SIEMENS VAI

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Metals Magazine

Innovation and technology for the metals industry

The Life-cycle Partner For the Metals Industry

“A great ship knows her destination.”

Werner Auer (l) and Albrecht Neumann (r):
Former and new CEO of Siemens VAI Metals Technologies

Dear Reader,

The journey of Siemens VAI began with the revolutionary development and worldwide implementation of the LD steelmaking process. It continued with the company's progression to becoming one the most important metallurgical plant builders in the world. Today, Siemens VAI has transformed itself into a life-cycle partner for the metals industry. Each of these transition phases has always been characterized by the same preeminent goal – to serve our customers. And this is accomplished with world-class technologies, groundbreaking innovations and comprehensive services oriented to the needs of producers.

Siemens VAI strives to serve its customers within the framework of a life-cycle partnership. This is more than a business model, it is an obligation and a long-term commitment. A life-cycle partnership extends from the initial plant installation and continues throughout the entire lifetime of the plant – often exceeding more than half a century. Through the combination of dedicated services, process-optimization solutions and equipment upgrades, existing production facilities not only sustain their original design capacity, they also surpass all performance indicators by far. This is well documented in the operating plants of our customers throughout the world. This issue of Metals Magazine therefore presents numerous cases of demonstrated capabilities, which show how metals producers can profit and excel on the market with the solutions and services offered by a life-cycle partner.

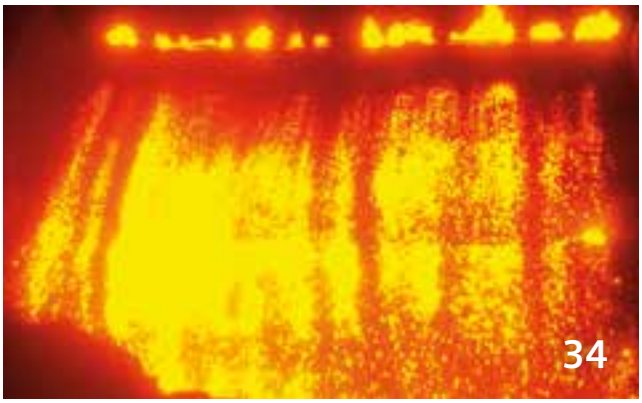
A great ship continues along her journey, however, from time to time the helmsman may change. Werner Auer, who has been with Siemens VAI since 1981, has culminated his career as CEO during the past few years. Thanks to his dedicated efforts, the foundation has been laid for the positioning of Siemens VAI as a life-cycle partner for the metals industry, which points the way forward for continued company success.

As of November 1, 2013, Siemens VAI has been under the leadership of Albrecht Neumann. Together with a team of thousands of employees, he will continue to place a strong emphasis on deepening and extending the range of services offered for optimized plant performance. The core elements of intensified business activities will be a stronger regional presence, a closer cooperation with customers and immediate assistance whenever required. Enhanced customer support will be achieved with pioneering innovations, plant modernizations, solutions for energy efficiency and environmental care, as well as industrial IT and automation. Above all, the charted course to serve as a life-cycle partner for the metals industry will be maintained as the basis for win-win project successes.

Yours sincerely,

Dr. Lawrence Gould
Managing Editor

Contents



Cover Story

Technology

Transition from a plant builder to a life-cycle partner

A major global overcapacity in steelmaking means that fewer new plants will be installed. Siemens VAI is therefore transforming itself from a plant builder to a life-cycle partner for the metals industry to help producers remain competitive. This is achieved by enhancing the performance of existing facilities with the latest technologies, process-optimization solutions and specialized services.

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Examples of recent Siemens VAI

Project Activities

1. Brazil

Votorantim reveals record mill performance at long rolling symposium

The Siemens VAI wire rod mill commissioned for Votorantim Siderurgia in Resende, Brazil, has delivered dramatic results since its commissioning in 2009, reported Votorantim on June 25 at a long rolling symposium in Worcester, Massachusetts, U.S.A. Figures for mill availability, yield, quality and performance and overall equipment effectiveness rose substantially between 2009 and 2012, and the mill set a production record in August 2012.

The 500,000 t/a wire rod mill received government quality approval within its first three weeks of operation. Mill performance measures rose from 57% in 2009 to a near-perfect score of 97% in 2012. In the same time period, quality rose from 91% to 99.5%. Yield gains went from 91% to almost 96%, and overall mill availability soared from 61.66% in 2009 to 79.73% in 2012. The single-strand mill set a production record last August 2012, producing 47,004 tons in a single month.

Outstanding performance of Votorantim Siderurgia's wire rod mill

2. China

Start-up of bloom caster at Zenith Steel

In July 2013, a 5-strand bloom caster supplied by Siemens VAI commenced operation at the integrated steelworks of Changzhou Zhongtian Iron & Steel Co. Ltd. (Zenith Steel) in Changzhou, Jiangsu province. The caster is capable of producing approximately 1.3 million tons of round blooms per year comprising structural steels; high-carbon, alloyed and low-alloyed steels; and pipe steel grades. The cast blooms, with diameters ranging from 360 mm to 600 mm,

Worldwide

1. Resende, Brazil
2. Changzhou, China
3. Zhongyuan, China
4. China
5. Bremen (1), Germany
6. Bremen (2), Germany
7. Duisburg-Huckingen, Germany
8. Raipur, India
9. Visakhapatnam, India
10. Ilva, Italy
11. Aktobe, Kazakhstan
12. Pohang, Korea
13. Dilovasi, Turkey
14. Fujairah Free Zone, U.A.E.
15. Corpus Christi, U.S.A.

are further processed into seamless pipes or are used to produce forging steels.

Siemens VAI designed the continuous casting plant, supplied key components, and provided the complete basic and process-automation systems. To support reliable casting operations and the production of high-quality blooms, a wide range of advanced technological packages was installed in the caster, including the DynaFlex hydraulic mold oscillator, LevCon mold-level control, DynaGap Soft Reduction to minimize center-strand segregation, and a sophisticated VAIQ quality management system. The scope of services also covered advisory services during construction and commissioning, and customer training.

5-strand bloom caster, Zenith Steel

3. China

Vertical caster for Zhongyuan Special Steel Co.

The Chinese steelmaker Zhongyuan Special Steel Co. Ltd. placed an order with Siemens VAI to supply a 2-strand vertical bloom caster for the production of up to 370,000 t/a of heavy round blooms with diameters of 400 mm, 600 mm and 800 mm. The new caster will enable the company to expand its range of products to include blanks for construction steel, tool and bearing steels, and heat-resistant stainless steels. Caster start-up is scheduled for late 2014.

A newly designed multi-roller drive unit will provide optimum support of the blooms with weights of up to 120 tons. Siemens VAI is supplying the entire process equipment, the secondary cooling system, and basic and process automation. The caster is equipped with the DynaFlex oscillator for flexible adjustment of the mold oscillation parameters. Additional caster features include the LevCon mold-level control system, the Mold Expert breakout-detection system, a straight DiaMold tubular mold, the DynaSpeed metallurgical cooling model and DynaJet cooling nozzles.

Example of a vertical caster supplied by Siemens VAI

4. China

Siemens to supply two Arvedi ESP lines to China

An order was placed by a Chinese steel producer for the supply of two Arvedi ESP (Endless Strip Production) lines. The new plants are designed for an annual production capacity of up to 2 x 2.55 million tons of high-quality, ultra-thin, hot-rolled strip products with widths of up to 1,600 mm and thicknesses down to 0.8 mm. Carbon steels, high-strength low-alloyed (HSLA) grades and dual-phase steels will be produced. The plant is scheduled to go into operation in 2015.

Siemens VAI is responsible for engineering the Arvedi ESP plants and will provide mechanical equipment, media-control systems, technological packages and integrated automation systems. The project scope also features a comprehensive training and assistance package.

In the Arvedi ESP process hot-rolled coils are produced in a linked casting and rolling plant directly from liquid steel in a continuous and uninterrupted manufacturing process. The energy consumption required for this type of casting-rolling facility is reduced by up to 45% compared with conventional casting and rolling processes.

5. Germany

Commissioning of twin-ladle furnace at ArcelorMittal Bremen

In April 2013, a 300-ton twin-ladle furnace supplied by Siemens VAI went into operation at ArcelorMittal Bremen GmbH in Bremen. This plant replaces the two conditioning stands that were previously used for treating liquid steel, resulting in a reduction of treatment costs.

The twin-ladle furnace is installed directly downstream of the LD converter in such a way as to ensure the best-possible logistic links to other parts of the plant and to minimize crane movements. The ladle furnace is used to treat up to 3.5 million tons of crude steel per year. Its main task is to heat the liquid steel, which allows the tapping temperature at the LD converter to be lowered by about 30°C. This reduces the consumption of refractory material in the converter. A Simelt AC electrode control system is applied for precise control of the electrodes. The ladle furnace also can be used for fine alloying work and injection processes.

Existing Arvedi ESP plant at Acciaieria Arvedi SpA, Cremona, Italy

Siemens VAI SmartMold equipped with a hydraulic mold oscillator

6. Germany

Slab caster modernization at ArcelorMittal Bremen

A 2-strand slab caster with a casting capacity of nearly 4 million t/a will be modernized by Siemens VAI for the German integrated steel producer ArcelorMittal Bremen GmbH in Bremen. The machine heads will be furnished with new SmartMold cassette-type molds for easy replacement of the copper panels. DynaWidth technology packages will be installed to enable dynamic slab-width changes during ongoing casting operations. Furthermore, DynaFlex technology packages will allow online adjustments of the mold oscillation parameters to be carried out for optimized strand-surface quality. The project aims to boost the availability and reliability of the caster and to further increase product quality. The first strand is to be modernized in the fall of 2014 and the second in 2015.

Twin ladle furnace installed at the ArcelorMittal Bremen plant

The energy consumption required for rolling in an Arvedi ESP line is reduced by up to 45% compared with conventional casting and rolling processes.

7. Germany

Modernization of No. 1 Slab Caster at Hüttenwerke Krupp Mannesmann

In order to increase the slab output to 1.1 million t/a and to improve internal slab quality, Hüttenwerke Krupp Mannesmann GmbH (HKM) commissioned Siemens VAI to modernize the No. 1 Slab Caster at the company's Duisburg-Huckingen plant. The caster will be equipped with a hydraulic mold divider required for the production of twin narrow slabs, which is used as the input material for the rolling of medium strip. This will result in tighter product tolerances. In a second stage, the first casting segment will be redesigned to allow additional rolls to be installed to support the slab. This will reduce bulging on the narrow faces of the strand and improve internal slab quality. To boost plant capacity, a new runout area of the caster will be installed. The entire conversion of the casting plant will take place during a scheduled ten-day plant standstill.

8. India

Dephosphorization plant for Vandana Global

A low-cost and highly compact treatment stand for the dephosphorization of liquid steel will be installed at Vandana Global Ltd. in Raipur, in the Indian state of Chhattisgarh. This unit was specially developed by Siemens VAI for small- and medium-sized steelmakers who use the induction furnace route to produce liquid steel from scrap and sponge iron. This dephosphorization plant is being put to use for the first time ever at Vandana.

The plant will ensure compliance with the new specifications mandated by the Bureau of Indian Standards (BIS) with respect to the maximum permitted phosphorus and sulfur content. Vandana Global will also be able to offer higher-grade structural steels to the market. Commissioning is scheduled for the beginning of 2014.

9. India

Modernization of blast furnaces at Vizag Steel

As part of a major expansion project underway at Visakhapatnam Steel Plant (Vizag Steel) to boost the total hot metal output from 6.3 million to 7.3 million tons per year, Siemens VAI received an order for the modernization of the company's three blast furnaces. The project scope features the complete renewal of Blast Furnace No. 2 and the installation of a new offgas-cleaning plant. The interior volume will be expanded from 3,200 m^3 to 3,820 m^3, which, together with numerous other upgrading measures, will increase the plant's hot metal output from 1.7 million to 2.5 million tons per year.

Furthermore, five hot blast stoves will be upgraded on Blast Furnaces 1 and 2 to bring them in line with state-of-art technology. Modernization of Blast Furnace No. 2 is expected to be completed in the third quarter of 2015, while the refurbishment of the hot blast stoves will be concluded in 2016.

Blast Furnace No. 2, Vizag Steel, India

Dust emissions from Ilva's sinter plants will be reduced to less than 10 mg/Nm^3.

10. Italy

Secondary dedusting systems for Ilva's sinter plants

Ilva S.p.A. placed an order with Siemens VAI to install secondary dedusting systems in the two sinter plants at the company's Taranto steel mill. The dedusting systems will be able to clean 1.5 million m^3 of ambient air per hour and will reduce dust emissions from the sinter plants to less than 10 mg/Nm^3, which is well below the legal limit. The sinter plants have a nominal capacity of 11 million tons of sinter per year.

The project scope includes the installation of offgas ducts, fans, clean air ducts, stacks and an integrated automation solution. A special filter control will ensure efficient dedusting even under changing operating conditions. Commissioning of the dedusting plants is scheduled for early 2014.

11. Kazakhstan

Aktobe Rail and Section Works orders new mill

An order was received from Aktobe Rail and Section Works LLP, Kazakhstan, for the supply of a combined rail and section mill with an annual capacity of 430,000 tons. The new mill will be constructed in the town of Aktobe, and it will be the first rail manufacturing plant in Kazakhstan.

A total of approximately 200,000 tons of rails with lengths of up to 120 meters, and 230,000 tons of angles, U- and I-shaped sections will be produced. Siemens VAI will supply the complete rolling line, a walking-beam furnace, a reversing blooming stand, a reversing universal mill train, a 125-meter-long cooling bed, and bundling and handling equipment. A special feature of this project will be the application of the Idhra+ (Injector Dual-phase Rail Hardening) system – jointly developed by Siemens VAI and Centro Sviluppo Materiali S.p.A. – to produce high-strength rails. Production is scheduled to start in the second half of 2014.

12. Korea

300-mm-thick stainless steel slabs produced at Posco

A single-strand stainless steel slab caster capable of casting 300-mm-thick stainless steel slabs was put into operation in July 2013 at the Pohang steelworks of Pohang Iron and Steel Co. Ltd. (Posco). This ultra-thick slab caster is designed to produce 700,000 tons of austenitic and ferritic steel slabs per year. Slabs are cast with thicknesses of 250 mm and 300 mm, and in widths ranging from 800 mm to 1,650 mm.

Siemens VAI was responsible for engineering, basic automation and process-optimization systems, and the supply of key components and technology packages. The latter included LevCon mold level control, the DynaFlex mold oscillator, DynaWidth for the flexible adjustment of the slab width and DynaGap Soft Reduction 3D, the latter of which is decisive for achieving the highest-possible internal slab quality. The secondary cooling system features a combination of the Dynacs 3D cooling module, DynaJet spray cooling and internally cooled I-Star rollers for producing slabs with high-quality surfaces.

The new mill will be the first rail manufacturing plant in Kazakhstan.

Ultra-thick stainless-steel slab caster in operation at Posco's Pohang steelworks, Korea

13. Turkey

EAF dedusting plant to be modernized at Diler

Siemens VAI received an order from Turkish steel producer Diler Demir Çelik End.Ve Tic. A.Ş. (Diler) for the modernization of the dedusting plant for the company's finger-shaft electric arc furnace located at the Dilovası steelworks in Kocaeli province. The goal of this project is to ensure that the plant's emission levels conform to the latest European standards on a long-term basis.

The new dedusting system will be capable of cleaning up to 1.5 million Nm^3 of furnace offgas per hour. Siemens VAI will provide a post-combustion chamber with the burners, the associated control system and the primary exhaust gas line with a forced draught cooler. This special cooler considerably accelerates the secondary cooling of the exhaust gases for improved cleaning efficiency. The modernized dedusting plant was recently started up.

Example of a reversing blooming stand from Siemens VAI

14. United Arab Emirates

Long-product rolling mill under construction for United Steel Industries

A new long rolling mill is currently being built by Siemens VAI in the Fujairah Free Zone for United Steel Industries LLC. The plant will have an annual production capacity of up to 950,000 tons of structural steels comprising both rods and wire coils. The diameters of the rods will range from 10 mm to 40 mm, and coiled wire will have diameters between 5.5 mm to 16 mm.

The merchant-bar line will consist of 21 rolling stands, a heat-treatment system, a 120 m cooling bed, and machines for counting, bundling and binding the bars. The wire mill includes a 10-stand monoblock finishing mill, pinch rolls, the laying head, a cooling conveyor, machines for forming and compacting coils, and crop shears for both rolling lines. A water-treatment plant, electrics and automation, and media-supply systems are also being supplied by Siemens VAI. The rolling mill is scheduled to come into operation in mid-2014.

Example of a rod mill roller table supplied by Siemens VAI

The plant will produce 2 million tons of hot-briquetted iron per year, making it the largest HBI module in the world.

15. United States

Direct-reduction plant to be built for voestalpine in Texas

Siemens and consortium partner Midrex Technologies, Inc. received an order from the Austrian voestalpine group to build a direct-reduction plant near the city of Corpus Christi, Texas. The plant is designed to produce 2 million tons of hot-briquetted iron (HBI) per year, making it the largest single module of this type in the world. The Midrex facility will produce HBI from iron ore pellets. The HBI will be partially shipped to voestalpine's steelworks in Linz and Donawitz to produce high-quality long and flat steel products.

The consortium will supply engineering, mechanical and electrical equipment, and advisory services for the direct-reduction plant. The plant is due to begin operations in late 2015.

News Flashes

Anshan Iron and Steel Group Corporation — China

An order was received for the supply of a new, highly accurate slitting line to be installed at the company's Anshan plant in southern China. The equipment will be used to cut high-quality cold strip for the automotive industry. The project will be the first application of a capstan-type slitter head in China, an advanced technology that enables fast tool changes to be carried out.

ArcelorMittal Eisenhüttenstadt GmbH — Germany

A new cooling stack equipped with the Simetal ECO Prime Cooler system – a new dual-flow nozzle spray system from Siemens VAI – is being installed on LD (BOF) Converter No. 2.

ArcelorMittal South Africa — South Africa

An order was placed for the supply of new Gimbal controllers for the two Gimbal charging systems that have been in use in the company's Corex plant since 2004 and 2006, respectively.

Armenian Steel Casting Enterprise — Armenia

(ASCE Group OJSC) A new reinforcement bar mill with a 125,000 t/a capacity was started up.

Dragon Steel Corporation — Taiwan

The newly supplied Sinter Plant No. 2 (rated capacity: 3.8 million t/a) and Blast Furnace No. 2 (rated capacity: 2.5 million t/a) were started up. Both plants are part of the Phase II Expansion Project of this Taiwanese steel producer.

Emirates Steel Industries — U.A.E.

Commercial production has commenced in a new Siemens VAI-supplied mill for reinforcement bars and rounds with 400,000 t/a capacity.

Izhstal OAO — Russia

Siemens VAI received the FAC* after the completion of a modernization project for bars, rods and light sections with a 300,000 t/a capacity.

İzmir Demir Çelik Sanayi A.Ş. (IDÇ) — Turkey

Commercial production has commenced at a new Siemens VAI-supplied medium-section mill with 400,000 t/a capacity.

JSW Steel Ltd. — India

An order was placed for the supply of Level 2 automation systems for Steelmaking Shops Nos. 1 and 2 at Vijayanagar, Toranagallu.

Kentucky Electric Steel (KES) — U.S.A.

Siemens VAI received a contract for the modernization of shearing and handling equipment for the medium-bar mill.

*FAC = Final Acceptance Certificate

Nexans S.A. — France

An order was received to modernize a copper rod mill with a modular crop shear solution and to install a mechatronic package that will facilitate automated operations for increased output and personnel safety.

Outokumpu Stainless USA, LLC — U.S.A.

The FAC was received for a new 1-million t/a stainless steelworks supplied by Siemens VAI that included an EAF, AOD converter, secondary metallurgical facilities and a continuous slab caster.

PJSC Yenakiieve Iron and Steel Works (EMZ) — Ukraine

An order was received for detailed engineering of a new 4.3 million t/a sinter plant to be equipped with Siemens VAI's Intensive Mixing and Granulation System, Selective Waste Gas Recirculation and Meros sinter offgas cleaning technology.

Posco Specialty Steel Co. Ltd. — Korea

A specially designed hydraulic billet shear was commissioned, thus completing the modernization of the mill capable of producing large rounds and flats with 350,000 t/a capacity.

Qatar Steel Company Ltd. — Qatar

The 5th million ton of rebars was produced at the long rolling mill in Mesaieed Industrial City, which Siemens VAI designed, supplied, installed and commissioned by on a full turnkey basis.

Riva Acciaio — Italy

The FAC was received for the modernized medium-section mill with 250,000 t/a capacity.

Tangshan Iron and Steel Group Co. Ltd. — China

A major order was received for the supply of a new cold-rolling complex comprising a coupled pickling line and tandem cold mill, a continuous annealing line and a galvanizing line for the production of 1.6 million t/a of high-strength, high-quality steels for the automotive industry.
(See "The Future Is Quality," page 72)

Tata Steel Europe — U.K.

Seven years after completion of a major modernization project by Siemens VAI, the millionth ton of rail was dispatched from Tata Steel's Scunthorpe plant.

ThyssenKrupp Steel Europe AG — Germany

The FAC was received for the replacement of process-optimization models for two slab casters at Duisburg Beeckerwerth.

Viraj Profiles Ltd. — India

Hot commissioning took place for phase 1 of a new mill supplied for the production of stainless rounds and sections with 180,000 t/a capacity.

Solutions and services to keep metallurgical plants operating at peak performance throughout their entire lifetime

The Life-cycle

Partner

For the Metals Industry

Massive investments in primary steelmaking in the past have led to a huge overcapacity of installed steelmaking plants. Greater competition and lower prices is the result. Producers can still remain successful with the support of a life-cycle partner.

A major paradigm change is underway in the steel industry. This is the result of the current discrepancy between actual production requirements and installed steelmaking capacity. For example, during the past 50 years global steel output has dramatically increased from 346 million tons in 1960 to nearly 1.55 billion in 2012. However, according to the World Steel Association, the global capacity utilization ratio (steel output versus installed capacity) fell to a level of approximately 73% in 2013. In other words, steelmaking facilities throughout the world are currently capable of producing an excess of 550 million tons of steel over actual consumption.

"About 27% of the steel sector's installed capacity will not be used this year [2013], compared to a historical average of 17%," stated André Gerdau Johannpeter, CEO of Brazil's Metalúrgica Gerdau S.A., in the May 7, 2013, issue of *BNamericas*. "Growing demand is not enough to absorb excess capacity in the steel industry."

Steelmaking facilities throughout the world are currently capable of producing an excess of 550 million tons of steel over actual consumption.

This sobering fact is also reflected in China, the world's largest steel manufacturer. In 2012, the country produced 731 million tons of steel that accounted for some 47% of global output. Yet the country's installed steelmaking capability is 976 million t/a, which means a utilization rate of only 74.9% (*Steel Times International*, September 2013). Steps are now being proposed by the central government to reduce this overcapacity by initiating measures to force the closure of steelmaking facilities that operate with outdated technologies or with high pollution rates.

In Europe, the situation is even more precarious. European steelworks are capable of producing approximately 210 million tons of steel per year. Nonetheless, current production is only in the range of 140 million tons per year. This means that a full one-third of the potential steelmaking output remains idle.

Consequence of steelmaking overcapacity for the industry

What impact will this overall situation have for steel producers? First of all, steel exports will increase from those countries capable of producing excess quantities of steel and where steel can be manufactured at competitive costs. China, for example, has been a net steel exporter since 2005 and is the largest exporter in the world today. In 2008, the country sold nearly 41 million tons of steel abroad, and this figure has climbed to above 51 million tons in 2012.

Excess global steelmaking capacity combined with increasing exports has resulted in greater international competition and lower steel prices. This means that for inefficient steelworks – which are also confronted with high costs for raw materials, energy, transport, personnel and environmental penalties, among others – the consequence will be an increasing number of plant closures for economic reasons. This is already taking place at many older steelworks in Europe.

The present annual European steel production of 140 million tons will be cut by half by the year 2030, predicted Dr. Wolfgang Eder, Chairman of the Management Board and CEO of voestalpine AG in an interview with *Oberösterreichische Nachrichten* on April 4, 2013.

A greater focus must be placed on generating value-added products and entering into niche markets.

Driving forces behind future investments

In order for steel producers to survive in this harsh international business climate and to remain competitive, a greater focus must be placed on generating value-added products and entering into niche markets. Future steelmaking investments in most regions of the world will not be to increase steel output but to slash costs, improve product quality and increase operational flexibility. Furthermore, efforts will concentrate on developing new and specialized steel grades to satisfy changing market requirements and to also create new markets. And by minimizing the consumption of energy to produce steel, total emissions and the overall environmental footprint can be substantially reduced. Considering that a company's staff of well-trained personnel is ultimately its most vital asset, personnel safety must be accorded the highest priority. These are the driving forces behind investments in the steel industry today (Figure 1).

Transition from a plant builder to a life-cycle partner

And what does excess global steelmaking capacity mean for a traditional plant-building company such as Siemens VAI? The consequence is an ongoing transition from a metallurgical plant builder to a life-cycle partner for the metals industry. Siemens VAI now focuses on supporting its customers to uphold and improve their competitive position on the market. This is accomplished through the provision of a wide range of modernization packages, process-optimization solutions

Fig. 1: The driving forces of the steel industry today

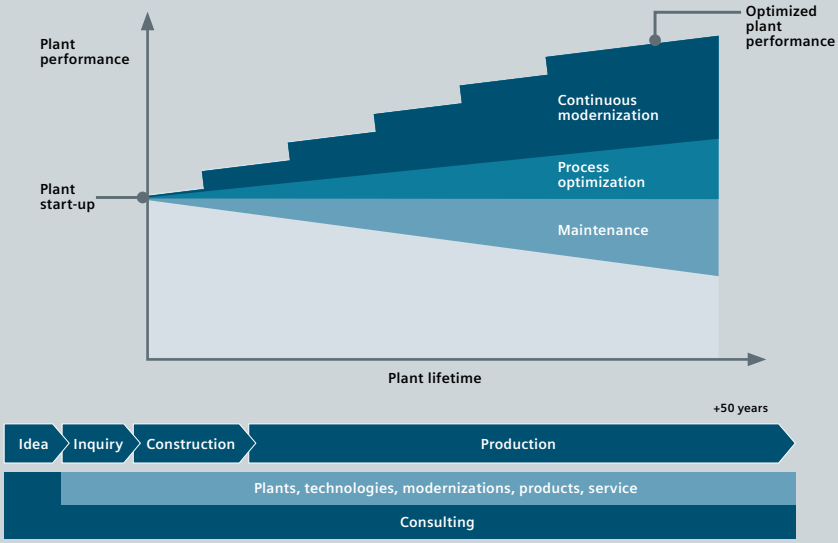


Fig. 2: Optimized performance of metallurgical plants with the support offered by a life-cycle partner

and comprehensive services to ensure that metallurgical plants and the integrated production processes and systems are maintained at benchmark performance levels throughout their entire lifetime (Figure 2).

Siemens VAI understands its role as a life-cycle partner in this way: A metallurgical plant has a useful lifetime that typically exceeds 50 years. Following the initial installation, methodical maintenance work performed at regular intervals can at best keep a plant operating at its originally installed design capacity in terms of productivity, output and product quality. However, plant performance normally deteriorates as a function of time. This is a result of increasing incidences of plant downtime as a consequence of equipment and component failures – most of which can be avoided with expert preventive maintenance services and with the installation of the latest sensory and condition-monitoring systems. The execution of continuous plant modernizations and the integration of process-optimization systems by an experienced life-cycle partner lead to improvements in plant performance that usually exceed the original design capacity of the plant.

Productivity and product quality are increased with innovative solutions and technological packages. Reliable plant operations and optimized production processes are achieved with the installation of the latest automation, IT and mechatronic systems. Through the application of energy-saving solutions, energy costs and the associated emissions can be substantially reduced. Ever-stricter environmental regulations are fully met with state-of-the-art offgas-cleaning and dedusting solutions. Vertically integrated supply packages and manufacture of key components in the company's own workshops safeguard equipment quality and minimize interface problems with products from third-party suppliers. Furthermore, personnel safety is considerably enhanced thanks to the use of robotic systems in hazardous working areas. All of this is backed by a worldwide service network to support customers whenever required (Figure 3).

The three dimensions of a life-cycle partnership

On the basis of its unique historical background, acquired experience and integration within Siemens, Siemens VAI can serve its customers in the context of a three-dimensional life-cycle partnership. This comprises a horizontal supply capability for every step of the value-added steel-production chain; the vertical integration of complete plants; and all modernization and service activities performed throughout the entire lifetime of supplied plants (Figure 4).

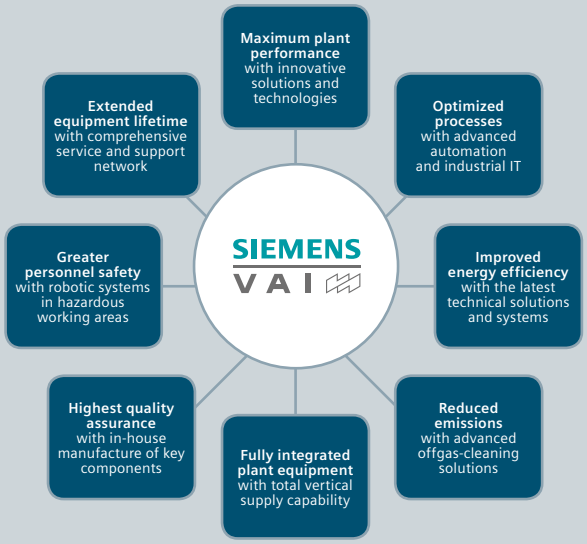


Fig. 3: Benefits and services rendered by a life-cycle partner

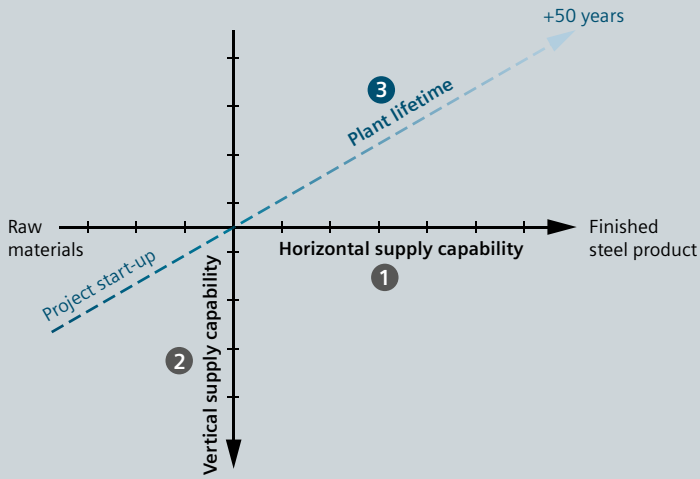


Fig. 4: A three-dimensional life-cycle partnership: horizontal supply capability, vertical supply capability and lifetime plant support

Without continuous modernization improvements, plant performance normally deteriorates as a function of time.

Horizontal supply capability: The roots of Siemens VAI can be traced to the revolutionary development and the subsequent worldwide marketing of the LD (BOF) steelmaking process by VAI that began in the 1950s.* Today, LD technology and its process variants account for roughly 70% of global steel production (Report by the World Steel Association entitled "Sustainable Steel. At the Core of a Green Economy," June 18, 2012). In the decades that followed, the product portfolio of Siemens VAI has expanded to include innovations, technologies and solutions for every step of the iron and steel production chain – from the raw materials to the finished steel product. Figure 5 illustrates many of the innovation milestones and technological highlights of Siemens VAI that were introduced to the market since the company's founding in 1956. The experience acquired from the successful implementation of thousands of metallurgical projects during this time underlines the know-how and capability of Siemens VAI to offer producers the best-possible solution to meet all production targets and requirements.

Vertical supply capability: A unique aspect of Siemens VAI is its ability to provide nearly its entire product portfolio as vertically integrated solution packages. As part of Siemens, in-house-supply capability covers engineering, mechanical equipment, electrics and automation (E&A), media and fluids systems, drives and motors, energy generation and distribution, environmental facilities, and condition-monitoring and energy-management systems. The company's capability to supply complete plants from a single source is the basis for the total integration of all components and systems, optimized processes and the avoidance of interface problems.

*The former VAI (VOEST-ALPINE Industrieanlagenbau – now Siemens VAI Metals Technologies GmbH since the company's merger with Siemens in 2005) was founded in the year 1956 as the plant-building department of VÖEST (Vereinigte Österreichische Eisen- und Stahlwerke AG – now voestalpine AG). This was in response to the first international order received from the Indian steel producer Rourkela for the construction of a complete LD (BOF) steelworks together with Krupp-Industrieanlagenbau in the state of Odisha.

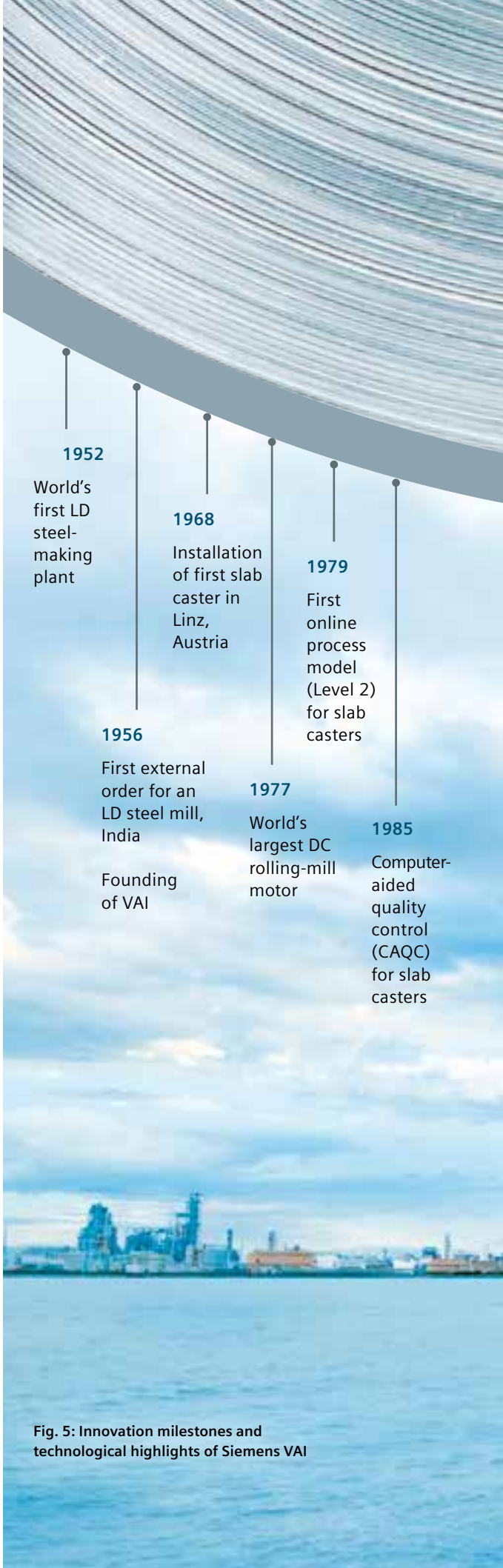


Fig. 5: Innovation milestones and technological highlights of Siemens VAI

1986

World's first coupled pickling line and tandem cold mill

1989

Start-up of first Corex plant, South Africa

1994

Dynacs secondary cooling model for slab casters

1996

EAF with scrap-preheating shaft

1997

Dynamic gap adjustment for slab casters

2001

Advanced cooling line model for hot-rolling mills

2002

AOD converter process-optimization model

2004

Microstructure calculation and quality prediction of hot-rolled strip

2005

Power Coiler (coiling of thick strip)

Selective Waste Gas Recirculation

2007

Ultimate EAF

Corex C-3000

World's first Finex plant

World's first Meros plant (voestalpine)

2009

Arvedi ESP (Endless Strip Production)

Meros start-up, Maanshan, China

2010

World's thickest slab caster (400 mm)

Introduction of Simetal Merim technology

3D DynaGap Soft Reduction, Dynacs 3D

2011

Simetal EAF Quantum (shaft-type furnace)

Intensive Mixing and Granulation System

2012

Circular Pelletizing Technology (CPT)

Simetal EAF Fast DRI (Furnace Advanced Slag-free Tapping)

Heat2Power (waste-heat recovery system for electric arc furnaces)

2013

Chinese order for two Arvedi ESP plants

World's largest HBI plant (2 million t/a)

Posco's integrated iron and steelworks in Pohang, Korea

Fig. 6: Siemens VAI workshop, Montbrison, France

The experience acquired from the successful implementation of thousands of metallurgical projects underlines the know-how and capability of Siemens VAI.

Siemens VAI is not only a life-cycle partner with turnkey plant-building competence, it is also an equipment manufacturer with numerous workshops and service centers all over the world. Some 2,000 specialists locally based at 28 workshops and service centers in 12 countries ensure that production rigidly adheres to the demanding Siemens quality standards. Figure 6 shows the Siemens VAI manufacturing center in Montbrison, France, where core equipment and specialized plant components are produced.

Lifetime plant support: Siemens VAI is committed to lifetime partnerships with its customers. This is the basis for mutual trust, optimized services and profitable, win-win project activities. Peak plant performance levels can be maintained and continuously improved with regular modernizations and the installation of the latest process-optimization systems, innovative technologies and mechatronic packages. This is the key not only to survive but to thrive in today's harsh market conditions. The Austrian steel producer voestalpine and the Korean steel giant Posco (Pohang Iron & Steel Co. Ltd.) are but two of many customer examples where the solutions and services offered by Siemens VAI as a life-cycle partner have helped manufacturers to become world-class producers of highest-quality steel. Siemens VAI recently received the Supplier of the Year award from voestalpine in recognition of outstanding performance and support. (See next pages)

Making visions become reality

Siemens VAI has the background, experience and competence to help producers meet market demands and achieve their targets and visions for tomorrow. This issue of Metals Magazine presents numerous examples of the innovations, solutions and services offered for improved plant performance by the leading life-cycle partner for the metals industry.

Dr. Lawrence Gould

Siemens VAI is committed to life-time partnerships with its customers. This is the basis for mutual trust, optimized services and profitable, win-win project activities.

An Outstanding Life-cycle Partnership

More than 500 successful steelworks projects during the past six decades

The Austrian steel producer voestalpine AG and Siemens VAI have mutually benefited from an exemplary life-cycle partnership that goes back to the founding of VAI in 1956. Beginning with the turnkey supply of the LD Converter Plant No. 2 at the Linz steelworks that started up in 1959, Siemens VAI has implemented more than 500 projects of all types for the voestalpine group of companies. These include projects for every step of the iron and steel production chain, extending from coking plants, sintering plants and blast furnaces all the way to cold-rolling mills, strip-processing facilities and finishing lines. This long list of projects also includes plate mills, bar and wire rod mills, and tube and section mills – in addition to the supply of all integrated electrical, automation, environmental, media-supply and process-optimization systems. One of the latest projects received from voestalpine is for the supply of the world's largest HBI (hot-briquetted iron) plant in Texas, U.S.A. (See Project Review section, page 12.)

Many of the technological innovations in the Siemens VAI portfolio were jointly developed with engineers from the voestalpine Group, and thoroughly tested and optimized in the steel mills of voestalpine before they were offered on the market. In this way, the *inherent risks* of new innovations could be minimized and the *achievable benefits* of new innovations maximized.

As a life-cycle partner, Siemens VAI has accompanied voestalpine at every step of the company's evolution, from the early days of LD steelmaking to its standing today as a world-class supplier of highest-quality steels for the automotive industry, niche markets and other specialized downstream applications.

Panoramic view of the voestalpine Stahl site in Linz, Austria

In Recognition of Performance

Siemens VAI receives the prestigious Supplier of the Year award from voestalpine

On September 25, 2013, on the occasion of the annual Supplier and Service Partner Conference, voestalpine Stahl GmbH presented the Supplier of the Year award to Siemens VAI in the performance category. The ceremony took place at the headquarters of voestalpine AG in Linz, Austria.

The supplier award for performance is only granted to those companies that meet the highest standards of voestalpine Stahl.

"voestalpine needs excellent partners in order to stay at the top. Our annual supplier award is a way of giving thanks to our suppliers and loyal partners of many years who have supported us over the years on our way to success," said Wolfgang Eder, Chairman of the Management Board of voestalpine AG and Managing Director of the Steel Division.

Alfred Düsing, a member of voestalpine Stahl's management board, underlined the accomplishments of Siemens

Finex plant, Posco's Pohang steelworks, Korea

An Incredible Journey

Life-cycle solutions and services for a premier supplier of quality steel

Posco and Siemens VAI represent another outstanding example of a life-cycle partnership that has flourished during the past 45 years. The close cooperation and partnership between the Korean steel producer and the technology provider started in 1969 when Siemens VAI received a major order for the supply of a plate mill for the production of ship plate. The mill was successfully put into operation in 1972. Since then, Siemens VAI has implemented some 370 metallurgical projects for Posco's Korean steelworks in Pohang (production of carbon and stainless steel grades), Gwangyang (production of carbon steel grades) and Changwon (production of speciality steels), its Chinese joint-venture company in Zhangjiagang (production of stainless steels), and its Vietnamese joint-venture steel company in Ho Chi Minh City (galvanized steel products).

The hundreds of large and small projects that Siemens VAI has carried out for the world's fifth-largest steel producer with an output of 39.9 million tons in 2012 (World Steel Association) extend from raw material agglomeration to the finished steel product. Projects have covered the supply of new plants as well as the upgrading, expansion and performance enhancement of existing production facilities. Highlights include the installation and start-up of a Corex C-2000 plant (600,000 t/a to 800,000 t/a hot metal) in 1995, the joint development and start-up of a Finex F-1.5M plant (1.5 million t/a hot metal on the basis of fine iron ore and coal) in 2007, and the start-up of the world's thickest stainless steel caster at the company's Pohang works in July 2013 (see Project Review section, page 11). The lastest highlight in the ironmaking sector was the start-up of a Finex F-2.0M plant with an annual production capacity of 2.0 million t/a hot metal.

As a life-cycle partner, Siemens VAI has accompanied Posco along its incredible journey from the company's inauguration in April 1968 to its position today as a premier global supplier of the highest-quality steels suitable for the most demanding downstream applications.

The voestalpine management board and former Siemens VAI CEO Werner Auer at the award presentation (left to right: Alfred Düsing, Dr. Wolfgang Eder, Werner Auer, Peter Ackerlauer, Dr. Wolfgang Lakata)

VAI: "We select only the best for our pool of suppliers. The winners at the voestalpine supplier award are always the best, always a step ahead – just like voestalpine."

Werner Auer in expressing his thanks on the receipt of the award: "This award is a token of appreciation for every employee at Siemens VAI who has put forth great effort to develop and implement high-quality products for voestalpine in collaboration with their teams."

Demonstrated Capabilities

Of a Life-cycle Partner

The term life-cycle partner is more than a watchword. It must be backed by proof. In the following, a selection of demonstrated capabilities from Siemens VAI along the iron and steel production route illustrates how producers can better meet the market challenges of today and tomorrow.

Sintering: In the field of sintering, maximum benefits for producers are derived when the complete sintering plant is supplied by a life-cycle partner. The vertical integration of mechanical equipment, E&A, media supply, process optimization models, offgas-cleaning and recycling solutions is the basis for the production of high-quality sinter at low operating costs and with a minimum environmental impact. Continual sinter plant improvements and updates with the latest innovative solutions ensure that existing plants operate at world-class levels. For example, the Intensive Mixing and Granulation System (IMGS) from Siemens VAI allows excellent-quality sinter to be produced even using up to 80% pellet feed in the sinter raw mix. Not only can raw material costs be significantly reduced, raw material blending yards are no longer required (Figure 1).

Up to 50% of the sinter offgas can be recirculated back to the sintering strand with the Selective Waste Gas Recirculation system. The system not only reduces the required solid-fuel consumption for sintering by up to 10%, it also substantially decreases the offgas volume and the specific quantity of pollutants, CO_2 emissions and other greenhouse gases discharged to the environment through the stack (Figure 2).

Simetal Meros (Maximized emission reduction of sintering) is an environmental milestone for the treatment of sinter plant offgas. Atmospheric emissions of dust, acidic gases, and metallic and organic components are reduced in a series of process steps to levels previously unattained using conventional offgas treatment systems. This future-oriented solution allows sinter producers to meet today's strict environmental regulations as well as those expected in the years to come (Figure 3).

Pelletizing: With the steadily increasing quantities of iron ore fines and concentrates in the world market, pelletizing will become more important for the agglomeration of iron ores for use in the blast furnace. In order to reduce investment costs for new pellet plants, Siemens VAI recently developed a new generation of pelletizing plants known as Circular Pelletizing Technology, or CPT (Figure 4). Thanks to

Maximum benefits are derived when the complete plant is supplied by a life-cycle partner.

Fig. 1: The Intensive Mixing and Granulation System (IMGS) allows up to 80% of pellet feed to be used in the sinter raw mix

Fig. 2: The Selective Waste Gas Recirculation system reduces fuel costs by up to 10% and the offgas volume emitted to the atmosphere by up to 50%

the circular design of the induration furnace, CPT is the most compact pelletizing plant in the world today. This innovation facilitates the installation of new pelletizing plants both at the mining site and within an existing steelworks. The circular induration furnace also offers another distinctive advantage: more than 75% of the pallet cars are always inside the furnace, which reduces equipment costs. Plant capacities are available from 800,000 t/a to 3 million t/a. Mining companies and steel producers alike can therefore profit from the advantages offered by CPT. The first CPT plant is being installed at Pro Minerals Private Limited in India.

Blast furnaces: With the experience acquired from the supply and installation of around 180 new blast furnaces, Siemens VAI is the leading supplier of this technology in the world. With consideration to the global overcapacity in ironmaking, the focus of future blast furnace investments in most countries will be to enhance the performance and energy efficiency of existing facilities. For example, hot blast stoves, required to heat the blast furnace hot blast up to 1,300°C, are one of the largest consumers of energy in a steelworks. However, nearly 20% of the total energy required for generating the hot blast exits through the chimney in the form of waste gas. With the installation of an advanced waste-heat-recovery (WHR) system from Siemens VAI, nearly half of this lost energy can be reclaimed (Figure 5).

Meros allows sinter producers to meet today's strict environmental regulations as well as those expected in the years to come.

Fig. 4: Circular Pelletizing Technology (CPT), the world's most compact pelletizing plant, can be easily installed at the mine or in a steelworks

Fig. 3: The world's lowest sinter plant offgas emissions are achieved with the Meros process, which was installed at Maanshan Iron & Steel Company, China

Fig. 5: Application of an energy-recovery system in the hot blast stoves can recover nearly 50% of the energy lost to the environment through the chimney

Fig. 6: Installation of pulverized coal-injection technology reduces the coke consumption in blast furnaces by 30% to 40%

Fig. 7: The Simetal VAiron process optimization system increases productivity, ensures continuously high hot-metal quality and reduces blast furnace coke consumption by up to 10 kg/t hot metal

Fig. 8: The 170-ton-capacity AOD converter at Lianzhong Stainless Steel Corp., China, features a Level 2 process optimization system that specifies the quantities of charge materials required for each stainless steel grade

Between 30% and 40% of the coke charge required for smelting operations in the blast furnace can be substituted with low-cost coal applying pulverized coal-injection (PCI) technology for notable cost savings in energy (Figure 6).

Lower fuel rates, increased productivity and continuously high hot-metal quality are offered by the well-proven Simetal VAiron Blast Furnace Optimization package. This solution has already been installed in some 80 blast furnaces worldwide – accounting for roughly 10% of global hot-metal production. For a medium-sized blast furnace employing Simetal VAiron, blast furnace coke savings of typically 10 kg/t of hot metal translate into a return on investment within six months (Figure 7).

The new Simetal Merim (Maximized emission reduction and energy recovery in ironmaking) system is another example of a cost-saving innovation for ironmaking plants. The system features a specially designed cyclone for the removal of coarse dust, a temperature-control unit to maintain the offgas temperature to within 80°C and 250°C, and pulse-jet-type pressure filters outfitted with high-performance fabric filters for fine dust removal. Clean-gas dust concentrations can be reduced to well below 5 mg/Nm^3. Thanks to the dry-type cleaning of the blast furnace top gas, the top-gas pressure and temperature is higher than in wet-type systems. This enables a top-gas pressure-recovery turbine to generate 20% to 30% more electrical energy. Additionally, no sludge and wastewater treatment is required.

Converter steelmaking: A series of modernization steps carried out by Siemens VAI at the Alchevsk iron- and steelworks in Ukraine show how productivity, energy efficiency and environmental compatibility can be greatly improved with the support and services of a life-cycle partner. Steel production at this plant was previously based on the Siemens Martin process followed by ingot casting and rolling. Siemens VAI supplied two new 300-ton LD (BOF) converters, a 300-ton VOD plant, a twin-shell ladle furnace, two 2-strand slab casters and the related technological packages, process automation models and environmental systems. Following completion of these projects, the nominal steel output could be increased by 50% to 5.5 million tons of steel per year. Yield losses were reduced to less than 10%, and dust emissions from the steel mill were lowered by a factor of more than 100 to less than 20 mg/Nm^3.

Stainless steelmaking: Siemens VAI is one of the leading suppliers of stainless steelmaking technology in the world. Since 1995, 15 new stainless steelmaking converters were supplied to customers in Belgium, China, Finland, South Africa, Sweden and the United States. In a major project implemented for Lianzhong Stainless Steel Corp., China, Siemens VAI supplied a 160-ton electric arc furnace, a 170-ton AOD plant, a 170-ton ladle treatment station, a 170-ton VOD plant and a slab caster (Figure 8). Stainless steelmaking is carried out in both the duplex and triplex process routes, allowing approximately 800,000 tons of a wide range of austenitic and ferritic steel grades to be produced per year. Thanks to the installation of a

unique process-optimization system, the exact charge-material recipes to produce the required stainless steel grades are defined on the basis of the hot-metal composition and available scrap. Precise control of injected oxygen and other process gases ensures the shortest-possible blowing times and minimum alloying-material losses.

Electric steelmaking: Simetal EAF Quantum is the latest generation of shaft-type electric arc furnaces offered by Siemens VAI. This high-power scrap-melting plant features an impressive combination of innovative solutions for scrap charging, preheating, melting, slag-free tapping and off-gas treatment. Due to the preheating of the charged scrap by means of the hot furnace offgas, conversion costs for the processing of scrap to liquid steel are reduced by up to 20%. A 100-ton EAF Quantum plant is nearing completion at the electric steelmaking plant of Talleres y Aceros (Tyasa) in Mexico.

Continuous casting: The increasing application of hydraulic fracturing in oil and gas production throughout the world means that the demand for high-quality pipelines is continually growing. The production of ultra-thick slabs serves as the basis for the manufacture of superior-quality plates that are required not only in the petroleum industry but also in shipbuilding and for pressurized vessels. Steel producers can benefit from the know-how and experience of Siemens VAI in continuous casting to penetrate new market niches for high-end products. The ultra-thick slab caster that Siemens VAI supplied to Qinhuangdao ShouQin Metals Material Co. Ltd. in China is capable of casting slabs with thicknesses up to 400 mm for subsequent use in the most demanding downstream applications (Figure 9).

Vertical slab casters allow a wide range of highly critical steel grades to be continuously cast that would otherwise not be possible to produce with conventional bow-type casters. The vertical slab caster that Siemens VAI supplied to Baosteel's Special Steel Branch in Shanghai is pictured in Figure 10.

Robotic systems: In any field of occupation, personnel safety must be accorded the highest priority. This is especially true for the dangerous environment of a steelworks. Simetal LiquiRob is a highly flexible robotic system developed by Siemens VAI. It is capable of performing a wide variety of tasks in a steel mill, particularly in those areas where liquid metal is handled (Figure 11). LiquiRob is ideally suited for routine work in the vicinity of LD (BOF) converters, EAFs, ladle furnaces and continuous casting machines. Its capability to perform fully automatic and systematic measurements and operations in a steelworks is a key factor for improved process reliability, high product quality, higher productivity and maximum personnel safety. All activities are carefully monitored from the safety of the control room.

Hot rolling: A wide range of advanced steel grades can be produced in the cooling section of hot-strip mills with precise and accelerated strip-cooling rates. This is made possible with Siroll Power Cooling, which allows fine-grained, targeted

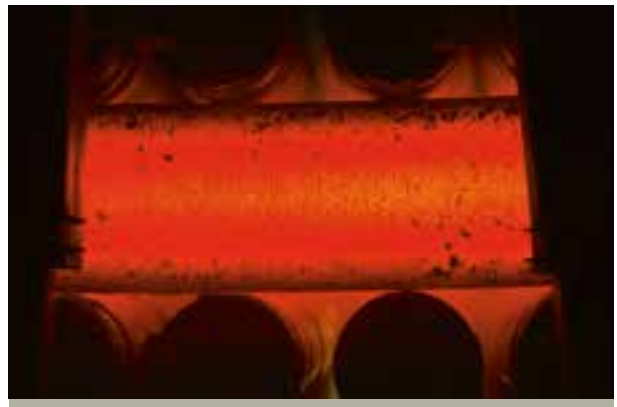


Fig. 9: Production of ultra-thick slabs (400 mm) at Qinhuangdao ShouQin Metals Material Co. Ltd., China, is the basis for superb internal strand quality

Fig. 10: Vertical casting of highly alloyed carbon, special and stainless steel grades at Baosteel's Special Steel Branch brings enormous cost advantages and increased productivity compared to conventional ingot casting

Fig. 11: LiquiRob, here in operation on the casting platform, performs fully automatic operations in the steelworks and greatly improves process reliability, productivity and personnel safety

Fig. 12: Accelerated and carefully controlled cooling rates provided by Siroll Power Cooling in the cooling section of hot-strip mills allows advanced high-strength steels to be produced for a dramatic reduction in alloying costs

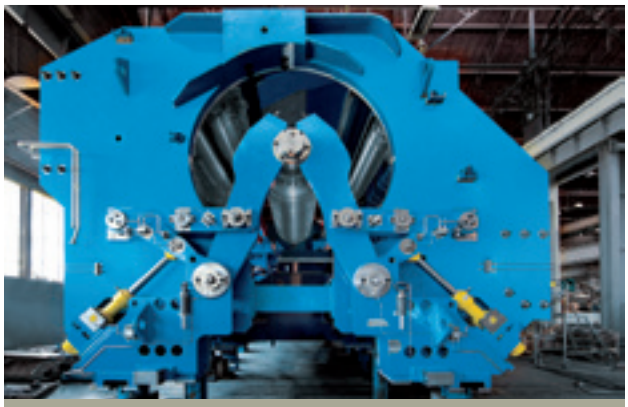


Fig. 13: Siroll Power Coiler reliably coils heavy-gauge and high-strength steels

Fig. 14: Cold-rolling mill complexes from Siemens VAI, such as this one installed at voestalpine Stahl in Linz, Austria, meet the most demanding quality, material strength and tolerance criteria

steel structures to be generated as required for the production of high-strength steels (HSS) such as API*, DP*, TRIP*, martensitic grades and others (Figure 12). This new strip-cooling innovation features the use of special cooling headers through which immense quantities of water are ejected under pressure onto the hot strip surface. The water flow is regulated using a sophisticated metallurgical model that takes into consideration strip temperature, thickness, speed and composition. The production of HSS grades in the mill-cooling section results in far lower alloying requirements and major cost savings. Siroll Power Cooling thus enables producers to penetrate profitable niche markets for advanced high-strength steel grades.

Increased production of advanced and special steel grades, including dual-phase steels and high-strength steels as required by the automotive industry, places greater demands on the coilers in hot-strip mills. The Siroll Power Coiler ensures the reliable and precise coiling of heavy-gauge and high-strength steels, and thus goes hand in hand with the greater focus placed on the manufacture of value-added products by steel producers (Figure 13).

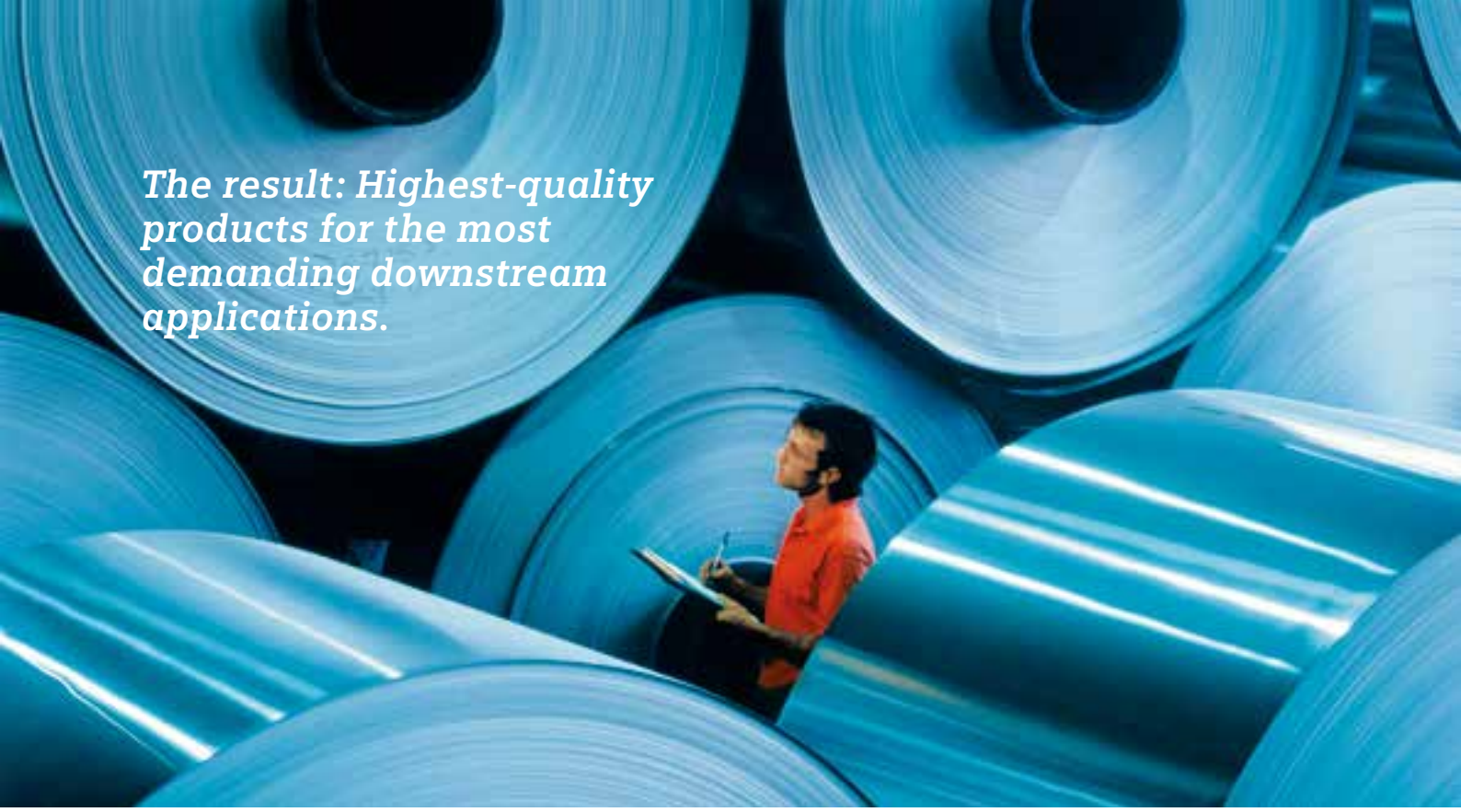
Cold rolling: The supply of cold-rolling mill complexes capable of producing strip that satisfies the most demanding quality, material strength and tolerance criteria is a particular strength of Siemens VAI (Figure 14). The company's extensive experience in this field and its single-source supply capability serve as the basis for the optimization of an entire cold-rolling mill complex. As a life-cycle partner, Siemens VAI supports producers to transform existing mills into state-of-the-art facilities that are able to meet the most stringent quality criteria. This is made possible with the installation of sophisticated Level 2 process-optimization models and Level 3 strip-quality tracking and feedback systems that assure that the defined targets for quality, consistency, output and yield are met. Thanks to improved control of rolling mill parameters, operational expenditures can be reduced by up to 30%. The considerably improved product quality in combination with lower production costs opens the door to market opportunities for steel manufacturers.

The key to success

The various technological solutions outlined in this article serve as examples of the scores of innovations, products and process-optimization systems that are available for improved plant performance, higher product quality and lower production costs at every link in the value-added production chain. To excel in the market, to be a leading supplier of high-quality products, or to ensure that iron and steel production fully comply with the demands of the environment and personnel safety, the services of an experienced life-cycle partner are invaluable.

Dr. Lawrence Gould

*API: American Petroleum Institute, DP: dual-phase steels, TRIP: transformation-induced plasticity



An example of teamwork from nature

Joint Efforts, Joint Success

When geese and other birds migrate to warmer climates in the late fall, they typically fly in a V formation, or so-called skein. Scientists have discovered that the V formation considerably improves the birds' efficiency and performance, allowing them to fly greater distances. In fact, air drag for geese flying in a skein is reduced and their flight range is extended by 70% with the same energy exertion. This is because the air upwash of each bird supports the weight of the bird immediately following it – similar to an ascending glider plane in rising air.

When the lead bird doing most of the work at the head of the formation gets tired, it falls out of position and lets another bird from behind take its place. This cycle continues as the geese continue on toward their destination. Eventually, each bird assumes the responsibility for leading the skein and the flying work is fairly shared among all of the birds.

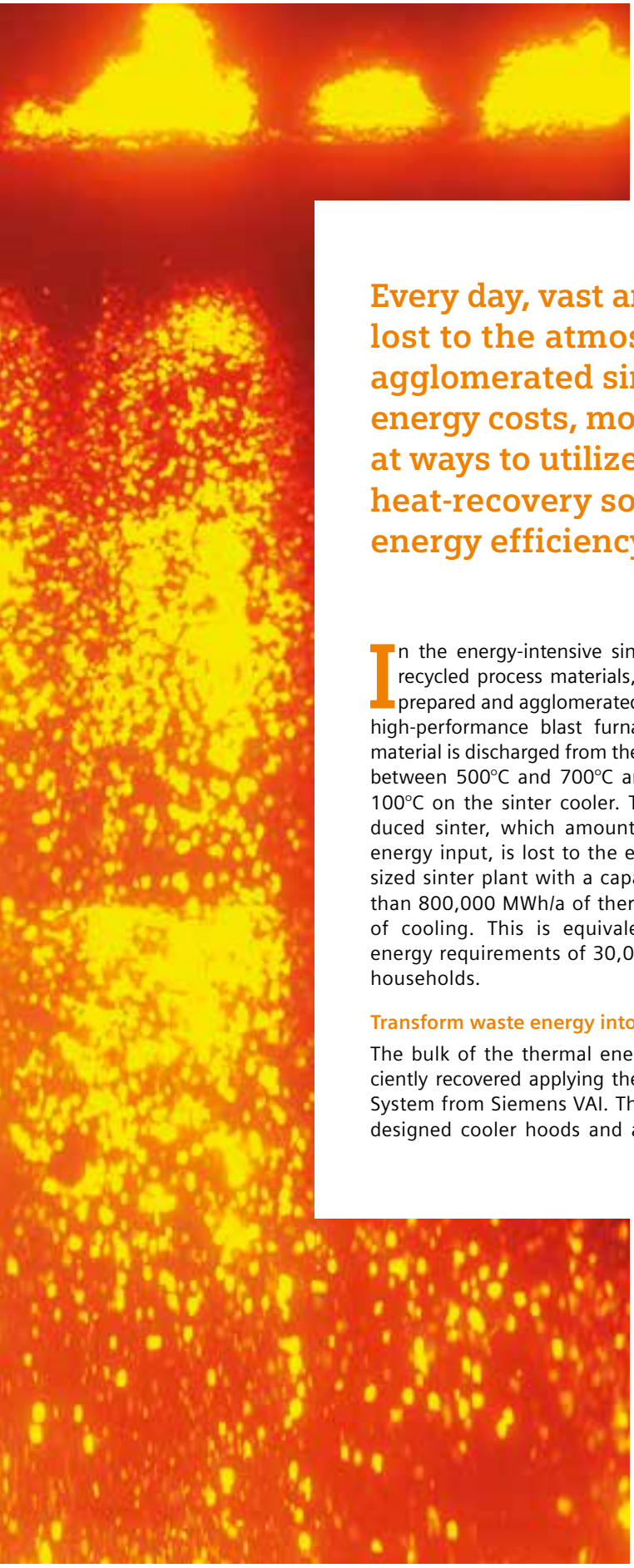
This V formation thus helps the migrating geese to use their energy effectively to reach a common goal. All members of the team play their part and mutually benefit from this teamwork effort.

Cooperation is the heart of a long-term life-cycle partnership between a steel producer and supplier. When both parties work closely together towards a common goal, the result is joint success.

Typical V formation of migrating geese

Solutions to maximize energy recovery from sinter coolers

Why Waste Energy?



Every day, vast amounts of heat in sinter plants are lost to the atmosphere during the cooling of hot agglomerated sinter in the sinter cooler. To reduce energy costs, more and more operators are looking at ways to utilize this heat. In the following, various heat-recovery solutions are presented to improve energy efficiency within a sinter plant.

In the energy-intensive sintering process, fine iron ore, recycled process materials, fossil fuels and additives are prepared and agglomerated to fulfill the requirements for high-performance blast furnace operations. The sintered material is discharged from the sinter strand at temperatures between 500°C and 700°C and cooled down to less than 100°C on the sinter cooler. The sensible heat of the produced sinter, which amounts to about half of the total energy input, is lost to the environment. For an average-sized sinter plant with a capacity of 4.5 million t/a, more than 800,000 MWh/a of thermal energy is lost as a result of cooling. This is equivalent to the average heating energy requirements of 30,000–40,000 central European households.

Transform waste energy into profit

The bulk of the thermal energy in hot sinter can be efficiently recovered applying the Sinter Cooler Heat Recovery System from Siemens VAI. The system comprises specially designed cooler hoods and a waste-heat boiler in which

The potential energy recovery from the sinter cooler is 50–80 kWh of steam per ton of sinter.

Recovery of waste heat from hot sinter significantly reduces energy costs

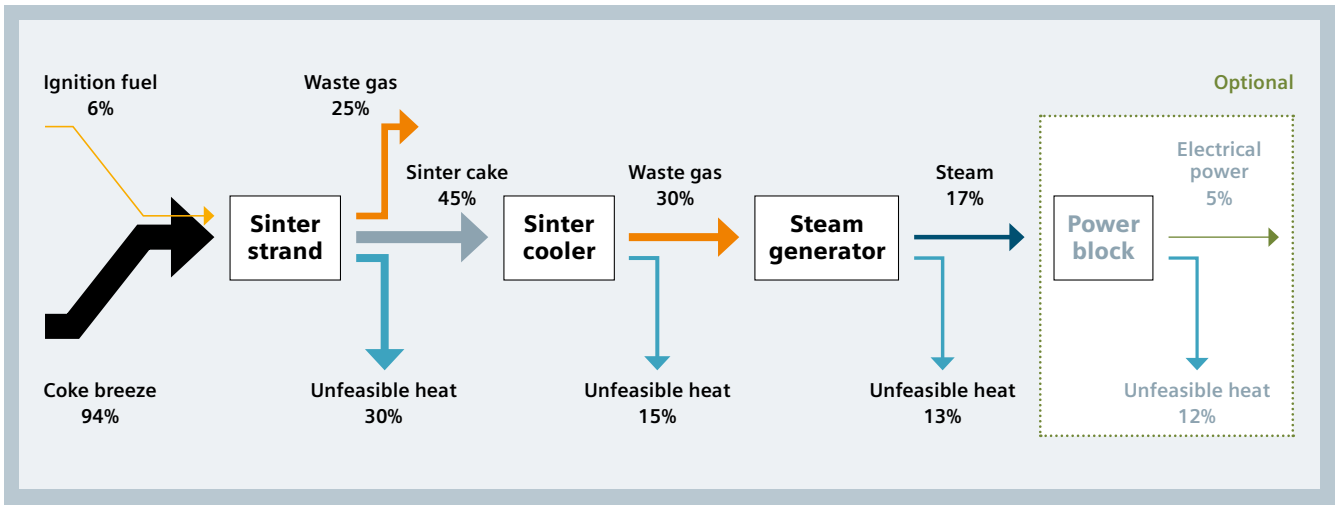


Fig. 1: Main energy flows of a sintering process with heat recovery at the sinter cooler for the production of steam and, optionally, power

steam is generated for various on-site applications, or to produce electricity in a dedicated modular power block developed expressly for such applications (Figure 1). The potential energy recovery from the sinter cooler is 50–80 kWh of steam per ton of sinter, corresponding to the generation of 40–60 tons of steam per hour for a sinter plant with an output of 4.5 million t/a. The actual figures depend on the sinter discharge temperature, sinter characteristics, type of sinter cooler and required steam parameters.

"The right waste-heat recovery plant allows customers to reclaim their investment costs within three years. After this, it's pure profit."

Dieter Bettinger

Optimum integration of the energy-recovery system in the energy network of a steelworks is decisive to ensure maximum economic feasibility. A low payback time of less than three years, depending, of course, on plant size and local energy costs, is realistic. With consideration to the local conditions, Siemens VAI can design and provide the following process variants of the Sinter Cooler Waste Heat Recovery System:

- Feed-in to the on-site steam network for various process applications
- Generation of additional electrical energy in an existing power plant
- On-site generation of electrical energy in an autonomous power block of the sinter plant
- Utilization of produced steam or hot water for district-heating
- Supply of steam to external consumers

Customized solutions for steam generator design

For the integration of steam produced from the waste-heat recovery plant into the existing energy network, an evaluation of the local energy situation is first carried out. On the basis of the sinter-plant parameters, operational figures and specific customer requirements, an optimized steam-generator system is offered. Possible solutions include simple, single-pressure systems to produce steam at the required pressure for the local steam network, up to advanced, dual-pressure boilers with high efficiency and flexibility to simultaneously generate low- and high-pressure steam.

Preheaters for the demineralized make-up water and return condensate can be installed to increase potential waste-heat utilization. For the design of the boiler and performance calculations, Siemens VAI applies its own dedicated engineering tools. These have been successfully proven in connection with the design of small energy-recovery systems up to large power plants supplied by Siemens.

Increased boiler efficiency

To further enhance the potential waste-heat utilization and overall plant efficiency, cooler waste gas can be further cooled within the waste-heat boiler. This is done through the extraction of hot water via the heat exchanger before the waste gas is discharged. Depending on the demand for hot water within a steelworks and surrounding area, the extraction of hot water can lead to additional value and increased profitability.

Additional firing system for power generation

In the Sinter Cooler Waste Heat Recovery System variant with power generation, high-quality steam at high temperature and pressure is required for efficient conversion to electrical energy. To meet these demands, the boiler can be equipped with a specially designed combustor system for external superheating of steam. For instance, a low-calorific gas burner using blast furnace gas can be installed for the

additional heating requirements. The waste-heat recovery steam generator is then capable of producing saturated steam at high pressure, and the external firing system ensures superheating of the steam to the required temperature. Generation of electrical energy then takes place either in a modular power block or in an existing power plant.

Energy reuse within the sintering process

The hot boiler exhaust gas can be recycled back to the sinter plant for the fresh air supply via a recirculation hood. Furthermore, additional energy from the boiler exhaust gas can be recovered at the ignition furnace through the preheating of the combustion air. In this way, the solid fuel consumption for sintering can be noticeably reduced, and dust emissions from the cooler are decreased as well. Alternatively, the residual sensible heat of the boiler exhaust gas can be recovered by recirculation to the first section of the sinter cooler. This leads to a higher energy-recovery potential and reduces dust emissions from the cooler (Figure 2).

Modular power block to convert steam to electricity

If electrical energy needs to be generated, Siemens VAI can provide a modular power block for the conversion of steam into electrical power. The turbine house is designed for the integration of all required power-block components and can be equipped with flexible industrial steam turbines from Siemens. If the cooling water for the condensation of the turbine exhaust steam cannot be supplied by an existing cooling-water system, the necessary cooling-water system can also be installed by Siemens VAI.

Sinter burn-through point control

High sinter-discharge temperature, suitable sinter grain-size distribution and controlled charging of hot sinter onto the cooler bed are important factors to ensure maximum energy output of the heat-recovery system. A high average sinter-charging temperature is attained when the position of the burn-through point (BTP) is located as close as possible to the end of the sinter strand. (The BTP is the position on the sinter strand where the flame front reaches the bottom of the sinter mix.) This can be achieved with Siemens VAI's Advanced Control Strategy to regulate the strand speed. This BTP control system is part of the company's Level 2 Sinter Optimization System.

Induced sinter segregation on the cooler bed

Siemens VAI has designed a simple yet clever sinter-cooler charging chute for obtaining an ideal particle-size distribution within the cooler sinter bed. Coarse 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, after which the mid-sized sinter fraction is charged onto the top of the sinter bed. By sandwiching the finest sinter fraction between the coarser lower layer and the mid-sized upper layer, the cooling rate is accelerated and dust emissions to the environment are reduced.

Energy saved is profit earned

Energy costs in a steelworks, particularly in a sinter plant, are very high. Siemens VAI has therefore developed solutions for every step of the iron- and steel-production chain to save and recover energy. Upon the completion of detailed on-site investigations and ROI calculations, a complete cost-optimized solution is proposed. Once the decision has been made to implement an energy-saving project, engineering and project-management services up to plant start-up are carried out in close cooperation with the customer.

As a life-cycle partner for the metals industry, Siemens VAI supports its customers to minimize energy costs and thereby improve their overall sustainability and competitiveness.

Dieter Bettinger, Vice President, Energy Efficiency Technology
Gerald Strasser, Product Life-cycle Manager
Thomas Fenzl, Process Technology Engineer

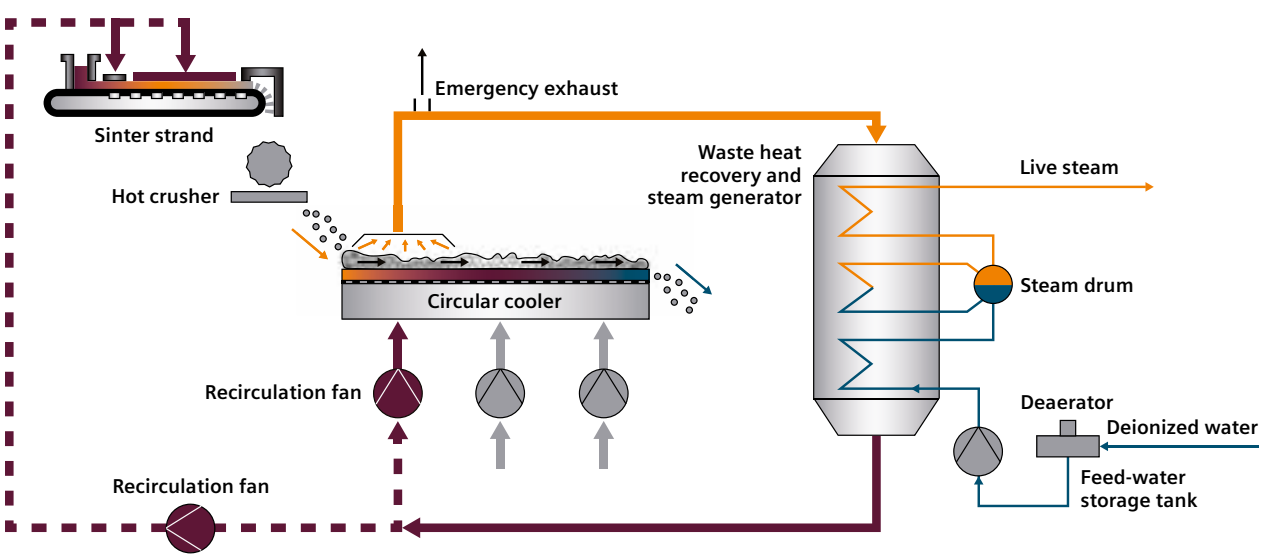


Fig. 2: Overview of the heat-recovery system for a circular-type cooler with recirculation of boiler exhaust air to either the sinter strand or the sinter cooler

Trends in gas cleaning for new and rebuilt blast furnaces

A Cleaner Future

All technology providers need to consider the impact of their solutions and innovations on the environment. In an iron- and steelworks, for instance, in relation to its physical size the blast furnace has an over-proportional impact on the surroundings. Siemens VAI therefore continues to focus its activities on world-class solutions for top-gas cleaning technologies that are both effective and flexible. Standardization and optimum cost structures are achieved by considering both the micro and macro aspects of the blast furnace design.

Siemens VAI is the most comprehensive technology provider for the blast furnace and its associated systems. To date, the company has built over 190 new blast furnaces at sites all over the world. And since the 1980s, 38 plant rebuilds were carried out, and electrical and automation systems were installed in more than 120 blast furnaces.

Siemens VAI is introducing new technologies into the marketplace, including cyclone gas cleaning and the triple external venturi gas scrubber. These innovative products complement the tried-and-tested solutions for blowers, internal and external hot blast stoves, total condensation slag-granulation systems, coal-injection systems and other blast furnace equipment.

This article focuses on gas-cleaning options that truly show how a cleaner future is being implemented for our customers.

JSW Steel Ltd., India – Blast Furnace No. 3

In February 2009, Blast Furnace No. 3 at JSW Steel was successfully blown in. With an annual production of 2.8 million tons, it became the largest blast furnace in India. The No. 3 furnace is a key facility in the ongoing expansion of JSW Steel's Vijayanagar plant in Toranagallu, in the Bellary-Hospet district of the state of Karnataka, India. The site has two Corex plants and two additional smaller blast furnaces that together produce 4.6 million tons per year of hot metal. Blast Furnace No. 3 expanded the plant's hot metal output to over 7 million tons per year. Siemens VAI provided the main technology and took over responsibility for the design of all primary blast furnace equipment along with construction and commissioning support (Table 1).

This project represents the first step in a journey with JSW Steel that has encompassed the construction of a second blast furnace as well as upgrades in capacity for both units with the addition of fourth stoves, plus further enhancements to gas-cleaning and coal-injection systems. These steps increased the plant's output to over 10 million tons per year.

Gas-cleaning system: This project proved also to be a turning point in the development of gas-cleaning systems for Siemens VAI. The new cyclone and wet-scrubber design is now part of the company's blast furnace solution portfolio. The cyclone provides greater efficiency for the primary gas-cleaning stage and allows efficiency adjustments to be made to control the split of heavy metals such as zinc in the dry or wet dust. At the same time iron recovery is optimized. An efficiency of approximately 80% translates into a dust recovery of up to 10 tons per hour.

View of the new cyclone for Blast Furnace No. 3, JSW Steel, India

Table 1: Statistics of Blast Furnace No. 3 at JSW Steel, India

Hot metal production	2,800,000 t/a
Daily production	7,800 t/d
Hearth diameter	13.2 m
Throat diameter	9.6 m
Belly diameter	15.2 m
Stack angle	81.02°
Bosh angle	74.36°
Inner volume (IV)	4,019 m^3
Working volume (WV)	3,445 m^3
Productivity	2.28 t/d/m^3 (WV)
PCI rate	150–200 kg/t hot metal
Coke rate	350–510 kg/t hot metal
Slag rate	250–350 kg/t hot metal
Hot blast volume	5,500 Nm^3/min
Hot blast temperature	1,250°C
Oxygen enrichment	7%
Furnace top pressure	2.5 bar g

Blast Furnace No. 3, JSW Steel, India

The triple annular-gap cone scrubber uses three external cones in order to achieve the most efficient gas cleaning with respect to the dust content while assuring only a minimum pressure drop of the blast furnace gas. An energy-recovery turbine installed downstream of the gas-cleaning plant is used to recover the pressure energy of the clean gas. A revolutionary new design, wherein the scrubber cone elements are located outside the main vessel, was installed. This solution enables a quicker and easier exchange during furnace outages.

Tata Steel Ltd. U.K. – Port Talbot Blast Furnace No. 4 rebuild

Recently undertaken by Siemens VAI in the U.K., the rebuild of Blast Furnace No. 4 at the Port Talbot steelworks of Tata Steel shows further development in the evolution of the gas-cleaning system design with regard to the cyclone element. Table 2 gives a breakdown of what was carried out as part of the project. The rebuilt blast furnace is designed to typically produce approximately 7,500 tons of hot metal per day with a maximum possible daily output of up to 9,000 tons of hot metal.

Cyclone: The new dirty-gas cleaning system utilizes a tangential cyclone that is designed to maximize collection efficiency with a consequential reduction in dust loading at the scrubber. The efficiency of this cyclone, the so-called Tri-Ax or triple-inlet cyclone, ranges between 80% and 85%. This solution was installed for the first time in the Port Talbot blast furnace.

An internal refractory lining was applied to the cyclone to reduce wear. The lining thickness was altered in certain areas according to the potential for wear – for example, a thicker lining was used in the tangential inlets due to the relatively high dust-laden gas velocity in this area.

The dust is removed by two separate legs. Each leg comprises the following in descending order: two dome isolation valves, one intermediate hopper, one dome isolation valve, one dust control valve and one pug mill. The dust from the cyclone falls into a pressurized intermediate vessel with a storage capacity of approximately two hours. The cyclone is emptied about once per shift, and the lock vessel is filled and emptied until the required quantity of dust has been discharged. The pressure within the vessel is maintained with nitrogen. Full and empty states are determined with a simple weighing system. In addition to controlling the filling and emptying of the cyclone by recording the dust weighed, an inventory of the dust leaving the cyclone is also taken.

When the hopper is full the inlet isolation valves close and, following depressurization of the hopper, the outlet isolation valves open. The dust-flow control valve moves to a set position to ensure an acceptable flow of dust to the pug mill. The dust is then deposited into a skip via the pug mill. As such, the design offers a most environmentally friendly solution for the removal of dust from the cyclone itself.

RINL Vizag, India – Blast Furnace No. 1 rebuild

Visakhapatnam Steel Plant (Vizag Steel), owned by Rashtriya Ispat Nigam Limited (RINL), produces about 4 million tons per annum of hot metal from its existing two blast furnaces. Since March 1990, Vizag has been operating Blast Furnace No. 1 at its site in Visakhapatnam. Vizag intends to carry out a Category-I capital repair of Blast Furnace No. 1, which includes improvements in the energy efficiency and working environment of the furnace. The furnace operating conditions, size and parameters are shown in Tables 3 and 4.

In order to achieve a 10% increase in production after the rebuild, the furnace productivity is to be increased to 2.02 t/d/m^3 inner volume (compared with the current productivity of +1.79 t/d/m^3 IV), and simultaneously the furnace inner volume will be increased to 3,891 m^3. The future productivity is within world norms for furnaces with raw materials of consistent quality, and similar to furnaces being commissioned in India today.

Gas-cleaning system: As part of the rebuild project in this case, the gas-cleaning system design was developed to make the most of existing equipment and vessels, and thereby reduce capital expenditure. This practice was first established as a strategy for Siemens VAI during a series of gas-cleaning projects carried out in the United States in the 1990s.

The gas-cleaning system design for Vizag uses a three-cone arrangement in conjunction with a packed bed demister for water-droplet removal. This combination of equipment in a single vessel optimizes space and saves money. The successful and proven cone design using a duplex stainless steel material for both male and female elements forms the core of the facility.

This design is arranged to function with an existing energy-recovery turbine. Matching the capacity of the newly relined furnace with the new scrubber to the turbine capacity is a key activity. In the final design proposal, energy recovery is maximized with all of the necessary back-up options provided should a maintenance downtime be required. For these situations, a septum valve is provided for the case that the turbine is not in operation. At all times, however, clean gas content will be assured and achieved in order to meet the needs of the rest of the works.

Proven solutions for new and existing plants

A range of primary and secondary gas-cleaning options are illustrated in the projects presented in this article. They show that this key area of blast furnace technology is indeed an area of continuous review and development. The result for Siemens VAI is a portfolio of gas-cleaning products that can be employed to meet any particular customer requirements.

The solutions described are based on proven wet-gas cleaning configurations as the secondary stage of blast furnace gas cleaning. However, dry-gas cleaning options can also be provided by mixing and matching elements from the portfolio described in this article. A cleaner future can truly be achieved for all blast furnace customers based on these products.

Martin Smith, Technology Director, Ironmaking
Carys Woolley, Lead Process Engineer

Table 2: Statistics of the Port Talbot Blast Furnace No. 4 rebuild

	Normal production	Maximum production
Hot metal output	7,465 t/d	9,000 t/d
Sinter	53%	53%
Pellets	42%	42%
Ore	5%	5%
Coal injection	180 kg/t hot metal	220 kg/t hot metal
Coke rate	336 kg/t hot metal	296 kg/t hot metal
O_2	29%	34%
Blast volume	260–270,000 Nm^3/h	248–254,000 Nm^3/h
Hot blast temperature	1,200°C	1,250°C
Normal top pressure range	1.5 to 1.8 bar g	1.5 to 1.8 bar g
Normal hot blast pressure range	3.0 to 3.6 bar g	3.3 to 3.6 bar g
Furnace top design pressure	2.5 bar g	2.5 bar g
Hot blast design pressure	4.0 bar g	4.0 bar g
Offgas volume (dry)	440,000 Nm^3/h	410,000 Nm^3/h
Top gas temperature (max. operating)	150°C	118°C

The blast furnace off-gas cleaning efficiency of the triple-inlet cyclone ranges between 80% and 85%.

Table 3: Statistics of Vizag's Blast Furnace No. 1 before the rebuild

Hot metal production	2.0 million t/a
Daily production	5,715 t/d
Useful volume (U.V.)	3,200 m^3
Productivity	~1.80 t/d/m^3 U.V.
Working days per year	350
Sinter rate	78%
Sized ore rate	22%
Coke ash	~15%
Coke rate – hard and nut	543 kg/t hot metal
PCI rate	0 kg/t hot metal
Operating top pressure	2.0 bar g
Hot blast temperature	1,050°C
O_2 enrichment to blast	~1.5%
Steam injection	35–40 g/Nm^3

Table 4: Design parameters of Vizag's Blast Furnace No. 1 after the rebuild

Furnace working volume	3,416 m^3
Furnace inner volume	3,891 m^3
Maximum operating top pressure	2.44 kg/cm^2g
System design blast pressure (at furnace)	4.59 kg/cm^2g
Hearth diameter	12.140 m
Hearth area	115.75 m^2
Productivity per hearth area	61.77 t/d/m^2
Number of tuyeres	32

Successful start-up and operation of two relocated Corex plants at Essar Steel India

Latest Corex Successes

View of the two Corex plants at Essar Steel India

Two Corex ironmaking plants originally supplied by Siemens VAI to a Korean company were relocated to the steelworks of Essar Steel India and started up in 2011. Since that time, plant operations have been highly reliable and production performance has exceeded expectations.

Essar Steel Ltd., a subsidiary of Essar Group, is a 14 million t/a global producer of steel with production and processing facilities located in India, Canada, Indonesia and the United States. As part of a campaign to expand its steel output in India, Essar Steel purchased two Corex ironmaking plants that Siemens VAI had originally installed at the Dangjin Works of the former Hanbo Steel Co., Ltd. in Korea. The plants with a combined design capacity of 1.7 million t/a were relocated to the Hazira steelworks, modernized with new special equipment and automation systems, and subsequently started up in September and December 2011, respectively. The rated design capacities of both plants were achieved within days after start-up.

The high-value Corex export gas, which is generated in the plants, is used to produce direct-reduced iron at Essar Steel's Midrex direct-reduction plants (Modules 5 and 6), and it is also applied for heating purposes within the steelworks. Corex export gas substitutes natural gas as a fuel in the direct-reduction plants for reformer heating, which lowers the overall natural-gas consumption for the Midrex plant by approximately 30%. Furthermore, a portion of the top gas from the direct-reduction plant is recycled and fed to a VPSA (vacuum press swing adsorption) unit, and from there the gas is mixed into the process-gas flow upstream of the reformer. The tail gas from the VPSA is used for heating purposes in the steelworks.

The Corex modules are operated with pellets, lump ore and imported coals. The pellets are produced at Essar-owned pelletizing plants in Visakhapatnam, state of Andhra Pradesh, and in Paradip, state of Orissa. Approximately 25% lump ore from Australia and South Africa is used as the iron ore feed. Imported coal from Australia and South Africa is used to generate both the heat required for melting the reduced iron in the melter-gasifier of the Corex plant to hot metal and the gas required for the reduction of the iron ore in the reduction shaft. Currently, approximately 100 kg nut coke per ton of hot metal is charged as part of the overall fuel mixture. The Corex plants are operated with a slag rate of 380–400 kg/t of hot metal, and both modules are equipped with slag-granulation plants.

The sludge is dewatered by means of decanters and granulated together with other dust sources in the steelworks in the sludge-treatment plant. The sludge granules are recycled to the sinter plant.

Operational results

After approximately two years of operation, both Corex plants at Essar Steel have proved to be very reliable with high availability, stable operating conditions and excellent hot-metal quality. Fuel consumption of the Corex modules was reduced to approximately 900 kg/t of hot metal, which is far below the expected figures. The Corex plants also proved to be very flexible with regard to the required gas production for export-gas utilization as well as hot-metal production.

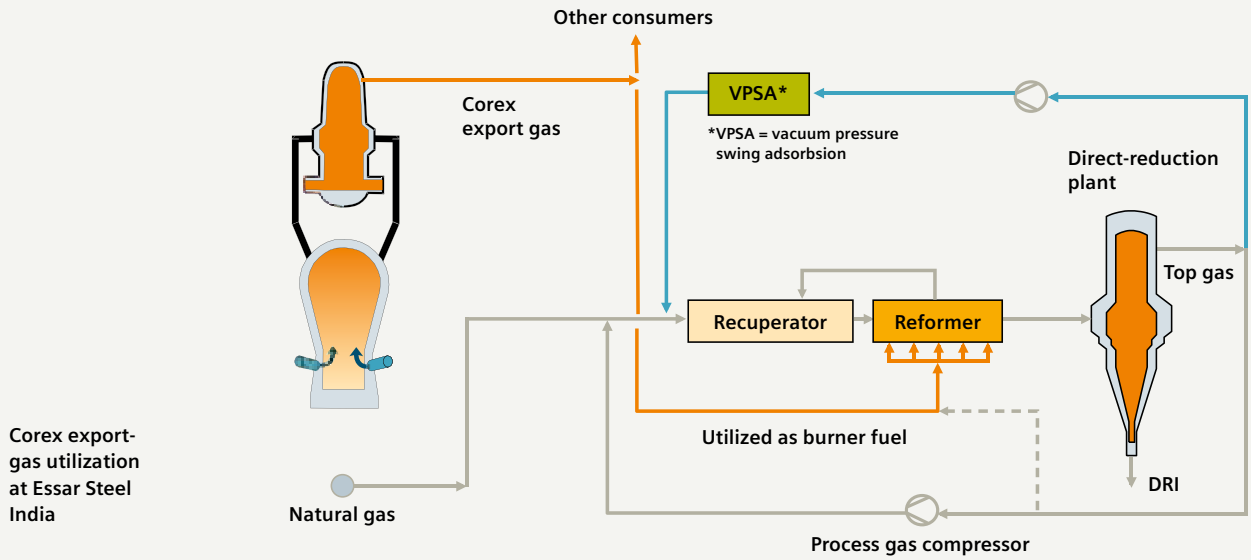
In the coming months, the focus will be on further optimization of export-gas utilization by enabling additional consumers at the Essar steelworks to use this gas. The hot-metal rate will be increased in conjunction with higher export-gas generation. Furthermore, plans are in place for the installation of a briquetting plant for the screened coal fines, which are currently being sold. The produced coal briquettes will be charged together with the lump coal to the Corex plants for an additional reduction of fuel costs and to lower nut-coke consumption.

"The operating staff of Essar Steel is extremely pleased with the start-up and operation of both Corex plants," said Subhajyoti Mukherjee of Essar Steel India. The generated export gas from the process represents a valuable, cost-saving substitute for natural gas and, hence, substantially brings down production costs.

"The operating staff of Essar Steel is extremely pleased with the start-up and operation of both Corex plants."

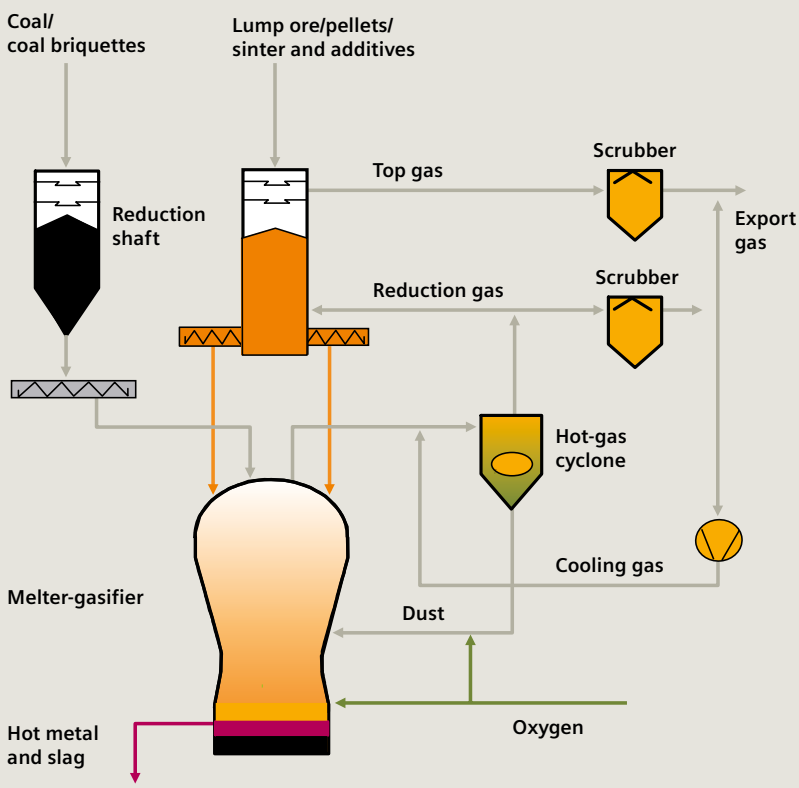
Subhajyoti Mukherjee, Essar Steel India Ltd.

Use of Corex export gas to produce direct-reduced iron



Corex export-gas utilization at Essar Steel India

Overview of the Corex process



In the Corex process all metallurgical work is carried out in two separate process reactors – the reduction shaft and the melter-gasifier. Iron ore (pellets, lump ore) is charged into the top of the reduction shaft and is reduced to metallic iron during its gradual descent through the shaft by reduction gas from the melter-gasifier.

Coal is directly charged and oxygen injected into the melter-gasifier where at high temperatures high-quality reduction gas is generated for the reduction of the iron ore. The gas consists of 90% CO and H_2 and about 3% to 6% CO_2. After exiting the melter gasifier, the gas is first cooled to the required reduction-gas temperature between 800°C and 850°C. The gas is then fed into the reduction shaft where the iron ore is reduced to direct-reduced iron. The DRI is conveyed by screw conveyors from the reduction shaft into the melter-gasifier where melting takes place.

The tapping procedure for hot metal and slag, the tapping temperatures as well as the quality of Corex hot metal are all exactly the same as in standard blast furnace practice.

Corex hot-metal production costs are up to 15% less than in the conventional blast furnace route.

Subhajyoti Mukherjee (Essar Steel India), Head Iron & Steel, Strategic Manufacturing Unit, Hazira Steelworks
Wolfgang Sterrer (Siemens VAI), Senior Expert, Ironmaking
Josef Stockinger (Siemens VAI), Corex plant Start-up Manager

Comparison of hot-metal desulfurization technologies

Hot-metal ladle

Cleaner Hot Metal

General requirements for hot-metal desulfurization can vary greatly from steel plant to steel plant. The local availability and price of desulfurization agents, the initial sulfur content of the hot metal, desulfurization targets, heat size, treatment duration and the existing plant facilities all play a role in choosing the optimal hot-metal desulfurization solution.

Siemens VAI, a global leader in metallurgical process technology, offers individual and innovative hot-metal desulfurization processes that include the Kanbara Reactor (KR) and various injection technologies. Depending on the actual conditions prevailing at a steelworks and customer requirements, Siemens VAI identifies and provides the ideal desulfurization solution as the basis for the production of high-quality steel in an integrated steelworks.

KR desulfurization technology for hot metal

KR technology was developed in Japan and was applied mostly in Asia. During the last decade, 70 new KR units were installed in China, and interest in this technology is growing in the Indian market.

In the KR process lime is added to the hot metal in a ladle and intensively stirred by means of a rotating impeller. This results in a thorough mixing of the additive with the hot metal to achieve ultra-low final sulfur contents – down to 0.002%. A high hitting ratio is ensured and the short desulfurization duration of about 10–11 minutes is basically independent of the ladle size and initial sulfur content. The process is simple and does not require costly magnesium or fluidized, fine-grained lime.

A low initial quantity of carry-over slag from the blast furnace is a prerequisite for the KR process. Pre-deslagging of the hot metal is therefore necessary, which leads to some iron losses. Furthermore, the hot-metal temperature loss is higher because generally more desulfurization agents are added to the hot metal in comparison with injection processes.

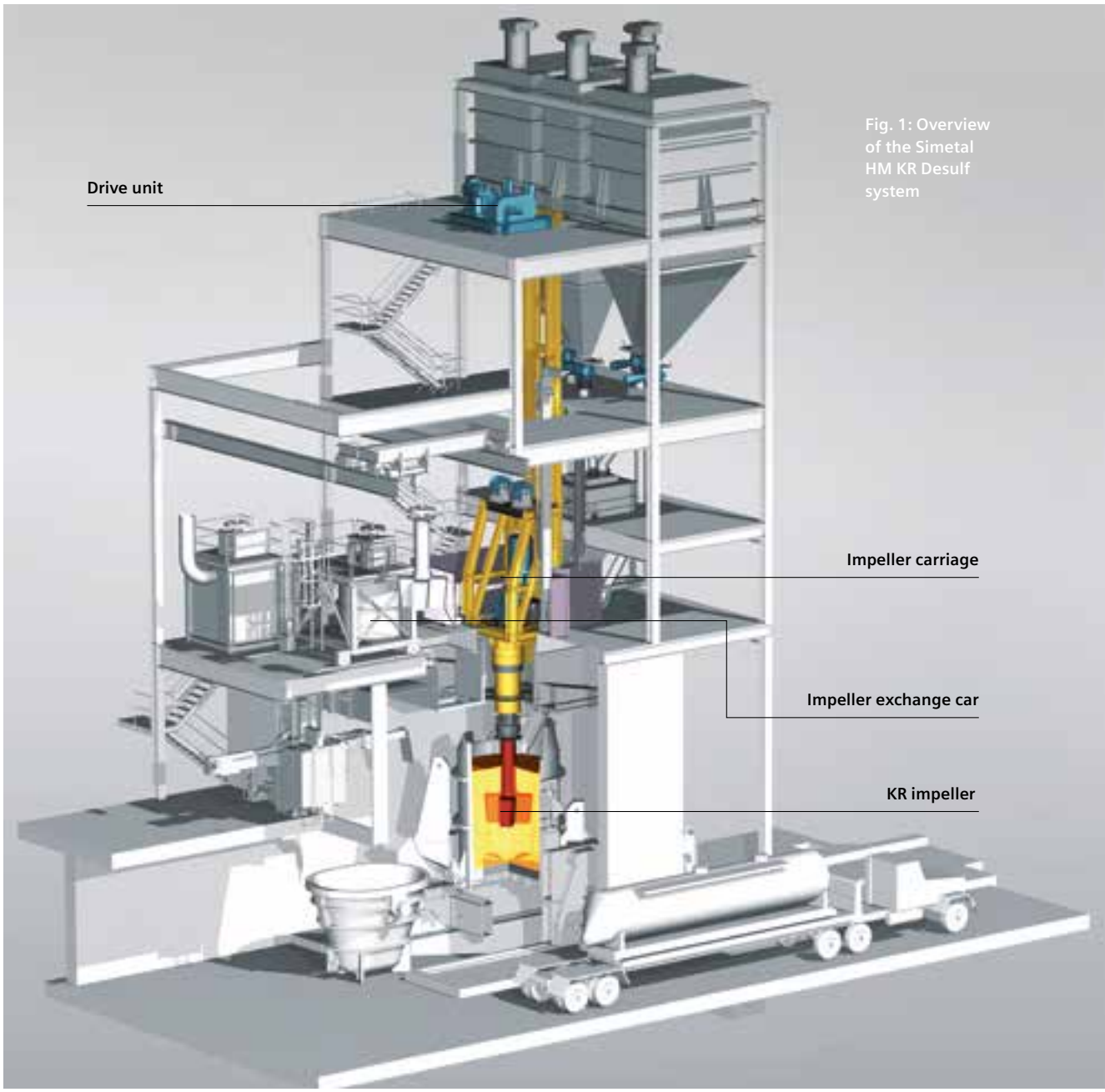


Fig. 1: Overview of the Simetal HM KR Desulf system

Siemens VAI has engineered a new KR plant with the lowest installation height compared with other desulfurization units (Figure 1). Referred to as Simetal HM KR Desulf, this solution is characterized by its compact design and ease of accessibility for maintenance. Furthermore, a smart, self-centering impeller exchange unit allows an impeller to be exchanged within one hour.

Simetal HM Injection Desulf technology

Worldwide, injection systems are the most commonly used method for hot-metal desulfurization. The solution offered by Siemens VAI is Simetal HM Injection Desulf, which employs an injection lance through which desulfurization agents such as fluidized fine-grained lime, calcium carbide and magnesium are injected deep into the hot-metal bath. The most widespread injection practice is co-injection. Here, lime and magnesium, or calcium carbide and magnesium, are injected at a ratio between 3:1 and 5:1, or even higher. The decision on which ratio is to be used depends on the initial sulfur and desulfurization target, the available treatment duration and the costs for desulfurization agents.

To ensure the best-possible solution, a dynamic automation system is provided by Siemens VAI that guides operators with respect to cost- and time-optimized process strategies. Efficient hot-metal desulfurization relies on precisely calculated flow rates, which are especially important to optimize the consumption of expensive additives such as magnesium. In response to market demands, Siemens VAI offers the innovative Simetal Feldhaus material-dosing system for the highly accurate conveying of magnesium granulates (Figure 2).

In contrast to conventional systems, the Simetal Feldhaus system responds immediately to defined setpoints and features superior flow-rate precision capabilities coupled with high injection-rate flexibility. Conveyor operation is based on volumetric dosing, which is characterized by a proactive regulation of the material flow (no control loops). The Simetal Feldhaus system increases process efficiency, reduces the amount of desulfurization agents required and, if necessary, speeds up the desulfurization process. The technology has been proven in industrial operations at ThyssenKrupp Steel (Duisburg) for many years.

Main features and benefits

- Application of an innovative pneumatic conveying system for the highly uniform dosing of magnesium granulates
- Suitability to use materials with diameters up to several millimeters
- Optimization of the lime to magnesium ratio according to requirements and market prices
- Greater reproducibility of sulfur targets
- System comprised of nearly maintenance-free equipment

Costs

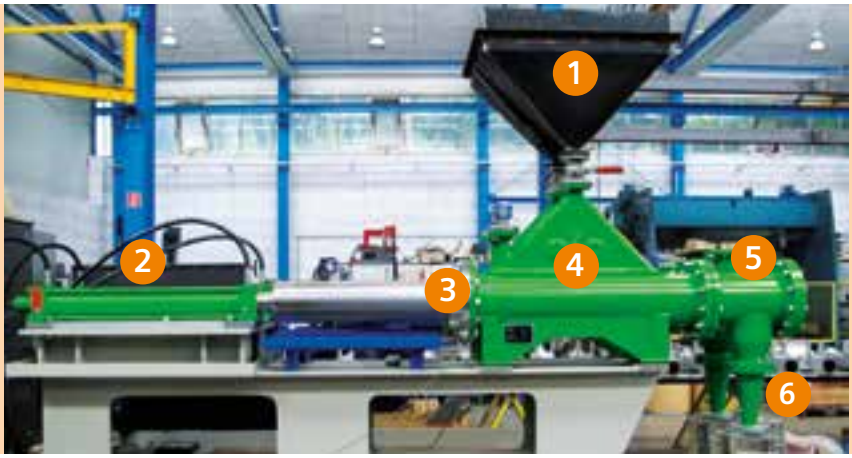
Operational expenditures (OPEX) were compared for KR, co-injection with calcium carbide and magnesium, and co-injection with lime and magnesium for different initial sulfur contents (Figure 3). Included are the costs for desulfurization agents, refractories, temperature loss and additional items (energy, media, personnel, slag removal and logistics). A comparison was made for initial sulfur contents of 0.020%, 0.035%, 0.050% and 0.070%. A production mix of 85% hot metal with a target sulfur content of ≤0.002% and 15% with a target sulfur content of ≤0.005% was assumed. Iron losses, as one of the main expense factors, was not taken into consideration because these losses vary considerably between steelworks and with respect to the different recycling strategies and consequential iron credits.

In general, the KR process showed higher iron losses compared with injection processes due to the higher amounts of generated slag and the two required deslagging steps.

The optimum desulfurization solution

Various solutions exist today to achieve the low hot-metal desulfurization levels essential for quality steelmaking. The selection of the most suitable technology is ultimately determined by the costs and availability of desulfurization agents, site conditions, hot-metal characteristics and steelmaking targets. As a life-cycle partner for the metals industry, Siemens VAI performs detailed investigations to assist producers to identify the optimum desulfurization solution to meet individual requirements.

Christian Bruckner, Metallurgist Steelmaking
Dr. Jens Kluge, Principal Expert, Integrated Steelmaking



The Simetal Feldhaus system increases process efficiency, reduces desulfurization agents and can speed up the desulfurization process.

1: Mg inlet
2: Hydraulic cylinder
3: Dosing piston
4: Mg stocking
5: Dosing area
6: Mg outlet

Fig. 2: Testing of the Simetal Feldhaus system in the workshop

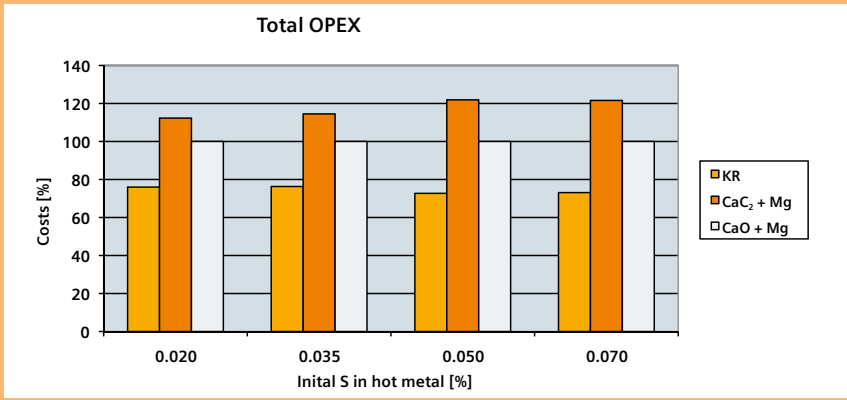


Fig. 3: Comparison of total operational expenditures (without iron loss) between the KR system and Simetal HM Desulf co-injection (CaO and Mg co-injection set at 100% OPEX for comparison)

Seven years of quality steelmaking at Evraz Pueblo, Colorado, U.S.A.

Record Performance Figures

In nearly every year since start-up of the Ultimate EAF at Evraz Pueblo in 2005, new production and quality records have been set. In a close life-cycle partnership with Siemens VAI, annual furnace output could be increased on a step-by-step basis to nearly 50% more than the original design capacity.

In 2004, Rocky Mountain Steel, today Evraz Pueblo (a company of Evraz plc), commissioned Siemens VAI to modernize its liquid steel production by replacing two low-power EAFs equipped with spout tapping with one high-power, high-capacity furnace. The new electric arc furnace (EAF) features major elements of the Simetal EAF Ultimate technology. This includes single-bucket scrap charging, high-performance electrical power input in combination with current-conducting electrode arms, extremely efficient oxygen management using Simetal EAF RCBs (Refining Combined Burners) with carbon injection, Energy Optimized Eccentric Bottom Tapping (EO-EBT) and new systems for Level 1 automation and Level 2 process optimization. The project scope also covered the supply of a more powerful transformer, a new environmental dedusting system and refurbishing of the bag houses. The project was successfully completed in October 2005, and since plant start-up more than 7 million tons of quality steel have been produced.

Charging of the Simetal EAF Ultimate furnace at Evraz Pueblo, Colorado, U.S.A.

Steel production at Evraz Pueblo

The melt shop, comprised of the Ultimate EAF, a ladle furnace, a vacuum tank degasser and a six-strand round billet/bloom caster, supplies the liquid steel required for three production lines: a rail mill, a rod and bar mill, and a seamless pipe mill. Each of these facilities has its own specific requirements with respect to steel grades, quality and analysis tolerances.

In 2012, Evraz Pueblo produced 140 grades of steel in three cast-section sizes. The grades encompass a carbon range from

Dedication to excellence in steelmaking is the decisive factor for success.

0.08% to 0.94% and require secondary treatment such as deep desulfurization and degassing according to the specific steel grade. Thanks to the unique design features of the EAF and ongoing process and equipment improvements, a record production of 1,086,118 liquid tons of steel was tapped in 2012.

Recent and ongoing Level 2 system upgrades have greatly increased process-control capabilities and plant productivity. Efficient management of the processes both upstream and downstream of the furnace is integral to maintaining short tap-to-tap times. In 2012, an average tap-to-tap of 51 minutes (operating time) or 55 minutes (total time) could be achieved.

Ladle and furnace-refractory practices are also fundamental to maintaining low overall power-off times. The content of magnesium oxide in the furnace slag and the basicity of calcium oxide/silicone dioxide are carefully controlled to allow the slag to foam and to protect the upper furnace walls.

Features of the Ultimate EAF

The contract figures for the main performance and design parameters of the new EAF are seen in Table 1. A key factor for achieving consistently high liquid-steel quality was the change from spout tapping to an EBT-type lower shell with bottom tapping. This allows a sufficiently high hot heel level and minimizes slag carry over during tapping.

Furnace shell

The furnace shell is divided into a lower and an upper section. The EO-EBT system is installed in the lower shell. It is characterized by a taphole positioned in the eccentric bottom of the shell, which reduces the buildup of cold spots in the sump area.

The upper shell is designed to provide easy access to piping and water-cooled panels for observation and maintenance. Furthermore, the design enables single-bucket charging for heats with a tap weight exceeding 100 tons, which is typical of steelmaking production at Evraz Pueblo. Special features include a tunnel burner, a sump burner and three RCBs for fossil energy input. For foaming-slag practice, three carbon-injection lances are positioned adjacent to the RCB. Necessary amounts of coke and lime are charged into the scrap bucket with the scrap prior to charging.

Performance parameters

Table 2 shows the average furnace performance values for the year 2012. It is to be noted that the EAF is not the production bottleneck – a maximum production of 36 heats per day and 19 heats in 12 hours has been achieved. The low electrical energy consumption and the extremely low natural gas and oxygen input figures represent benchmark values for EAFs. Thanks to the single-bucket charging practice, electrical power is switched on only once and not turned off until tapping conditions are reached.

Production increase

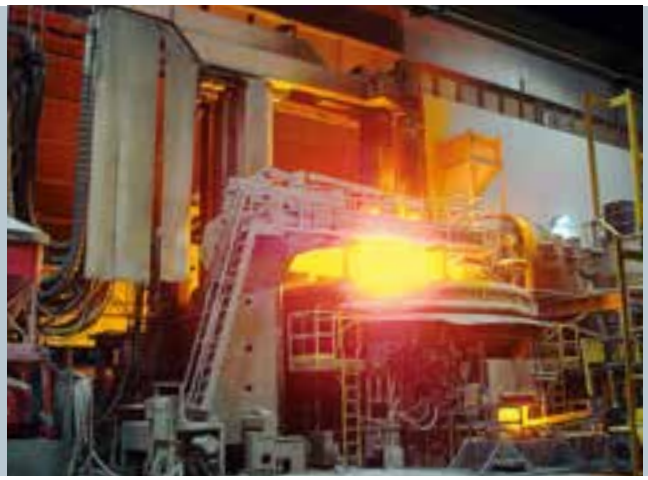
Once the operating team became accustomed to the new equipment, which was much more powerful and sophisticated than the two previous EAFs, production output increased continuously, which was only slowed down by the economic recession in 2009/2010 (Table 3). The outstanding figures underline

Table 1: Main design parameters of the Ultimate EAF

Nominal heat size	109 tons (with single-bucket charging)
Tap-to-tap time	60 minutes (rated)
Annual production	730,000 tons (rated)
Heel size	27 tons (approximately)
Furnace charge volume	116 m³
Bath volume (including heel)	18.4 m³
Bath depth (including heel)	1,050 mm/41.5 inches
Furnace diameter – lower shell	6.9 m
Furnace diameter – upper shell	7 m
Transformer power	85/95 MVA
Electrode diameter	610 mm/24 inches
Electrode pitch circle	1,150 mm

Table 2: Average performance and consumption figures of the Ultimate EAF in 2012

Heat size	113 tons
Tap-to-tap time	55 min. total (51 min. operating time)
Annual production	1,086,118 tons (actual)
Single-bucket charging	95.6%
Tons per hour	133 t/h
Heats per day	26 (36 max.)
Power-on time	37 min.
Power-off time	17.5 min. total (13.5 min. operating time)
Tapping temperature	1,650–1,680°C
Electric energy consumption	388 kWh/t
Electrode consumption	1.15 kg/t overall
Oxygen consumption	24 m³/t
Natural gas consumption	4.5 m³/t
Coal injection	3.6 kg/t
Charge coal	900–1,135 kg/heat
Furnace lining life	2,538 heats
Gunning material consumption	0.38 kg/t



Annual output of the Simetal EAF Ultimate could be increased by nearly 50% of the original design capacity.

the performance capability of the equipment and the excellent teamwork at Evraz Pueblo. In 2013, the 10,000 heats mark was reached. Overall productivity is expected to reach an average hourly minimum of 136 t/h (Figure 1).

People make the difference

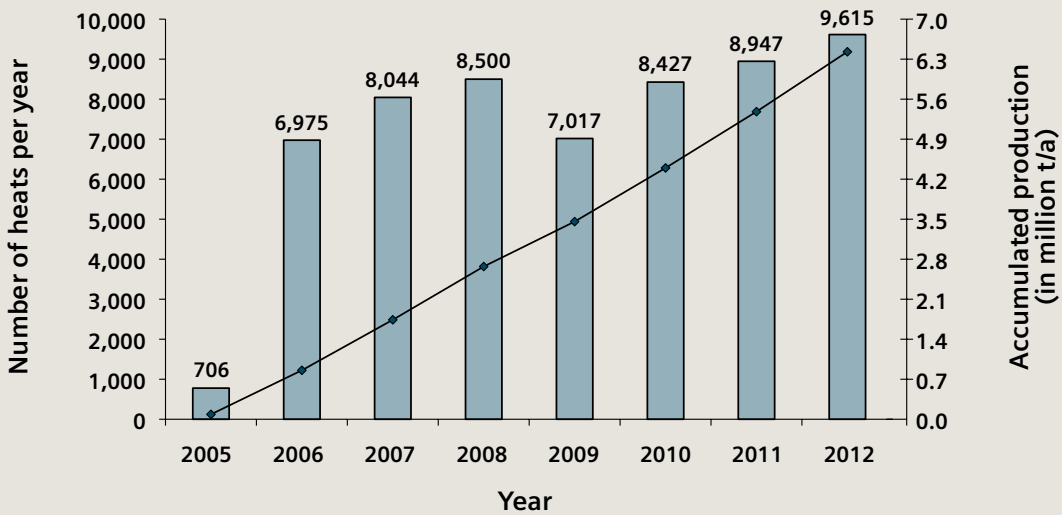
Competitive electric steelmaking requires that the melt shop is operated efficiently with respect to production output and energy consumption. Advanced equipment and systems in combination with rigid maintenance practices, of course, are a prerequisite for this. However, it is ultimately the people who operate the equipment and control the processes that are the true key to Evraz Pueblo's continuous productivity improvements. Their dedication to excellence in steelmaking is the most important factor for success.

Dave Ellis (Evraz Pueblo), Manager – Melting & Casting
Valoree Varick (Evraz Pueblo), Steelmaking Process Control Coordinator
Markus Abel (Siemens VAI), Senior Expert Electric Steelmaking

Table 3: Productivity development from 2005 to 2012

Year	Production in tons	Heats
2005	88,900	706
2006	799,133	6,975
2007	915,868	8,044
2008	966,308	8,500
2009	814,909	7,017
2010	973,460	8,427
2011	1,021,161	8,947
2012	1,086,118	9,615

Fig. 1: Production results of the Simetal EAF Ultimate furnace at Evraz Pueblo



Start-up of a new AOD converter at Viraj Profiles, India

Meeting the Demands For Stainless Steel

Viraj Profiles Ltd. is the leading manufacturer of stainless steel long products in Asia and the second-largest producer of these products in the world. In order to expand its output, in July 2010 the company awarded Siemens VAI a contract for the supply of a new 55-ton AOD converter to be installed at the Viraj plant in Boisar in the Indian state of Maharashtra. The plant was started up in April 2012 and has been successfully operating since then.

The main target of this investment was to increase the annual production capacity in Steelmaking Shop No. 2 by an additional 245,000 tons of stainless steel comprising mostly austenitic grades (300 series and occasionally 200 and 400 series). A customer stipulation was that the new production line should reuse as much existing equipment as possible in order to minimize required modifications. A major challenge in this difficult-to-execute task was to install a new AOD vessel next to an existing vessel without interrupting ongoing production. Siemens VAI provided not only the AOD vessel but other components and systems for the converter that included tilting drives, the trunnion ring, valve stands for the bottom tuyeres, the top lance, and complete Level 1 automation and Level 2 process-optimization software. The project scope also comprised the supply of a movable hood for the cooling stack, basic engineering for the new alloying and dedusting systems, a ladle transfer car and the new converter foundation.

The new AOD converter was mounted on its foundation in December 2011 and was put into operation in April 2012. The final acceptance certificate was issued by the customer in March 2013.

Shorter charge-to-tap time

One of the main benefits that resulted following the start-up of the new converter was the shorter charge-to-tap time. Less than 70 minutes per heat are now required, including time-consuming intermediate deslagging for each heat, compared to about 110 minutes with the older, adjacent converter installation.

Decisive reasons for the improvement in charge-to-tap times include the installation of a top-blowing lance, customized bath-blowing equipment and the new Level 2 process-optimization system that Siemens VAI installed as a full-feature online version. Precise online information about the ongoing metallurgical progress is augmented with laboratory results and temperature measurements. The information makes it easier for the operator to decide when to finish the process without the risk of overblowing or incomplete decarburization. The Level 2 automation system also calculates and controls the optimal amounts of ferroalloy and additives (e.g., lime, dolomite) to be charged into the vessel in a cost-optimized manner.

The project was successfully completed to the full satisfaction of the customer – not only in regard to improved operational advantages and the ensuing financial benefits, but also with consideration to overall project costs – without any compromises to equipment quality.

Subrata Bhattacharya (Viraj Profiles), Chief Production Officer
Krzysztof Pastucha (Siemens VAI), Senior Expert, Stainless Steelmaking Technology
Gerhard Losbichler (Siemens VAI), Project Manager

Tapping of the new 55-ton AOD converter at Viraj Profiles, India

A 40-minute reduction in tap-to-tap times could be achieved thanks to the installation of advanced technologies.

Scenes from the mill modernization at Hoesch Hohenlimburg, Germany (Phase 2)

1. Rolling operations at the original mill

2. Removal of mill stand housings

Modernization of the medium-wide hot-strip mill at Hoesch Hohenlimburg, Germany

Rolling Mill Metamorphosis

In response to downstream demands to supply higher-strength and higher-value steel grades, Hoesch Hohenlimburg GmbH, a company of ThyssenKrupp Steel Europe, commissioned Siemens VAI to completely modernize its hot-strip mill.

6. Installation of Mill Stand No. 19

7. Completion of mill stand replacement work

8. Start of rolling in modernized finishing mill

3. Dismantling work in full swing

4. Mill stand disassembly nearly completed

5. Installation of mill stands Nos. 16 and 18

The 9-stand finishing mill of the medium-wide hot-strip rolling mill of Hoesch Hohenlimburg, originally installed in 1955, was modernized by Siemens VAI in two phases. During phase 1, which took place in the summer of 2012, two mill stands were extensively modernized and two new stands were installed. In phase 2, which was carried out in December 2012, three of the existing stands (Nos. 16–19) were replaced with new ones. The new and refurbished mill stands were outfitted with work-roll shifting devices; SmartCrown technology for improved strip profile and flatness performance; L-type bending blocks; hydraulic gauge control (HGC) cylinders; and automation systems based on the Siroll HM platform for roughing mills and finishing mills.

The modernized mill was restarted in January 2013. A 25% increase in the rolling mill capacity to approximately 1.3 million tons per year is targeted for 2015. The medium-wide strip is primarily used for the production of automotive parts such as seat rails, brake pistons and gear components – components that must be capable of withstanding extreme loads. Hoesch Hohenlimburg can now better meet the increased demands for higher-value steel grades and supply high-strength hot-rolled strip in thicknesses from 1.5 mm to 16 mm, and in widths between 150 mm and 720 mm.

Siemens VAI had previously supplied a new downcoiler to Hoesch Hohenlimburg in 2003 and, between 2008 and 2011, equipped the roughing mill and finishing mill with new Level 1 basic automation, Level 2 process optimization and the associated mechanical equipment. The latest mill modernization projects carried out for this specialist supplier of hot-rolled strip are additional examples of the life-cycle partnerships that Siemens VAI upholds with its customers.

Dr. Lawrence Gould

To see a film showing the complete modernization of the mill from start to finish, go to

http://youtu.be/vGjURVyRrNM

Hoesch Hohenlimburg can now better meet the increased demands for higher-value steel grades.

Modernization solutions boost productivity and quality

Updated Mills Yield Rising Revenues

Vertical compactor installed at Sterling Steel Company, Illinois, U.S.A.

Economic pressures in the global steel industry are forcing producers to find new ways to remain competitive. Selective mill modernizations can maximize the benefits of capital investments. Developments in rod and bar mill equipment and process design have generated major improvements in size control, mill productivity and utilization, operating cost and product quality.

Long-product rolling mills continue to provide an essential industry segment with the capability for coiled and straight products in a wide range of sizes and steel grades for thousands of end-use applications. With the industry's consolidation in the last two decades, however, the surviving long-product mills have streamlined operations and cut costs. This trend is expected to continue as the world economy experiences either very slow growth or further contractions.

The recent industry evolution has led to severe shortages of skilled, experienced workers. While previous generations could draw on their experience to make the best use of aging equipment and operating practices, the key to success in sustaining and improving operations today is to selectively replace outdated equipment with new technology and increase automation levels. Modernizations can provide consistent operations with higher speeds, less maintenance and downtime, longer wear-part life for more uptime between changes, and minimal operator intervention.

From the starting billet to the finished coil or bar bundle, the conventional long rolling mill has many possibilities for improvement through equipment and process modernization. Recent process improvements involve a combination of robust rolling stands and finishing blocks, high-speed shears, pinch rolls, laying heads, ring distributors, coil handling systems and compactors, and controlled temperature rolling and controlled cooling. To minimize downtime, reduce capital expenditures and maximize return on investment, mill operators can take a phased approach to upgrades.

With advances in rod mill equipment and system technology, Siemens VAI has been able to successfully upgrade numerous mills around the world in recent years.

Example of a Morgan Vee Mini-Block installed as a pre-finishing block

The key to success in sustaining and improving operations today is to selectively replace outdated equipment with new technology and increase automation levels.

Morgan high-speed laying head installed in the Siemens VAI-supplied rod mill at Changzhou Zhongtian Iron & Steel Co. Ltd. (Zenith Steel), China

New laying head and reform modernization improves utilization and quality

Nucor Nebraska wanted to improve its coil package in order to reduce delays in its wire rod mill and to provide a better product for its wire-drawing customers. The modernization project focused on the laying head and the reform areas.

Installing a new Morgan High Speed Laying Head offered consistently good ring formation onto the controlled cooling conveyor. Supplied with the patented tail-end control deflector plate, the laying head helped deliver consistency of head and tail ends. To ensure proper delivery of the rings to the conveyor, a new adjustable entry section was added to span from the laying head to the existing conveyor.

On the reform end of the conveyor, Nucor installed a new reform station with a ring distributor to further ensure formation of a good coil package. A new sliding exit section of the conveyor, designed to receive the rings from the drop off in the existing conveyor, enables speed changes ahead of reform. A new section of the coil handling system with vertical-stem pallets interfaces with the existing pallet system.

As a result of this modernization, the mill operates at greater utilization, and customers are satisfied with Nucor's higher-quality products.

Reform and coil handling modernization expand product range

The single-strand wire rod mill at Celsa Atlantic in Spain was built in 2006, primarily to produce ribbed reinforcing products and industrial-grade rod in coil. The finishing end of the initial mill consisted of a Morgan Vee No-Twist Mill, water boxes with intermediate pinch rolls for HYQST (High Yield Quenching & Self Tempering) production, a Morgan High Speed Laying Head, a Morgan Stelmor conveyor, and a reform with a two-arm mandrel and transfer car for interfacing with a horizontal hook-coil handling system and a single horizontal compactor. After several years of operation, changes in market demand and mill ownership created a need for new sizes and increased coil handling system capacity.

The solution included alterations to the reform tub with a new nose cone to improve coil formation with the existing ring distributor, plus modifications to the lower reform area to replace the two-arm mandrel with an interface to a new section of vertical-stem pallet coil handling. In addition, the horizontal hook system was extended with a new section to provide more coil positions and to integrate with the new vertical-stem pallet system, which incorporates a transfer car and trimming stations. Celsa also installed a second horizontal compactor.

To accommodate changes in the existing equipment, Celsa upgraded automation for the coil handling area, which now controls the new pallet system, interfaces and compactor. The customer now offers an expanded product line and has increased the mill's coil handling capacity.

One upgrade has enabled Sterling to increase mill utilization to more than 90% and to set several new production records.

Stelmor, reform and coil handling modernization set new records

Originally installed in 1983, the U.S. single-strand rod mill at Sterling Steel LLC underwent various upgrades over time: laying head modifications in the late 1990s, a new Stelmor conveyor in the early 2000s, changes in the finishing block area, and new water boxes with a temperature-control system in 2008. The latest modernization included extending the Stelmor conveyor and installing a new reform station with a ring distributor, a new vertical-stem pallet system and a new-generation vertical compactor with wire binding.

This upgrade has enabled Sterling to increase mill utilization to more than 90% and set several new production records. The totally vertical system, from reform through to compacting, has resulted in less distortion of the coil during cooling, so that the final coil package offers better coil storage, shipment and customer use. Fewer coils have to be reworked due to loose or broken bindings. With less frequent manipulation, there have been significantly fewer coil scratches. Easily accessible system components have improved worker safety. In addition, the mechanical design has reduced maintenance costs.

An experienced partner for mill modernizations

Rolling mill equipment and process improvements by Siemens VAI during the last decade have enabled many mills to undergo successful modernizations. These modernizations have delivered significant increases in rolling speed, production rate, mill efficiency and product quality. The combination of highly flexible and reliable equipment, superior process design and automation systems offer many possibilities for improving mill operations.

Dr. Bruce V. Kiefer, Intellectual Property Manager

Fig. 1: Human-machine interface (HMI) of Compact Speed Master

Cost-effective performance enhancement in long rolling

Compact Speed Master

Challenged to provide products that meet ever-increasing quality standards, long rolling producers with older or outdated automation systems cannot achieve the degree of quality required by today's steel market. Cost-efficient equipment and automation from a supplier with know-how from more than one hundred long rolling installations around the world ensure an ideal solution – and the basis for the production of highest-quality products.

Mills throughout the world are still running with redundant or archaic control systems that have not evolved from the time these mills were installed. While operators and maintenance personnel may be able to yield saleable products to limited markets, anything less than the most modern tracking methods and process-handling equipment risks compromising productivity, metallurgical properties, cut length, packaging quality and overall product quality. Furthermore, it is difficult and often impossible to obtain spares for older control systems.

Siroll LR

To support today's complex mill requirements, Siemens VAI is uniquely positioned to offer a compact solution to the long-products market. The full Siemens VAI solution Siroll LR incorporates well-designed mechanical, control and information systems that increase mill utilization and yield, reduce unplanned outages, improve product tolerance, decrease product variability and lower inventory. With open communication, standard hardware and modular software, the system delivers a totally integrated control system for long rolling that leads to lower costs and greater flexibility in plant operations.

The Siroll LR solution for the automation of a long rolling plant is designed to meet every application required for that facility. Furthermore, it can be easily expanded from controlling a single piece of equipment to a full mill train or an entire rolling facility. An investment in one area can lead to minimal investment to upgrade the control system in phases, resulting in a state-of-the-art long rolling control system.

Siroll LR Compact Speed Master

Siroll LR Compact Speed Master is an effective, low-cost solution that upgrades the control system for the roughing and intermediate mill. Incorporating many of the proven modules from the Siroll LR product, it includes a modern operator desk, intuitive human-machine interface (HMI) and control functions to optimize all mill operations (Figure 1). Siroll LR Compact Speed Master is designed for the utmost modularity and compatibility, and it meets the requirements of existing mill equipment as well as rod and bar outlet upgrades for years to come. Compact Speed Master is a complete system ready to be installed in any plant, and optimized commissioning requires minimal mill downtime. Furthermore, this compact automation package is suitable for any long rolling mill. It is designed as a cost-effective standard solution to run new mill equipment or replace existing automation systems in a cost-efficient, time-saving and risk-free way (Figure 2).

A comprehensive Siroll LR automation hardware and software system containing all the important technological functions ensures safe, reliable and repeatable rolling with high mill performance. Standard interfaces to the drive system and field devices allow the replacement of analog automation systems and old PLC systems for revamping projects.

A modern, powerful HMI system displays all important production and mill conditions, thereby supporting the mill operator and best operator practices. Roll-pass schedules can be stored and modified, and the displayed mill parameters and setpoints are adjustable. The message and fault system tracks mill events to optimize performance of both plant and product (Figure 3).

Siroll LR Compact Speed Master hardware consists of one automation cubicle, including centralized I/O modules and a main operator desk, all based on the best standard products in the Siemens portfolio. The automation cubicle can also be installed in the drive room, the operator pulpit or the cabin. Interfaces are available via Profibus DP or analog and digital I/O – approximately 200 in total from drives, field devices, and areas before and after the rolling mill.

An integral part of the HMI is the WinCC User Archive, a flexible and stable system for schedule handling. It requires no additional programming languages or tools to implement sufficient schedule handling for wire rod mills and bar mills.

Advantages for mill operation

Siroll LR Compact Speed Master improves mill availability and performance through the following capabilities:

- Cascade control
- Minimum tension control
- Digital loop control
- Head and tail-end tracking
- Cobble detection
- Mill set-up
- Mill speed reference, section start and stop
- Tracking
- Simulation or ghost rolling
- Pass schedule storage
- Shear cut control

The system can be adapted to control up to 18 stands, up to 2 shears and up to 8 loopers.

Level 1 pass schedule

The product spectrum of long rolling mills is very broad and requires considerable flexibility in pass-schedule handling. Siroll LR Compact Speed Master's modular schedule system provides the following functions:

- Creates a new pass schedule by the rolling expert directly in the HMI
- Edits an existing pass schedule by the rolling expert
- Loads a schedule from the archives, changes it online and saves it
- Selects the pass schedule and sends it to the rolling process
- Changes/adapts roll-set data to the actual mill status by the operator
- Stores optimized schedules after successful rolling for future use
- Connects easily to the existing Level 2 system

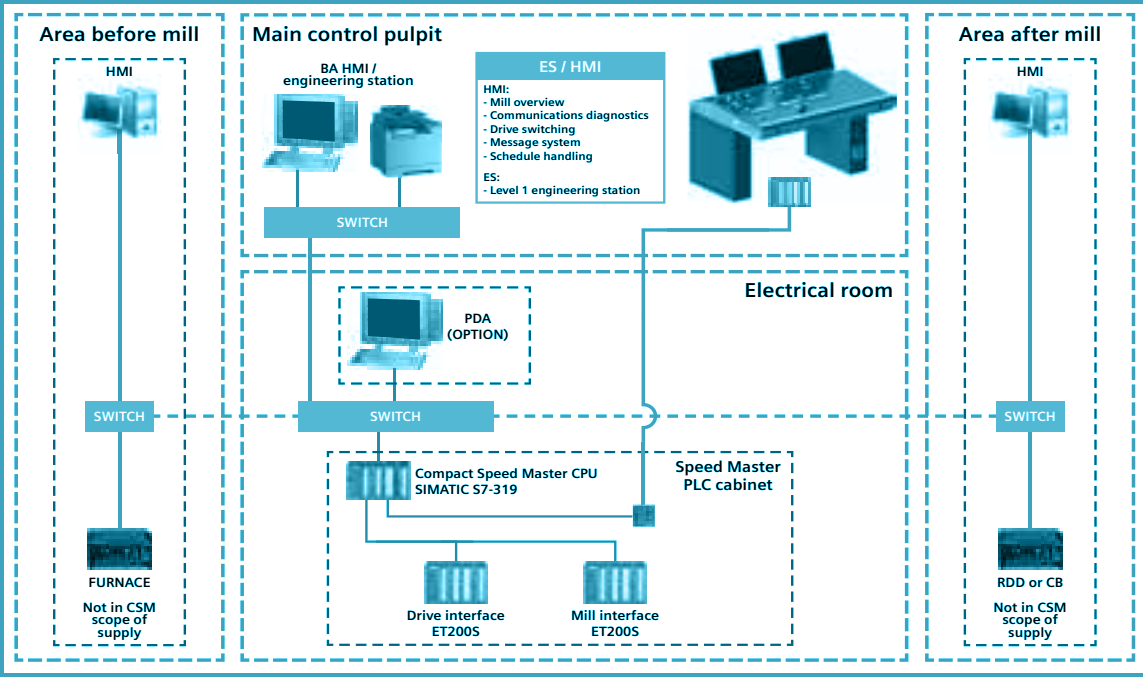


Fig. 2: Integration of Compact Speed Master within any automation system

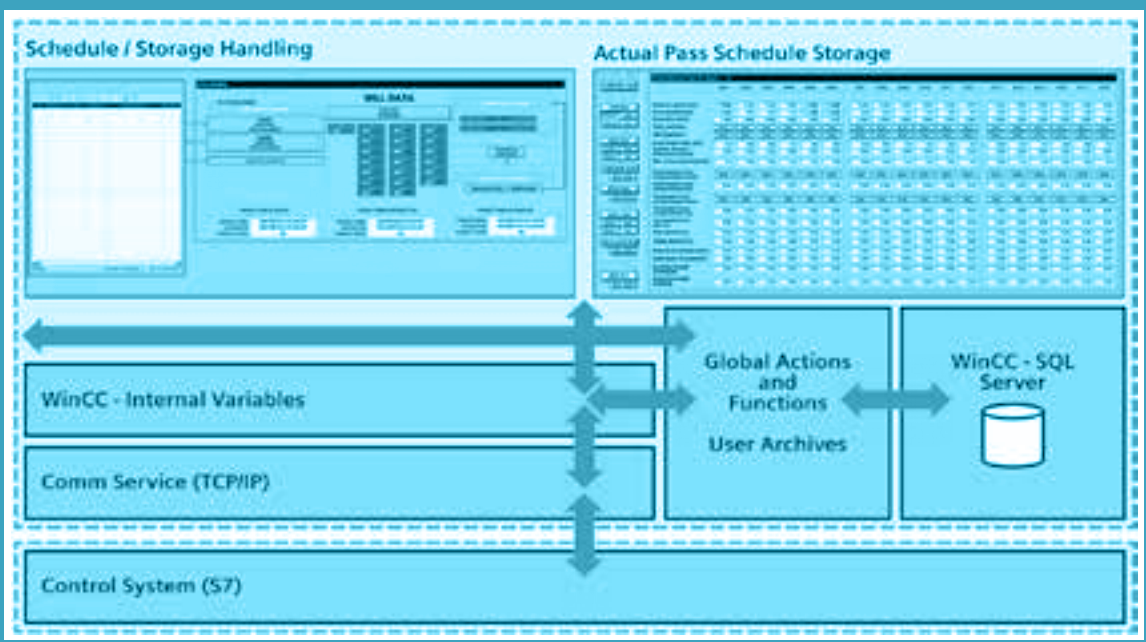


Fig. 3: Pass schedule handling using Compact Speed Master

Benefits of Compact Speed Master in a nutshell

- All-in-one solution, vigorously tested and based on proven Siroll LR software
- Complete hardware solution (automation stations and control stations)
- Compact and stand-alone with limited interfaces
- S7-319 – highest speed CPU in the Siemens portfolio
- ET200S – reliable remote I/O
- Repeatable and reliable rolling
- Easy implementation in existing plants – limited downtime for installation and commissioning
- Modular design, rod or bar control can be upgraded in the existing mill control

Compact Speed Master is a cost-effective control system that serves as the basis for the production of highest-quality long products in both new and existing mills.

Paul B. Riches, Head of Electrics and Automation, Long Rolling

Worcester, Massachusetts, U.S.A.

Siemens Hosts 10th Long Rolling Symposium

Focus on innovative, cost-effective modernization solutions in long rolling

Worcester, Massachusetts, was the site for the Siemens VAI Long Rolling Symposium, held from June 24 to 27, 2013. The event marked the tenth gathering of rolling mill experts, continuing the tradition begun by Morgan Construction Company in 1970.

"About 100 customers attended from around the world," said Bruce Kiefer, Intellectual Property Manager, who chaired the symposium committee. Planned as a forum for the exchange of ideas and experiences, the theme was innovative, cost-effective modernization solutions.

The three-day program, held at the city's downtown convention center, included customer presentations of technical papers, discussions on new technology and innovations, and breakout sessions on topics ranging from section and rail mills to maintenance and finished-product handling. A large exhibit area in the convention center featured demonstrations and displays of Siemens VAI technology for long rolling, including new equipment, electrics and automation, and services. Symposium attendees also enjoyed a tour of the Siemens VAI facilities for manufacturing high-speed rolling mill equipment, and some took part in an optional field visit to Sterling Steel in Illinois.

Dr. Bruce V. Kiefer, Chair of the Siemens VAI Long Rolling Symposium

Dr. Bruce V. Kiefer, Intellectual Property Manager

Long rolling symposium participants toured the Siemens VAI manufacturing facilities in Worcester

Advanced modernization packages improve line performance and pickling quality

A Fountain of Youth For Pickling Lines

Older pickling lines are typically no longer able to meet growing market demands. Instead of investing in costly new equipment, upgrading existing facilities with the latest technologies gives plants a second life. The result is enhanced performance capability that can be compared to new plants. Siemens VAI offers a complete range of solutions for pickling lines that ensures optimized pickling quality at high line speeds and at low operating costs.

Example of modernized pickling line equipment (l to r): pickling tanks, rinsing tanks, and side trimmer equipped with the Dynamic Width Adjustment (DWA) system (courtesy of Tata Steel Ijmuiden, the Netherlands)

In the pickling process iron oxide or scale is removed from the surface of the hot-rolled strip with the use of chemicals prior to cold rolling. In the 1950s, when the process was developed, the pickle liquor consisted of sulfuric acid in a concentration of about 25%. The pickling bath was heated to around 65°C to obtain a better scale-removal efficiency. As market demands increased with regard to both production and quality, the use of hydrochloric acid was introduced in the 1990s. The pickle liquor with concentrations of around 18% HCl was heated to approximately 85°C. This method is the most commonly applied process to pickle carbon steel strip today.

An analysis of existing pickling lines shows that many are no longer up to date and require an upgrade to maintain their level of performance in terms of throughput and quality. The availability of new technologies allows existing pickling lines to perform better and at lower operational costs.

New trends in the pickling process

The availability of new steel grades such as advanced high-strength steels (AHSS) has made it necessary to adjust pickling process parameters. For example, the higher coiling temperature in the hot-strip mill increases the growth of metal oxide scale and, consequently, a longer pickling time is required.

Reducing downtime in the entry section

An increase in pickling capacity is achievable by upgrading the pickling line entry section, mainly by reducing the entry downtime. Most older lines are equipped with a single

uncoiler. A line entry arrangement of this type typically results in a production bottleneck. The solution is to install a second payoff reel or an additional coil transfer car that can be used as an auxiliary uncoiler. Entry-time cycles can be decreased from 120 seconds to 90 seconds with this measure. This new concept is already employed in high-output pickling lines, both in stand-alone lines and in directly linked pickling and tandem cold-rolling facilities. The solution is very affordable, and it leads to a production increase of around 4%.

A new generation of strip welders

Over the course of a year, around 45,000 strip joints must be welded in a pickling line with a capacity of 1 million tons. This figure underlines the importance of the welder. The strip has to be kept running in continuous mode without changing process parameters to ensure the best-possible quality results along the production chain. To smoothly execute the welding process, all possible errors must be avoided. A laser-welded joint offers a high degree of quality and reliability: a slowdown in the line speed is avoided, strip tension is maintained in the scale-breaker area, mill rolling force is sustained, and even more severe issues such as strip breakage are prevented.

The latest heavy-duty laser welders from Siemens VAI allow hard incoming material to be efficiently welded. Thanks to the integrated annealing unit, the welded zone can be immediately treated to relieve stress. This laser type fulfills the following criteria:

- High performance level for all steel grades (low- and high-carbon steel, HSS, TRIP, DP, etc.)*
- Ability to weld from 0.8 mm to 6.5 mm strip thicknesses
- Weld breakage rate less than 0.2%
- Perfect control of the welding quality and geometry

Improved strip shape and better scale removal

The superior mechanical properties of new steel grades is related to improved alloying techniques, which also results in harder steel strip. For the physical descaling of strip by means of strip bending in the scale-breaker area, a higher strip tension is necessary to attain the original strip shape. With this in mind, Siemens VAI developed a machine capable of exerting a powerful strip tension (from 65 tons to 95 tons) for materials with yield stresses between 750 MPa and 1,000 MPa. Strip elongation ranges from 0.5% to 3% and the following benefits are derived:

- Efficient breaking of metal oxide scale
- Improved strip shape that promotes a uniform and homogeneous acid attack along the entire strip length

*HSS = high-strength steel, TRIP = transformation induced plasticity, DP = dual phase

The combination of advanced processes and specialized products is the basis for an optimized pickling product.

New 6-strand entry looper

Many pickling lines still use small-capacity horizontal entry loopers that are designed with two or four strands. If pickling line space is available in the existing building, it may be advisable to replace the complete entry section with a new 6-strand looper. This can be done during routine production, and only a short line shutdown is needed to link the new section with the existing installation. This solution can increase line capacity by around 5% on an existing pickling line configuration.

Latest generation of pickling and rinsing tanks

Originally, pickling tanks consisted of a steel shell outfitted with additional protective layers made of rubber and brick linings. This prevented acid contact with the steel tank that can result in severe tank-body damage and pickling downtime. Siemens VAI introduced its own turbulent acid-circulation technology that features the use of a shallow or flat tank made of polypropylene, which is equipped with side jets to improve pickling efficiency.

Installations of this type have demonstrated the following benefits:

- Superior acid attack on strip surfaces
- Avoidance of unscheduled line stoppage due to tank leakage
- Significantly enhanced pickling-bath turbulence, allowing line speeds to be increased by 10% to 15%

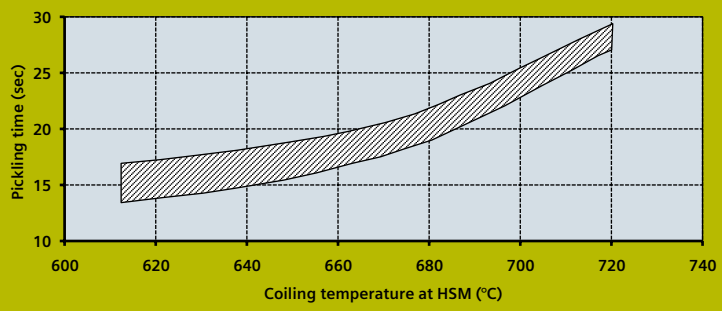
A new five-stage cascade rinsing section was also introduced, which is equipped with a high-pressure rinse in the last stage. This solution minimizes acid carry-over and acid loss with the strip exiting the rinsing section. Furthermore, control of the rinsing process is improved, especially with the implementation of acid concentration control in the first two cascade steps. Strip surface quality is enhanced thanks to the avoidance of acid stains and brown color.

Pickling process model

Siemens VAI also developed the Siroll Faplac (Fully Automatic Pickling Liquor Analysis and Control) system to help line operators in their daily work to maintain high production rates with optimized pickle liquor management. This solution minimizes pickle liquor wastage, the associated costs and the environmental impact. Furthermore, pickling efficiency is improved by automatically monitoring and controlling the acid and iron concentration of the pickling bath.

No more line stoppage at the side trimmer section

Line production and production yield is always hampered by strip-width changes and the necessity to stop the line to reposition the side-trimmer heads for strip trimming.



Relationship between coiling temperature and pickling time

Pickling line upgrades with advanced solutions from Siemens VAI result in an enhanced performance capability that can be compared to new plants.

Siemens VAI therefore developed the DWA (Dynamic Width Adjustment) system to avoid line stoppages resulting from strip-width changes. The benefit of this solution is a 5% increase in overall production.

The DWA system runs in a fully automatic mode on the basis of incoming setpoints from the line PLC. During the transient period (change between two strip widths), the line speed is slowed down to 30 m/min and a maximum format change of 100 mm per side is achieved in two-meter strip lengths. In this way, an ideal strip-width change is assured.

Automatic surface inspection for high strip quality

Product quality is the final judgment criteria, and it becomes most evident at the line exit. In order to detect product defects as early as possible, the Siroll SIAS system was developed by Siemens VAI for automatic, online surface inspection to increase process transparency and minimize product rejection.

The main benefits of the system include:

- High performance with "high-sensitivity" inspection along the entire strip on both sides
- Easy operability, maintenance and administration thanks to simple hardware architecture, fewer electronic parts to maintain and a user-friendly maintenance interface
- Use of a powerful, third-generation LED illumination system for a high defect/non-defect detection ratio
- Line-scan camera inspection for optimal image quality

Application of the latest Siroll SIAS XLine version increases processing power and allows:

- Full strip inspection at high resolution (no saturation)
- Increased archiving capability
- Easier interface and control (full graphic user interface and dynamic settings)

Automation with extended diagnostics

For the operation of the line, production supervision and maintenance support, equipment from Siemens VAI is equipped with powerful diagnostic tools integrated into the automation and HMI system. This includes, for example, a guiding system to help operators find the right information and to assist them in keeping production up. This solution can be implemented in an existing automation system while mechanical equipment is upgraded. Benefits are manifested when the line is in operation as well as in the area of preventive maintenance.

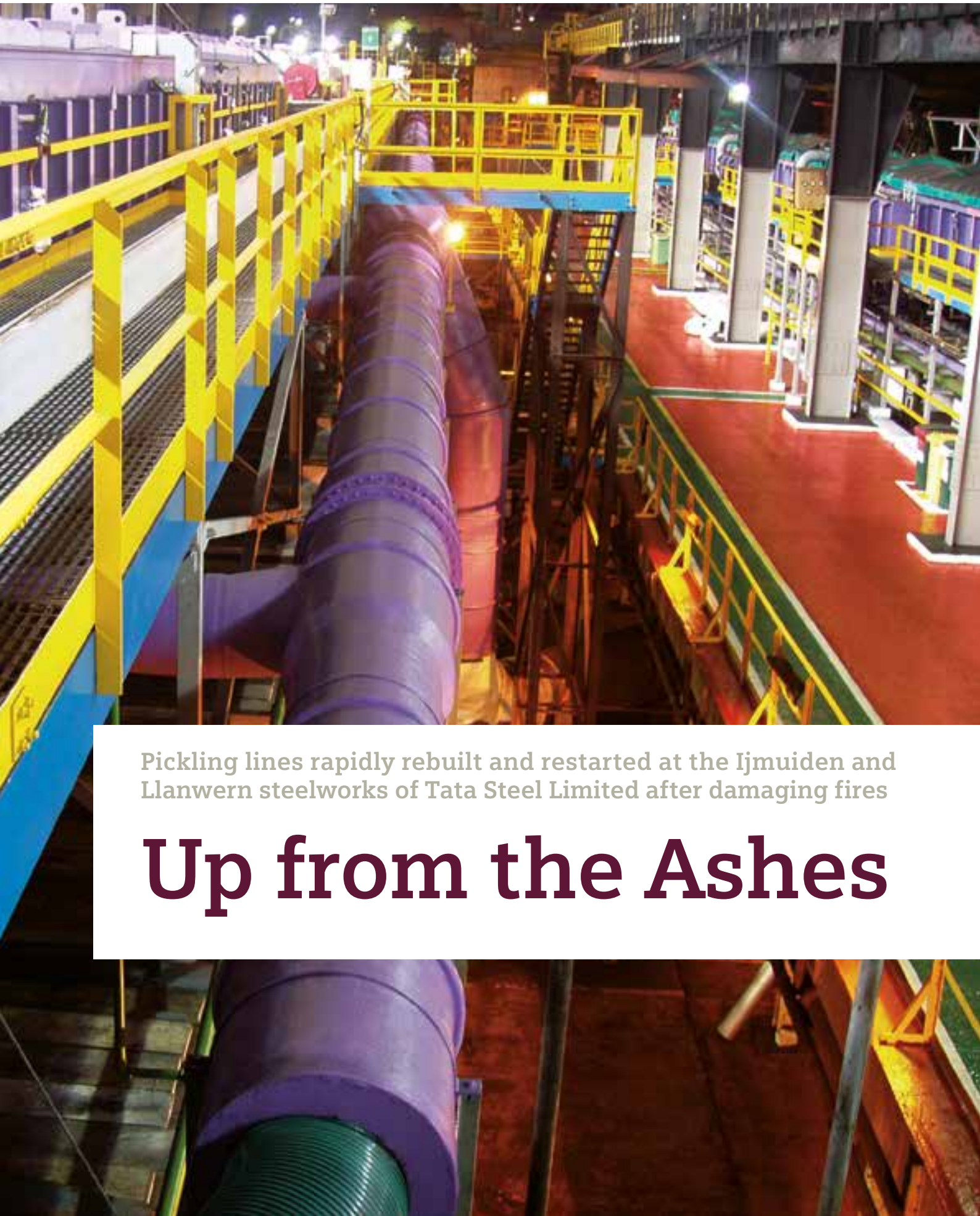
A broad suite of solutions for ideal pickling results

On the basis of its extensive experience in the design, supply, installation and commissioning of continuous pickling lines as well as linked pickling lines and tandem-cold-rolling mills, Siemens VAI has developed numerous products and solutions to ideally control all pickling line processes. These start with the laser welder, comprise the scale breaker and turbulent pickling process, and extend up to the advanced rinsing section and inspection station. Special solutions include the Dynamic Width Adjustment system for strip-width changes, a unique scrap chopper unit and a sophisticated automatic surface-inspection system. The combination of all these advanced processes and specialized products is the basis for assuring an optimized pickled product to serve the premium strip market.

Alain Challaye, Technical Director, Carbon Steel Processing Lines

Overview of the upgraded pickling line at Tata Steel's Llanwern steelworks, U.K.

It's a bad situation for a steel producer when an unpredictable event causes a lengthy production stoppage. It's even worse when it happens twice. Within the space of a year, two of Tata's European steel plants suffered terrible fires, destroying major production lines and putting both plants' pickling lines out of commission for an extended period. In each case, Siemens VAI engineers helped to restore production as quickly as possible – with solutions that are providing long-term benefits for Tata.



Pickling lines rapidly rebuilt and restarted at the Ijmuiden and Llanwern steelworks of Tata Steel Limited after damaging fires

Up from the Ashes

The first fire occurred in December 2010 in the Netherlands at Tata Ijmuiden, totally destroying the existing PL22 pickling line that had been linked to the Siemens VAI-supplied tandem cold mill in 2007. According to initial estimates, it would take a whole year before the steelworks could be restored to full production. Just about a year after the first fire, the U.K. plant at Llanwern in Wales experienced a similar fire, but with damage more concentrated in the last pickling tank and in a rinse section. Thanks to the construction design of the steel tanks, the fire at Llanwern did not spread as fast as it had in Ijmuiden.

While each plant required different repairs, Tata's goal remained the same: recover as soon as possible, restart the lines and return to normal production. The task for Siemens VAI was to quickly bring appropriate solutions that would produce the best results when operations began again.

Fire opens door to new upgrades at Tata Ijmuiden

The severe fire at the PL22 pickling line of the Tata Ijmuiden plant created unprecedented production problems upstream from the mill's cold-rolling line. Revamping the pickling line posed a number of challenges as it required refurbishing existing equipment while taking the plant's environmental constraints into consideration.

Looking beyond the immediate devastation, Tata took the opportunity to upgrade certain areas of the line to improve quality and increase line production. Almost immediately, Siemens VAI was requested to provide solutions that would address two major topics:

1. Replace the entire pickling and rinsing process section in order to improve certain weaknesses in the previous design
2. Upgrade outdated technology in specific areas in order to increase line production

There was no time to lose. Tata wanted the project completed in less than nine months – an extremely tight time frame to complete engineering, manufacturing, erection and commissioning of the whole line, including all mechanical, fluid, electrical and automation systems.

A team comprising mechanical and process specialists from Siemens VAI met weekly with Tata representatives to keep the project focused and on schedule. The following solution steps were implemented:

- The complete pickling and rinsing process sections were replaced. Five flat turbulent polypropylene pickling tanks with wringer rolls and sump were installed to increase pickling efficiency at high process speeds. The turbulent circulation created by side jets improved pickling efficiency compared with the previous design.
- A steering unit was installed at the last wringer roll prior to strip entry into the rinse section to address strip-guidance problems resulting from high line speeds and numerous wringer rolls.
- A polypropylene rinsing tank with five rinse cascades was installed. This proved effective in preventing stains on the strip surface by keeping residual chloride at low concentrations.
- A new acid-recirculation system was supplied, including all piping, cabling, pumps, valves heat exchangers and instrumentation, with complete access for maintenance work.
- The strip tension of the No. 6 exit bridle was increased after the pickling section to avoid strip marks on the strip bottom.
- A new dedicated programmable logic controller (PLC) and automation system were integrated to ensure close monitoring and control of the new equipment. The automation and HMI systems include powerful tools for plant diagnostics, production supervision and maintenance.

The project scope also covered the following improvements:

- Two new coil cars were supplied to serve the preparation station and the coil manipulator at the line entry.
- A preparation station was installed to facilitate coil feeding and create a coil buffer at the line entry.
- A new 65-ton-power scale breaker (wet type) was employed to allow a strip elongation of up to 3%.
- A Dynamic Width Adjustment (DWA) turret-type side trimmer and scrap chopper was installed. The side trimmer no longer needs to stop during a strip-width change, thus reducing the exit-time cycle. The width change occurs at a reduced line speed of 30 m/min for an approximately 2 m strip length.
- A safety PLC was integrated into existing equipment to ensure compliance with safety regulations. This was done in close cooperation with Tata electrical and automation engineers.

Main data of the rebuilt pickling line at Tata Ijmuiden

Annual capacity	1.6 million t/a
Material to be processed	Hot-rolled steel
Strip thickness	0.7 mm to 5.0 mm
Strip width	700 mm to 1,650 mm
Entry and exit speed (max.)	650 m/min
Process speed (max.)	400 m/min
Dimension of pickling tanks	5 x 20 m
Rinse cascade tank	5 stages

Improvement of the rinse section at Tata Llanwern following fire

The Tata Llanwern plant was the second line to catch fire in the process section, only a year after the Tata Ijmuiden PL22 event. Led primarily by a Tata team with an extremely tight time frame to restart the mill, the project required replacing all existing equipment, except for the rinse section, which was significantly upgraded.

The previous rinse section comprised a water tank with only two pools. The result was that the rinsing process was not performing as required. A chloride residue remained on the strip surface after the pickling and rinsing steps. Tata contracted with Siemens VAI for a state-of-the-art solution based on technology with five rinse cascades. The greater rinsing efficiency prevented residual stains and the result was improved strip surface quality. Steel-rinsing tanks could be manufactured quickly and Siemens VAI supervised installation and commissioning work.

The technical scope of work included:

- Technical design assistance at site
- Design of a new five-stage rinse tank, manufactured by Tata
- Design of new wringer roll change car, manufactured by Tata
- Design of the new rinse recirculation system
- Installation of this system in an area with tight space restrictions
- Installation of the wringer roll change carriage on the top deck
- Erection and commissioning assistance

Tata revamped the existing damaged steel tank and replaced all destroyed steel structures, platform access and piping. New electrical and automation systems were installed by a third party to operate the new rinse section. In less than two months after the fire, the line could be restarted, quickly achieving production and quality goals.

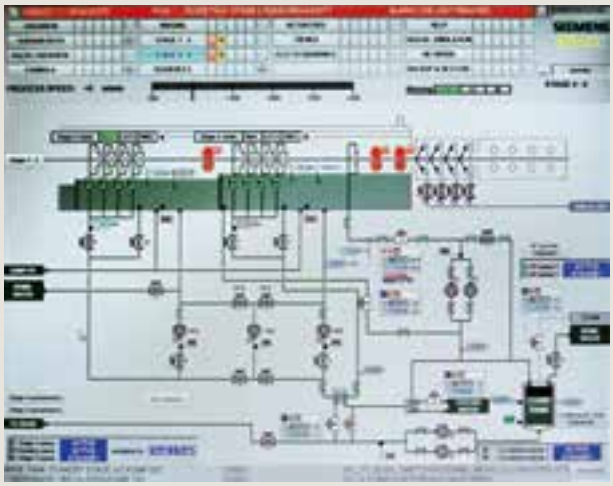
Main data of the rebuilt pickling line at Tata Llanwern

Annual capacity	1.25 million t/a
Material to be processed	Hot-rolled steel
Strip thickness	1.4 mm to 5.5 mm
Strip width	735 mm to 1,550 mm
Coil weight	33 tons
Entry and exit speed (max.)	700 m/min
Process speed (max.)	305 m/min
Pickling tanks	3 x 25 m
Rinsing tank	Cascade spray rinsing with 5 rinse stages
Overall length	approx. 15 m
Overall depth	approx. 2 m
Spray headers	8 per stage
Wringer roll pairs	8
Edge wiper	1
Wringer roll changer car	1

Total customer support during challenging situations

Faced with two separate challenging situations and tight project schedules, Siemens VAI demonstrated the capacity to mobilize teams on short notice and the capability to fully support its customers, design and install new equipment, and restore production to previous performance levels or exceed them. The successful implementation of these projects brought new knowledge, which Siemens VAI engineers will most certainly apply to future improvement projects.

Alain Challaye, Technical Director for Carbon Steel Processing Lines



WinCC HMI for the rinse section at the Llanwern steelworks

Rinse section

The latest high-performance cold-rolling complexes for world-leading steel producers

The Future Is Quality

Siemens VAI is a leading supplier of state-of-the-art cold-rolling mill facilities – from upgrades to the turnkey installation of complete cold mill complexes comprising mechanical equipment, electrics, Level 1 basic automation and Level 2 process optimization, media supply, and all related logistical and auxiliary facilities. Since 2006, the company has been awarded five major projects for coupled pickling lines and tandem cold mills (PLTCM), in addition to downstream processing facilities (Table 1). The cold mill complexes all have in common a strict focus on the manufacture of products with the highest quality and material strength, combined with high production capacities, to meet market requirements for decades to come. The stringent quality demands of the most prominent European automotive strip producers are met with the installed technology. The most recent plant installations include a modernization project for Austrian steel producer voestalpine Stahl and the supply of two new cold-rolling mills in China. What follows is a brief overview of the three plants.

Fig. 1: Pickling section of the existing coupled pickling line and tandem cold-rolling mill, voestalpine Stahl, Austria

Continued commitment to excellence: voestalpine Stahl, Austria

voestalpine Stahl GmbH, headquartered in Linz, Austria, is a well-known producer of high-quality strip for the automotive and household industries. Siemens VAI is currently modernizing the pickling line and tandem cold mill at the company's

The demand for high-quality cold-rolled strip is increasing worldwide, particularly in Asia. During the past few years, Siemens VAI has implemented or received contracts for the supply of highly innovative coupled pickling line and tandem cold mill (PLTCM) complexes that allows steel producers to offer products with added value and higher profit margins.

Production of highest-quality coils for the most demanding downstream applications

Cold Mill Complex No. 2 (Figure 1). The project was awarded in spring 2012 and will be completed in September 2014. The contract is part of a long series of projects that have been implemented together with voestalpine Stahl during the past six decades.

The upgrading of the existing PLTCM is intended to further improve the pickling process and operational reliability. The pickling section will be renewed, new mechanical components will be installed in various plant sections, and the electrical, automation and safety systems will be upgraded to comply with increasingly stringent demands with respect to plant safety. The complete basic and process automation, including the pickling-line process models and drive technology, will be brought up to the latest technological standards. The flat-type pickling tanks will be upgraded with new pickling tanks, piping and instrumentation to improve monitoring of all pickling parameters. The Generation 2 Siroll Faplac APM (Fully Automatic Pickling Liquor Analysis and Control – Advanced Pickling Model) process model, together with online measurements, pre-calculates pickling-line parame-

"Extensive experience and single-source supply capability allows Siemens VAI to optimize the entire production route of a complex cold mill up to the final high-quality product."

Dr. Gerhard Finstermann

ters of planned production in advance. The line will be optimized with respect to throughput and strip surface quality, and all material-related factors and operator experience are taken into consideration. Existing mechanical and fluids components, such as valve stands and bridle units, will be replaced. A new visualization system for the pickling line equipment, instrumentation and fluids will help to not only optimize the entire process but also support preventive maintenance.

Expanding automotive steel production: Valin ArcelorMittal Automotive Steel, China

In June 2012, Siemens VAI received an order to supply a combined PLTCM for the automotive steel producer Valin ArcelorMittal Automotive Steel Co., Ltd. (VAMA) in China, a joint venture between ArcelorMittal and Valin Iron & Steel Group Co., Ltd. The line is part of a new cold-rolling complex being erected at Loudi in Hunan. Start-up of the PLTCM is scheduled for mid-2014. In its initial construction stage, the cold-rolling mill is designed for an annual production capacity of 1.5 million tons of steel strip. In a second construction stage it can be expanded to produce 2 million tons of strip per year by adding a second payoff reel, a fourth pickling tank and a fifth mill stand.

Siemens VAI is engineering and supplying the entire mechanical and electrical equipment – including the hydraulic, pneumatic and safety systems – for the combined pickling line and tandem cold-rolling mill. The line will be equipped with advanced basic (Level 1) and process-optimization (Level 2) automation featuring highly sophisticated process models for the precise setup of all key process steps. These steps will enhance line availability and yield while maintaining product quality. Siemens VAI is also responsible for supervising the erection and start-up activities of the PLTCM.

The tandem mill consists of four 6-high mill stands with an installed power of 7,000 kW per stand and a maximum roll force of 35,000 kN. This makes it possible to roll high-strength steels for narrow thickness tolerances with a considerably extended final strip envelope with respect to width

Fig. 2: Project milestone: installation of first two mill stands at VAMA's cold-rolling mill, China (August 8, 2013)

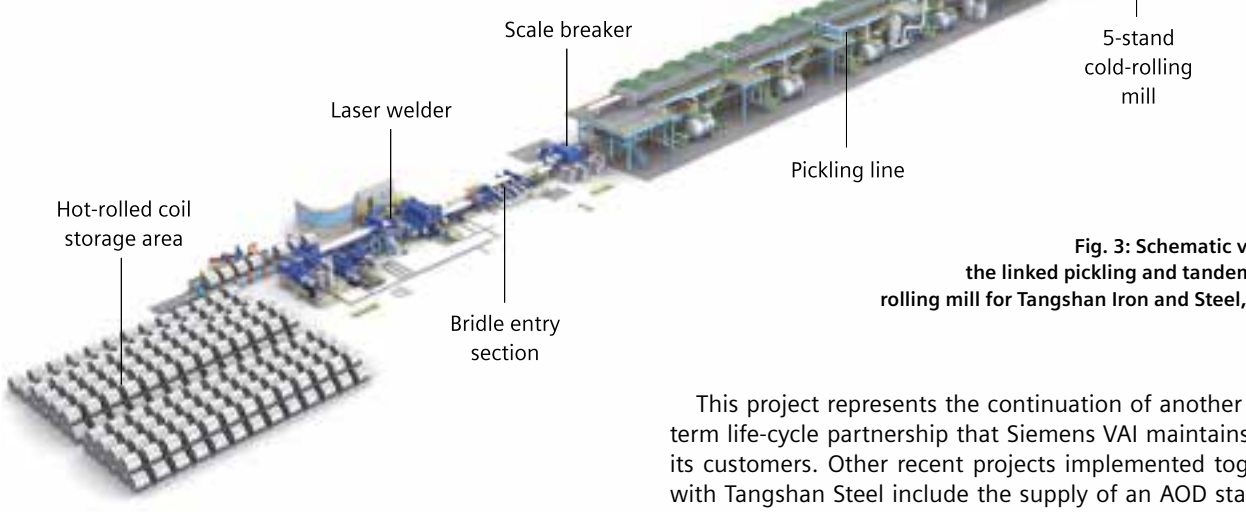
Customer	Country	Project	Mill	Order
Tangshan Iron & Steel Group, Tangshan, Hebei province	China	New	PLTCM, 5 stand/ 6-high mill	2013
Valin ArcelorMittal Automotive Steel, (VAMA), Loudi	China	New	PLTCM, 5-stand/ 6-high mill	2012
voestalpine Stahl, Linz	Austria	Upgrade	PLTCM upgrade	2012
SAIL, Bokaro Steel Plant, Bokaro	India	New	PLTCM, 5-stand/ 6-high mill	2008
Tata Steel, Staal B.V., Ijmuiden	The Netherlands	New	PLTCM (Figure 4)	2006

Table 1: Examples of recent Siemens VAI cold-rolling projects

versus thickness. SmartCrown rolls, special actuators and control features ensure highest accuracy and fulfillment of the specified flatness requirements of the final product. A wide range of steels can be processed in the line, including mild, high-strength, low-alloyed, IF (interstitial free), DP (dual phase), TRIP (transformation induced plasticity) and bake-hardening grades. Even high-strength steels with tensile strengths of up to 1,200 N/mm² can be processed in the line. Figure 2 shows the first two mill stand housings being installed for the cold-rolling mill.

Continuation of a rewarding life-cycle partnership: Tangshan Iron and Steel, China

The most recent PLTCM project awarded to Siemens VAI was in April 2013 for the supply of a complete cold-mill complex for Tangshan Iron and Steel Group Co., Ltd., a member of the Hebei Iron and Steel Group Company Ltd. This new facility will be built at Tangshan in Hebei province, China. It will be capable of producing 1.6 million t/a of high-strength, high-quality steels for the automotive industry. Steel strip will be rolled to thicknesses of 0.2 mm to 2.5 mm at widths of between 700 mm and 1,600 mm. Figure 3 shows a schematic layout of the PLTCM.



Siemens VAI will engineer and supply the mechanical, electrical, media supply and process control equipment for the cold-strip mill that will consist of five 6-high rolling stands. In addition to the new PLTCM, a new continuous annealing line (capacity: 767,000 t/a) and a new galvanizing line (capacity: 416,000 t/a) will be installed. The PLTCM and the annealing and galvanizing lines are to share an integrated automation system comprising basic automation (Level 1), process optimization (Level 2) and an integrated Level 3-based strip-quality tracking and feedback system for all cold mill and upstream production facilities. The entire plant can therefore be precisely controlled and coordinated, ensuring high availability and yield with uniformly high product quality. The first pickled and cold-rolled strip is scheduled to be produced in December 2014.

Fig. 4: Mill stand area of the PLTCM, Tata Steel, Ijmuiden, the Netherlands

Fig. 3: Schematic view of the linked pickling and tandem cold-rolling mill for Tangshan Iron and Steel, China

This project represents the continuation of another long-term life-cycle partnership that Siemens VAI maintains with its customers. Other recent projects implemented together with Tangshan Steel include the supply of an AOD stainless steelmaking converter, a vacuum decarburization plant, a continuous galvanizing line and the coupling of an existing tandem cold mill and pickling line.

Total mill optimization to meet the highest strip-quality demands

Siemens VAI has been awarded five major cold-rolling projects since 2005, and three during the past two years alone. The projects cover both new installations and plant modernizations. Extensive experience and single-source supply capability allow Siemens VAI to optimize the entire production route of a complex cold mill up to the final high-quality product. With state-of-the-art solutions to manufacture, for example, AHSS (advanced high-strength steels) and automotive steel grades, producers can better meet the ever-increasing demands placed on the quality of cold-rolled steel products.

Dr. Gerhard Finstermann, Head of Sales, Cold Rolling Mills

The Dynamic Shape Roll from Siemens VAI offers decisive advantages

The Better Actuator

The Siroll Dynamic Shape Roll (DSR) is the most capable mill actuator currently available on the market to meet the challenges of modern aluminum production. Recent experience has clearly demonstrated the benefits of the DSR, such as exceptional results in terms of head-end flatness results and overall dynamic performance. In all, the DSR has been installed at 11 mills worldwide with excellent results.

Servo valve for hydraulic cylinder

The DSR is a replacement for one of the back-up rolls, usually the top one. It consists of a hollow shell rotating around a static beam that is mounted between two back-up chocks. An arrangement of hydraulic pads exerts load on the inside face of the shell, which is transferred through to the work roll to generate the rolling load. The clear advantage of this setup is that the load can be applied directly where it is required and not simply at the roll ends, as is the case in conventional 4- or 6-high mills. The figure illustrates the main components of the DSR.

Proven benefits

A 4-high mill with a DSR has a larger control range than other mill actuators or a 6-high mill. Also striking is that a DSR extends the effect of roll bending by 20% to 30%.

A review of a typical new large cold mill producing around 100,000 t/a revealed estimated potential benefits upwards of well over $5 million per year. This, of course, depends on the product mix. The savings are approximately evenly divided between the benefits from improvements to the head and tail performance and the ability to minimize out-of-specification material during width changes.

Operational advantages with the DSR

The operational benefits of a DSR can be summarized under three main headings: overall flatness; cold starts and head and tail performance; and width changes. Each of these areas improves yield, as described below:

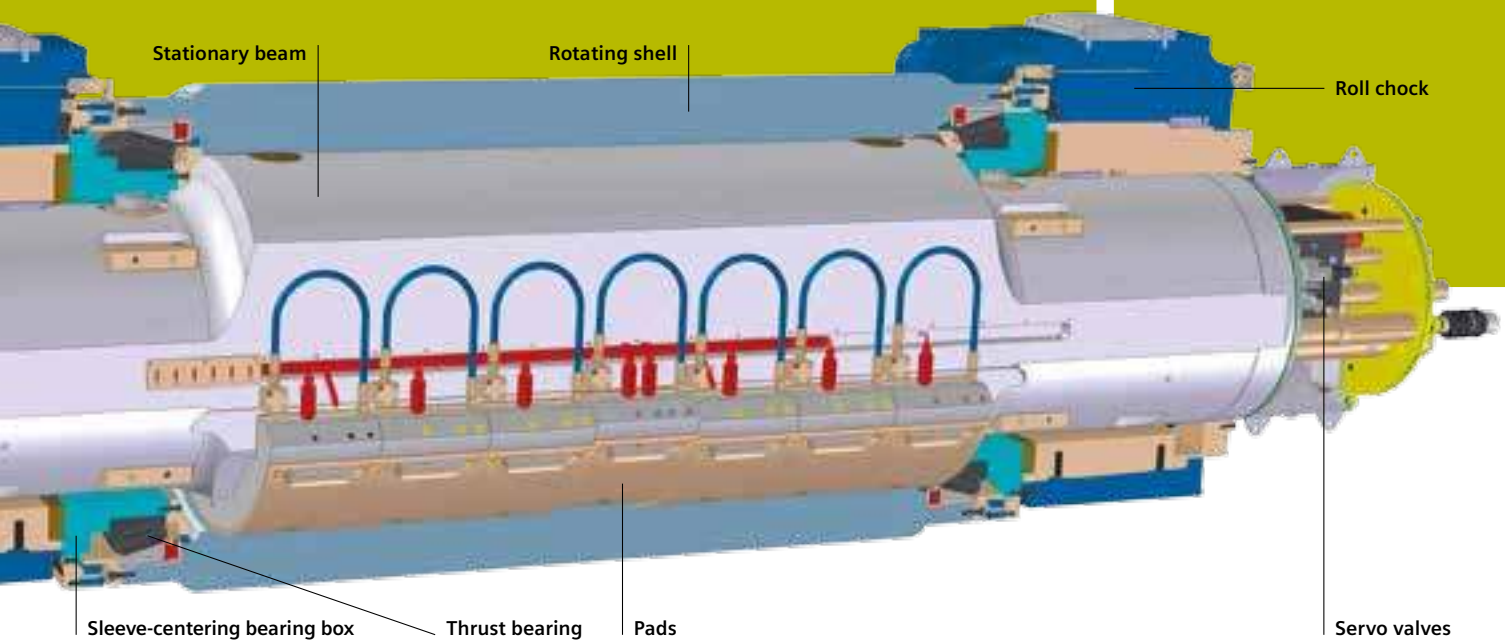
Overall flatness: Results show that flatness is more consistent when the DSR is in use. For one, a larger percentage of the coil can be consistently rolled to within a very small residual error. This improvement is due to the combination of a better control range, improved dynamic response, and the ability to address fourth-order errors.

Cold starts and head and tail performance: Cold starts are particularly impressive using a DSR. For example, following a mill restart after a prolonged stoppage of 16 hours, the peak flatness error on a 0.447-mm-thick strip with a width of 1,870 mm was below 20 I (flatness index) units at just over 90 meters rolled. The operator is able to accelerate to a rolling speed in excess of 1,000 m/min straight from thread speed.

Experience has shown that the length taken to get the peak flatness error to within a small tolerance is typically in

The DSR offers a capability that provides the best-possible current mill performance and is well placed to address the challenges of the future.

DSR sectional diagram with the main components. Noteworthy is that the servos are mounted at the ends of the beam, and they can be easily accessed below removable covers



a range of a few tens of meters. Solid-roll mills can, on occasion, achieve good head-end flatness, but the DSR is much more consistent. Similar benefits can be seen at the tail end of the coil.

Width changes: The ability to efficiently handle product-width changes with the DSR is unrivaled by any other actuator. In fact, it is possible to switch rolling widths by considerable amounts (in excess of 600 mm) and still achieve excellent flatness results without any warm-up (transition) coils. This is a considerable benefit for mills where frequent product changes are carried out.

Designed for performance

The trend in the aluminum industry is clear: ever-increasing requirements for both quality and production flexibility that place considerable demands on the mill actuator capability and the controllability of the mill. The DSR is well positioned to face all of these challenges. Trained operators and mill technicians can easily operate the DSR. Although mainly suited for cold and foil rolling, the actuator has also been used on two hot mills in Europe with good results.

Siemens VAI is confident that the DSR offers a capability that provides the best-possible current mill performance and is well placed to address the challenges of the future.

Philip J. Lawlor, Section Leader Process Engineering, Aluminum Mills

A Dynamic Shape Roll in the workshop prior to dispatch

Siroll TCOptimizer expert system

Best-Possible Performance





The steel industry has made tremendous progress in improving product quality through process control. Fully automated production lines are equipped with an increasing number of sensors that generate a huge amount of data. As a result, line operators are drowning in data. Anomalies, their root causes and corrective measures cannot be identified in time, meaning a slowdown in the production process. A newly developed solution from Siemens VAI provides an answer to this situation.

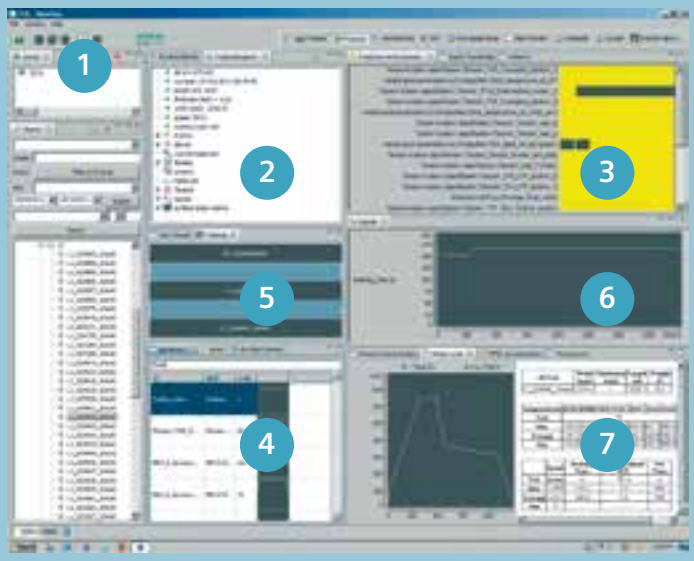
Achieving the final required product quality in steel production is the result of a succession of production steps all along a defined metallurgical route, from the raw materials through to the hot-strip mill, the pickling line and cold-rolling mill up to the processing line. Each of these areas individually has a significant impact on the final product quality. Focusing on the final processes is necessary but not sufficient; instead, the whole production route, including upstream processes, has to be carefully monitored.

Unfortunately, steelmakers become rapidly saturated with data of all types. Metallurgical plants with their fully automated hot and cold mills and processing lines are now equipped with countless digital sensors that measure and communicate dimensions, speeds, temperatures, etc., creating an abundance of data stored in large-scale databases of various process automation systems (Level 2). This "big data" is a collection of data sets so large and complex that it becomes difficult to process using available database management tools or traditional data-processing applications. Adding more sensors or screens for data follow-up only makes matters worse. An intelligent software system is needed to combine the data into valuable information.

Siroll TCOptimizer keeps an eye on the entire metallurgical production route

Siroll TCOptimizer technology

To deal with the flood of data and assist steelmakers in the daily operation of a processing line, Siemens VAI developed Siroll TCOptimizer (Total Condition Optimizer), a unique and advanced software for just-in-time warnings, including computing intelligence that highlights relevant events without overwhelming users with gigabytes of data.



Siroll TCOptimizer, which is part of the Siemens VAI suite of solutions for Industry 4.0 (see "From IT4Metals to Industry 4.0," page 86), is designed to be a central expert system that collects data and signals from all parts of the production chain. As a non-exhaustive list, examples include upstream data (hot-rolling finishing and coiling temperatures, reduction rate in a cold-rolling mill), the process data (line speed, furnace temperatures, skin-pass rolling force, zinc-bath chemistry), the product data (strip width, thickness, profile, chemistry, surface defects, online mechanical properties) and additional data (fuel consumption, fan speed). To varying degrees, all these data make a contribution to production quality control.

To analyze the hundreds of gigabytes of information, Siroll TCOptimizer embeds a so-called Business Rule Management System (BRMS). With a business-oriented vocabulary syntax (e.g., thickness, width), simple logical expressions (and, or, if) and decision trees, BRMS allows non-IT specialists to handle the incoming signals and create rules. Each rule follows a similar pattern:

- Validation of incoming signals
- Signals filtering and storage in the local database
- Combination of signals though the application of multi-source data-correlation models and defined business rules
- Alarm triggering if defined thresholds are violated

Thanks to this system, the analysis of a huge amount of data becomes automatic and repeatable, and it highlights only relevant information. The TCOptimizer transforms gigabytes of raw and unworthy data into relevant manufacturing events and just-in-time warnings. These alarms are related to the conditions of the ongoing process and the coil quality. The just-in-time feature allows immediate and focused corrections by the line manager or the operator. Operators no longer are confronted with an overflow of data to be analyzed.

TCOptimizer transforms gigabytes of raw data into relevant manufacturing events and just-in-time warnings that allow immediate and focused corrections to be carried out.

User-oriented screens

To display the results of the previous analysis, Siroll TCOptimizer offers various screens depending on the final use. The so-called blank screen – as it remains empty most of the time – is mainly targeted to production staff. Special attention is given to displaying as few disturbances to the operators as possible: the target is to only display alarms for soon-emerging issues.

A screen for metallurgists, which shows all relevant parameters of the metallurgical route, opens the door to in-depth examination (Figure 1). The complete metallurgical history of the product is available in an instant. With such an arrangement, only a few mouse clicks are required to detect quality issues.

Extra features

To meet its customers' expectations, Siemens VAI recently added a coil-grading module that tracks all the parameters falling within the scope of the coil quality assessment and computes a global quality level based on final customer requirements (Figure 2). With its ability to connect with advanced gauges such as the automated surface-inspection system, a full product grading that takes into account defect maps, for instance, is possible.

Thanks to the experience of Siemens VAI, Siroll TCOptimizer is delivered with some pre-installed business rules, among them cleaning section handling, zinc-pot handling and furnace handling. A user-friendly runtime environment allows customer experts to improve existing rules or create new ones.

Fig. 1:
The metallurgist screen is shown here with seven different functionalities:
1 Coil selection and search module
2 Coil-related data (primary data, presets)
3 Abnormal events (out-of-range rule parameters)
4 All available coil- or time-related measured signals
5 Tracking data (product-life follow-up between hot-strip mill, tandem cold mill and processing line)
6 Graphical area displaying selected signals
7 Chemistry, furnace cycle and heat-treatment data

Another smart aspect is the ability to share experience through an embedded wiki database. The software uses the same principle of the well-known free encyclopedia that allows its users to add, modify or delete content to aid knowledge management. This lessons-learned information system can be accessed by all users, and dealing with re-occurring problems becomes routine.

Industrial references and achievements

Siroll TCOptimizer was successfully commissioned at both Tianjin Tiantie Metallurgical Group (TTMG) and Xinyu Iron & Steel Co. Ltd (XISCO) in 2011 and 2012, respectively, for new continuous annealing lines.

Siemens VAI metallurgical experts visited the upstream installations of both steelmakers to obtain a good overview of their upstream processes and understand how they are used. After the plant visits, a list of recommendations was issued to help control end steel quality. Those recommendations were then converted into tailored business rules for each of the two steelmakers. Once implementation was completed, the system proved to be a useful tool during commissioning steps, namely for production ramp-up and achieving desired steel quality. With the Siroll TCOptimizer it only took a couple of hours to make the correlation between some guiding problems in one of the processing lines and poor control of the strip profile in the hot-strip mill. Without this tool, investigations like these would have taken a couple of months to complete.

Outlook and perspectives

Siroll TCOptimizer includes various modules that allow different types of operation: data recording and visualization, just-in-time alarms, warnings regarding product quality and processes, automatic and systematic data processing, product grading, knowledge management, and remote assistance by Siemens VAI specialists. With all its functionalities, the presented solution is a unique expert system with a large amount of possibilities to monitor lines for exacting steelmakers. The success story continues: in 2013 Siroll TCOptimizer was installed on a directly linked stainless steel rolling, annealing and pickling line for a Chinese steel producer.

Benoit Jalard, Product Owner

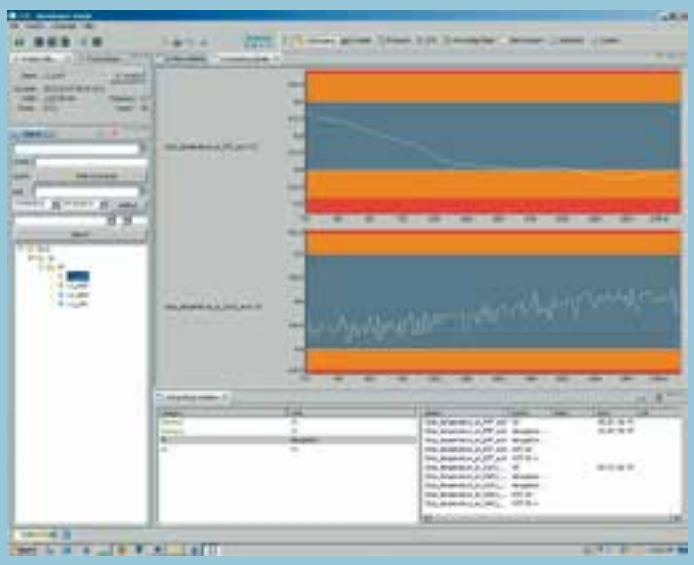


Fig. 2: Coil-grading module (partial view) for the tracking of all quality-related parameters and assessment of coil quality

Novolipetsk Steel, Lipetsk, Russia

Siemens VAI performs study for NLMK to reduce energy costs

Energy Efficiency Pays Off

The business relationship and technological cooperation between Novolipetsk Steel OJSC (NLMK) and Siemens VAI began in the 1960s with the signing of a contract for the supply of an LD (BOF) plant with three converters to NLMK's steelworks in Lipetsk, Russia. In the meantime, more than 15 steelmaking, treatment, casting and rolling facilities have been delivered to NLMK or are currently under construction. For example, a primary and a secondary dedusting system for a new 330-ton converter and a fully revamped caster to enable the casting of ultra-thick slabs were supplied to the company and put into operation 2011.

NLMK supplies 100% of the iron ore, lime, dolomite and coke from company-owned mines required for steel production. More than 50% of its electrical power demand is covered by its own power plants. In view of high energy costs worldwide, energy efficiency is a key objective at the company's steelworks. NLMK therefore intends to modernize its facilities – particularly in Russia – with a focus on energy-efficient and environmentally friendly processes. In view of the close life-cycle partnership between NLMK and Siemens VAI that extends back nearly 50 years, Siemens VAI was nominated to execute an energy-efficiency study with a focus placed on reducing influenceable costs.

Steps to success

To determine the most feasible and efficient waste-heat recovery solution, in a first step customers fill out standardized questionnaires. In a subsequent fact-finding mission, Siemens VAI experts investigate the local and external energy situation in order to properly assess on-site conditions.

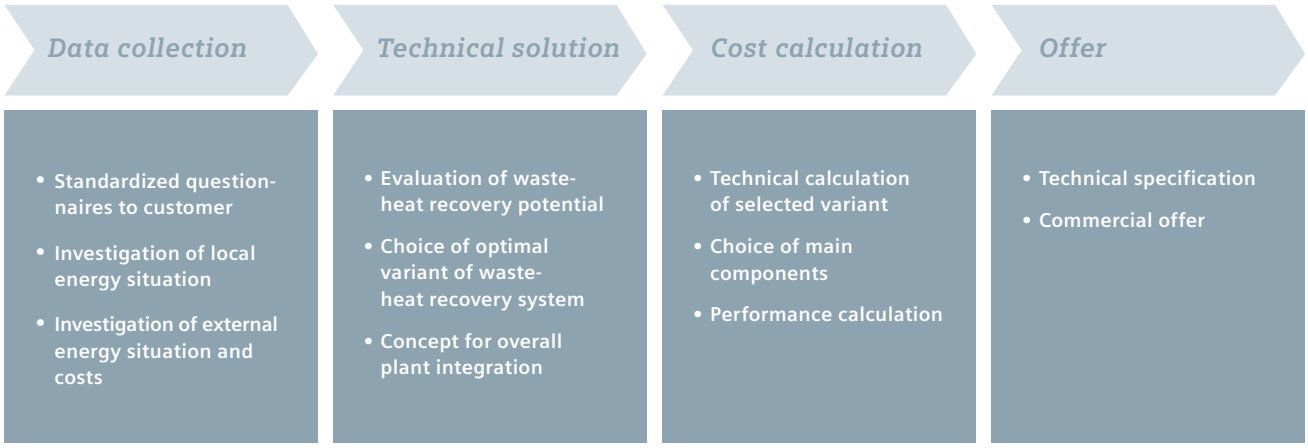
Novolipetsk Steel OJSC (NLMK), headquartered in Lipetsk, Russia, is a leading manufacturer of steel with a worldwide crude steel output of 15 million tons in 2012. The company produces a comprehensive range of flat and long steel products at different locations in Russia, Belgium, Denmark, Italy and the United States. To get a hold on increasing energy costs, NLMK approached Siemens VAI to find ways to make the most of waste heat.

With this information, Siemens VAI estimates the waste-heat recovery potential and – in close coordination with the customer – chooses the optimal solution to derive a maximum of benefits for the customer. Based on the technical evaluation of the potential alternatives, the main plant and system solutions are proposed and the resulting performance improvements are calculated (Figure 1). If desired, services can also include a complete design concept for integration of the recommended solutions into the existing energy network. This information serves as the basis for the customer to select the most attractive and feasible solution variant. Following the customer decision, the improvement measures can be implemented with the services of a life-cycle partner.

"As a responsible steel producer, we want to reduce costs through better energy efficiency and improve our environmental sustainability. The study carried out by Siemens VAI shows us the way forward."

Alexander Starchenko,
Director of Fuel and Energy, NLMK

Fig. 1: Typical approach of Siemens VAI energy-efficiency studies



Investigations and proposed solutions at NLMK

With this step-by-step approach, Siemens VAI investigated and evaluated opportunities to increase the energy efficiency of the sinter plants, blast furnaces and LD steel mills at the NLMK site. Highlights of the investigation results are outlined in the following.

Sinter plant

NLMK operates four sinter strands with sintering grate areas of 312 m² each. As such, the potential to save or recover energy is quite large. The study investigated possible measures to improve the overall energetic efficiency and productivity as well as product quality. The following solution measures were proposed:

- Installation of an Intensive Mixing and Granulation System. Benefits: improvement of raw-mix properties and bed permeability; reduced fuel requirements by up to 5%
- Modernization of the ignition furnace to enable the use of hot combustion air. Benefits: reduction of gaseous fuel consumption by up to 30%
- Implementation of a Waste Gas Recirculation System to partially reuse sinter offgas. Benefits: decreased waste gas volume by approximately 40%; less environmental pollution; 5% lower solid-fuel consumption in the sintering process
- Application of a waste-heat recovery system to utilize the heat energy of the hot sinter from the sinter cooler. Benefits: generation of approximately 30 MW of electrical energy in steam turbines (see "Why Waste Energy?", page 34)

Blast furnace top-gas pressure-recovery plant

In order to improve the energy independence of the NLMK steelworks, the installation of top-gas pressure-recovery turbines (TRT) downstream of the top-gas-cleaning systems of Blast Furnaces Nos. 3, 4 and 5 was investigated. Operation of the TRT plant is to be controlled from the control pulpits of the respective blast furnaces. With this solution the top-gas pressure of the blast furnace can be used to generate 30–40 kWh electrical power per ton of hot metal.

The sensible heat energy of the hot sinter can be recovered in the sinter cooler to generate electrical power

Example of a plant section showing a blast furnace top-gas pressure-recovery system (Dragon Steel Corporation, Taiwan)

LD (BOF) gas-recovery plant

Currently, waste gases from converter operations at NLMK's LD steel shops No. 1 (three 160-ton converters) and LD No. 2 (three 327-ton converters) are flared. Following a detailed onsite investigation of the potential benefits of an integrated solution for converter gas recovery, storage and distribution, Siemens VAI proposed two solution variants. These included a switch-over station, gas holder, wet-type electrostatic precipitator, booster fans, valves, ducting and instrumentation. Variant I comprises a combined converter gas-collection system for both shops with wet-type electrostatic precipitators installed upstream from a common gas holder (Figure 2). Variant II features a converter gas-recovery plant configuration with two independent gas-recovery lines for both melt shops, including two gas holders and two

downstream wet-type electrostatic precipitators. This variant, which is more capital-intensive, maximizes the CO gas recovery potential.

With the proposed variants NLMK can benefit from significant energy cost savings. Approximately 38,000 Nm³ of natural gas can be replaced with CO gas per hour. State-of-the-art gas-recovery technology is highly reliable and is characterized by low utility and maintenance costs.

A life-cycle partner for energy efficiency

NLMK is actively focusing on improving the energy-efficiency and environmental compatibility of its steelworks. The company enlisted the support of Siemens VAI as a life-cycle partner to undertake a study to identify the most feasible and economical solutions to achieve these ambitious goals. The proposed solutions described in this article will support NLMK to improve their overall cost efficiency and competitiveness.

Siemens VAI has considerable experience with the supply, installation and implementation of energy-saving solutions. On the basis of previously implemented projects of this type, overall cost savings and the pay-back time can be calculated. This information supports the customer to make the right investment decision.

Christian Friedrich Hammer, Sales Manager for Energy Technology Plants
Gerhard Enickl, Head of Energy Technology

Approximately 38,000 Nm³ of natural gas can be replaced with recovered converter CO gas per hour.

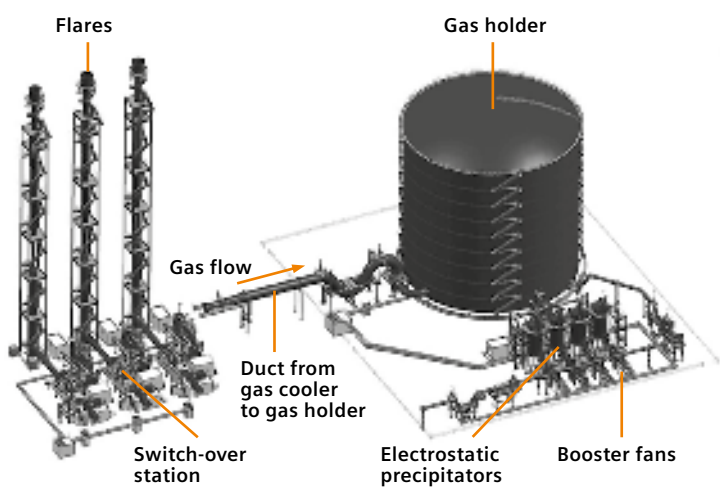


Fig. 2: Combined standard LD (BOF) gas-recovery plant configuration for three converters

Recovery and use of CO-rich offgas from converter operations can significantly reduce energy consumption in an integrated steelworks

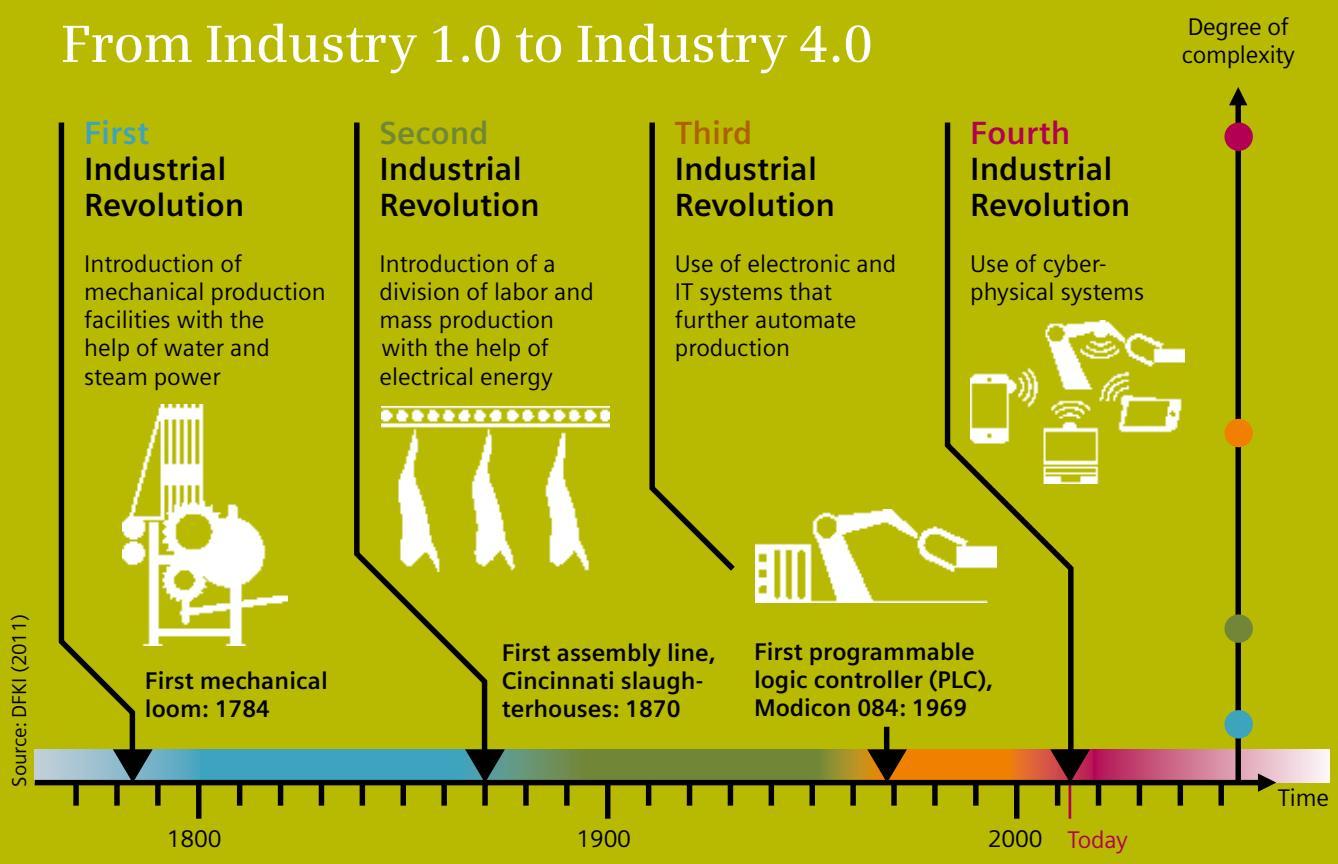


Fig. 1: Dawn of the fourth industrial revolution "Industry 4.0"

IT solutions pave the way for the next industrial revolution

From IT4Metals To Industry 4.0

Industry 4.0 is a future-orientated project from the German government to support the process of stepping into the next industrial revolution. One of the main characteristics of Industry 4.0 is the convergence of the physical world and the virtual world in the form of cyber-physical systems. As a driver of this trend, Siemens offers a number of solutions in its IT4Metals portfolio that can be implemented today to get a metallurgical plant ready for tomorrow.

The first three industrial revolutions came about as a result of mechanization, electricity and IT. Now, the introduction of the "Internet of Things and Services" into the manufacturing environment is ushering in a fourth industrial revolution, known as Industry 4.0 (Figure 1).

The Internet of Things and Services refers to the connection between a physical object and its representation in the Internet (or an equivalent structure such as the Intranet). One example for this could be the evaluation of plant conditions via sensor technology and subsequent actions. As a result of Industry 4.0, machines and objects become smarter, and they can communicate with one another.

Industry 4.0 focuses on the following overarching aspects:

- Horizontal integration of the different production steps within a single plant or multiple plants
- End-to-end digital integration of engineering across the entire value chain
- Vertical integration of mechanical, automation, process, production and business systems

IT4Metals – the future today

IT4Metals solutions from Siemens VAI address the challenges of Industry 4.0. Solutions for horizontal integration offered by Siemens today include, for example, strategic company-wide planning and the exchange of information between supplier and customers related to product specifications or quality results. An example of digital integration of engineering is the automatic translation of product specifications into specific production order details such as quality and process parameters. Vertical integration consists of the diverse systems at different hierarchical levels. The concept is shown in Figure 2. Products in the IT4Metals portfolio available today already connect the physical and the virtual worlds. Three key products for the metals industry are described below:

Simetal Condition Monitoring System (CMS)

The key to successfully improving the efficiency of a production facility or its individual equipment is the collection, analysis and interpretation of all relevant data. A fully integrative condition monitoring system – in conjunction with competent maintenance services – helps to visualize a plant's condition and serves as the basis for predictive and focused maintenance activities. The resulting avoidance of unplanned downtimes and equipment damage leads to an increase in the overall productivity of the facility, while also keeping product quality and operation at a high level.

The challenge: In the metals industry, monitoring the condition of machines, automation and processes is crucial for preventing unplanned downtimes and unintentional impacts on product quality. To derive the necessary information, a huge amount of data has to be analyzed – data that needs to be gathered from a variety of systems throughout the entire plant without having to generate the information twice. Existing information also must be incorporated. Because it is inevitable that the plant and its processes change over the years, the information system must be adaptable to the ongoing needs of the plant without influencing the operative automation system. For maintenance and quality reasons, new condition monitoring information and analyses (evaluation packages) should be easy to install.

The solution: Siemens offers an innovative condition monitoring system that integrates information from several automation levels in order to provide the best description of the condition of functions, equipment and even complete plants. This system is designed for the metals industry and combines the specific expertise of a process turnkey supplier with the technological skills of a leading automation solutions provider. The Simetal CMS uses open machine-to-machine communication to allow even third parties to automatically connect their CMS information with the Siemens VAI system. An information broker consolidates the required data from each individual source to centrally display a plant's condition.

Unlike an online automation system whose first priority is to control the plant in the defined operation mode, the actual and the reference condition of the plant or its individual parts may change during their lifetime. This makes flexibility an important requirement for a condition monitoring system so that it can easily be adapted to new situations – or extended with additional evaluation packages. The Siemens solution is built on standard libraries extended by functions specifically designed for the metals industry. This modular approach enables future functionalities to be easily integrated in new or existing CMS solutions. In addition to the central display of a plant's condition, detailed analyses of plant conditions can be viewed on standard PCs and mobile units.

Simetal Manufacturing Execution System (MES)

To support and integrate production management and business processes, Simetal MES offers a wide range of IT systems. The networking of plants and workshops of a metals enterprise requires fast and reliable exchange of technology data through a so-called marketplace for technology data.

The challenge: Production operations in steel plants and rolling mills form a network of specific tasks in which materials must be processed according to their specific production route and manufacturing sequence. The technological constraints of each step as well as the processing status and the available resources must be taken into consideration for optimum production conditions.

The solution: A marketplace for technology data needs to be established. This is achieved by a central data platform, embedded in Simetal MES, which makes the technology data available to those agents (functional modules) that require it for managing the production process and technical evaluation process. This marketplace ensures an integrated data flow in the vertical direction from the business level to the operator level and vice versa, as well as in the horizontal direction from the first to the last workshop involved in the workflow.

As such, all processing of raw, intermediate and finished products can be steered and controlled. The factory's transparency is improved and management can make decisions based on reliable and actual data. The allocation of production orders to the respective processing stations is optimally performed. The stock levels and the available capacities for melting, casting and rolling are supervised. The product quality is continuously checked at quality gates either in in-line mode, at-line mode or offline mode. The acquired quality data is made available on the marketplace to agents who propose measures to avoid production of scrap material in the case of quality deviations. These measures may be, for example, upgrading/downgrading steel grade, instruction to re-process the material, issue of a re-application request, etc.

Decisive benefits: As a result, delivery reliability and lead times are improved considerably, and stock levels are reduced. In addition, operators can be assured that workshops and materials are used optimally, and that machines are only released for maintenance if no running orders are hampered. These measures increase productivity and availability. Furthermore, fewer quality issues reduce customer complaints and faulty production. The data collected by the MES is provided for every production step every time, and they can be aggregated to efficiency coefficients, such as key performance indicators. The advantage is that detailed analyses of equipment performance and of downtimes can be carried out, which allows visualization of KPIs. This therefore provides a basis for continuous improvements along the whole production chain. The MES system with its marketplace for technology data contributes to fast and flexible production control, which ensures high product quality, and reduced energy and raw-material consumption.

Simetal Energy Management System (EMS)

To complete the information flow through the entire plant, the Simetal EMS visualizes and helps optimize energy flow within the complete production process. Simetal EMS enables dialog between energy consumers and can be seen as the "Internet of energy." The result is maximum transparency to produce metals with less energy input and to offer a basis for optimized energy flows in the iron and steel industry.

Simetal EMS, a product of the Siemens IT4Metals portfolio, allows metals to be produced with less energy and offers a basis for optimized energy flows in the iron and steel industry.

The challenge: Energy costs alone typically account for 20% to 30% of total production costs in iron- and steelworks. A large portion of these costs can be avoided by improved energy awareness and associated energy-reduction measures. Suitable interfaces between a plant's energy consumers need to be established.

The solution: With EMS, two components – a smart meter and a smart grid – work together: A smart meter is an intelligent electronic meter that enables consumption data for electricity, gas, heating, water, etc., to be recorded and automati-

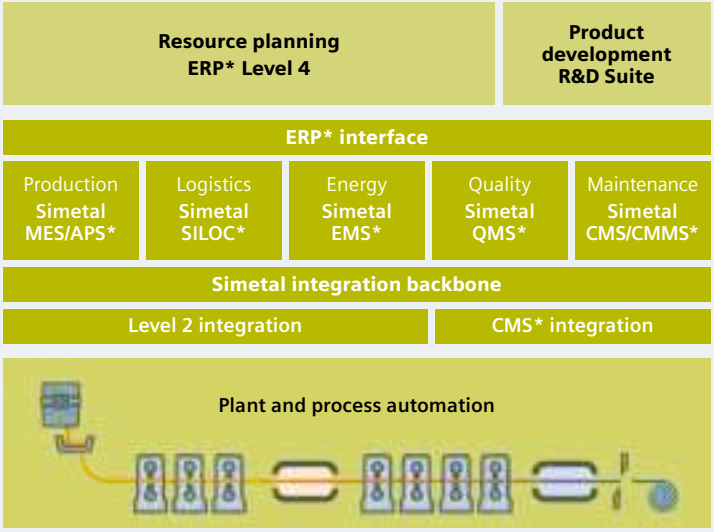
Newly developed Siemens VAI human-machine interface for improved operator guidance – a stepping stone for future Industry 4.0 applications

cally evaluated. The smart meters act as an important interface between the energy consumers – which have not been integrated into the processes until now – and the smart grid network. Smart grids are distributed intelligent control centers that communicate via interfaces.

In the future, smart meters will communicate with the network to optimally balance supply and demand. With its solutions like B.Data, X-Opt, WinCC and powerrate, Siemens provides a basis for "small talk" between various energy consumers and producers. In fact, the entire centralized plant control system based on processes and energy optimized workflows may one day become obsolete – material and machines would communicate during production process and coordinate manufacturing sequences as far as possible autonomously and in an optimized fashion. Furthermore, surpluses or shortages of energy capacities that have been detected and communicated could be balanced out by specialized "energy brokers."

Permanent optimization: Siemens designs the Internet of energy as a virtual reflection of the physical energy world. The product is an energy web that interacts with various participants in different and changing constellations. People only describe the main targets and influence the global system via forecasting tools and objective functions. Hence, a permanent optimization of resource use and energy efficiency becomes possible according to various parameters.

Arno Haschke, Sales and Product Management,
Simetal Condition Monitoring System
Dieter Wild, Sales Management, Simetal Manufacturing Execution System
Rene Grabowski, Sales Management, Simetal Energy Management System
Frederik Jaenen, Program Manager for IT4Metals



*ERP = Enterprise Resource Planning, MES = Manufacturing Execution System; APS = Advanced Planning and Scheduling; SILOC = Logistics and Stockyard Management System; EMS = Energy Management System; QMS = Quality Management System; CMS = Condition Monitoring System; CMMS = Computerized Maintenance Management System; R&D Suite = Platform for product development and new product introduction

Fig. 2: Scope of Industry 4.0 horizontal and vertical integration

Industry 4.0 in practice

On the way to Industry 4.0 a whole range of new applications, business models and products are imaginable. Already today, companies and research institutes in Germany are working on finding out what is possible. The following application scenarios defined by the working group of the German government provide examples of how Industry 4.0 can be applied in factories.

The resilient factory

Within Industry 4.0, a production line does not necessarily have to be defined for a certain product. With IT support it will be possible to flexibly adjust processing stations to a changing product mix – and to optimally use capacities.

Marketplace for technology data

The networking of factories and a company's plant areas offers the potential to exchange information quickly and easily.

Intelligent maintenance management

The indirect costs of unplanned machine downtimes can substantially surpass the direct costs of maintenance or repair. Anticipatory maintenance concepts allow operators to considerably reduce the costs associated with unplanned downtimes.

Networked production

Megatrends such as the individualization of products together with turbulent market activities lead to complex production processes. With respect to these framework conditions, organizational losses can be avoided through adequate planning and control of production to further increase the competitiveness of manufacturing companies.

Self-organizing adaptive logistics

In networked production, dependable production logistics processes are essential for a smooth, error-free added-value process. In the future, the demands on quantity and variant flexibility will continue to grow, and bottlenecks and delivery errors will become more probable. Cyber-physical systems (CPS) contribute to making material and part movements transparent. They set the technical foundation for dynamic intra-logistics control in a flexible factory.

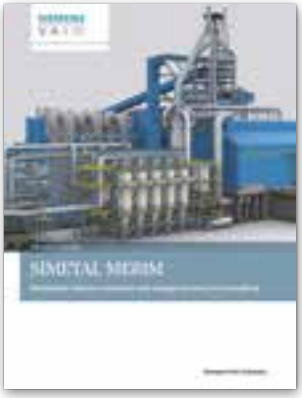
Sources:
1. Securing the future of German manufacturing industry – Recommendations for implementing the strategic initiative INDUSTRIE 4.0, April 2013, Final report of the Industry 4.0 Working Group
2. Platform Industrie 4.0 (http://www.plattform-i40.de/hintergrund/in-der-praxis)

Figure 1 was previously published in the spring issue of the Siemens AG magazine *Pictures of the Future*.

The latest brochures from Siemens VAI

Dare to Know More!

A selection of some of the most recently published brochures from Siemens VAI can be received free of charge either by submitting an e-mail request to contact.metals@siemens.com, or by downloading the desired brochures from the Siemens VAI Download Center at www.siemens.com/metals-magazine.



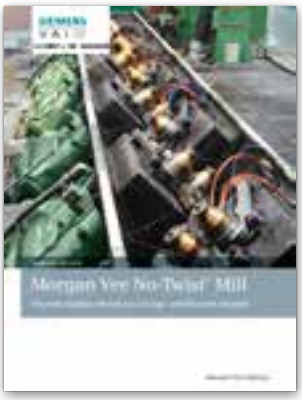
▲ SIMETAL MERIM
Describes the new dry-type Simetal Merim offgas-cleaning system for blast furnaces with coarse-dust separation performed in a specially designed cyclone, and fine-dust removal in a baghouse using high-performance fabric filters. The dust content of cleaned offgas is <5 mg/Nm³, and 20% to 30% higher energy recovery can be attained with a top-gas pressure-recovery turbine. **(8 pages)**

HM De-S
Introduces Siemens VAI's hot metal desulfurization system with injection technology. This system features highly precise injection flow rates in addition to flexible, cost-oriented operations based on the mono-, co- and multi-injection of desulfurization agents. **(12 pages)** ▼

▲ Competence in LD (BOF) steelmaking
Presents a comprehensive overview of technology, equipment, products, solutions and systems available for state-of-the-art LD (BOF) steelmaking, including automation, environmental facilities and services. The latest modernization packages are also outlined that allow metallurgical plants to be operated at peak production levels throughout their entire lifetime. **(24 pages)**

Flexible steelmaking
Describes tailor-made special converters equipped with top-, bottom- or combined-blowing systems that offer maximum flexibility to deal with changing availability and composition of input materials. Related costs and downstream demands are also taken into consideration. The production of carbon and stainless steel is even possible using the same steelmaking vessel. **(28 pages)** ▼

▲ The fast way to your steel-making plant modernization
Presents cost-efficient measures that can be easily and quickly carried out in the steel mill for significant improvements in overall plant performance and reliability. The complete range of products, solutions and services for LD (BOF) steel mills is described, extending from consulting, on-site investigations and single components up to complete plant modernizations. **(16 pages)**



▲ Morgan Vee No-Twist® Mill
Demonstrates widespread acceptance of this finishing mill and notes features of its improved design to increase productivity and product quality. References from customers on three continents are also included. **(8 pages)**

Protect the environment as effectively as your employees
Reviews highly effective modernization solutions available for steel mills to meet ever-stricter environmental regulations without the need for major investments in new facilities. The environmental solution portfolio extends from single product installations up to complete upgrading packages that create economic, ecological and social value for customers. **(16 pages)** ▼

Morgan Vee Mini-Block
Describes the operational and production advantages of using the new highly compact design of the mini-block either as a pre-finishing mill or as a mini-finishing mill in long rolling. Flexible applications in both single-strand or 2-strand rod mills are also outlined in this brochure. **(8 pages)** ▼

▲ Solutions for long product rolling mills
Provides a comprehensive overview of the full range of long rolling mill equipment for both rod and bar mills, from initial stands to reducing/sizing mills, and up to cooling beds, coil handling and compacting. Mechatronic packages that provide mill automation and process-control functions are described, in addition to recently launched product and process technology innovations. **(44 pages)**

▲ Morgan High Speed Pinch Roll and Laying Head
Explains new features of equipment designed for sustained high-speed operation. The brochure highlights the durability and improved quality experienced in mills with the new SR (Self Regenerating) Series laying head pipe. **(8 pages)**

Morgan Rod Reducing/ Sizing Mill
Outlines advantages of world-class, versatile rolling technology for mill owners seeking to expand their product range with higher quality and greater precision. Benefits of single-family rolling to increase mill utilization are noted, as well as processing capabilities for applications for wire drawing, cold heading, spring steel, bearing steel and welding rod products. **(8 pages)** ▼

Morgan Stelmor® Controlled Cooling Conveyor System
Details this highly versatile solution for rod mill owners seeking the best possible metallurgical and mechanical properties. The ability to optimize thermo-mechanical rolling with reducing/sizing mills is addressed, as well as controlled cooling for a wide range of steel products. **(8 pages)** ▼

Strong local presence of Siemens VAI in key market regions

Getting the Good News Out

More than 200 guests attended the Siemens VAI Metals Symposium in Chongqing

China

Siemens VAI underlines its commitment to the metals industry in western China

The city of Chongqing was the venue for the 2013 Siemens Metals Symposium from June 19 to 21. Under the banner "The Life-cycle Partner for the Metals Industry," Siemens VAI presented the company's leading technologies and service solutions to boost customer productivity, efficiency and competitiveness throughout a steel plant's entire life cycle. Attracting more than 200 guests, this industry gala also demonstrated the strong commitment of Siemens VAI to promote the development of the metals industry in western China.

"With our innovative technologies, close customer relations and a strong setup in China, we can achieve our goal of being the preferred life-cycle partner for China's Metals Industry," said Werner Auer of Siemens VAI. "From engineering to manufacturing and services, we are providing outstanding and customized solutions to help our customers improve their competitiveness through higher plant efficiency and productivity."

India

A fact-packed ironmaking road show covers three cities in three days

Siemens VAI held three one-day ironmaking conferences in the cities of Calcutta, Mumbai and Delhi from February 11 to 13, 2013. Some 90 representatives from India's leading iron and steel companies participated in the events to discuss the most recent trends and developments in the field of iron production. Cokemaking, sintering, pelletizing, blast furnace ironmaking, direct reduction, Corex hot metal production, environmental solutions, energy efficiency and automation were among the topics discussed. Furthermore, modernization and optimization solutions to enhance the performance of existing plants were also addressed.

"The conference was highly informative, and useful knowledge about ironmaking technologies was presented and followed by great discussions," remarked a participant from SAIL.

André Fulgencio, Vice President Marketing, presents the Siemens VAI product portfolio for ironmaking

Russian iron and steel specialists at the Siemens VAI Metals Symposium in Moscow

Russia

Introduction of market-place discussion forums

Sixty representatives from Russia's iron and steel industry were present at the Metals Symposium in Moscow on June 4 and 5, 2013. In addition to lectures and presentations covering the solutions and services offered by Siemens VAI for every step of the iron- and steel-production chain, a special feature of this symposium was the introduction of marketplace discussion forums. During these special sessions, participants had the opportunity to speak directly with Siemens VAI experts about pressing topics such as the metals industry of the future, Siemens VAI solutions to enhance productivity and flexibility, and support to meet ever-stricter environmental regulations.

"The interactive dialogues offered a very good opportunity to engage in intense discussions with our customers and talk in depth about new ideas and developments. We find out where our customers really need our support and how we can help them to make their plants more competitive," said Karl Baumgartner, Siemens VAI Regional Business Manager for Russia and Central Asia.

Thailand

Bright outlook for steel highlighted at the SEAISI Conference

Approximately 500 participants from across Southeast Asia attended the SEAISI Conference – the region's most important metals event – from June 3 to 6, 2013. The Southeast Asian market is growing at a rate of nearly 6% per year and annual steel consumption is expected to increase from some 60 million tons today to more than 70 million tons by 2016.

In view of the steadily rising demand for steel in this dynamic region, Siemens VAI presented an array of technological and services solutions tailored to local market needs. These included the company's latest innovations, modernization packages, energy-efficiency solutions and automation systems that enable optimized production performance of metallurgical plants to be achieved throughout their entire lifetime.

Project discussions with SteelAsia at the SEAISI Conference Left to right: Johann Kriechmair (Siemens VAI), Roberto Cola (Vice President, SteelAsia Manufacturing Corporation, Philippines), Klaus Stefanc (Siemens VAI), Roland Gutenbrunner (Siemens VAI) and Carlos Libres (Siemens Malaysia)

Turkey

Advanced technology and services for the local steel industry

More than 250 representatives from the Turkish iron and steel industry took part in three Siemens VAI metals symposia that were held in the cities of Istanbul, Eregli and Izmir from April 8 to 10, 2013. Technological highlights and innovations from the Siemens VAI portfolio were presented. Topics ranged from agglomeration and ironmaking up to hot and cold rolling, including minimills. In parallel technology sessions, intensive discussions were held in a free and open environment where Siemen VAI emphasized its mission to serve as the life-cycle partner for the Turkish steel industry.

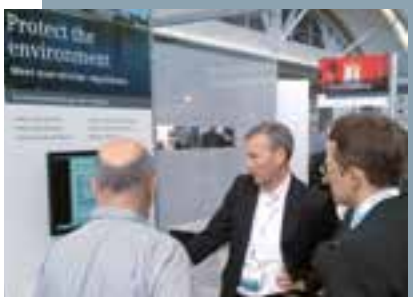
Johann Kriechmair, Siemens VAI Manager for Integrated Plants and Consulting, outlines the advantages of a life-cycle partnership to a Turkish audience of steel specialists

U.S.A.

Strong presence of Siemens VAI at AISTech 2013

For four days, from May 6 to 9, 2013, steel industry experts from 46 countries flocked to the AISTech Conference and Exhibition in the steel city of Pittsburgh, U.S.A. AISTech is the industry's largest trade show and exposition dedicated to steel. Siemens VAI presented its broad portfolio of products and services, fostered customer relationships in personal discussions, and held 29 technical presentations focusing on innovation, modernization and service.

A large number of guests and customers discussed technical issues and potential projects with Siemens VAI experts. Impressive exhibits, such as the full-scale model of the Lomas offgas analysis system for converter steelmaking, sparked considerable interest. "The Americans are interested in solutions that increase efficiency, safety and reliability. That is exactly where we are able to offer high-quality solutions," said Markus Abel, Senior Expert for electric steelmaking at Siemens VAI.



CTO Andreas Flick discusses the benefits of environmental solutions from Siemens VAI

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Contact address for all reader inquiries:
contact.metals@siemens.com

Fairs & Events Team

Manuela Merz
Event Manager (AISTech trade, Chinese and Turkish metals symposia)

Kerstin Reitterer
Event Manager (Russian metals symposium)

Michaela Heindl
Marketing Manager, (Indian conferences)

Martina Fuchs-Auer
Regional Communication Coordinator

Editorial Team

Dr. Lawrence Gould
Managing Editor, Metals Magazine, Siemens VAI

Bettina Wimmer
Editorial Assistant and organization, Siemens VAI

Allison Chisolm
Freelance Editor
Chisolm@ChoiceWordsOnline.com

Alexander Chavez
Freelance Editor
chavez@ac-communications.de

Graphic design team

Clarissa Albrecht
Art Director, Agentur Feedback
grafik@agentur-feedback.de

Tina Pauly
Graphic Designer, Agentur Feedback
grafik@agentur-feedback.de

Siemens VAI offers a wide range of social-media activities to keep in touch

Join Us on the Network

Staying close to our customers is an important part of an active life-cycle partnership. Siemens VAI makes use of the latest social-media channels to regularly communicate with our customers and friends, and to keep everyone up to date about recent company activities.

Marlene Peter is the person in charge of social-media marketing at Siemens VAI. She wants you to know more about our company successes, ongoing project activities and metals events. And there is a lot that we can offer. The scope of social-media activities at Siemens VAI extends from Facebook and Twitter up to dynamic Flickr photostreams. The latter features a series of theme-related pictures dealing with, for example, fairs and conferences, award ceremonies and customer symposia. Have you ever heard of XING, a social-media business network that allows us to network with our customers and business partners? We offer this too. On the YouTube channel, you can watch and enjoy exciting videos showcasing plant start-ups, innovations, production highlights and much more.

Don't miss out on all the excitement! You too can be part of a growing community of people interested in the latest events and activities going on in the metals business.

Example of a Flickr photostream

Sign up now and get networking!

Access to the Siemens VAI social-media channels is via the following link:

www.siemens-vai.com

- Facebook
- Twitter
- Flickr
- YouTube
- XING

Marlene Peter
Manager, New Media

The hot-strip mill of Hoesch Hohenlimburg GmbH – a company of ThyssenKrupp Steel Europe – was completely modernized by Siemens VAI in two phases. The mill, which is located in Hagen, Germany, rolls medium-wide strip that is primarily used for the production of automotive parts.

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E-mail inquiries: contact.metals@siemens.com