip dimensions; side-guide force control; oscillation function; and tracked tension relief during strip thread-out from the finishing mill.



Thick-gauge strip coiled with a Siroll Power Coiler

#### Siroll Power Coiler references (as of November 2010)

Year of start-up	Customer	No. of Coilers	Max. strip width	Project type
2006	ArcelorMittal Fos-sur-Mer, France	1	2,150 mm	Mill modernization
2007	ArcelorMittal Poland	2	2,100 mm	New mill
2009	Welspun, India	1	2,800 mm	New mill
2011	Severstal, Russia	2	1,850 mm	Mill modernization
2011	ArcelorMittal Indiana Harbor, U.S.A.	1	1,981 mm	Mill modernization
2013	ATI Allegheny Ludlum, U.S.A.	2	2,083 mm	New mill

## Preassembly of the Siroll Power Coiler in the Siemens VAI workshop in France

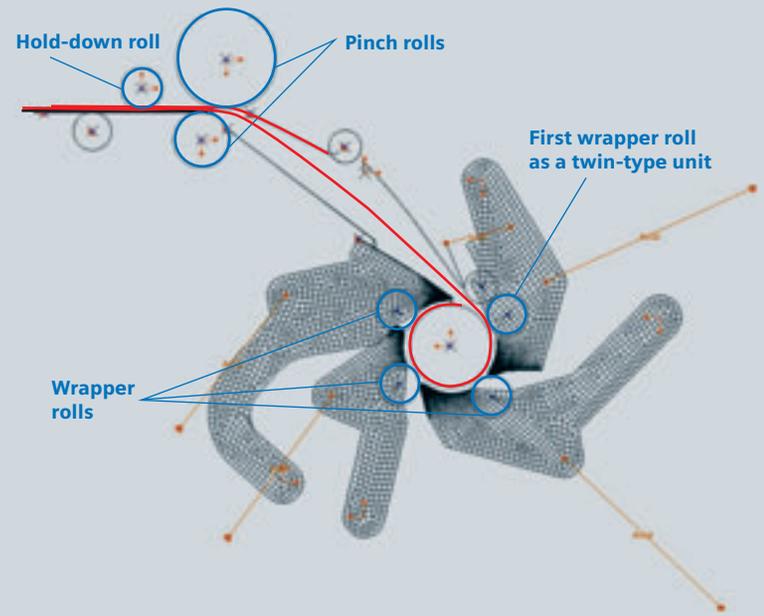


### Main design features

- Fully hydraulic and improved pinch-roll design featuring high-speed position and pressure control in addition to integrated hold-down roll for strip prebending
- Design of initial wrapper roll as a twin-type unit (patent No. W0206040497B)
- Application of precise force control on the first wrapper-roll unit
- Installation of 4<sup>th</sup> wrapper roll permitting shorter apron lengths for reduced friction with incoming strip
- Use of automatic step control for the coiling of a wide range of strip dimensions, including thinner steel strip

### Main benefits

- Reduced power requirements for initial strip windings due to pre-bending of strip with the pinch-roll and initial wrapper-roll unit
- Reliable and improved coiling quality right from the start of coiling
- Installation of 4<sup>th</sup> wrapper roll for improved operational safety, particularly for thin-gauge strip
- Compact and tight coiling of heavy-gauge and high-strength steels
- Coiling of complete product mix possible, from conventional strip dimensions to thick-gauge wide strip



Schematic design of the Siroll Power Coiler

The described solution enables a complete range of strip thicknesses – from 1.2 mm up to 25.4 mm – to be reliably and efficiently coiled at strip widths up to 2,800 mm.

### Industrial application

The Siroll Power Coiler can be ideally installed in both new and existing hot-strip mills. Four units are already in operation in France, Poland and India, and orders for the installation of five additional units in Russia and the United States have been received.

The Siroll Power Coiler is another example of recent innovative developments by Siemens VAI in the field of hot rolling that helps producers reduce costs, improve product quality, and expand their product mix to meet market demands for new and improved steel grades. ■

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Comprehensive strip temperature and microstructure control revolutionize hot-strip mill automation

# Unified Temperature Control

ROLLING >

Traditional mill-automation systems divide a plant into its specific process areas, each with separate controllers. With this layout, performance is less than optimum. Reorganizing the automation of a finishing mill and cooling section with only one comprehensive controller for strip temperature and microstructure provides substantial product-quality and line-flexibility benefits. This new solution expands the capabilities of the Microstructure Target Cooling that Siemens VAI has already implemented in more than 20 plants along with the established Microstructure Monitor solution.

**M**odern steel grades require constant and reproducible production conditions both in the hot-strip mill and in the cooling section to achieve constant material properties along the entire strip length and from strip to strip.

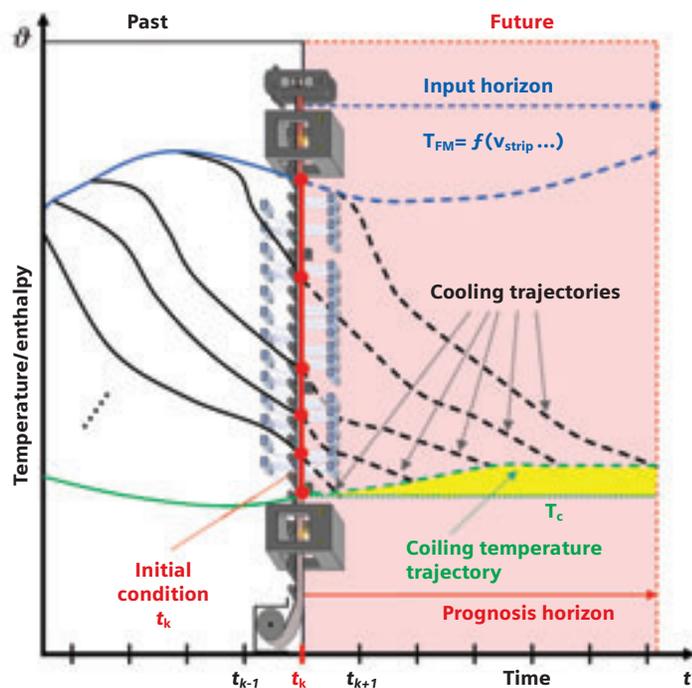
## Model-predictive control within the cooling section

Classical control uses cooling patterns during controlling as well as coiling target temperature and cooling gradients. The cooling automation of Siemens VAI directly controls the individual enthalpy time trajectories for each strip point using model-predictive control (Figure 1).

A real-time model computes enthalpy, temperature and phase fractions along the entire strip and determines cooling-valve setpoints for a number of points along the strip at each time step. Until these strip points pass the coiling pyrometer, future cooling trajectories are predicted using the cooling model and are compared to their target enthalpy trajectories. An optimization algorithm computes appropriate future valve settings, taking into account plant limits as well as future changes during the rolling process. The cooling trajectories for all strip points end at the coiling pyrometer, thus allowing the course of future  $T_c$  coiling temperatures to be predicted. The control algorithm therefore can minimize its deviation from the target-coiling temperature in advance.

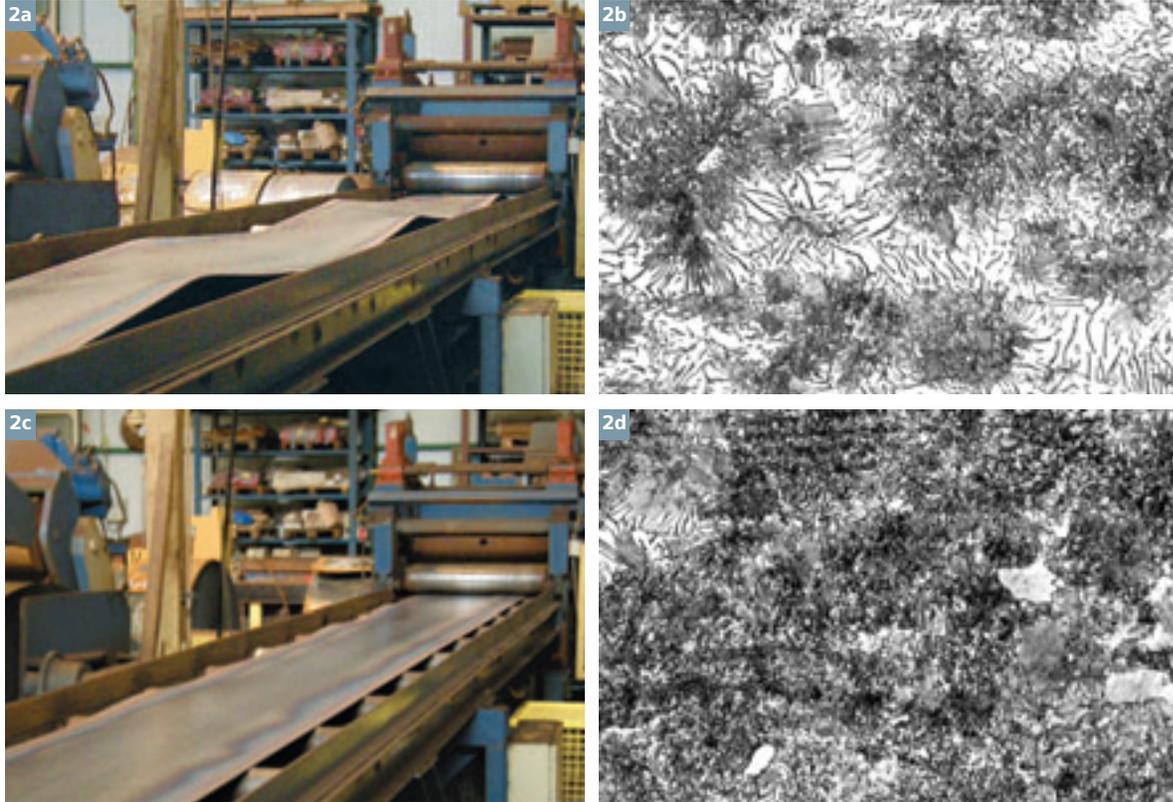
## Limits of coiler target temperature control

Nonuniform material properties can occur even with a perfectly controlled coiling temperature – particularly with high-carbon steel grades. This happens due to



**Fig. 1: Model-based predictive cooling control.** For each sample point on the strip, the future enthalpy trajectories are computed and compared to their desired enthalpy trajectory. The desired enthalpy trajectory is derived from the cooling strategy and the coiling temperature target

phase transformation; if phase transformation is still in progress at the coiling pyrometer position, any subsequently released phase-transformation heat will compromise coiling-temperature-based control. This may even result in ambiguity, so that very different amounts of water applied to the strip may lead to the same coiling temperature.



**Fig. 2a: Warping of high-carbon steel strip after some of the phase transformation has occurred on the coiler**

**Fig. 2b: Strip microstructure shows coarse pearlite due to phase transformation on the coiler**

**Fig. 2c: High-carbon-steel strip is flat if phase transformation has been completed before coiling**

**Fig. 2d: Homogenous strip microstructure only shows sorbite**

If phase transformation with a high-carbon steel grade occurs on the coiler, then warping due to internal stress becomes visible when the strip is uncoiled (Figure 2a). A microstructure analysis of such a strip shows a lot of coarse pearlite that has evolved from the remaining austenite after the finished coil has cooled down for several hours (Figure 2b).

#### Microstructure target cooling for high-carbon steel grades

A refined control strategy – microstructure target cooling – solves the problem by supplementing the coiling target temperature  $T_c$  with a phase transformation reference value  $f_{pt}$ . The target enthalpy under the coiling pyrometer is computed from the above values. The coiling enthalpy is unique regardless of strip history and phase fractions, and thus resolves the ambiguity.

For the first implementation at Hoesch Hohenlimburg in Germany, a strategy value (typically primary

data) was used for the  $f_{pt}$  parameter, which can be changed by the operator using a slider on the HMI. In this way, the operator can adjust  $f_{pt}$  to control the coiling temperature similar to previously changing the valve patterns. This smooth transition did not interfere with the quality evaluation and certification process.

Tensile-strength tests were made on the resulting strip to verify the control strategy. Figure 3 shows tensile strength vs. coiling temperature for a steel grade with 0.85% carbon content. Two strips were slightly out of tolerance. The graph indicates that there is no direct correlation between coiling temperature and tensile strength. Hence, controlling coiling temperature within tight tolerances does not guarantee a low variance of material properties.

Depicting the same strips as a function of the applied  $f_{pt}$  value (Figure 4) shows that tensile strength is significantly correlated to  $f_{pt}$ . So, by using the  $f_{pt}$  parameter as a metric for cooling control instead of coiling temperature control, material properties can >>

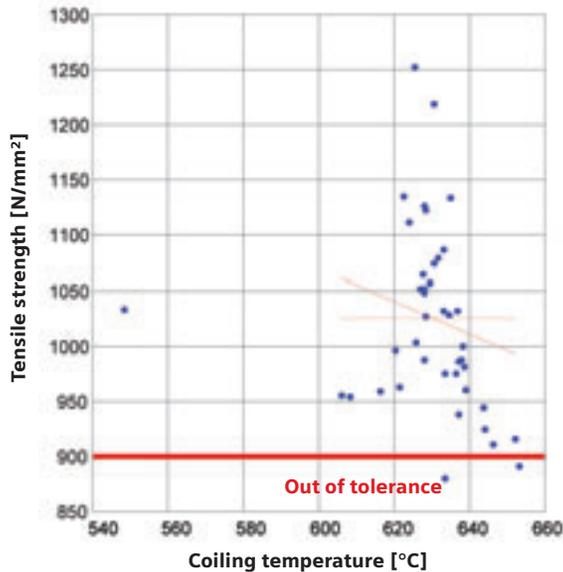


Fig. 3: Tensile strength vs. coiling temperature for 85 high-carbon steel strips with 0.85% carbon content. Apparently there is no correlation to coiling temperature

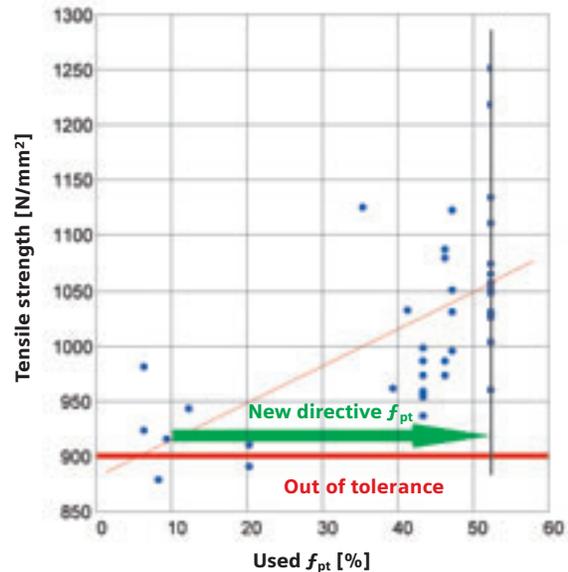


Fig. 4: Tensile strength vs. coiling enthalpy for the same strips as in Fig. 3. There is a significant correlation between tensile strength and  $f_{pt}$

>> be set without ambiguities. Microstructure cooling not only helps to control material properties from strip to strip but also within a strip. Phase transformation has finished before coiling (Figure 2c), and no internal stress is visible on uncoiling. Strip microstructure is homogenous and only shows sorbite (Figure 2d).

#### Microstructure monitor

Steel microstructure depends on various factors such as microalloying elements like Nb, V or Ti, and on substitution hardening elements like manganese and the interstitial elements C or N. The behavior of these elements is simulated by the microstructure monitor (MSM), which calculates recrystallization and grain-size development in the hot-rolling mill. Cooling control has a big influence on the phase transformation and on mechanical properties. Therefore, the cooling model and the MSM have been combined for microstructure target control (Figure 5).

Siroll MSM from Siemens VAI is available both as an embedded and a stand-alone solution. In the embedded solution, the MSM is completely integrated in the Siroll automation. In the stand-alone solution, input data are collected from the existing automation.

#### Traditional strategy yields competing control targets

In a traditional temperature-control strategy (Figure 6), the finishing mill's exit temperature is often controlled by adjusting the strip speed with a feedback

control, which accelerates the mill immediately in the case of a detected deviation. This control only affects the rest of the strip and not the actual part with the temperature deviation.

With separate cooling control, the cooling section will not be aware of what speed and strip temperature that will appear from the finishing mill in the future. Because of valve-switching delays, the cooling section cannot react to speed changes in real time. Any unexpected finishing-mill acceleration thus produces a deviation from the target-cooling course and the target-coiling temperature.

Cooling-section performance thus decreases the faster the finishing temperature controller reacts – even for model-predictive cooling control. Consequently, speed changes on the finishing mill must be limited, thus impairing finishing temperature regulation. In other words, the two separate controllers interfere with each other when trying to reach competing control targets, resulting in suboptimal overall performance.

#### Comprehensive temperature control provides a solution

Finishing- and cooling-temperature control is performed by a single comprehensive controller that updates the strip-speed diagram as well as the valve settings of the mill interstand cooling and the cooling section. A real-time model (Figure 7) computes and predicts temperature and phase fractions from the roughing temperature down to the coiler. The con-

troller (running with 200 ms cycle time) announces any strip speed changes in advance.

If the temperature in a certain part of the strip is lower than in the rest, the comprehensive controller will compute an appropriate speed diagram and interstand valve settings for compensation. Using the speed diagram data, the cooling section is prepared for an impending mill speed increase and switches valves to compensate in time. Thus, as opposed to traditional control, the cooling section valves are switched before the mill accelerates. This result is optimum performance in regard to both finishing and coiling temperatures.

### Conclusion

The concept described above provides an excellent basis for comprehensive microstructure rolling and cooling control so that material properties can be kept constant over the entire strip length. The integrated concept will be verified in a pilot project at Hoesch Hohenlimburg in 2011 and 2012.

By relying on the excellent results of the already proven Microstructure Target Cooling and Microstructure Monitor, we are sure that this new comprehensive control brings us a huge step forward in the control of material properties over the entire hot-rolling process.

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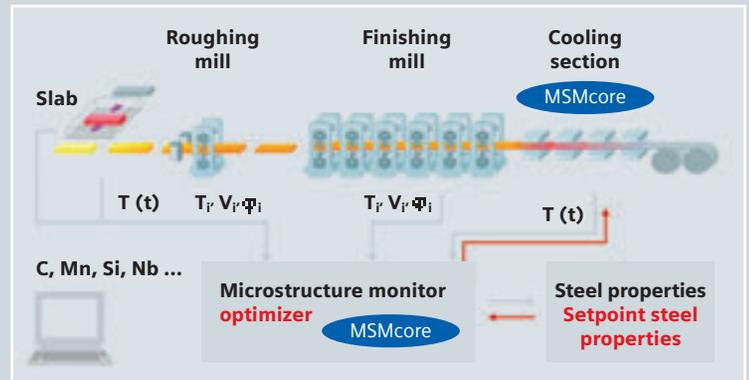


Fig. 5: Microstructure and mechanical properties of steel depend on the complete deformation process. Thus, parameters from the slab, from the roughing and finishing mill and from the cooling section are all input data for the microstructure monitor

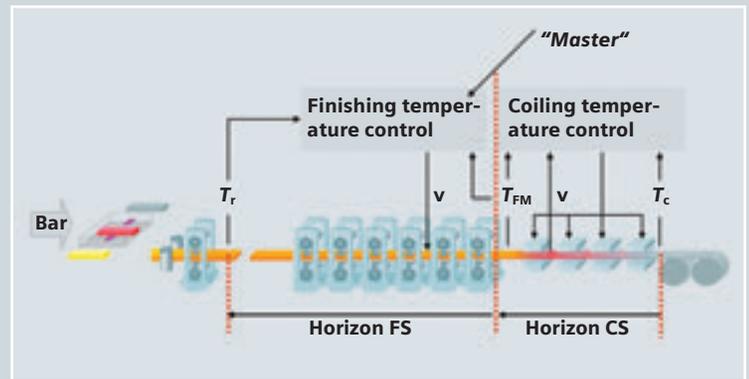


Fig. 6: Classical control scheme treats finishing mill and cooling stage separately

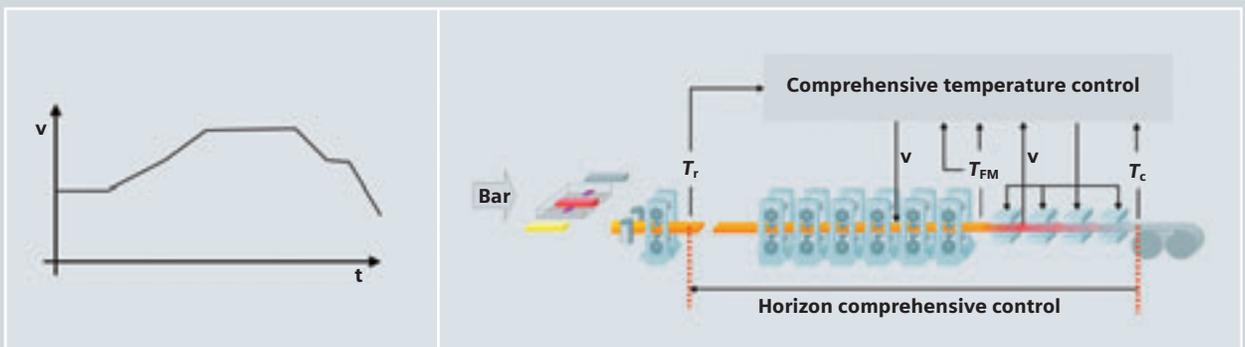


Fig. 7: A comprehensive model predictive controller updates the strip speed diagram as well as the valve settings of the cooling section in each time step

## Innovative filtering system for pickling lines

# Siroll Si-Filter Benefits

Silicon is increasingly being used in carbon steelmaking to produce steels with a higher mechanical strength. Pickling lines, which are dedicated to removing the oxide layer formed on the steel strip during the upstream treatment steps, process a high proportion of such steels. The dissolving of silica in the pickling liquor eventually leads to equipment clogging and reduced pickling efficiency. Siemens VAI now offers an innovative solution to this problem based on a new filter system.

ROLLING >

**T**he pickling of high-strength or silicon steels generates silica colloidal gel in the pickling liquor. Over time, the silica gel sticks to piping, the heat exchangers and other equipment. As a result, pickling efficiency and pickled coil quality are decreased.

### The system at work

The Siroll Si-Filter operating principle is based on continuous extraction of the insoluble silica from the pickling liquor by filtration through a cake. The filters are installed in parallel on the recycling tanks in various stages of the pickling section. The core of the process comprises candle-type filters with a cloth support for the formation of the cake. The installed filtration surface depends on the quantity of silica to be removed from the pickle solution. Siroll Si-Filter control software automatically manages the different operating sequences linked to this type of filtration: filling the filters with pickling liquor, filtration, filter draining, water flushing, cake removal, and the return of cleaned pickle liquor.

## Innovative Siroll Si-Filter removes the silica from the pickling liquor without any chemicals

Siroll Si-Filter was designed after trials at a customer site. Siroll Si-Filter uses the pickle liquor (based on hydrochloric acid) from a pickle line dedicated to silicon steel. Two weeks of tests were conducted to define the operating parameters that included the

filtration coefficient (liter/h/m<sup>2</sup>); time of filtration sequence between two regenerations (cake removal, washing and flushing sequences); the inert agent to promote cake formation and the type of cloth support.

The utilities used in the process are compressed air and industrial water. The filtering process produces acidic sludge containing the insoluble silica removed from the pickle liquor and the inert agent needed for the cake formation (inert product mainly composed of silica). The sludge has to be neutralized and dried and can be used as a filler for cement.

### Low maintenance, no chemicals

Pickle lines that process a certain quantity of silicon steel benefit the most with this solution. Since the process continuously removes the insoluble silica, no scaling appears on recycling equipment and the line must not be shut down for unscheduled maintenance. This leads to an increased line productivity (estimated at 5% to 7%) and significantly reduces maintenance costs.

Unlike other silica removal systems, Siroll Si-Filter does not require the use of chemicals such as flocculants. Only an inert adjuvant is needed to assist cake generation and ensure a good filtration flow rate.

What is more, the process is able to operate several filters in parallel. Depending on the silica content in the pickle liquor, one or more filters can be put into operation. Siroll Si-Filter can be connected to all pickling tanks and can treat all the tanks or just a selection, as required. ■

#### Author

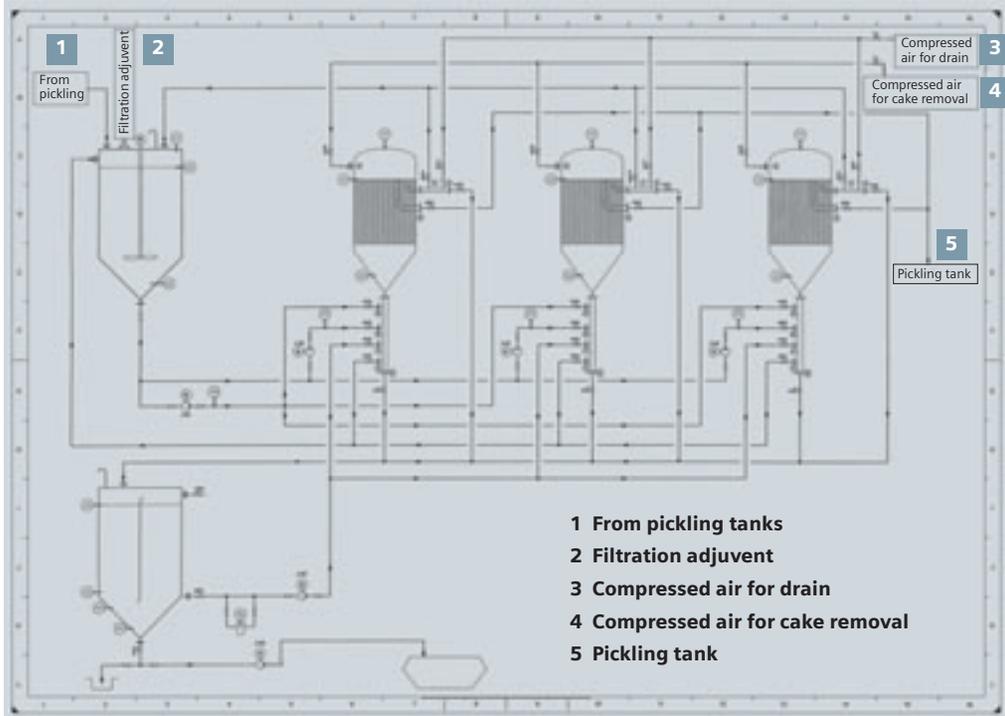
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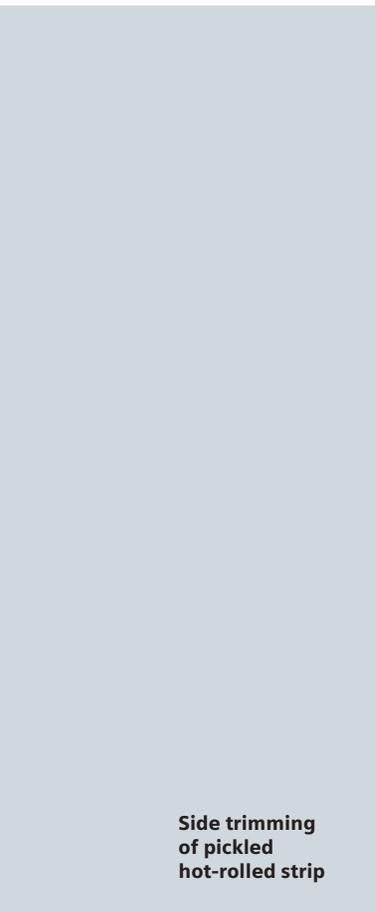


Siroll Si-Filter in operation on a pickle line dedicated to treating silicon steel

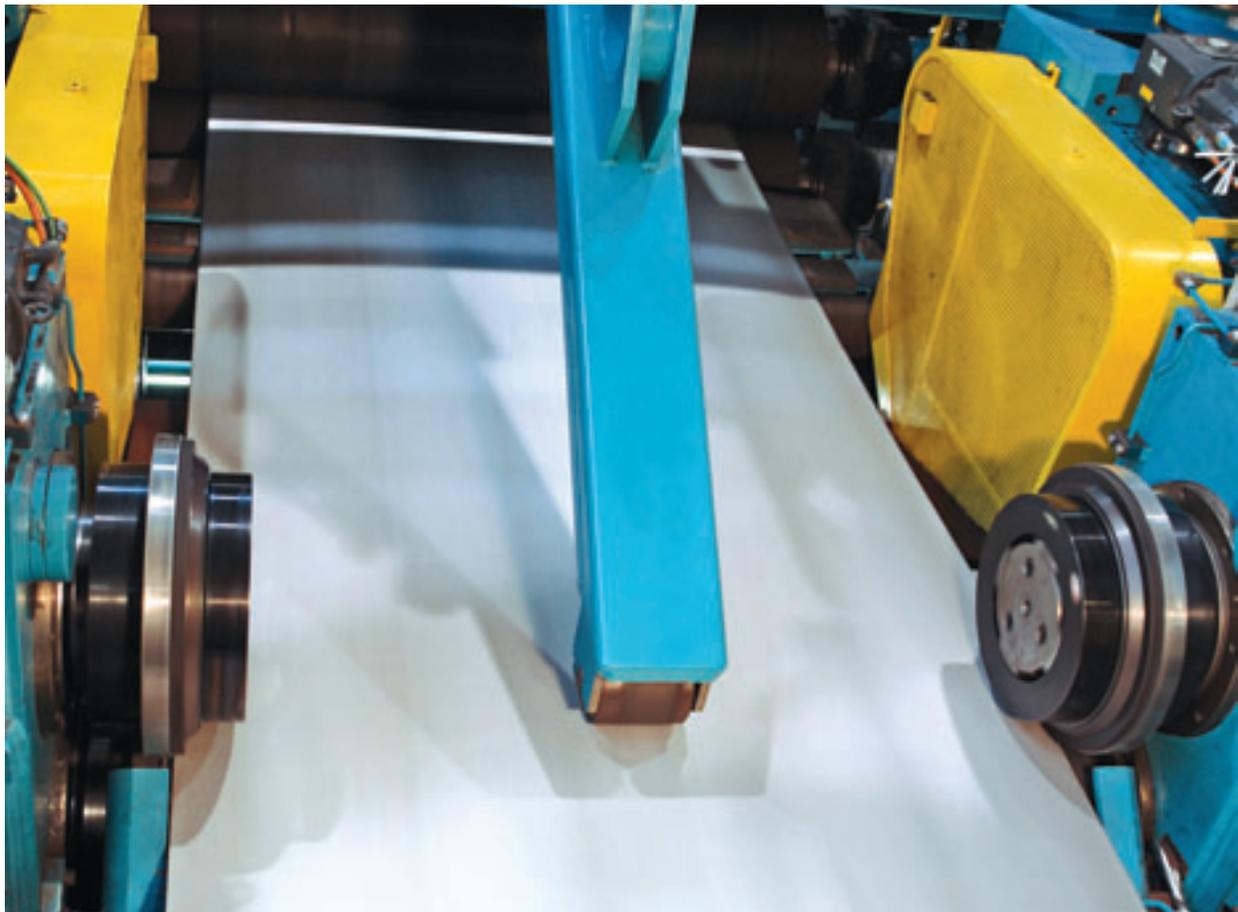


- 1 From pickling tanks
- 2 Filtration adjuvent
- 3 Compressed air for drain
- 4 Compressed air for cake removal
- 5 Pickling tank

Flow diagram of the silica removal process



Side trimming of pickled hot-rolled strip





ROLLING &gt;

**Siroll Off-Gauge Optimizer helps improve cost structures**

## Slash Reprocessing Costs

Most modernization projects are carried out to take advantage of the resulting decreased conversion costs as well as to better serve the market for cold-rolled products. Scrap resulting from off-gauge lengths leads to increased processing costs, which have a direct impact on the final cost structure. The Siroll Off-Gauge Optimizer from Siemens VAI significantly reduces off-gauge lengths. Based on the mass-flow principle of a tandem cold mill, this technology package ensures process reliability, low-maintenance operation and the highest possible product quality.



Tandem cold mill,  
voestalpine Stahl,  
Austria

**F**or manufacturers of flat products, meeting today's quality requirements means consistently producing perfectly flat products within tight thickness tolerances. This calls for sophisticated measurement devices and control systems. With its extensive experience in cold rolling, Siemens VAI offers a number of technological packages that save money as well as take energy and environmental considerations into account.

Available as an integrated package within Siroll CM or as a flexible stand-alone package ready to be integrated into an existing automation system, the newly improved technological packages from Siemens VAI

help our customers meet their project objectives and provide a quick return on investment (Figure 1).

#### **Siroll Off-Gauge Optimizer**

Strip sections with nonacceptable gauge performance have to be cut off after cold rolling. This scrap must be processed again, which involves hot and cold rolling, and consumes energy, manpower and plant-utilization time.

With the perfect combination of technology, process control and instrumentation, Siroll Off-Gauge Optimizer helps operators avoid undesirable scrap at tandem cold mills. The solution features smart >>

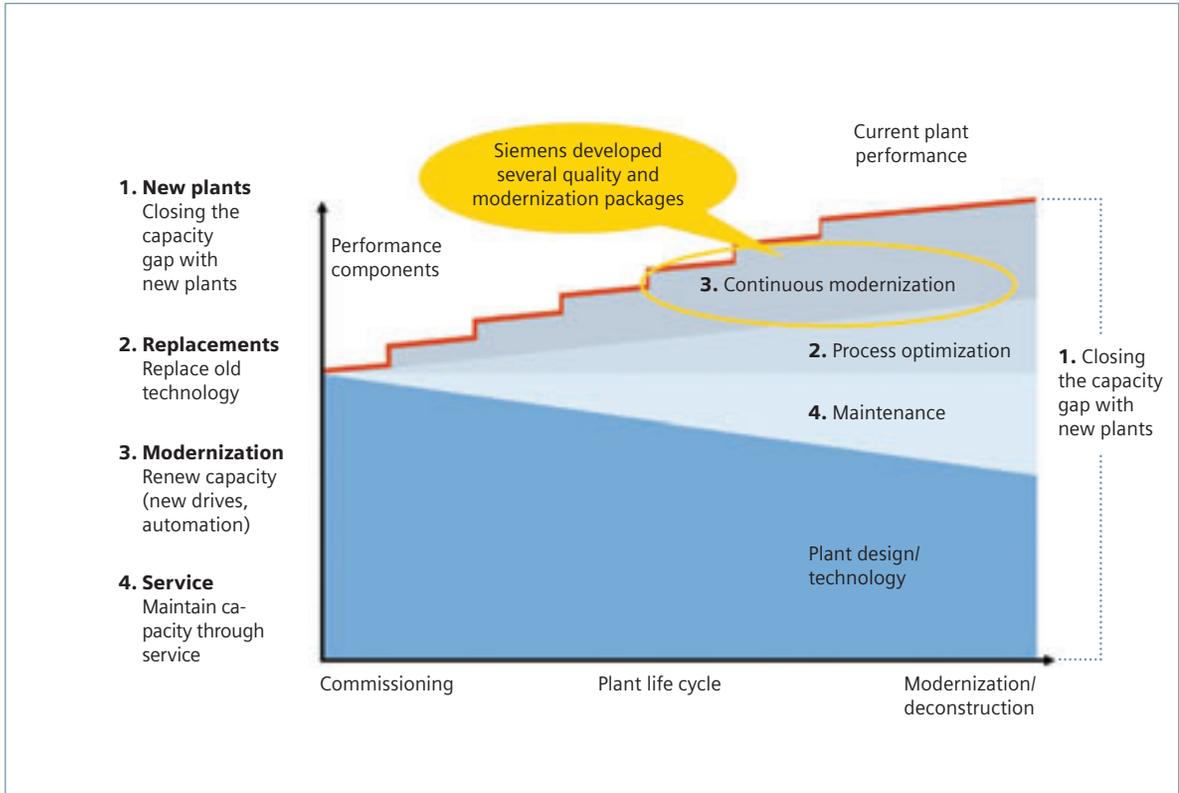
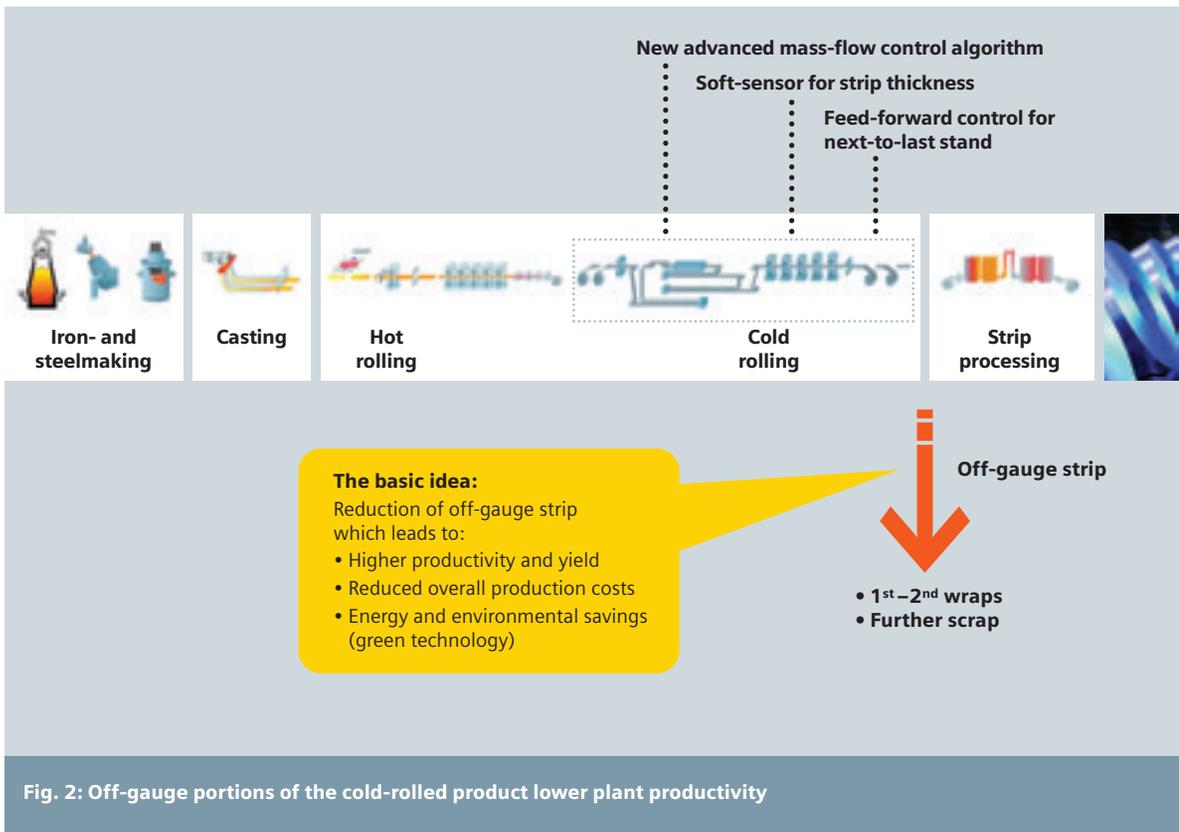


Fig. 1: Continuous modernization helps increase mill performance

ROLLING >



>> implementation of the control algorithm of a tandem cold mill based on the mass-flow principle. The Siroll Off-Gauge Optimizer comprises three new modules:

**AMF<sub>new</sub>: New advanced mass-flow control algorithm**

AMF<sub>new</sub> controls the mass flow from the tandem cold-mill entry to the mill exit. The tool assures very stable rolling conditions so that the corrections of the target thickness by the mill exit feedback control can be kept to a minimum. The targeted thickness is achieved directly after the end of the flying-gauge-change function.

**SST: Soft-sensor for strip thickness**

A soft-sensor-based roll-gap-thickness estimator perfects the performance of the Siroll Off-Gauge Optimizer during weld-seam transition rolling. Interstand roll-gap thicknesses are modeled by means of the strip speeds and one initial strip-thickness measurement. A comparison of the measured and the calculated target strip thicknesses discloses a high correlation, which serves as an endorsement of our strategy to reduce non-essential measurement equipment.

**FFC<sub>n-1</sub>: Feed-forward control for the next-to-last stand**

FFC<sub>n-1</sub> decreases thickness errors occurring, for example, from unavoidable tension disturbance during weld-seam rolling. Thickness errors are read through the SST or an existing gauge in front of the next-to-last stand.

From the performance perspective, the Siroll Off-Gauge Optimizer significantly reduces the average off-gauge length by approximately 8 m (verified at our reference plants), which leads to a higher productivity/yield (+0.25%) of the tandem cold mill. For a plant with a production of 1.6 million tons per year, this corresponds to an annual increase in yield of some 4,000 tons.

After a three-month production period, a statistical analysis of the Siroll Off-Gauge Optimizer installed on the 5-stand continuous tandem mill of voestalpine Stahl GmbH in Linz, Austria, showed that the average length of off-gauge strip could be significantly reduced.

In Figure 3 the number of coils during the three-month production period are diagrammed over the measured off-gauge length of the strip head. The red curve represents a typical tandem cold mill and comprises about 15,000 coils; the green curve is from the pilot plant and comprises about 6,400 coils. Figure 3 reveals that the yield of about 3,000 coils with off-gauge strip-head lengths of 20 m, and about 2,000 coils with off-gauge strip-head lengths of 10 m could be significantly improved if the Siroll Off-Gauge Optimizer had been installed in the tandem cold mill. ■



Coupled pickling line and tandem cold mill, Liuzhou Iron & Steel, Guangxi, China

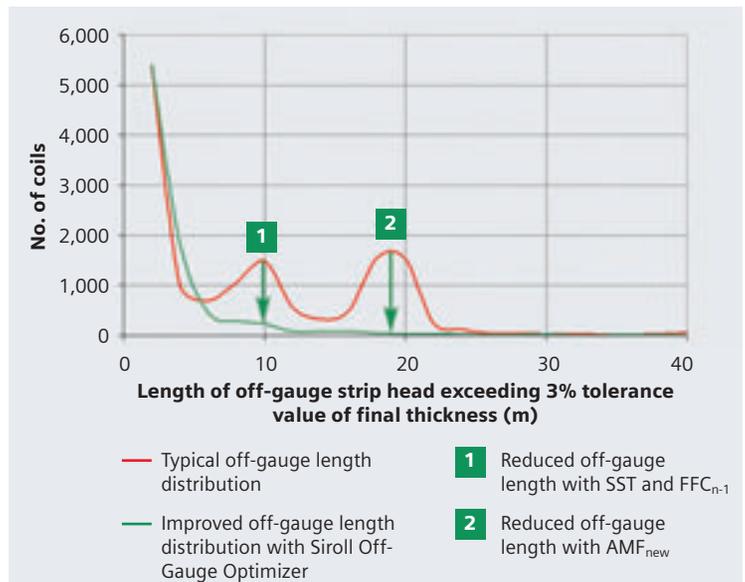


Fig. 3: Typical off-gauge length distribution with and without the application of the Siroll Off-Gauge Optimizer

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Advanced process models for the design of scale breakers and tension levelers

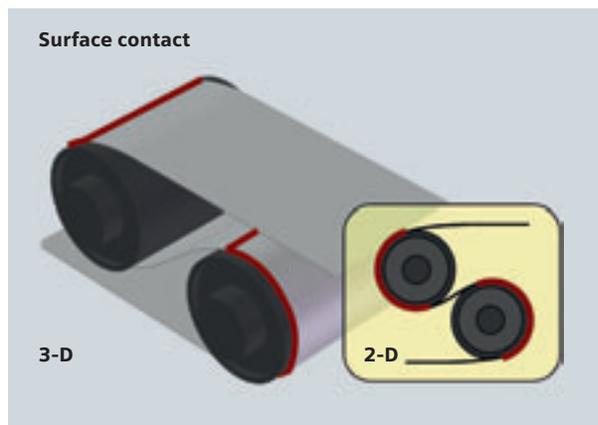
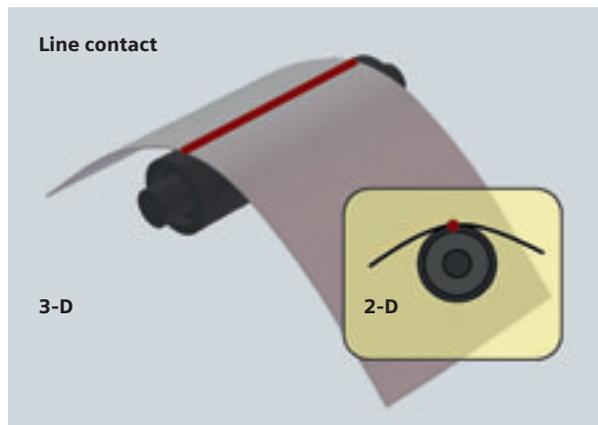
# Optimizing the Tension Leveling Process

In the metals industry, perfect flatness and outstanding surface quality are crucial factors for the market success of cold-rolled products. Precise simulation models that integrate tension leveling and scale breaking – as well as sophisticated drive concepts for the machine performing this process – optimize overall performance, promote efficient energy consumption and reduce plant investments. The authors describe this smart and green approach.

ROLLING >

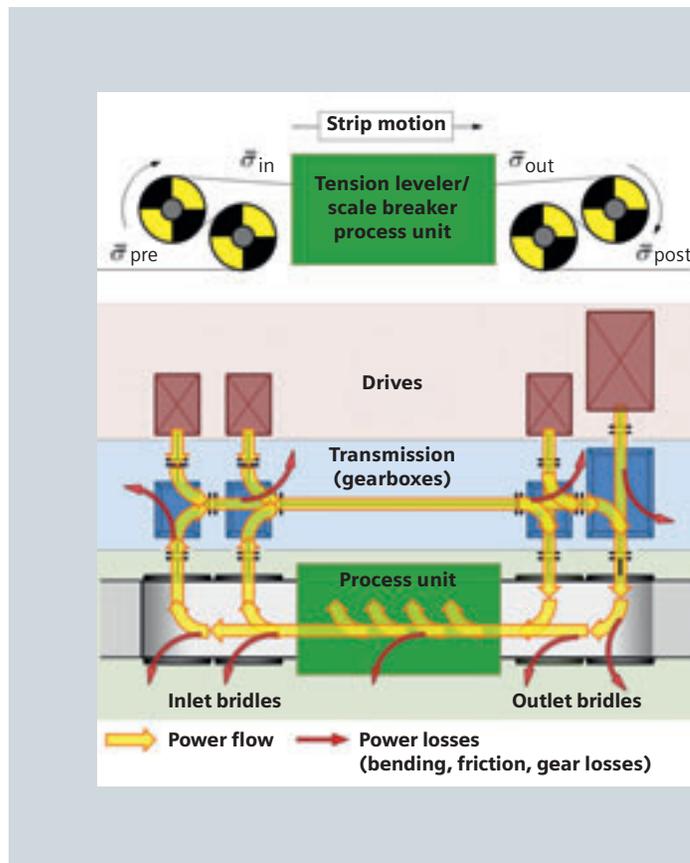


Siemens VAI scale breaker at the continuous pickling line of ISD Dunafer in Hungary



Strip/roll contact modes

Within the production chain of pickled cold-rolled metal strips, scale breakers are typically installed at the entry of the pickling section to break the oxide layers on the strip surface (which often emerge during and after hot rolling). Tension levelers are normally located at the exit of strip-processing lines, such as continuous galvanizing or finishing lines. The tension levelers improve strip flatness by reducing flatness deficiencies such as center or edge buckles and strip camber, and minimize residual stresses of the finished strip. When running through such machines, the strip is bent alternately around multiple nondriven rolls with small diameters while high tension stresses are applied. The combined bending and tensile stresses yield small elasto-plastic strip deformations, with strip elongations typically not exceeding a value of about 5%. These plastic strip deformations lead to energy dissipation and thus to power and tension losses that have to be compensated by adequate drives. The evaluation of the elasto-plastic strains in the strip and of the correlating energy dissipation (based on the determination of the strip curvature distribution) is therefore an essential and indis-



The power flow in a typical tension-leveler drive system

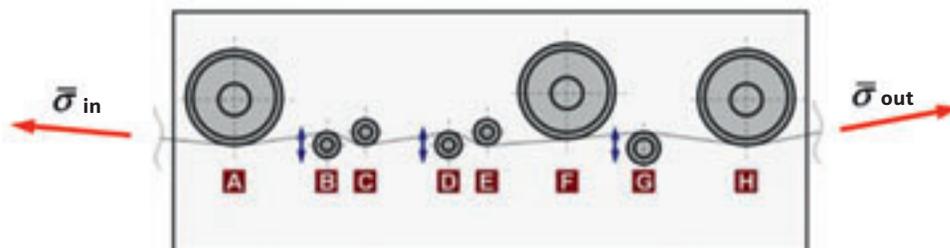
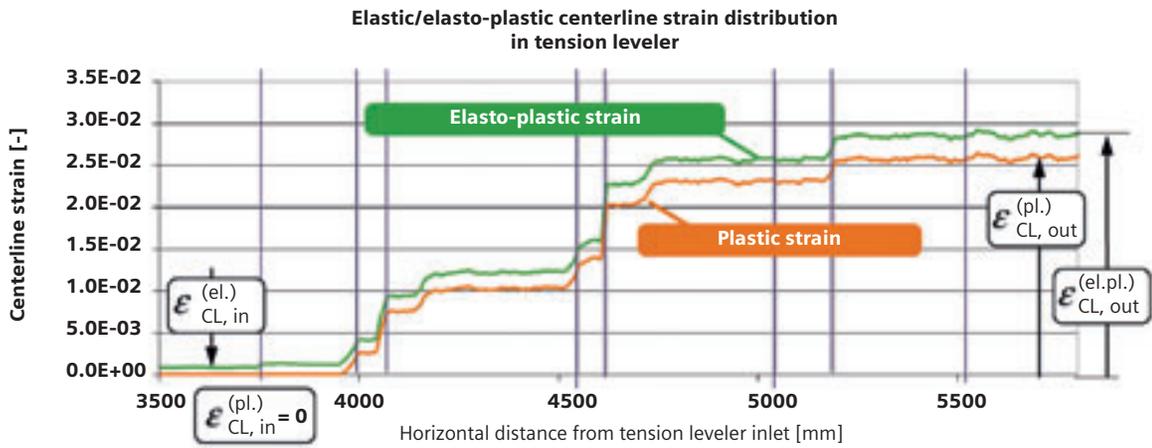
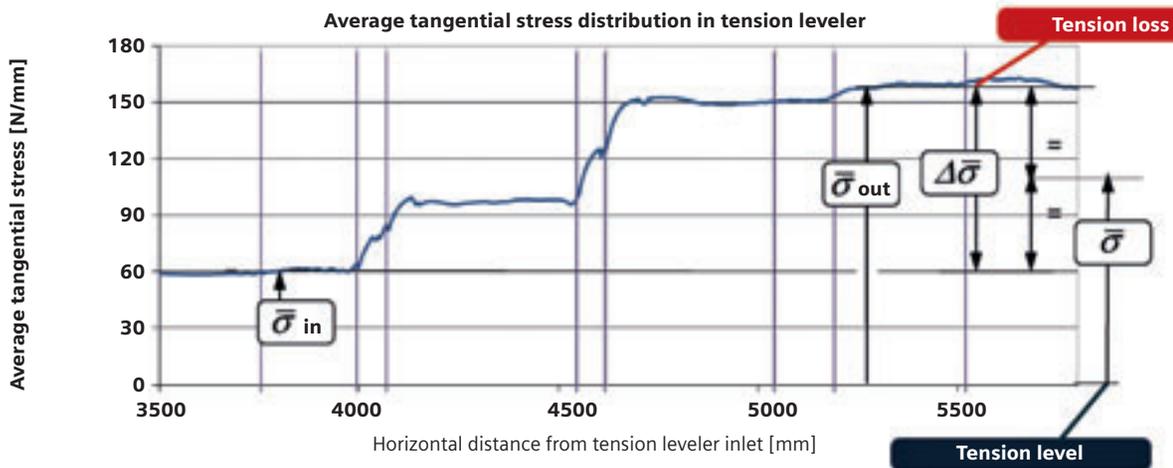
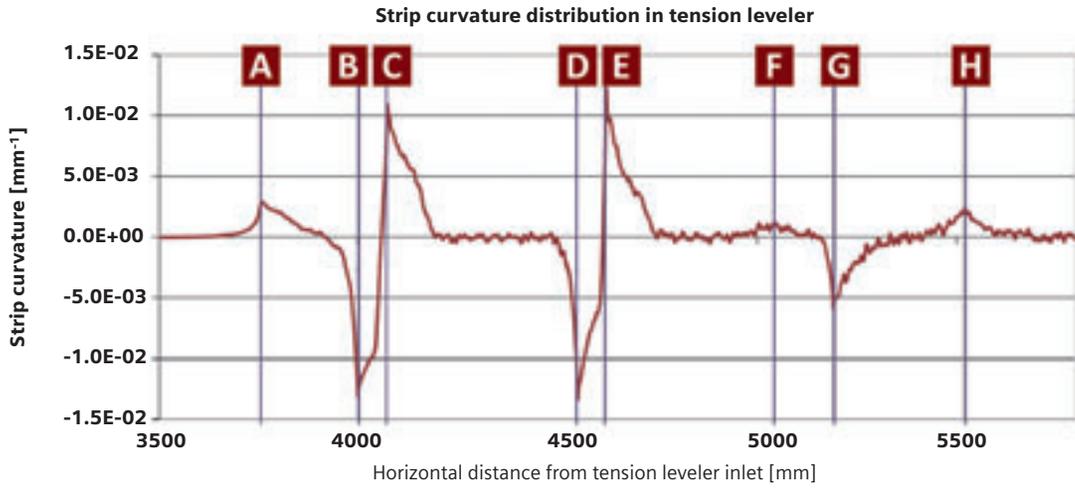
pensable step for the reliable prediction of power and tension losses and, hence, for the determination of the drive power to be installed.

### A challenging simulation environment

In order to improve the design of scale-breaking and tension-leveling machines, precise numerical models are essential. Even when using the finite-element method (FEM), the numerical simulation of the tension-leveling process is particularly challenging, as the small and coupled elasto-plastic deformations occur simultaneously at defined regions along the strip bending line. A steady-state solution cannot be obtained before at least one strip cross-section has passed through the entire process unit of the tension leveler. These requirements lead to simulation models with very large numbers of nodes and degrees of freedom, and – in combination with the highly non-linear characteristics of contact, material and geometry – to excessive computational effort even on modern mainframe computers.

### Reliable simulation concepts

To master this shortcoming, Siemens VAI, the Institute of Computer-Aided Methods in Mechanical Engi- >>



>> neering at Linz University, and the Austrian Center of Competence in Mechatronics (ACCM) have jointly developed, tested and evaluated reliable FEM models for tension levelers on 3-D and 2-D modeling assumptions and structural and continuum elements. Core objectives of the models include the determination of the bending line with the peaks of the strip curvature distribution for the evaluation of the strip/roll line or surface contact; the analysis of the reaction forces at the leveling rolls; the required level of tension; the tension losses due to plastic deformation; and the power requirements of the drives. All models take into account strip thickness, geometrical setup of the machinery, selected roll adjustments, desired degree of strip elongation, and elastic and inelastic material properties. The constitutive elasto-plastic path-dependent material law applied here takes into account the effects of linear work hardening as well as the typical reduction of the yield strength in those fibres where reversed plasticity occurs (Bauschinger effect).

### Increased computational efficiency

To overcome the high computational costs of FEM simulation models, a novel and highly specialized modeling approach has been elaborated that employs the principle of virtual work and a specialized Arbitrary Lagrangian-Eulerian (ALE) formalism. This new concept is based on Parametric Shape Functions (PSF) that describe both geometry and strain distribution of the deformed strip.

The aim is to define the steady-state strip bending line in 2-D (plane strain) by employing a drastically reduced number of degrees of freedom compared to concepts based on commercial finite element packages. In order to attain the utmost flexibility, the parametric sampling points of these shape functions (i.e., the nodes, where the parameters are prescribed) can be distributed appropriately along the strip-bending line, allowing, for instance, an increased concentration of parameters in the areas of high interest (i.e., typically where plasticity occurs).

Key results of these robust and tailor-made simulation models lie in high agreement with the output obtained from FEM simulations, while the number of degrees of freedom (and the computational effort and cost) can be reduced by a factor of 100 and more in typical test cases. Extensive comparative analyses, consistency checks as well as measurement data retrieved from an industrial tension leveler emphasize the reliability of the PSF modeling concepts. Due to their high efficiency, the PSF models show great promise in the design of scale breakers, tension levelers and any other roll systems appearing in strip processing lines.



Scale breaker located after the entry section of a continuous pickling line

### Analysis of drive concepts

What is more, a generic drive model has been developed for the analysis and evaluation of electrical, electro-mechanical, hybrid and double-hybrid drive systems with regard to power effort, dimensioning characteristics and different power flows. Flexible and modular, this model can be readily adapted for a wide range of customer-specific drive-train solutions and process requirements for power, torque and gear ratios.

At every point of the drive train, the current angular speeds (in RPM), torques and powers can be extracted. By utilizing these data, the power flow of any drive system can be determined directly by value and direction. For this reason, the generic model allows a facilitated and deepened understanding of the operation mode of any tension leveler or scale-breaker drive system.

Following a holistic mechatronic modeling strategy, the metallurgical process models are designed for easy integration into the generic drive model.

### Smart and green

Customized simulation models are reliable and efficient – as well as innovative – and help optimize the tension leveling process and the operation of the mechanical equipment behind the process. Improved plant performance and a significant reduction of energy costs are the direct benefits of this intelligent and green approach to cold rolling in metal-processing plants. ■

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Variable-speed drives help improve energy efficiency in water-pump stations

## An Investment for a Better Life-Cycle Balance

Heavy industry is increasingly being required to implement energy-saving measures. Siemens VAI continuously develops and improves its products to be more energy efficient and achieve major improvements in plant performance while assuring a favorable return on investment. The use of variable-speed drives in pump stations is one of many solutions offered by Siemens VAI to reduce energy costs in the metals industries.

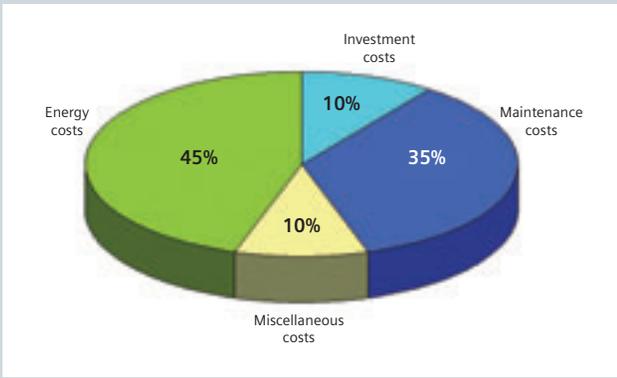
**T**he pump station is the main energy consumer in a water-treatment plant. Pump groups are normally operated continuously and at maximum capacity without process control. Second to maintenance, energy costs account for the lion's share of the life-cycle costs of pumps (Figure 1). Whereas more efficient variable-speed drives are widely used for many applications in the metals industry, when it comes to regulating water flow, mechanical overflow valves, on-off switching and throttling systems are the norm. These methods may mean lower initial investment costs, though overall operational costs are higher. Furthermore, due to continuous pump oper-

ation at maximum capacity, higher wear and maintenance costs are incurred in comparison to operation with variable-speed drives.

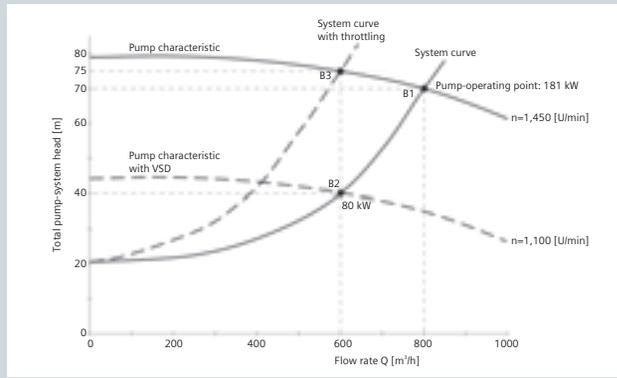
### A rundown of the options

Flow control with throttling is the simplest and least expensive solution to carry out individual adjustments and to assure continuous system control. However, the disadvantage of this method is that considerable amounts of energy are wasted.

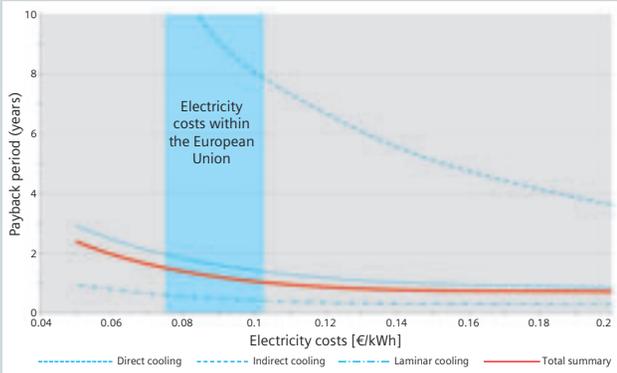
When valve control for throttling is applied, water-flow friction increases. This can be seen in Figure 2 where the system curve migrates from operating



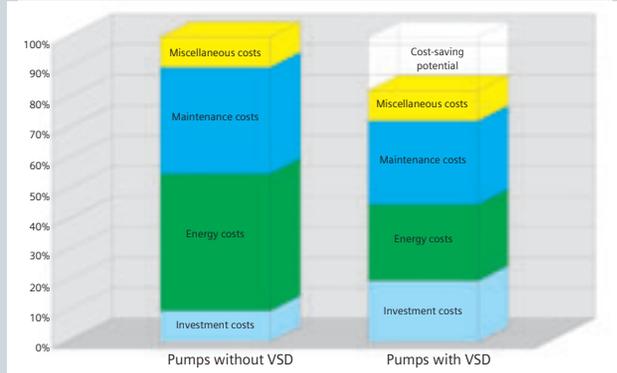
**Fig. 1: Life-cycle costs of a pump (Result of hydraulic Institute, Europump and the U.S. Department of Energy)**



**Fig. 3: Comparison between mechanical pump control and variable-speed-drive pumps**



**Fig. 2: Example of a payback period of variable-speed drives installed in the water-treatment plant of a hot-rolling mill**



**Fig. 4: Comparison of life-cycle costs between pumps with and without variable-speed drives**

point B1 to the more unfavorable operating point B3, indicating higher flow friction.

With the use of speed-controlled pumps, the rotational speed of the pump is synchronized exactly to system requirements. In comparison to the valve-control system, overall frictional forces are reduced, as can be seen by the migration of the operating point B1 to B2 in Figure 2. The result is lower electricity costs. The quick change of the velocity (as a result of closing a valve, shutting down a pump, etc.) transforms the existing energy, and a water hammer is generated. With a variable-speed drive, the process can be managed very smoothly.

### Energy savings assured

Investigations based on the preproject data for an actual project show a clear position. The payback period, depending on the different cooling systems and the energy costs, range from one to ten years (Figure 3). The installation of variable-speed drives in pump stations can reduce the life-cycle costs of a pump by up to 18% (Figure 4).

Not only energy costs are reduced, additional advantages can be derived from the “soft-starter effect,” such as avoiding water hammers, reduced stress on pipe systems and operation of motors up to 250 kW to 300 kW on low-voltage networks. Although the installation of variable-speed drives means higher investment expen-

ditures compared to valve- or throttle-control systems, the resulting electrical energy savings typically allow an average return on investment within two years.

### Conclusion

The aim of this investigation was to see in which range the use of variable-speed drives reduces energy costs, and which consequences the cost reduction has on life-cycle costs. The analysis of an existing project showed that life-cycle costs could drop up to 18%. Here most of the cost-saving potential is a result of energy savings. The payback period averages from one to ten years. Finally, the cost-saving potential is an important – however not the only – argument for the use of variable-speed drives. Additional arguments:

- Reduced energy peaks
- Operation of up to 250 kW to 300 kW pumps on low-voltage networks
- Lower maintenance costs compared to valve- or throttle-control systems
- Fewer water hammers during start-up and shut-down of water systems (less strain on pipes and valves)
- Smooth process operation

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Siroll ALU TCS process automation for aluminum rolling mills

# Advanced, Modular And Flexible

Siroll ALU TCS, the process automation system from Siemens VAI for aluminum rolling mills and foil mills, is based on the proven Simatic TDC platform and serves to optimize the production process and improve the quality of end products. Chinese customers are leading the way in the deployment of this advanced process technology, as the author explains.



Aluminum cold-rolling mill at Sanyuan Weifang, China

Even in economically challenging times, aluminum producers from China and elsewhere have not stopped looking for technologies to improve the output of their mills and the quality of the products they produce. Whether the project involves revamping a plant to improve quality and productivity or constructing an entirely new mill, plant operators always face similar challenges: short lead times; smooth start-up in the shortest possible time; and, of course, achievement of the required product characteristics and quality. To meet these demands, Siemens provides Siroll ALU TCS, which is based on the well-known Siroll suite of software and system solutions.

The hardware backbone is the high-performance Simatic TDC system, which includes all necessary functions. Building on the strength of Simatic TDC, the Siroll ALU TCS package features strip-thickness control, shape control, hydraulic roll-gap control, roll eccentricity compensation, a mill setup feature, an intuitive HMI user interface, various monitoring and diagnostics tools and standardized interfaces. The amount of re-engineering of the basic system for a single application is reduced to a minimum by the design of the I/O environment. Standardized, highly reliable hardware enables projects to be accomplished in a very short time compared to self-developed solutions.

Complementing the Siroll ALU TCS package is a special air-bearing shapemeter for flatness control, which covers cold rolled products of 0.05 mm to 5.5 mm in thickness. Siroll ISV (Integrated Solenoid Valve) handles spray-zone cooling and lubrication of the rolling mills.

### Siroll ALU TCS on a roll in China

In China in particular, the concept of standardized automation modules and optional components combined with local project management is in high demand. Two major projects – a 4-high cold mill at Weifang Sanyuan and a 4-high foil mill at Nantong Hengxiu – have recently gone into operation. With approximately 150 potential customers, the Chinese market is rich in opportunities for both revamps of existing facilities and equipment for new rolling mills.

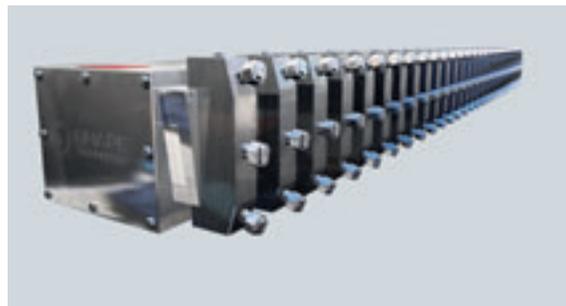
Another significant Chinese customer, Luoyang Longding Aluminum Co., Ltd., has begun start-up of 26 Siroll Alu TCS automation systems in its newly built cold- and foil-rolling mills in Henan Province. The project is due for completion in December 2011, by which time Luoyang Longding will have increased its aluminum production capacity to 600,000 tons per year of rolled aluminum products.

At Luoyang Longding, Siroll ALU TCS systems will be installed on cold-rolling and foil-rolling mill stands in conjunction with a heavy-duty shapemeter for the online flatness measurement of cold strip ranging between 0.05 mm and 5.5 mm in thickness. Even at slow rolling speeds, the heavy-duty shapemeter provides continuous, high-resolution data on the flatness of the strip being measured. In addition, Integrated Automatic Trend Alignment (ATA) will guarantee precise positioning of the measuring roller under all operating conditions. In China and elsewhere, Siemens will be responsible for the installation and start-up of all systems as well as for training customer personnel. Soon there will be more than 500 of these flatness-measurement systems in use worldwide.

Thanks to the proven Simatic TDC platform, the Siroll ALU TCS process automation system is able to optimize production flow and improve the quality of end products. Key characteristics include short realization time using standardized components, fast commissioning, high product quality, compact design and simple implementation. Potential customers in India, South America, Spain, and the United States have all expressed strong interest in Siroll technology. ■



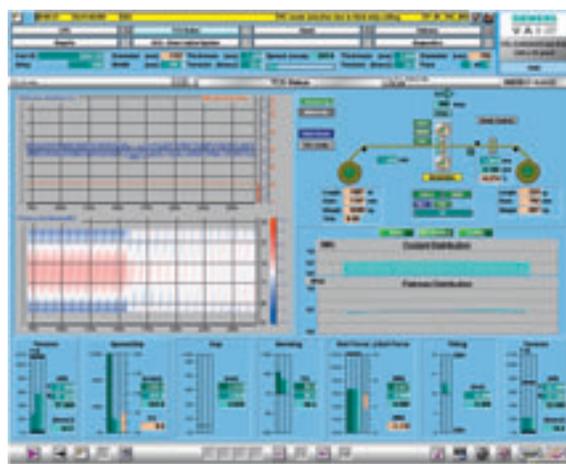
Siroll ALU TCS control cubicle



Typical system components:  
ISV spray valves



Air-bearing shapemeter



HMI – mill operator overview screen

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Optimized mill maintenance ensures operation at full potential

# High Performance, Low Cost

Analyzing the current status of key measurement areas in the rolling mill and deploying the latest in maintenance practices and equipment technology helps to increase mill utilization and achieve maximized performance on a tight budget.

SERVICES >

**M**ost long-rolling mills in the world base their mill performance on a few critical operating measurements: yield, cobble and rejection rates are the prime metrics for rolling-mill efficiency. Based on experience, world-class long-rolling mills operate with yield values of more than 96%, cobble rates smaller than 0.4%, rejections of less than 1% and an overall utilization of 80–90%.

The Peace of Mind maintenance program provides a comprehensive approach with clear, concise and achievable goals.

The most critical parameter for success, however, is utilization, as unscheduled downtimes can quickly erode the operating company's profits if the plant is not working at world-class level.

A detailed analysis of key rolling-mill parameters, coupled with the latest maintenance practices and equipment technology, can help ensure continuously high mill performance. Once critical mill areas are identified, improvement plans can be set up to proactively increase mill utilization and minimize out-of-schedule downtimes.

**Systematic maintenance improves performance and limits risks**

Measurement without planning and action is a waste of time and effort. Leveraging Siemens VAI expertise with proven methodologies, the Siemens VAI Peace of Mind (POM) maintenance program provides a comprehensive approach that uses proven methods with clear, concise and achievable goals.

The program begins with mechanical and operational audits of a mill's primary operating parameters, which are used to identify potential improvements with limited capital investment in various areas of operation and maintenance.

Operational support	Maintenance services	Equipment optimization
Rolling and process audits and services	Maintenance audits	Rebuilding and/or reconditioning
Guide equipment audits and services	Lubrication system audits	Equipment upgrades
Spare parts	Predictive maintenance	Engineering and technical support service
	Service and training contracts	

Fig.1: The Siemens VAI spectrum of services for rolling mills



Fig. 2: Siemens VAI vibration data collection unit

Code	Severity	Description
★★★★	Dangerous	Immediate shutdown and corrective action recommended
★★★	Urgent	Significant problem. Corrective action recommended without undue delay
★★★	Developing	Problem is developing or already exists. Timely corrective action may be recommended
★	Potential	Problem may exist. Vibration levels are within tolerable limits, however some action may be recommended
No stars	Acceptable	No problems indicated and no actions recommended
Highlight	Information	Observation made by technician OR information/response required from customer
→	Improvement	Significant Improvement recognized

Fig. 3: Vibration analysis report – severity criteria for maintenance activities

### Preventive and predictive maintenance

After auditing, a preventive and predictive maintenance scheme is developed on the basis of the corresponding equipment’s failure impact and scheduling maintenance steps for regular wear and tear. The execution of this scheme focuses on critical mill sections that have the greatest impact on production in the case of failure.

Predictive systems can help to prevent and properly plan maintenance, thus ensuring successful long-term mill operation. Predictive maintenance uses specific techniques to forecast potential machine failures based on known machine parameters. The key components of such a program are lubrication schedules as well as vibration and failure analyses. Most of these predictive techniques are non-invasive and can be carried out during normal rolling-mill operation. The systems produce advance warnings for potential problems, allowing for scheduled maintenance planning well in advance of major issues without disrupting production schedules.

**The capability to predict potential problems before they occur can yield significant benefits.**

As a result of efficient planning of maintenance tasks, maintenance costs can be reduced significantly thanks to more effective use of downtime and manpower, and a reduction in spare-part inventories. Another factor for maintenance-cost reductions is efficient maintenance task planning, as downtimes and service personnel are used more effectively, and on-site spares inventories can be greatly reduced.

The capability to predict potential problems before they occur can yield significant benefits. However, only few companies have the resources and the expertise to implement predictive technologies. Remote diagnosis and condition monitoring, offered by Siemens VAI as part of the POM program, provides mill operators around the world the ability to transmit data via Internet. Machine experts in the Siemens VAI service centers can then perform a predictive analysis of potentially imminent failures.

An optimized total maintenance program combines a mix of predictive technologies with typical preventive practices. The most effective approach uses knowledge-based maintenance schedules together with condition monitoring to optimize equipment service life.

### From optimization to continuous improvement

Once the maintenance scheme is implemented and functional, the user’s attention will shift to maintaining the gains that have been realized and concentrating on continuous improvement. Training and auditing for and by the mill staff, assigning ownership of the measurements and processes and follow-up are critical for continuously successful operation.

Most long rolling mills have all of the necessary data and resources at their disposal. Regularly logged measurement data hold the key to proactively maximizing rolling-mill performance. The Siemens VAI LR Service package provides all the necessary tools, techniques, detailed equipment and process knowledge to maximize mill utilization, and provides the peace of mind that mill operators deserve. ■

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# ISO Certifications for Siemens VAI Locations

## Environment, Health and Safety, Quality



Certified commitment to excellence

As a consequence of the long-term commitment to environmental protection and occupational health and safety, Siemens VAI sites in Austria and Germany received ISO 14001 and BS OSHAS 18001 certification in October 2010. In Austria, the certificates were awarded to the company's headquarters in Linz following in-depth auditing by Quality Austria, a leading internationally recognized certification and evaluation company accredited by the Federal Republic of Austria. Quality Austria also awarded the certification to the German site in Willstätt-Legelshurst. TÜV Süd, an official German testing, inspection and certification organization, awarded the certificates to the Erlangen Mechanic Center in Germany.

Siemens VAI is committed to meeting the targets of environmental protection, occupational health and safety, and quality.

Environmental protection, occupational health and safety, and quality – company core values of Siemens VAI – are integrated within a company-wide Integrated Management System (IMS). The IMS involves the coordination and reporting of all activities related to these matters, regular employee and management training programs, and the assurance that all laws and regulations pertaining to environmental and workplace safety are rigidly adhered to.

Customers often request documentation that supplier companies are committed to the core values mentioned above. The possession of such certificates is proof of a company's adherence to these values. The certificates received by Siemens VAI underline that company management and business processes are dedicated to meeting the targets of environmental protection, occupational health and safety, and quality. ■

#### Authors

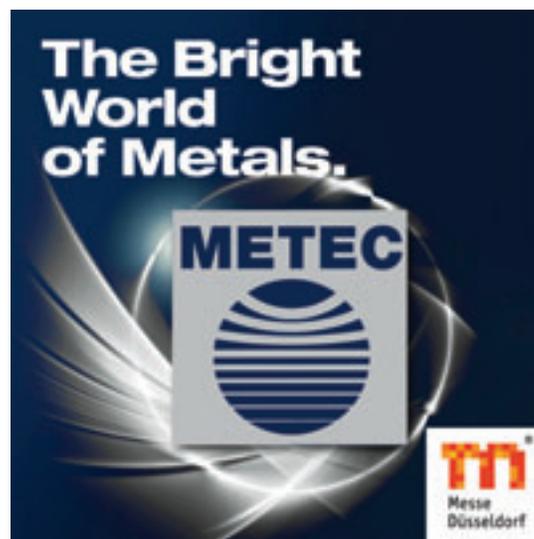
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# Events: Upcoming Conferences and Fairs

- JAN. 25 – 26** EUROPEAN MINING FORUM, London, UK, Convention Centre  
<http://www.fleminggulf.com>
- 
- JAN. 25 – 26** REGIONAL MINING, METALS & MINERALS SUMMIT TURKEY, Istanbul, Turkey, Polat Renaissance Hotel  
<http://www.ebysummits.com/events.asp?recID=97>
- 
- JAN. 29 – FEB. 02** ASHRAE WINTER CONFERENCE 2011, Las Vegas, U.S.A., Convention Centre  
<http://www.ashrae.org/lasvegas>
- 
- FEB. 02 – 04** STEELRISE'11: International Conference on Iron & Steel Industry: Emerging Trends, Jamshedpur, India, R&D Centre
- 
- FEB. 03 – 04** 18<sup>th</sup> INT. STEEL SUMMIT, Kolkata, India, Taj Bengal
- 
- FEB. 07 – 10** MINING INDABA, Cape Town, South Africa, International Convention Centre  
<http://www.miningindaba.com/>
- 
- FEB. 11 – 14** MMMM 2011 (Minerals, Metals, Metallurgy & Materials), New Delhi, India, Pragati Maidan  
<http://www.europeanpavilion.com>
- 
- FEB. 22 – 23** STAHLMARKT 2011, Düsseldorf, Germany, Intercontinental  
<http://www.handelsblatt-stahlmarkt.de>
- 
- FEB. 24 – 25** IRON ORE SUPPLY CHAIN CONGRESS, Bali, Indonesia, Conrad Bali  
<http://www.metalbulletin.com/events/iosc>
- 
- FEB. 26 – 28** METAL AND STEEL 2011, Cairo, Egypt, CICC
- 
- MARCH 01 – 03** ARAB STEEL SUMMIT, Beirut, Lebanon  
[http://events.arabsteel.info/summit2011/summit2011\\_e.asp](http://events.arabsteel.info/summit2011/summit2011_e.asp)
- 
- MARCH 23 – 24** ISIS 2011, Düsseldorf, Germany, Maritim  
<http://www.isis-world.com/>
- 
- APR. 27 – 29** 14<sup>th</sup> CONFERENCE OF EUROPEAN SCIENTIFIC ASSOCIATION FOR MATERIAL FORMING (ESAFORM), Belfast, N. Ireland, Queen's University  
<http://www.qub.ac.uk/sites/ESAFORM2011/>
- 
- MAY 02 – 05** AISTECH 2011, Indianapolis, USA  
<http://www.aistech.org>
- 
- MAY 17 – 19** 4<sup>th</sup> WORLD MINING INVESTMENT CONGRESS, London, UK  
<http://www.terrapinn.com/2011/mining/>
- 
- MAY 23 – 26** METALLURGY-LITMASH, Moscow, Russia, Expo-Center  
[www.metallurgy-tube-russia.com](http://www.metallurgy-tube-russia.com)
- 
- MAY 24** 3<sup>rd</sup> INTERNATIONAL CONFERENCE ON ALLOYS, PROFILES AND ROLLED PRODUCTS IN ALUMINIUM, Moscow, Russia, Expo-Center  
<http://www.metalinfo.ru/en/conference/?id=136>
- 
- MAY 31 – JUNE 02** HSLA STEEL CONFERENCE – The 6<sup>th</sup> Int'l Conference on High Strength Low Alloy Steels, Beijing, China, [hsla@csm.org.cn](mailto:hsla@csm.org.cn)
- 
- JUNE 01 – 03** 7<sup>th</sup> CHINA INTERNATIONAL COAL EQUIPMENT AND MINE TECHNICAL EQUIPMENT EXHIBITION 2011 (CICIME), Beijing, China International Exhibition center (old center)
- 
- JUNE 22 – 25** GALVATECH 2011, Genova, Italy, Sheraton Genova Hotel & Conference Center  
<http://www.aimnet.it/galvatech2011.htm>
- 
- JUNE 28 – JULY 2** METEC – 8<sup>th</sup> International Metallurgical Technology Trade Fair, Düsseldorf, Germany  
<http://www.metec.de/>
- 
- JUNE 27 – JULY 1** METEC InSteelCon 2011, (Congresses):
- ECIC – The 6<sup>th</sup> European Coke and Ironmaking Congress 2011
  - ECCC – 7<sup>th</sup> European Continuous Casting Conference
  - STEELSIM – 4<sup>th</sup> International Conference on Modelling and Simulation of Metallurgical Processes in Steelmaking
  - EECR<sub>STEEL</sub> – 1<sup>st</sup> Energy Efficiency and CO<sub>2</sub> Reduction in the Steel Industry
- Düsseldorf, Germany  
<http://www.metec.de/>
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See you at the Metec 2011 in  
Düsseldorf, Germany, Hall 4, Booth C03



## The next issue of metals&mining

### Focus on Plant Integration

Not many companies are capable of offering engineering and plant-building competence that covers the entire iron and steel production chain, from raw materials to the finished rolled products. With an experience record that extends back more than half a century and with the know-how acquired from the implementation of thousands of metallurgical projects worldwide, Siemens VAI stands for fully integrated plant solutions that assure that customer targets for performance, quality and reliability are met. This integration capability is not only restricted to the linking of individual metallurgical plants and production processes, but also uniquely includes vertical integration competence for entire steelworks. As part of the international Siemens network of engineering, service, workshop and manufacturing locations, Siemens VAI provides all solutions required for state-of-the-art metallurgical plants, comprising mechanical equipment, sophisticated automation systems for all levels, electrical systems, drives, motors, media-supply and water-treatment facilities. Integration solutions also include plant logistics; product tracking and quality control; plant-wide energy management; and the latest environmental and recycling systems.

The focus of the next issue of metals&mining is therefore placed on the topic of plant integration. Numerous project examples, process-optimization solutions and the latest product developments will be presented that underline an exceptional competence that works in service of and for the benefit of our customers. ■



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