

# metals & mining

The magazine for the metals and mining industries

Issue 1|2010

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

## India Hungry for Steel

Arvedi ESP

**Performance at Its Best**



# A partnership made of steel

## Siemens VAI and JSW Steel

World class technology from Siemens VAI is helping JSW Steel to boost production with the largest Blast Furnace's in India utilising 'state of the art' and 'high efficiency' technology.

[www.jsw.in](http://www.jsw.in)



By 2011, the new JSW Steel plant in Toranagallu, Karnataka, India, will be producing 10 million t/a.

With the installation of its second blast furnace from Siemens VAI, JSW Steel will make the major breakthrough in its bid to achieve that goal. Completion of this new state-of-the-art blast furnace will boost production by an initial capacity of 2.7 million tonnes per year by 2011 - which has already been exceeded by 10% during Blast Furnace No 3's first year of operation - while also cutting coke consumption. With this, more than 50% of hot metal produced at JSW Toranagallu will come from Siemens VAI blast furnace technology - further proof of their highly successful collaboration.

#### Our solution:

- New blast furnace with >4,000 m<sup>3</sup> inner volume
- Advanced environmental systems
- Level 1 automation systems
- Level 2 control and optimization systems

#### Our customer's benefits:

- Capacity: 2.7 million t/a
- Low fuel consumption rate
- Flat casthouse floor
- High coal-injection rate
- Large furnace capacity

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**SIEMENS**  
VAI 



Ashoke Pan

## Dear Readers,

India is developing into one of the key economies in the world and is increasingly playing a major role in world events. Analysts expect India to become the world's second-largest steel producer by 2016. Investments in infrastructure, housing, the energy sector and machine construction are behind the country's hunger for steel. Current megaprojects include the construction of a 20,000 km long highway, new airports and sea-ports, irrigation networks and power plants – all part of a nationwide infrastructure program that will require staggering amounts of steel in the years to come.

That is why Siemens is considerably expanding its activities in India. In the next three fiscal years, the company will nearly double its investments from today's levels. New competence centers are part of this effort; they will be responsible for the entire value-added chain – from product design and development through to production and sales in India and beyond.

For Siemens' metals business this means working further on strengthening the local engineering and manufacturing network as well as considerably expanding the service network. In the past, Siemens VAI projects introduced state-of-the-art technologies to India for the first time. That tradition continues to today. Siemens VAI installs advanced solutions for the protection of the environment, improved operational reliability and operator safety at industrial-scale steel production sites. Examples include Corex for the production of hot metal, the Gimbal Top blast furnace burden-distribution system and LiquiRob.

With its advanced solutions and technologies, Siemens VAI is the right partner for the Indian steel industry. Our service centers in India keep us in close contact with the needs and requirements of our customers. This setup, along with our commitment to uphold our reputation as a trend-setter, is indeed the seed for success in the years to come.

Yours sincerely,

A handwritten signature in blue ink, appearing to read 'A. Pan', written over a light blue grid background.

Ashoke Pan  
Managing Director & CEO of Siemens VAI  
Metals Technologies, India

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# Start-up of Four Slab Casters in Four Weeks



2-Strand slab caster at Zhangjiagang Rong Sheng Co. Ltd., China

Four continuous slab casters with a total of seven strands were started up by Siemens VAI within just four weeks at Chinese steel producer Zhangjiagang Rong Sheng Co. Ltd. (ZRS). These comprise three 2-strand casters (Nos. 4, 5 and 6) and a single-strand, thick-slab caster (No. 7) with a maximum slab thick-

ness of 320 mm. Each caster was equipped with the latest equipment and technological packages to enable ZRS to cast highest-quality slabs for a multitude of industrial applications.

In addition to all standard carbon-steel grades, the casters are also capable of casting micro-alloyed, peritectic, high-strength, low-alloy (HSLA) steels, line-pipe grades and silicon steels. The total casting capacity of all four slab casters is nearly eight million tons of steel per year.

ZRS is the largest privately owned steelmaker in China and also the country's leading producer of electrical steel. The company is a subsidiary of Jiangsu Shagang Group, which produced just over 23 million tons of crude steel in 2008. Siemens VAI had previously supplied the Slab Casters Nos. 1, 2 and 3. A total of twelve strands, including those of the new casting facilities, were installed by Siemens VAI at ZRS. ■

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FACTS & FIGURES >

## World-Record Production Speed

A two-strand wire rod mill was recently commissioned by Siemens VAI for Votorantim Metais in Resende, Rio de Janeiro, Brazil. Production expectations were quickly exceeded with several industry firsts.

The mill, initially rolling one strand, is capable of producing plain rod from 5.5 mm to 24 mm, and HYQST (High Yield Quenched and Self-Tempered Steel) rebar from 6.35 mm to 16 mm. The 6.35 mm rebar was rolled at the contracted speed of 85 m/s – the fastest production speed in the world for quenched rebar products. This allows maximum-capacity output levels of 130 tons per hour of saleable products with exceptional metallurgical properties.

The Siemens VAI supply scope for this project included hot and cold billet-charging equipment, a 28-stand mill comprising a roughing, intermediate and pre-finishing mill with three “vee”-style



No-Twist Mill at new Votorantim wire rod mill, Brazil

mini blocks, the HYQST system, a Stelmor conveyor, a reforming station with a ring distributor and a vertical pallet system. The integrated 10-stand No-Twist Mill presented several new features – a drive located at the entry side, a novel heavy-duty design that enables lower-cost production at lower temperatures, and a new gear-clutch disengaging system designed for the last two stands.

Project implementation and the outstanding production results were achieved thanks to the integrated teamwork of Votorantim and Siemens VAI employees. ■

# Plant Start-ups (October 1, 2009, to January 31, 2010)

Company	Country	Project
Altos Hornos de México (AHMSA)	Mexico	FAC* received for Lomas Dynacon converter process-control system
Badische Stahlwerke GmbH	Germany	Start-up of a new DynaFlex hydraulic oscillator on 5-strand billet caster (No. 2)
Benxi Iron & Steel Company	China	Upgrade of 2-strand slab caster (CC2) with DynaGap Soft Reduction
Borcelik Celik Sanayii Ticaret A.S. (Borcelik)	Turkey	FAC received for continuous galvanizing line with capacity of 350,000 t/a
Dongbei Special Steel Group Co., Ltd.	China	Start-up of rod outlet section
Dongkuk Steel Mill Co, Ltd.	Korea	Start-up of new 5.0 m plate mill and finishing mill with a capacity of 1.5 million t/a of a wide range of plate grades, including ship plate and high-strength grades
Dragon Steel Corp.	Taiwan	Start-up of sinter plant with capacity of 7,440 t/day and a 2-strand slab caster (S1)
Echeng Iron & Steel Co., Ltd. (WISCO)	China	Start-up of DDS and single-strand slab caster (No.1)
Essar Steel Ltd.	India	Start-up of new 5.0 m plate mill with a capacity of 1.5 million t/a of mainly pipe-grade steels
Hunan Valin Iron & Steel Co.	China	Start-up of 1-strand slab caster (CC3)
Hyundai Steel Company	Korea	Start-up of two 2-strand slab casters (CC1 and CC3)
Jiangyin Xingcheng Special Steel Co.,Ltd	China	FAC for DDS and gas-recovery system for two 120-ton LD converters
JSW Steel Ltd.	India	FAC received for rod mill with capacity of 600,00 t/a
Minera Los Pelambres Ltda.	Chile	Start-up of two gearless mill drives for SAG* mill and ball mill
Mycron Steel Berhad	Malaysia	FAT* successfully completed on combined tension leveling and skin-pass mill line with an annual capacity of 400,000 tons
North American Stainless (NAS)	U.S.A.	FAC received for AOD stainless steelmaking converter
Novolipezk Metallurgical Combine (NLMK)	Russia	Start-up of LD Converters Nos. 1 and 2 (Meltshop 1), including FAC received for dedusting system and Dynacon process optimization installed in LD Converter No. 1
Nanjing Iron & Steel Co., Ltd.	China	Start-up of reducing and sizing mill
Pohang Iron & Steel Co, Ltd (Posco)	Korea	FAC received for annealing, pickling and finishing line and also for side trimmer installed on existing silicon-steel annealing line
Qasco Dubai Steel Fze	U.A.E.	Start-up of slitting and tri-slitting bar mill for production of 2x12 mm, 2x10 mm and 3x8 mm products
Salzgitter AG	Germany	FAC received for ladle furnace dedusting system
Shougang Qian'an Iron & Steel Co., Ltd.	China	Start-up of two DDS* systems and two 2-strand slab casters (CC3 and CC4)
Siderúrgica de Guatemala SA (Sidegua)	Guatemala	FAC received for a 420,000 t/a bar & wire rod line
Societe National de Siderurgie SA (Sonasid)	Morocco	Start-up of rod outlet, laying head and Stelmor conveyor
Tangshan Stainless Steel Co. Ltd	China	FAC received for 110-ton AOD and VOD*, including Level 2 automation
Tata Steel Limited	India	Start-up of Gimbal Top charging system and gas-cleaning plant at 'C' Blast Furnace
Usiminas Cubatao	Brazil	FAC received for bottom-stirring systems supplied for 160-ton Converters Nos. 5 and 6
Zhangjiagang Rong Sheng Co. Ltd.	China	Start-up of two 180-ton RH vacuum-degassing plants (mechanical core components, electrics, Level 1 and Level 2 automation)

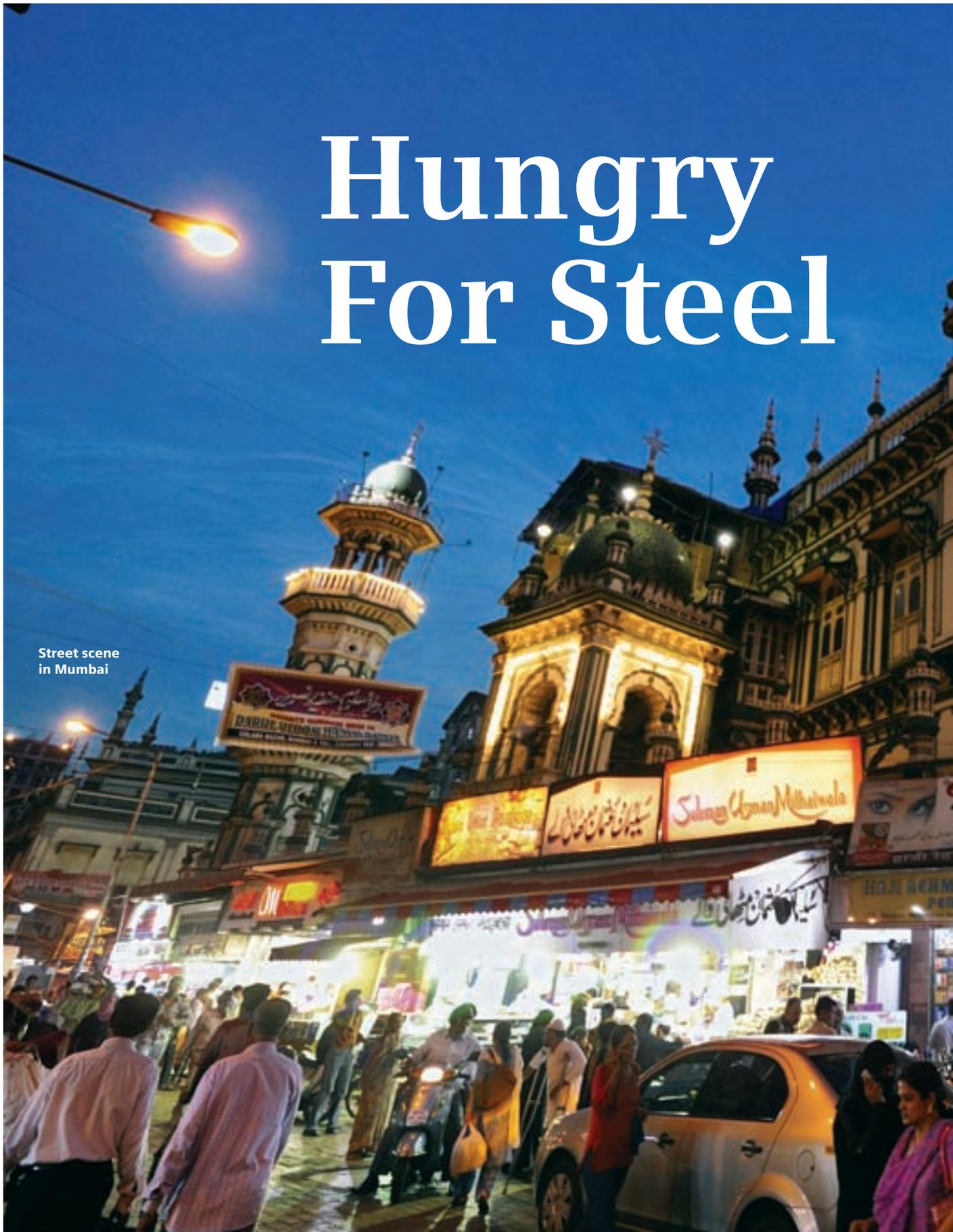
\*CGL = continuous galvanizing line  
 DDS = dry-dedusting system  
 FAC = final acceptance certificate

FAT = final acceptance tests  
 SAG = semi-autogenous grinding  
 VOD = vacuum oxygen degassing

# Hungry For Steel

COVER STORY >

Street scene  
in Mumbai





Steel will serve as one of the driving forces to meet the needs and expectations of a rapidly growing Indian population. Application of advanced technology and optimized environmental systems will be decisive for achieving the projected steel production figures.

India is the only country in the world today currently planning an enormous increase in steelmaking capacity. The challenges are formidable and will involve huge investments in both the private and public sectors. Siemens VAI, with more than five decades of plant-building experience in India, looks forward to continuing its long-term partnerships with the country's steel producers in this dynamic and thriving market.

**I**n the city of Delhi, at the center of the Quwwat-ul-Islam Mosque, a 7.3 m tall iron pillar stands as a testimony to ancient India's extraordinary achievements in metallurgy. Most historians agree that the pillar, also known as the Qutub Minar, was built some 1,600 years ago by the emperor Chandragupta II of the Gupta dynasty. It is comprised of 98% wrought iron and weighs nearly 6.5 tons. It has been an enigma ever since it was built, because it does not rust.

There is a popular tradition that if you stand with your back against the pillar and are able to clasp your arms around the structure so that your fingers touch, your wish will be fulfilled. Most steel producers today would envy the chance to attempt and to be successful at this feat. And their wish would certainly be that steel markets might recover more quickly.

But this is not necessary in India. There the steel industry is booming as never before and India is now the world's fifth-largest producer. According to the World Steel Association, the country's output in 2009 was 56.6 million tons – a 2.7% increase over the previous year. This figure is impressive when one considers that in 1998 Indian crude steel production was only 23.5 million tons. Since that time, steel output has grown by a remarkable 140%. In a press conference held on July 11, 2009, at the Bhilai steelworks of Steel Authority of India Limited (SAIL) in the state of Chhattisgarh, Indian Steel Minister Virbhadra Singh announced that the country's steel production is expected to surge to 124 million tons per year in fiscal 2011-2012. India is poised to become the world's second-largest steel producer by 2016. Longer-range forecasts by the government project a yearly production of 275 million tons of crude steel by fiscal 2019-2020. Whether or not these ambitious targets are actually achieved remains to be seen, but the intention is there and the growth trend will undoubtedly continue. Megaprojects are being initiated that include a 20,000 km highway-construction project, new airports and seaports, irrigation networks and power-generation

For India to meet its steel expansion targets, major initial investments are expected in primary production facilities



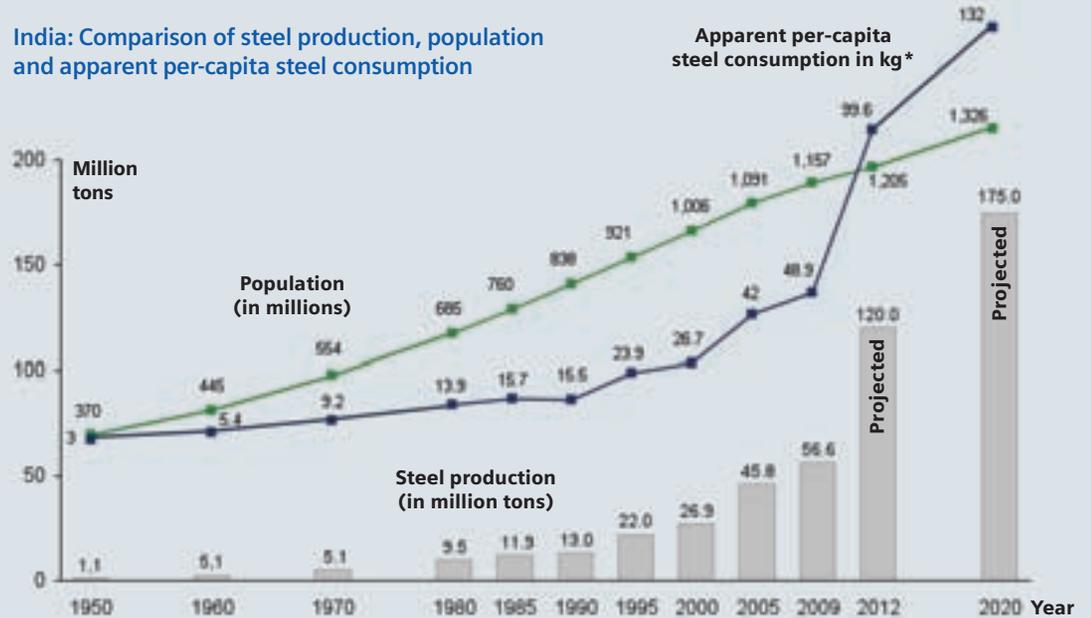
plants – all part of a nationwide infrastructure program that will require staggering quantities of steel in the years to come.

#### A history of innovation

The beginning of ironmaking technology in India can be dated back to around 1,000 B.C. Herodotus (484–425 B.C.), the Greek historian also referred to as the “Father of History,” wrote that the Indian army was equipped

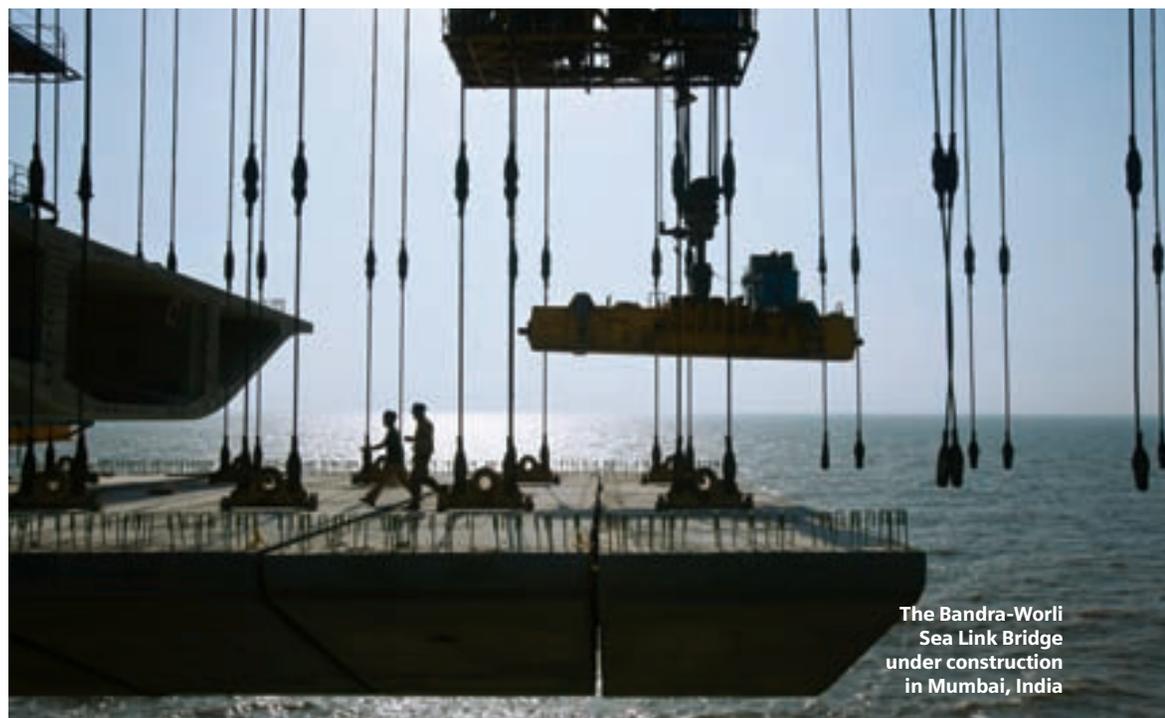


### India: Comparison of steel production, population and apparent per-capita steel consumption



\*Apparent per-capita steel consumption in kg in 2009 for other selected countries – China: 429; Russia: 428; E.U. (27 countries): 278; U.S.A.: 188; Brazil: 133

Sources: World Steel Association, U.S. Census Bureau



The Bandra-Worli Sea Link Bridge under construction in Mumbai, India

with iron-tipped cane arrows. Pliny the Elder (A.D. 23–79), Roman philosopher and naturalist, referred to “Indian steel” in his writings. Excavations at Taxila, the ancient capital of the northern Indian state of Punjab, have uncovered iron artifacts dating back to B.C. times, including bowls, dishes, cooking pots, lamps, pans, locks and keys, armor, various tools and agricultural implements. The fabled Damascus steel is also said to be of Indian origin. From the 3rd to the 17th centuries A.D.,

India shipped ingots of so-called wootz steel – an exceptional quality of steel first made in southern India as early as 300 B.C. – to the Middle East for use in Damascus steel. The iron pillar of Delhi is the most massive hand-forged block of iron from antiquity.

The company known today as Siemens VAI traces its birth to its invention of the revolutionary LD steel-making process in Linz, and the first order received from outside Austria in 1956 for the supply of this

>>

>> technology to SAIL's Rourkela Steel Plant (previously Hindustan Steel Limited) in Rourkela, Orissa. This plant was the first integrated steel plant of SAIL and celebrated 50 years of continuous steel production in 2009. Other LD steelmaking projects followed, the most recent being the receipt of an order from SAIL for the supply of three 160-ton LD (BOF) converters for a new LD steelworks under construction at the company's Bhilai Steel Plant in the state of Chhattisgarh. The project includes primary and secondary dedusting facilities, converter-gas recovery, electrics and automation. The converters, which will be successively started up beginning in the second quarter of 2011, will be capable of producing more than four million tons of crude steel per year.

The relatively new technology of continuous casting was already employed in the steel mills of Indian producers in the mid-1960s. These were provided by companies that are now part of Siemens VAI. The roots of Siemens VAI blast furnace technology in India can also be traced to the completion of a Davy McKee (now assimilated within Siemens VAI) blast furnace at Tata Steel in the year 1956. A particular highlight since then has been the commissioning of India's largest blast furnace at JSW Steel Ltd. in 2009, equipped with the unique VAiron expert system for optimized blast furnace performance. The start-up of the 'C' Blast Furnace at Tata Steel featured the world's first application of the Gimbal Top burden-charging system in a blast furnace, in addition to a new and highly efficient top-gas-cleaning plant designed with a single internal cone scrubber.

India's tradition of adopting innovative technologies is further exemplified by the supply of two Corex C-2000 modules to JSW Ltd. (previously Jindal Vijayanagar Steel Ltd.) in Tornagallu, Karnataka. Corex Module 01 was successfully put into operation in August 1999, followed by the commissioning of Module 02 in April 2001. The excess gas from the process is used for the generation of electrical energy in a power station, for the production of pellets in the pelletizing plant and for various heating purposes throughout the integrated iron- and steelmaking complex. Hot metal tapped from the Corex plants is processed to high-quality steel in two 130-ton LD (BOF) converters.

As another example of the application of Corex technology in India, two semi-completed Corex plants originally installed at Hanbo Iron & Steel Co. Ltd. in South Korea in 1995-96 were dismantled and relocated to Essar Steel Ltd. in Hazira, Gujarat, between 2006 and 2010. Each of the C-2000 modules is designed to produce up to 2,400 tons of hot metal per day. The start-up of the first module is scheduled for June 2010, and the second identical module is scheduled to be put into op-

eration in October 2010. India will then be operating a total of four Corex plants with a combined daily production capacity in the range of 9,500 tons, equivalent to approximately 3.3 million tons of hot metal per year.

In the Corex Process, a wide range of non-coking coals is directly used to produce liquid hot metal. This smelting-reduction process represents an attractive alternative to the blast furnace route, allowing expensive coking coal to be substituted with lower-cost coal blends.

#### Why doesn't the pillar rust?

*The extraordinary corrosion-resistant properties of the Delhi iron pillar have been an unsolved mystery since it was built. Numerous theories were proposed to explain why the pillar has not long since disintegrated into a mound of rust. Suggestions have included the high purity of its iron, the high phosphorus content or the low sulfur content, the lack of other metallic inclusions in the iron, the forge-welding process used to make the iron column, the dry humid conditions of the Delhi region and the application of currently unknown manufacturing technology. Some, for example Erich von Däniken, have even attributed this phenomena to the visitation of aliens to the earth with superior ironmaking knowledge. Recent investigations have finally shed light on why the pillar has survived through the centuries basically unscathed by the tooth of time.*

#### Complete portfolio of tailor-made solutions for producers

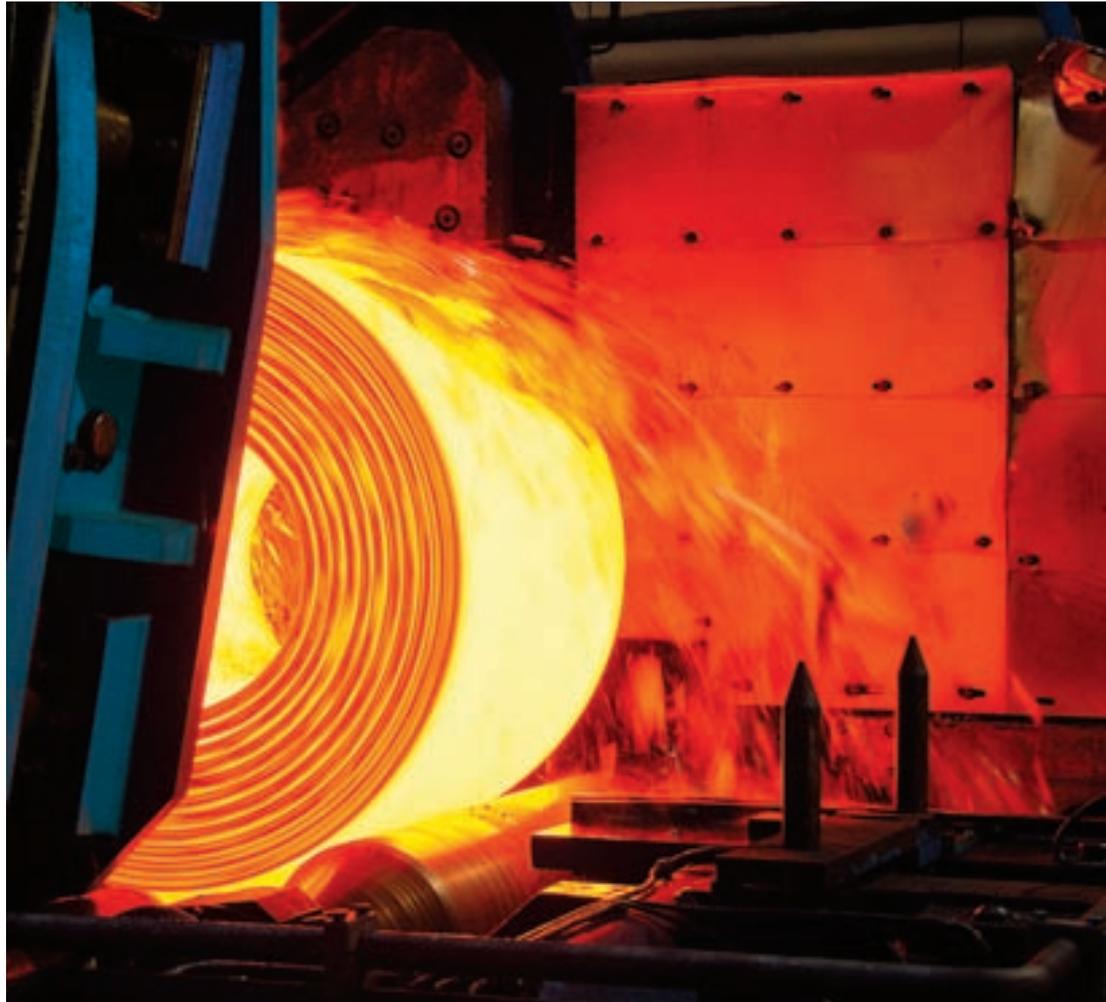
In order for India to meet its projected figures for steel growth, adoption of the most suitable technologies and the application of proven pollution-control techniques will be decisive prerequisites. This is where Siemens VAI can make significant contributions to India's steel growth. For each step of the iron- and steel-production chain, from the raw materials up to the finished steel product, optimized plants, processes and systems can be supplied that fully meet existing requirements in a cost-effective manner. This scope of solutions includes not only the mechanical hardware but also all necessary equipment and systems for electrics, automation, media supply, drives and pollution control in addition to energy generation, transmission, distribution and recovery. Efforts are placed on maximizing the local-supply portion, which is targeted at over 50% within India. This is made possible thanks to the strong local engineering and manufacturing capability of Siemens VAI in the Indian market – comprising over 700 professionals – which is being expanded to include additional services.

To help producers increase overall steelmaking capacity, the most advanced oxygen and electric steelmaking facilities available on the market are offered. A highlight on the electric steelmaking side was the >>

India is poised to become the world's second-largest steel producer by 2016.



The iron pillar of Delhi has withstood the forces of nature for some 1,600 years without rusting



>> recent development of the Ultimate EAF that incorporates all of the latest performance-enhancement solutions from Siemens VAI to maximize furnace output and productivity. Features include single-bucket charging, refining combined burner (RCB) technology and the application of postcombustion practices. Tap-to-tap times are possible down to nearly 30 minutes.

Not only the installation of new production facilities but also the modernization of existing plants will be important for achieving additional steelmaking capacity in India. As outlined in this and previous issues of *metals&mining*, Siemens VAI offers a full array of modernization solutions that incorporate sophisticated automation systems, specialized process models with expert systems and technological packages. These contribute to dramatic improvements in plant performance, product quality and energy savings – and also help producers to respond more quickly to changing product demands as stipulated by the market. Consultancy services, reengineering expertise and product life-cycle support are also provided.

All steel produced must, of course, be cast and rolled to useable products. The recently implemented Arvedi ESP (endless strip production) process at Acciaieria Arvedi SpA in Cremona, Italy, enables hot-rolled strip to be manufactured in a continuous and uninterrupted process from thin-slab casting to product coiling. ESP technology is ideally suited for the needs of Indian steel producers due to major energy savings achieved in rolling, the highly compact line length and the high quality of the thin-gauge rolled product. (See pages 56-63 as well as issue 3|2009 for more information.) Inquiries have already been received from five Indian steel producers and two pre-projects are currently in preparation.

It is obvious that capacity increases in steelmaking must go hand-in-hand with the best environmental-protection measures. The Siemens VAI product portfolio in this field includes primary and secondary dedusting of plant emissions, energy-saving and -optimization packages, waste-water-treatment facilities, and recycling and energy-recovery systems such as CO-gas recovery from converters. Meros technology offers sinter producers the possibility to reduce sinter-gas emissions to levels far below those attainable in conventional off-gas treatment processes. When considering that energy costs typically account for around one-third of the total costs in steel production, the application of energy-saving technologies not only can dramatically reduce expenditures for energy, but also CO<sub>2</sub> emissions.

In this issue of *metals&mining* a number of project examples are presented; they illustrate the competence of Siemens VAI in both the long- and flat-



The production of value-added steels will follow on the heels of investments in primary steel-making facilities

product sectors, include both new and modernized production facilities that extend from mining to rolling and processing, and cover metallurgical services.

#### The mystery revealed

*The answer to this age-old mystery is not as exciting as invoking extraterrestrial black magic. Metallurgists at the Indian Institute of Technology Kanpur (IITK), Uttar Pradesh, have discovered the reason behind the amazing durability of the Delhi iron pillar: Atmospheric conditions generate phosphoric acid from the high phosphorus content – up to 1% – present in the iron. This serves as a catalyst for the formation of a thin (one-twentieth of a millimeter) protective layer of “misawite,” an amorphous compound of iron, oxygen and hydrogen ( $\delta\text{-FeOOH}$ ), which has shielded the Delhi iron pillar from rust over the past 1,600 years. Today, a fence erected in 1997 protects the iron pillar from visitors attempting to encircle it with their arms. It was shown that sweaty hands damage the protective layer, resulting in pitting and corrosion at the base of the pillar until a new protective oxidizing layer could form.*

#### The Age of India has begun

India can look back on a long tradition of metallurgical expertise and innovation that has continued to the



**Advanced automation and process-optimization systems are decisive for high-quality steel production**



present day. It now looks ahead to a time of unparalleled growth in the economy. In a speech he delivered to both houses of the Indian Parliament in June 2009, Indian Prime Minister Manmohan Singh said, “I don’t promise you we won’t be affected by the international conditions, but we will be able to achieve a growth rate of 8%–9%, even when the world grows at a lower rate.”

The whole world is watching India. Expectations are enormous and hope abounds that with the continuation of prudent governmental guidance, prosperity will eventually come to a much larger share of India’s population. Steel is one of the key industrial segments that drives this trend and fuels optimism.

It is a truly unique time in India’s history. And if the world were able to clasp its arms around the Delhi iron pillar, it would wish India every success on its historical and remarkable journey into the future. ■

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The Bahá'í House of Worship

# An Indian Architectural Masterpiece

Every year more than four million people visit the Bahá'í House of Worship, popularly known as the Lotus Temple due to its flowerlike shape. Since its dedication in December 1986, the Bahá'í House of Worship in Delhi has attracted more than 70 million visitors of diverse religious backgrounds and nationalities, making it one of the most visited buildings in the world.

PANORAMA >



The Lotus Temple in Delhi, India

**O**n average, 8,000–10,000 people visit the Bahá'í House of Worship each day; on Hindu holy days as many as 150,000 people come. Many visitors encounter here for the first time the Bahá'í Faith teachings from Bahá'u'lláh (1817–1892), the religion's founder who brought together elements from all world religions and taught the oneness of God, of religions and of the human race. This Bahá'í temple on the Indian subcontinent is joined by six other Bahá'í Houses of Worship around the world in Apia, Western Samoa; Sydney, Australia; Kampala, Uganda; Panama City, Panama; Frankfurt am Main, Germany; and Wilmette, U.S.A. Each of these Houses of Worship, while sharing some basic design concepts, has its own distinct cultural identity embodying the principle of unity in diversity.

#### Open to all beliefs

The Lotus Temple is a religious homage to the beauty of creation, light and growth – symbolized architecturally in the form of a lotus flower with three wreaths, each with nine concrete shells shaped like petals that surround the dome. The brilliant white, the expansive space, the calm of the 26-acre park and the abstract beauty of the complex's geometry give the site a paradisiacal character. The rotunda has a diameter of 75 m and is 34.4 m high. Built on a terrace, the temple is surrounded by water. Many elements are repeated nine times, for example the circles of petals, ribs of the dome and ponds, and the identically formed entrances that open in all directions and symbolically invite members of the nine major religions.

The architecture of the Bahá'í House of Worship seeks to unite all people, regardless of religion, social status, race or nationality. For this reason, Canadian architect Fariburz Sahba chose a blooming lotus whose outermost petals have already started to open, with the innermost petals still surrounding the inner sanctum. In regard to the form, Sahba explains that the lotus is not only a symbol for all religions in India but also the world's most perfect flower.

“The design's significance is deeply rooted in the

minds and hearts of the Indians as the manifestation of God and a symbol of purity and tenderness. This temple symbolizes our love for aesthetics and is a humble offering to our Creator ... You may call it a flower in the corner of our hearts,” says Sabha.

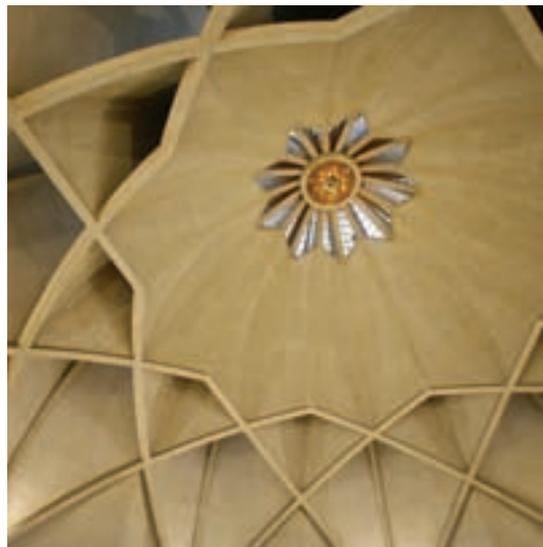
The beautiful concept of the lotus had to be converted into definable geometrical shapes such as spheres, cylinders, toroids and cones. These shapes were translated into equations, which were then used as a basis for structural analysis and engineering drawings. The resulting geometry was so complex that it took the designers over two and a half years to complete the detailed drawings of the temple.

Sahba himself worked on the project for ten years. A team of some 800 engineers, technicians, craftspeople and laborers built the Lotus Temple, one of the world's most complex structures, in just seven years. The 27 gigantic, shell-formed petals

– with a thickness between 133 mm and 255 mm and either 7.8 m, 22.5 m or 34.3 m high – are made of reinforced concrete covered in bright white marble. Every single slab of marble was cut precisely so that the dividing lines form a geometric design that extends to the adjacent petals. In fact, nowhere on the entire structure is a single straight line to be found.

#### An architectural masterpiece

Shortly after construction was completed, Sahba received an award from the International Federation for Religious Art and Architecture. In 1988, the edifice received its second international award, this time for its structural design, from the Institute of Structural Engineers of the United Kingdom. The American Concrete Institute named the Lotus Temple in 1990 one of the most finely built concrete structures. In 2000, GlobArt Academy of Vienna, Austria, granted an award to Sahba in recognition of “the magnitude of the service of this Taj Mahal of the 20th century in promoting the unity and harmony of people of all nations, religions and social strata to an extent unsurpassed by any other architectural monument worldwide.” ■





*For more than 50 years, Siemens VAI has constructed and installed iron- and steelmaking plants on the subcontinent. Can you name some milestone examples?*

**Ashoke Pan:** In 1952, the LD or basic oxygen steelmaking process was developed at voestalpine – “LD” comes from the two voestalpine steel plants located in Linz and Donawitz, Austria, where the process was made ready for production. The world’s third LD plant was constructed in the 1950s at SAIL Rourkela Steel Plant in India, which gave impetus to the plant-building activities of VAI and marked the long-term life-cycle partnership with the Indian steel industry. The next milestone activity was taken up in 1995 with the establishment of two subsidiary companies – VAI Automation at Jamshedpur and VAI India in New Delhi. A few years later, in 1999, VAI Automation moved to Kolkata with its 45 employees, only to be joined three years later by VAI India. That puts the business in the proximity of seven of the ten most important Indian producers, which account for 80% of produced steel, or approximately 30 million tons.

*So from a small beginning, Siemens VAI India has acquired considerable technical expertise and project management competence. What are the next steps?*

**Ashoke Pan:** As the business has grown so also has the office space required by Siemens VAI India. Today employees work from four offices around the country and currently a new large building with modern facilities and infrastructure is being acquired. Growth also naturally means the creation of new jobs.

*The business as we know it today was created in 2005 when Siemens acquired Austrian-based VAI. How did this acquisition modify the business of Siemens VAI India?*

**Ashoke Pan:** Touted as a marriage made in heaven, the two companies have proven to complement one another perfectly and today provide a comprehensive scope of supply and services with turnkey capability for the entire life cycle of industrial plants. Siemens VAI India is a 100% subsidiary of Siemens VAI Linz, Austria, and is actively engaged in all business areas. Our company offers the complete scope of all iron- and steelmaking technologies, from raw materials to

Interview with Ashoke Pan, Managing Director & CEO of Siemens VAI India

# Dedicated to Growth And Excellence

Over the years, Siemens VAI has grown to become the single-largest engineering and plant-building company for India's metals industry. Today the business employs more than 700 professionals who contribute their technical expertise and project-management competence to high-profile projects across the country. Ashoke Pan, Managing Director & CEO of Siemens VAI India, talks about the company's tradition in India and the steps necessary to continue on its successful path.

the finished product, and has successfully executed a large number of prestigious projects. We are a full-line provider and the mix of process know-how, plant engineering and automation expertise seems to be just what metal producers in India need.

*Last year Siemens VAI acquired U.S.-based Morgan Construction Company and expanded its business in the long-rolling area.*

**Ashoke Pan:** In keeping with the Siemens VAI policy of increasing business through regional setups, we are working further on strengthening the local engineering and manufacturing network. With the acquisition of the Indian operations of Morgan Construction, existing workshops have come within the fold of Siemens VAI. These are now being moved to a new location and they will be further augmented with a new manufacturing shop. The takeover means that equipment-sourcing activities shall be further strengthened along with work in the long-rolling area. With this added technical expertise and experience, we are working towards becoming a Center of Competence for certain products, for example small-size VD units, ladle furnaces and bil-

let casters. In the future, we will serve not only the local but also the global market with these products.

*Many plant-engineering and construction companies in the iron and steel industry have not been spared by the significant market downturn of the last year. What effects has the crisis had on Siemens VAI India?*

**Ashoke Pan:** India is currently one of the most important markets for Siemens VAI, and Indian customers are still making large investments. SAIL, the country's largest steel producer, ordered in March a steelworks for €200 million and in May a long-product continuous caster for more than €100 million. Jindal Steel & Power, the third-largest steel company in India, also placed a large order for a single-strand slab caster with a yearly capacity of 1.5 million tons. The new facility, which will be built in Angul, in the state of Orissa, is expected to start operations in September 2011, and upon completion it will be the most modern of its kind in India.

Jindal Steel & Power is a regular Siemens VAI customer. For the company's steelworks in Raigarh a combi-caster was built, which was the first caster in >>

Inauguration of the Tata BlueScope construction site



SAIL Bhilai BOF signing

Jens Wegmann, CEO of the Industry Solutions Division, received a warm welcome in Kolkata



Siemens VAI was the first company to use new technologies to contribute to environmental protection at industrial sites.

>> the world capable of casting beam blanks, blooms and rounds. The downturn has actually served as an opportunity for us to become a leading supplier for India's iron and steel industry.

*What lessons can you impart to your customers as a result of the downturn?*

**Ashoke Pan:** We advise our customers to concentrate on modernization and environmental technologies. In the past it was the level of investment that determined the competitiveness of a location or company; in the future it will be operating costs. Increasingly customers are interested in integrated plant solutions that optimize production in the face of fluctuating prices for raw materials, meet ever-stricter environmental regulations, and tackle rising energy costs in order to reduce operating costs and make more efficient use of input materials.

*Not only in the 1950s but also today, Siemens VAI projects introduce state-of-the-art technologies in India.*

**Ashoke Pan:** That's right. Siemens VAI was the first company to use new technologies to make an active contribution to protecting the environment in industrial-scale steel-production sites. One such technology is Corex, for the production of hot metals, which was introduced in 1999 and 2001 at JSW, in Toranagallu. And whether a new technology or a tried-and-tested solution, Siemens VAI India has a complete range of prestigious orders. Among them is the Gimbal Top blast-furnace burden-distribution system at Tata Steel, Jamshedpur, or Blast Furnace No. 3 at JSW Toranagallu, the largest blast furnace in India. And now we have recently won a prestigious megaorder – the new steel melt shop at SAIL Bhilai Steel Plant comprising three 160 t LD convertors. For these and a number of new projects, Siemens VAI is increasingly sourcing a major part of the equipment locally – up to more than 50% – with proper expediting and strict quality control.

*India is developing into one of the key economies in the world and increasingly plays a major role in world events. When it comes to steel, the tendency is no different.*

**Ashoke Pan:** Siemens VAI has confidence in India, proven by investments and the subsequent creation of new jobs. The company is committed to providing the best services to contribute and participate in the nation's growth. A stance like this is indeed the seed for tomorrow's success. Apart from serving the home market, Siemens VAI India is also providing its services for projects overseas, like the continuous galvanizing line at Benxi in China and the temper mill and tension leveler at Micron Steel in Malaysia.

*You have a number of new projects in the pipeline. How would you rate economic developments?*

**Ashoke Pan:** Megaprojects are still being executed joint-

ly by us and by the nine technological competence centers of Siemens VAI in Austria, Great Britain, France, Italy, Spain, Germany and the U.S. However, Siemens VAI India will itself be capable of acquiring and handling orders on its own in medium-size projects. In 2008, Siemens VAI India's order backlog grew to over €700 million with more than 300 employees. Together with Siemens VAI and Morgan India, we now have more than 700 employees and are the single-largest engineering and plant-building company in India's metals industry. In fiscal 2008, Siemens VAI India contributed 25% to Siemens VAI's total global order intake. ■

A brief overview of some Siemens VAI projects from yesterday, today and tomorrow.

#### Past projects:

- Essar: CRM Complex & Plate Mill
- JSPL: Combi Caster
- JSW: Slab Caster 3, Blast Furnace 3
- SAIL: Bokaro HSM Revamp, Slab Caster
- SAIL: Bhilai Rail Mill & RH Degasser
- Tata Steel: Slab Caster, Billet Caster, BF-F Process Optimization
- Visa Steel: VD
- Adhunik Metaliks: VD
- Usha Martin: VD
- Ramsarup: Billet Caster

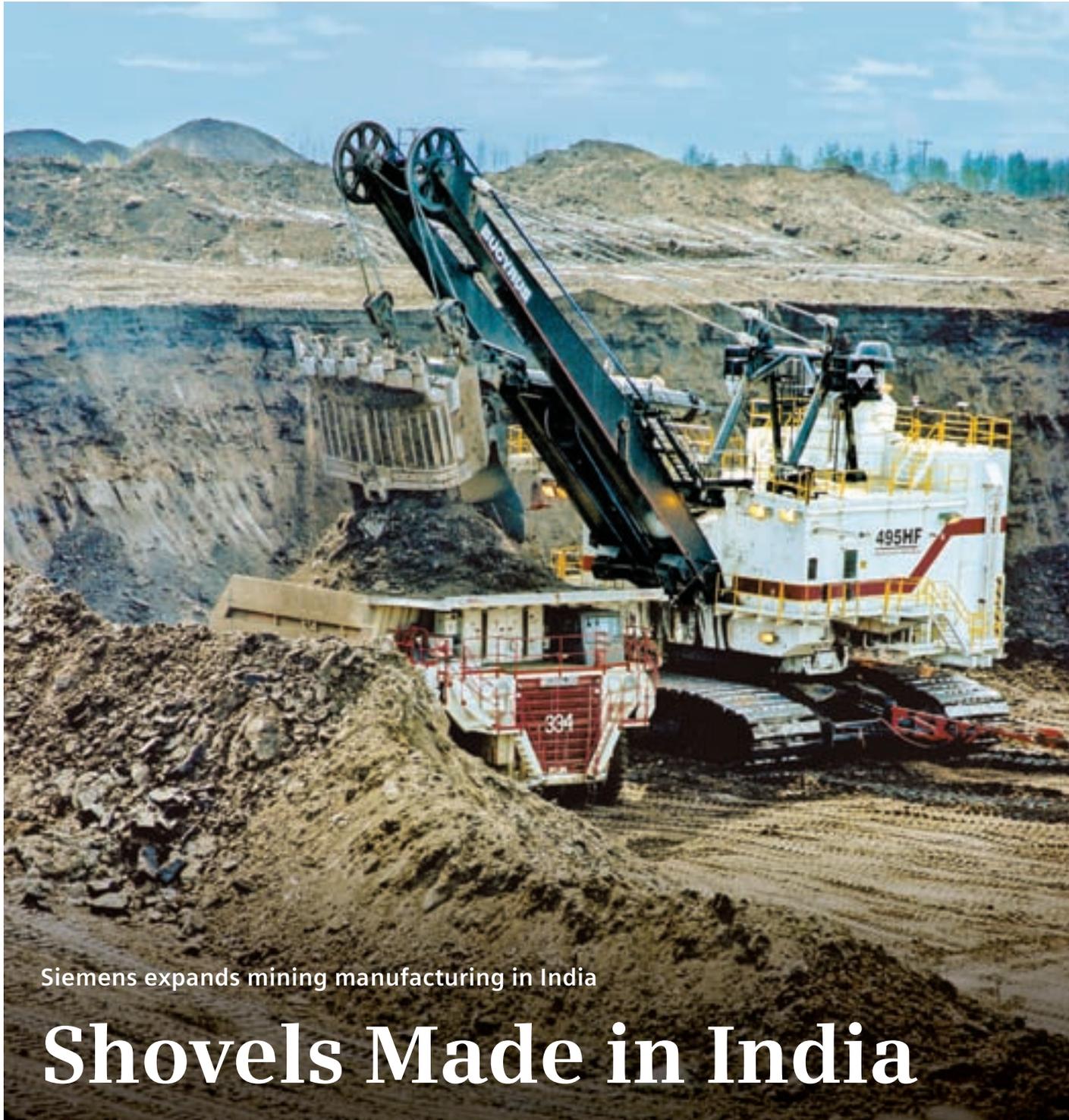
#### Ongoing megaprojects:

- Jindal Stainless Steel: Hot Strip Mill
- SAIL: Bokaro: Pickling Line & Tandem Cold Rolling Mill, Hot Dip Galvanising Line, Electrolytic Cleaning Line, Ladle Furnace
- SAIL IISCO: Billet Casters & Bloom cum Beam Blank Caster
- Tata BlueScope Steel: Metal Coating and Colour Coating Line
- Tata Steel: Billet Caster CC 3
- Tata Steel: KPO

#### Recent orders:

- JSPL: Slab Caster
- SAIL Bhilai: Billet Caster, Beam Blank Caster, Billet/Bloom Caster, Converter Shop
- Vizag Steel: Special Bar Mill

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Siemens expands mining manufacturing in India

# Shovels Made in India

The Indian mining and mineral sector has shown significant growth since the country's independence in 1947. Despite the global credit meltdown, India's GDP indicates continued growth, which in turn will increase the nation's energy requirements and demand for coal. Presently, the contribution of the mining and mineral sector to the Indian GDP is approximately 3.5%.

Similar to other rapidly developing nations, India has seen an explosion in the demand for energy and raw materials to support the local economy. In many regions, the construction of new power stations – whether fueled by coal, water or wind – represent a link to the future. But efforts are also being made to better use the primary energy in existing facilities through retrofits and modernization, especially in the case of coal.

These steps also call for further technology improvements and an increase in mining capabilities with more efficient equipment and recovery methods. Rope shovels continue to be the machine of choice for long-life mines. The electric rope-shovel market has few players and is evolving at a fast pace. Siemens, in partnership with Bucyrus International, Inc., has taken the drive control systems to a new level with the introduction of its AC IGBT drives. The Bucyrus 495 series shovel powered with Siemens drives technology is a well-known and proven product. The same AC drive technology with water-cooled devices and a more advanced control system is now available for a smaller series of shovels. These shovels have a smaller payload compared to the 495 series and are extremely suitable for developing economies like Brazil, Russia, India and China.

Last year Siemens began manufacturing its inverter/control components for the small shovels at its factory in Nashik, India. “We selected the Nashik factory because of its long history of producing traction inverters for Indian Railways, which operates equipment and technology similar to the shovel drive system,” said Walter Koellner, Director Marketing and Development for Mining at Siemens Industry, Inc. “By manufacturing in India, we will speed the time to market considerably and better serve India’s demand for mining equipment.”

Although Siemens has been supplying electrical drive systems and automation equipment for bucket-wheel excavators and conveyors for more than two decades in India, the production of shovel electrics for the world’s third-largest producer of coal marks a significant step for the company’s strategy in mining technologies.

The newly designed Siemens drive for smaller electric mining shovels with a 20–30 m<sup>3</sup> bucket load helps improve productivity while lowering maintenance costs. Produced in Nashik, these AC drives use Siemens IGBT technology, which enables a higher stall torque, faster acceleration and higher speeds in field weakening. The IGBT drive systems operate routinely at over 98% availability with mean time between failures (MTBF) in the thousands of hours and a mean time to repair (MTTR) of typically less

than one hour. They also have regenerative capabilities that direct excess energy back to the line.

## By manufacturing in India, we will speed the time to market considerably and better serve India’s demand for mining equipment.

In fiscal 2009, Siemens manufactured seven mining-shovel drive systems in the LD Traction factory in Nashik. Siemens Mumbai provided the design engineering, hardware and software as well as project management for these new shovel drive systems. In addition to the shovel drive system, Siemens’ offices in Mumbai procured the transformers, medium- and low-voltage switchgear, cables and installation materials.



Siemens Mobile Mining team at the Siemens Nashik plant

Three units have been shipped to a coal mine in northern India and are in being commissioned. In addition, four units have been exported to Brazil, where all but one have already been commissioned and are operating to the full satisfaction of the customer. ■

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Innovative belt conveyor system for open-pit mines

# Reliability and Ease of Maintenance by Design

For more than two decades, Siemens has been catering to the Indian mining industry by providing electrical turnkey solutions for various applications. Among the equipment offered is a range of electrical solutions and automation systems for the operation of conveyors and special mining machines such as spreaders, bucket-wheel excavators, stackers and reclaimers. Maintenance of the electrical and automation systems rounds out Siemens' proposition.

**N**eyveli Lignite Corporation Ltd. (NLC) is India's largest lignite mining company and one of the country's leading power-generation companies. NLC operates three open-pit mines in Neyveli, in the state of Tamil Nadu, that produce some 24 million tons of high-grade lignite per year. Mine I, the company's original mine, is operated over an area of nearly 27 km<sup>2</sup> and offers a reserve of about 365 million tons. Mine II, first opened in 1984 and expanded in the early 1990s, features a reserve of nearly 400 million tons. Most of that production is used in NLC's

thermal power-generation plants, which have a combined capacity of 2,490 MW.

## Complete data transfer via WLAN

In September 2008, Siemens commissioned at Mine II complete electrical and automation systems for a line of six conveyors and four special mining machines, including two bucket-wheel excavators (BWE), one crawler-mounted tripper car and one spreader. The system was designed for nine conveyors, which were subsequently put into operation step by step. The

In September 2008, Siemens commissioned at Mine II complete electrical and automation systems for a line of six conveyors and four special mining machines.

Transfer chute



**A bucket-wheel  
excavator  
in operation**



project represents the first time in India that conveyors were equipped with variable frequency drives. These conveyors can be speed controlled from a centralized location depending on the load condition. The result is low operating costs, high availability and very low wear. Individual speed controls at the head guarantee optimized operating conditions of the conveyors, especially under heavy load conditions or when the drive drums are wet.

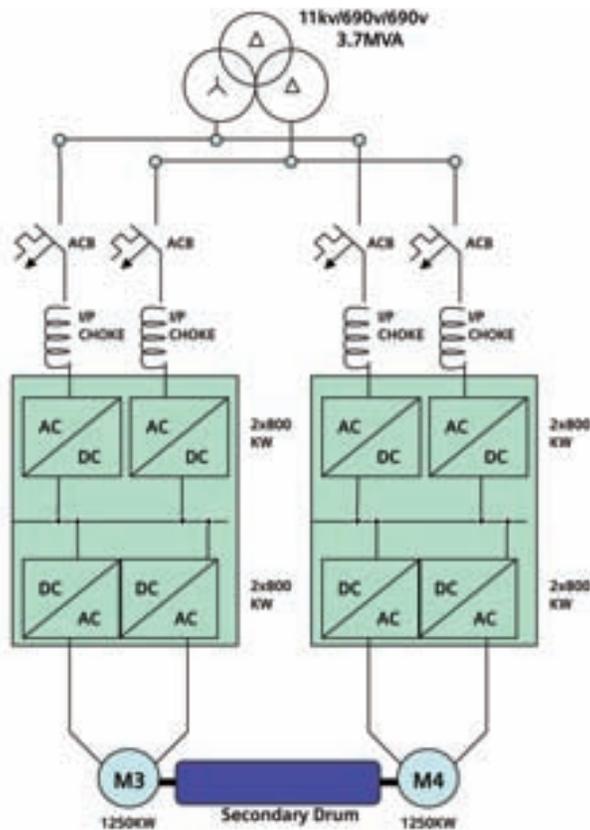
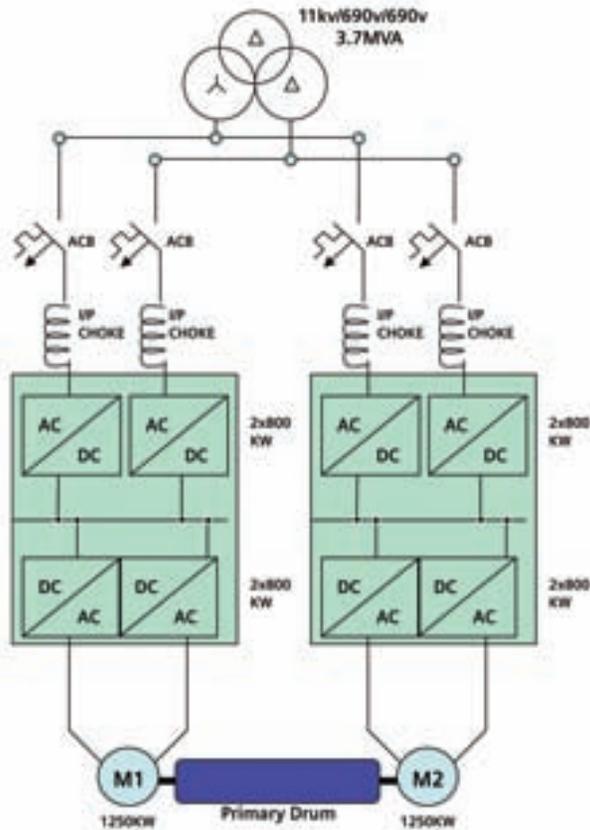
The entire flow of material in the open-pit mine is tracked and controlled by Simatic S7-400 route controllers. A WincCC server provides relevant production data online. Since the conveyors need to be shifted from time to time, communication via cables was impractical. To overcome this problem, Siemens Scalance industrial WLAN equipment is used to connect the conveyors and machines to the centrally lo-

cated gateway PLC. Even when the conveyors are shifted, the WLAN equipment ensures instant and reliable communication.

Now the operator at a central location can select one of the twenty probable routes and can issue the start-and-stop commands for each of them. All operation and machine-status data are available at a centralized control station, thereby reducing troubleshooting time and enabling the generation of sophisticated reports that allow management immediate access to the historical and live production data.

### **Variable frequency drives – first in Indian open-pit mines**

The intricacies of the project can best be understood with the help of Figure 1, which graphically represents the layout of the conveyor line with four mining >>



Drive-system configuration of the 2,400 mm conveyors



Fully loaded conveyor

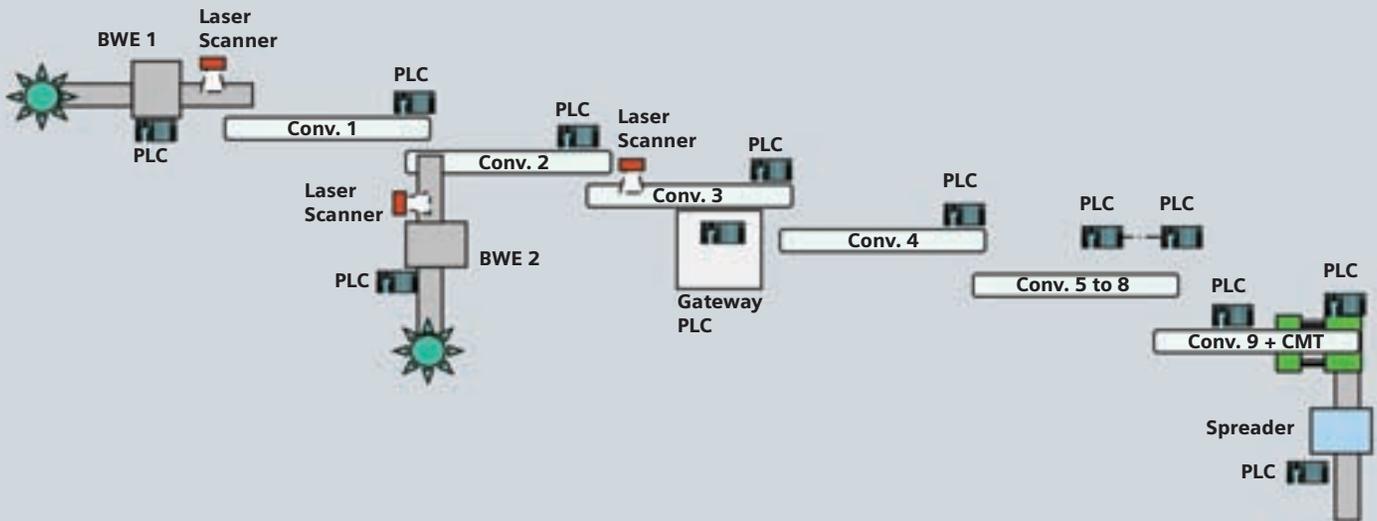
>> machines. The two bucket-wheel excavators (BWE 1 and BWE 2) carry out the excavation of overburden and dump the material on the first conveyor, which is then transported away by a series of further conveyors. The last conveyor, the furthest from the BWE, is equipped with a crawler-mounted tripper car, which in turn dumps the overburden onto the spreader.

The BWEs are equipped with industrial-grade laser scanners mounted on their discharge booms. These laser scanners detect the amount of overburden being excavated in real time and continuously transfer this data to the central control room over the wireless communication system. The centralized PLC in the control room analyzes this information and determines the cumulative loading on the conveyor line fed by both BWEs.

Each conveyor is capable of carrying 20,000 tons of overburden per hour at a maximum speed of 5.4 m/s. The conveyor lengths range from 800 m to 1,800 m. The primary drum and the secondary drum are each driven by two motors. To achieve the controlled power delivery to these high-capacity conveyors, each conveyor is equipped with Simovert AC Masterdrives in 12-pulse configuration and controlled by a special software tool kit that was developed for conveyor applications and runs on the FM458 technology module.

**Dynamic conveyor speed explained**

The speed variation of the conveyor ensures the safety of people and equipment, optimum usage of energy, and avoidance of oscillations. The software features belt-slip supervision for the safe operation of the conveyors. The current conveyor load is continu-



**Fig. 1: The configuration of the BWEs, conveyors, CMT and the spreader**

ously recorded and stored during breaks. This feature permits a sophisticated load-based precontrol function that optimally adapts the torque to the conveyor load after a shutdown. This guarantees equal load sharing at start-and-stop operations as well as during normal operation and helps avoid any oscillations even at varying speeds and changing loads.

Due to the length of the conveyors, it takes a long time for them to come to a complete stop from full-speed operation. In order to use this massive inertia, the power is fed back into the system. Thanks to this innovation, the mechanical brakes are only used when speeds reach near to zero, which also significantly reduces wear.

The maximum speed of each conveyor is specified at 5.4 m/s and the maximum length of a conveyor is 1,800 m including potential conveyor length extensions. To avoid sudden changes in the speed of the conveyors, speeds remain fixed within a certain band of tons-per-hour loading. When the loaded capacity is up to 60% of the maximum, the conveyor speed is 65% of the maximum possible; between 60% and 75% of maximum loaded capacity, the conveyor speed is 75%; and between 75% and 90% of maximum loaded capacity, the conveyor speed is 85%. To save energy, when empty the conveyor line works at 55% of the maximum speed possible.

After restarting the conveyor system with a simultaneous startup of both BWEs, the speed is immediately increased to 96% and it remains at that level for five minutes. This prevents the transfer chutes from being blocked by existing material on the conveyor

Time taken for clearing the material, in minutes					
At 100%	At 96%	At 85%	At 75%	At 65%	At 55%
(5.4 m/s)	(5.18 m/s)	(4.59 m/s)	(4.05 m/s)	(3.51 m/s)	(2.97 m/s)
5.56	5.80	6.54	7.41	8.55	10.11

line or by the discharge boom of the BWEs. After running the line at 96% speed for five minutes, the gateway PLC selects the optimal conveyor speed based on the loading pattern. Speed-increase commands are given to all the conveyors simultaneously to avoid chute blocking.

If only one of the BWEs is started up, then the command is issued to all conveyor PLCs to change the speed to 65% of the maximum speed. In a situation in which both BWEs are running and one stops, the line speed is reduced to 65% in a phased manner. This ensures that the higher loads on the conveyor line are cleared before the speed reduction is initiated.

In the event that both BWEs are stopped, the conveyor line will become empty in due course. To minimize the energy consumption in this phase, the conveyor line is operated at 55% of the maximum speed. Similarly, the speed reduction is done in a phased manner. ■

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Market in Varanasi,  
one of the oldest  
cities in India

Personal experiences in the marketing of coke-oven-battery  
automation projects in India

# Success with Patience



Siemens VAI Finland has worked closely with Indian coke-oven-battery operators since 1989. Commercial contracts for first-generation automation systems were first signed in 1994, and numerous other contracts were implemented since then for Steel Authority of India Limited (SAIL). Whereas 20 years ago discussions with state-owned enterprises in India typically required four to six years until an investment decision was made, today contract negotiations for large projects are normally completed within two years. In this article, the author shares his experience in the marketing of various cokemaking automation products in India, which indeed shows that success comes with patience.

**T**he development of a product is the first step to enter a market. The marketing of a product, or more exactly, the marketing of specialist engineering services and a tailored product, involves a lot more. It comprises an assessment of local and onsite plant and business conditions, adaptations of the product to meet the unique requirements and wishes of steel producers, detailed cost evaluations, infrastructure, winning the confidence and acceptance of customer personnel, and various other factors and conditions.

For example, first-generation Coking Process Management System (CPMS) automation was initially developed for Ruukki Production in Finland in the late 1980s. Subsequent R&D work was needed to adapt the product for other customer applications. A tailor-made product means that 10–40% of the supply scope consists of available modules, and the rest must be adapted to the customer's needs on a case-by-case basis. Calculations showed that this approach was very cost-effective. Initial markets were targeted where coke-oven batteries similar to those at Ruukki could be found, such as the Soviet-built installations in India. It was time to hit the road...

My first business journey to India was to Bokaro Steel Plant and Bhilai Steel Plant in 1990. During the trip, all possible modes of transport, from airplanes to rickshaws, were used. If a train happened to be on time, it was most likely yesterday's train. Hotel ratings were from +5 stars down to -5 stars – and all were checked into. Safe drinking water was hardly available outside of the hotels which meant, well, >>

>> you know what... But through it all we were treated with utmost hospitality and nearly all technical solutions were most welcome.

Back then, mobile phones and the Internet were virtually unheard of in India. Landline calls were generally only available to and from big cities, and connections were often unreliable. This meant that we were basically cut off from headquarters for weeks and that decisions about the terms and conditions of the contract, including financing, had to be made by young engineers onsite directly with the customer. Office programs worked with the legendary DOS system (fortunately without viruses), and all office equipment, such as the PC, printer, reserve ink, paper, presentation materials and more, had to be taken along. Customers naturally wanted numerous modifications to be carried out in the draft contracts daily; they were quite surprised when all changes could be made overnight and fresh documents could be presented the next morning. This procedure was repeated again and again until the final contract document was ready.

In any case, winning the full confidence and acceptance of the people, their organizations and project teams was relatively quick with highly specialized automation solutions. And so, at both Bokaro and Bhilai, contract negotiations could eventually be finalized in 1994 after a total of 18 business trips!

Today, doing business in India is totally different. Business practices are often similar to or even exceed those in the West. Internet, mobile phones, advanced technology and professional skills in computer sciences are available at every plant. Contracts are negotiated in a very professional manner and in the shortest possible time. In fact, most contracts can now be concluded within two years from the issuing of the tender. Projects are well planned by the customer's organization, and financing packages generally no longer have to be provided by the seller.

**Cokemaking automation solutions from Siemens VAI Finland**

Siemens VAI Finland is a Siemens VAI Business Center specializing in cokemaking automation and technology. Already in the late 1980s, the company developed its first-generation Coking Process Management System (CPMS), which is a statistics-based, heating-control system for coking batteries. Second-generation CPMS so-



The Darjeeling Train arrives in Siliguri Station. The railway was decreed a World Heritage Site in 1999

lutions, highlighted by feedforward- and feedback-control applications for neutral pause time (i.e., heating interruption after reversal of gas flow in coking battery), dynamic scheduling and energy-demand controls were implemented in the mid-1990s. Third-generation CPMS solutions included fuzzy logic and coking-index-control features that

Cokemaking automation solutions from Siemens VAI Finland

Customer	City	Project start
Bhilai Steel Plant	Bhilai	2008
Bhilai Steel Plant	Bhilai	2008
Bhilai Steel Plant	Bhilai	2008
IISCO Steel Plant	Burnpur	2008
IISCO Steel Plant	Burnpur	2007
Rourkela Steel Plant	Rourkela	2008
Rourkela Steel Plant	Rourkela	2007
Vizag Steel	Visakhapatnam	2006
Bhilai Steel Plant	Bhilai	2005
Rourkela Steel Plant	Rourkela	2004
Neelachal Ispat Nigam	Duburi	2004
Bokaro Steel Plant	Bokaro	1998*
Bhilai Steel Plant	Bhilai	1997*

\*Start-up of installed automation system



**Outfitting of coking plants in India with advanced automation systems was often a challenging yet rewarding experience**

were incorporated into the system in the latter part of 1990s. Since that time, new software tools and models have been developed and introduced to the market, all the way up to sixth-generation CPMS automation systems.

A CPMS conducts various process-model calculations. Dynamic-scheduling control of the coke-oven

machines and the heating-energy control of the battery are the main features of the system. The oven-identification system RaDiPosi supports the CPMS by providing accurate battery-machine positioning data based on wireless data transfer. After each coke-oven pushing operation, the dynamic-scheduling model calculates and sends the relevant information for the next pushing time, together with the respective oven number in the pushing sequence, to the coke-oven machines for the operators to follow. By means of the heating-control model, the heat-energy input into the battery is optimized. The control aims for a uniform end temperature of the coke within the entire battery.

## Specialist services for our cokemaking product portfolio are now being set up in India to enable customers to derive additional benefits.

### Main Benefits

- Lower heating-energy costs
- Increased coke-oven-battery service life
- Higher production rate
- Uniform final coke temperature resulting in improved coke quality
- Optimized process control of coke-oven batteries
- High degree of user-friendliness for process operators

### Concluding remarks

Over the past 20 years, Siemens VAI Finland has finalized 13 contract negotiations with SAIL. Specialist services for our cokemaking product portfolio are now being set up in India to enable customers to derive additional benefits from, for example, fast maintenance and expert advice. Those producers who are not yet familiar with our capabilities are invited to contact us to discover the advantages we offer with proven, efficient and cost-saving solutions for cokemaking. ■

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CDQ or COB No.	Battery height/ CDQ capacity	Automation
CDQ 11	4x50 t/h	L1
COB 6	7.0 m	L1, L2, RaDiPosi
COB 11	7.0 m	L1, L2, RaDiPosi
CDQ 11	4x50 t/h	L1
COB 11	7.0 m	L1, L2, RaDiPosi
CDQ 4-6	4x50 t/h	L1
COB 4	7.0 m	L2, RaDiPosi
COB 4	7.0 m	RaDiPosi
COB 5	7.0 m	L1, L2, RaDiPosi
COB 1	7.0 m	L1, L2, RaDiPosi
CDQ	3x50 t/h	L1 and Technology
COB 4	4.3 m	L2
COB 10	7.0 m	L2

COB = Coke Oven Battery, CDQ = Coke Dry Quenching, L1/L2 = Level 1 or Level 2 automation, RaDiPosi = Radio Digital Positioning System for Battery Machines

The Siemens VAI sinter cooler at Vizag Steel, India

# A Cooler Idea

Siemens VAI has been a leading supplier of sinter plants and all related equipment and systems for more than 50 years. On the basis of this experience, innovative solutions are offered to meet the highest operational, economical and environmental demands in sinter production today. This article outlines the main features of the sinter cooler supplied to Vizag Steel in India.

Sinter cooler under construction at Vizag Steel



IRONMAKING >

In July 2007, Siemens VAI received a contract from the Indian steel producer Vizag Steel for the installation of a cooler at its Sinter Plant No. 3. The steel plant is located on the outskirts of Visakhapatnam, in the state of Andhra Pradesh, on India's southeastern coast. The Vizag cooler is a so-called dip-rail circular cooler with a diameter of 35 m, a trough width of 4.6 m and a total sinter-cooling area of 420 m<sup>2</sup>. The cooler is capable of homogeneously cooling a maximum of 870 tons of sinter per hour to a temperature

of less than 100°C. It is characterized by a higher cooling efficiency compared to other cooler types because of certain optimized design features. The generation of fines and dust emissions is lower than in a scraper cooler, and the required space and moving parts are less than in a straight cooler.

The cooler includes the patented Grate Wings Cooler Trough design of Siemens VAI. Special rubber seals inserted between the moving cooler troughs and the air-channel system improve the

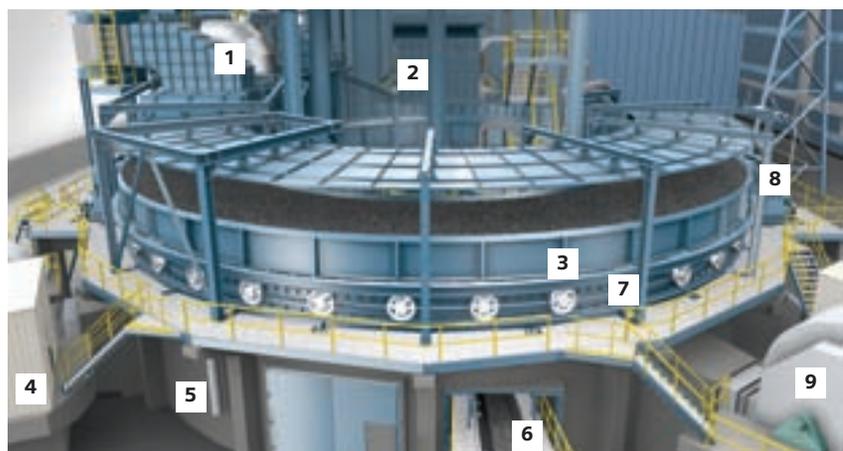
cooling-air efficiency, which reduces electrical energy consumption.

The cooler is comprised of moving troughs with louver-type bottom plates circularly arranged in a ring. It is driven by two heavy-duty planetary gears powered by variable-speed motors. The motors are reversible, allowing the cooler to be driven in local control in the reverse direction for maintenance purposes. The traveling speed of the cooler is variable between 0.3 and 2 revolutions per hour.

A special charging chute, the product of an intensive R&D project, was also installed at the sinter cooler of Vizag Steel. It is characterized by an improved, simple and virtually maintenance-free design that segregates the sintered material in such a way that coarser particles are concentrated at the bottom of the cooler trough and finer particles at the top, simultaneously with a homogenous distribution of the sinter across the cooler width. This is the main reason for the sinter bed's high degree of permeability, which results in an optimized utilization and efficiency of the cooling air. (See *metals&mining* 2|2009 for more information.)

Sinter filling of the cooler is controlled by level sensors in the cooler-charging chute. The speed of the cooler is regulated in such a way that the cooler is always completely filled. Two fans provide the necessary cooling air. The cooler-fan bearings are fur-

nished with vibration and temperature-monitoring sensors. Inlet silencers are provided to reduce the noise level. The cooling air is distributed by means of a circular concrete channel to the bottom of the cooler troughs where the air is forced through the bottom of the louver plates to cool the sinter above. Spillage pans below the louver plates protect the air channel from spillage and dust. A portion of the hot cooler off-air is available for use both for the selective waste-gas recirculation system as well as in a heat-recovery system for the generation of electrical energy.



**Main design features of the Siemens VAI sinter cooler**

- |                                 |                                  |
|---------------------------------|----------------------------------|
| <b>1: Off-air suction ducts</b> | <b>6: Cooled-sinter conveyor</b> |
| <b>2: Cooler-charging chute</b> | <b>7: Sealing system</b>         |
| <b>3: Cooler cars</b>           | <b>8: Drive unit</b>             |
| <b>4: Cooling-air fan</b>       | <b>9: Cooling-air fan</b>        |
| <b>5: Concrete air channel</b>  |                                  |

### Main data of Vizag Sinter Plant No. 3

#### Sinter plant

Sintering area	408 m <sup>2</sup>
Rated production capacity	456 t/h
Max. production capacity	560 t/h

#### Sinter cooler

Cooling area	420 m <sup>2</sup>
Feeding temperature	Less than 700°C
Design capacity	870 t/h
Heat-recovery system	26% of cooling area
Main diameter	35 m
Width of trough	4.6 m
Height of side wall	1.6 m
Nominal sinter-bed height	1.5 m

### Benefits of the Siemens VAI sinter cooler

- Lower investment and operational costs compared to conventional coolers
- Higher cooling efficiency and lower specific electrical energy consumption due to special sealing system
- Fast start-up and easy maintenance
- Fully automatic and reliable operations

The cooler is designed to enable a minimum sinter-residence time of one hour to ensure that the sinter is cooled to the specified value. The cooled sinter is then discharged into a discharging bin, which is supported on load cells for level monitoring.

The main construction work of the sinter cooler was completed in December 2009. Cold trials were already performed in November 2009, confirming the full functionality of the equipment and systems. The cooler is now ready for operation and awaiting the completion of the new sinter plant upstream. ■

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Siemens VAI blast furnace projects in India

# Ready for Blast Off

Siemens VAI has completed or is in the process of implementing a total of five blast furnace projects in India. These include new blast furnace designs as well as the application of innovative equipment and systems employed for the first time. As outlined in the following, these projects illustrate the proven project-management capability of Siemens VAI and the company's flexibility to adapt to the specific project needs of its customers.

**Blast Furnace No. 3 of JSW Steel Ltd.,  
Toranagallu, India**



In order to meet projected steel demands for the mid-term outlook, India will need about 100,000 m<sup>3</sup> of additional blast furnace volume operating at a productivity rate in excess of 2.0 t/d/m<sup>3</sup>. All of the major integrated steel plants such as Steel Authority of India Limited (SAIL), Vizag Steel, Essar Steel Limited, Ispat Industries Limited, JSW Steel Ltd. and Jindal Steel and Power Limited (JSPL) have plans for brown-field expansion and greenfield iron- and steelmaking projects on the anvil. Siemens VAI is able to offer a blast furnace design that incorporates the knowledge of some of the industry's leading experts and the experience gained from implementing more than 20 new blast furnace installations and almost 30 blast furnace rebuilds worldwide within recent years. Thus far in India, Siemens VAI has worked on non-turnkey projects, being responsible for basic engineering, critical offshore supplies and plant commissionings.

#### New blast furnaces at JSW Steel Ltd.

Siemens VAI first entered the recent Indian blast furnace market with a contract from JSW Steel Ltd for the supply of basic engineering and specialized equipment and systems for Blast Furnace No. 3 at the company's Toranagallu site. With a diameter of 13.2 m and a volume of 4,019 m<sup>3</sup>, the blast furnace is the largest in India. The project extended from the stock house up to the gas-cleaning plant (GCP) featuring the first installation of the Simetal GCP triple annular-gap cone scrubber from Siemens VAI. This revolutionary new design, wherein the scrubber-cone elements are located outside the main vessel, allows for a quicker and easier exchange during furnace repair. Furthermore, the use of cones to achieve the pressure drop and clean the gas provides extraordinary gas-cleaning efficiency with respect to dust content. This allows the energy available in blast furnace gas to be better utilized downstream, for example in an energy-recovery turbine. A cyclone separator, first developed by Siemens VAI, makes it possible to maximize the recovery of dust-bearing iron and avoids an excessive concentration of zinc or other heavy elements in the recycled dust. Blast Furnace No. 3 was also equipped with the latest sub-burden probe and hydraulic taphole drills from Siemens VAI.

The blast furnace blow-in took place on February 18, 2009, with commissioning services provided by Siemens VAI. From the start of construction to commissioning, the project was completed within only 31 months – one of the shortest time periods ever for a blast furnace of this size. Over 20,000 people worked at the site during the project's peak. (See *metals&mining* 2|2009.)

Siemens VAI also received the contract for the JSW Blast Furnace No. 4, a near replica of Blast Furnace

No. 3, except that alterations to the stock house and cooling-system design were made. Construction of this new furnace is now moving forward as part of the overall site-expansion plans of JSW Steel in Toranagallu.

#### Blast furnace projects at JSPL and Tata Steel

The next two blast furnace projects of Siemens VAI in India are very similar in scope to those at JSW Steel. They include basic engineering and commissioning services for Blast Furnace No. 1 at JSPL in Patratu, as well as for a blast furnace at Tata Steel Limited in Kalinaganagar, Orissa. The JSPL blast furnace will have a hearth diameter of 13.2 m and a working volume of 4,019 m<sup>3</sup>. The dimensions of the Tata Steel blast furnace are slightly larger: the hearth diameter will be 13.9 m and the working volume 4,384 m<sup>3</sup>. This will enable Tata Steel to increase its annual productivity by around 3.2 million tons of hot metal. The blast furnace will also include the first blast furnace profile meter from Siemens VAI to record the height of the burden.

The smallest of the Siemens VAI blast furnace references in India in terms of awarded project magnitude is arguably the most important. In February 2007, a contract was received from Tata Steel to install a Simetal Gimbal Top in the company's 'C' Blast Furnace. This highly innovative burden-charging system is described in a separate article in this issue. Additionally, a basic-engineering package was supplied for a gas-cleaning plant with a single internal cone scrubber. Start-up of the 'C' Blast Furnace with both the Gimbal Top and gas-cleaning plant took place in September 2009. Commissioning was carried out by Siemens VAI.

#### Local support

For each blast furnace project, a local Siemens VAI office in India provides detailed engineering of some equipment items and coordinates locally supplied systems. The office is also responsible for the detailed engineering and supply of portions of the Level 1 automation in addition to basic engineering for Level 2 automation – with detailed engineering provided from company headquarters in Linz, Austria. For upcoming projects, plans are in place to increase the involvement of the local office in order to offer customers more competitive pricing. This will present Siemens VAI as an even more attractive supplier of blast furnace equipment and technology to prospective customers in the Indian market. ■

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Furnace charging

IRONMAKING >

Blast Furnace Gimbal Top at Tata Steel

# Charging Forward With New Technology

An innovative charging technique proves its economical viability in a first installation on a blast furnace at Tata Steel in India.

**T**he ironmaking industry is constantly challenged to achieve higher productivity and to meet ever-tightening operating margins and stricter environmental controls. One of the key tools in the ironmaking process that can address these challenges is a flexible burden distribution control system.

A blast furnace burden distribution control system defines ore, additive and fuel distribution in the furnace. Controlling burden distribution is a means to define temperature profiles and burden permeability to gas flow. It provides the operator with the tools to control, influence and improve blast furnace operation and helps to overcome the limitations presented by the raw materials.

Having been at the forefront of blast furnace technology for more than 100 years, and with the system concept already proven in Corex and Finex plant installations, Siemens VAI unveiled its Simetal Gimbal Top charging system for blast furnaces in 2006.

In February 2007, Siemens VAI received the order for the world's first Gimbal Top blast furnace charging system from the Indian steel producer Tata Steel. With an annual production of 24.4 million tons in 2008, Tata Steel is India's leading steelmaker and is recognized as one of the world's most cost-effective steel producers. The contract is part of the scheduled rebuilding of the 'C' Blast Furnace at Jamshedpur in India's Jharkand province.

#### Innovative furnace top charging equipment

The furnace top charging equipment delivered by Siemens VAI consists of a single hopper, central feed, pressurized charging system designed for a stored volume of 9 m<sup>3</sup> capacity (see Figure 1). The system incorporates a weighing system with vibration monitoring to verify and control the burden material discharge rates.

Level 1 control of the furnace top charging system functions is achieved by means of Siemens VAI proprietary control and feedback system that is fully integrated into the overall furnace Level 1 control system devised by Tata Steel. The system ensures a high level of accuracy and control for hopper, valves and gimbal movements and hence for burden distribution by the tilting chute.

#### Operational testing

During project execution, the charging system was tested rigorously at the customer's works prior to final installation on the rebuilt furnace. Tests were performed during a three-month time period, focusing on validating all performance aspects of the top charging system against the required parameters for the new 'C'

Blast Furnace operation. Charging tests also focused on two key questions: can the system maintain continuous furnace operation even under less than optimum conditions, and can the system place any given burden in any desired location of the blast furnace's cross-section at the required stock levels? In cooperation with Tata Steel's operating and maintenance personnel, more than three hundred individual material tests were completed with iron ore, coke and sinter.

**The system provides the tools to control, influence and improve operation.**

The test facility incorporated all critical elements of the top charging system: receiving chutes, upper lock valves, material receiving hopper with material flow gate, lower lock valve, expansion bellows and the distributor. >>

**Fig. 1: The Simetal Gimbal Top blast furnace charging system**



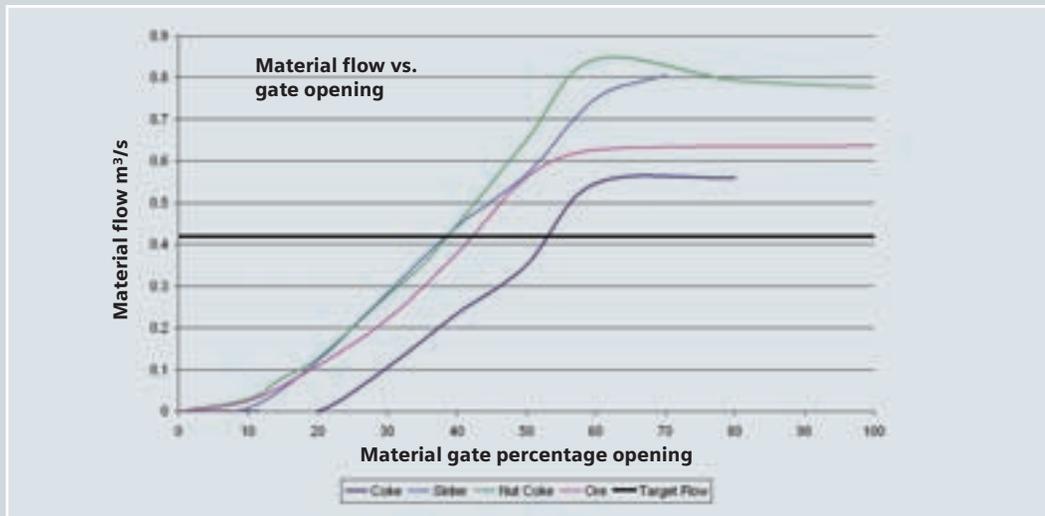


Fig. 2: Material gate – flow vs. percentage opening

>> The distribution tests executed and demonstrated conventional furnace charging patterns including ring, center, spot, segment or sector charging and the Siemens VAI patented spiral charging technique. Further tests analyzed the effects of instantaneous changes in rotational speed and/or direction of the tilting chute on distribution. Also, a sinusoidal wave charging pattern was developed during the gimbal technology’s design phase to demonstrate to customers the inherent flexibility of the distributor and its ability to implement non-ring-based charging.

The following validation tests were completed and documented for iron ore, sinter and coke during the three-month testing program: volume flow rates for

the material flow gate (see Figure 2); distributor falling curves (see Figure 3) including trajectories for the furnace throat at high and low stock line levels; and burden cross-section profiles for a range of discharge rates. Further tests confirmed the feasibility of conventional charging patterns including ring percent and spiral charging as well as of center and segment charging.

**First results**

Following Gimbal Top distributor installation and successful blow-in on September 22, 2009, the blast furnace reached its nominal 2,000 tons output of hot metal per day within 16 days of start-up. Following a

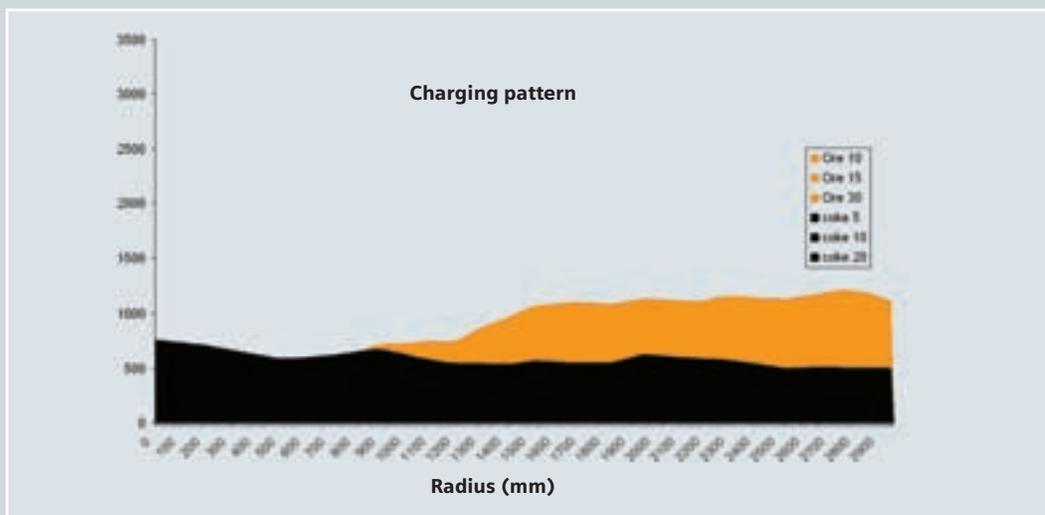
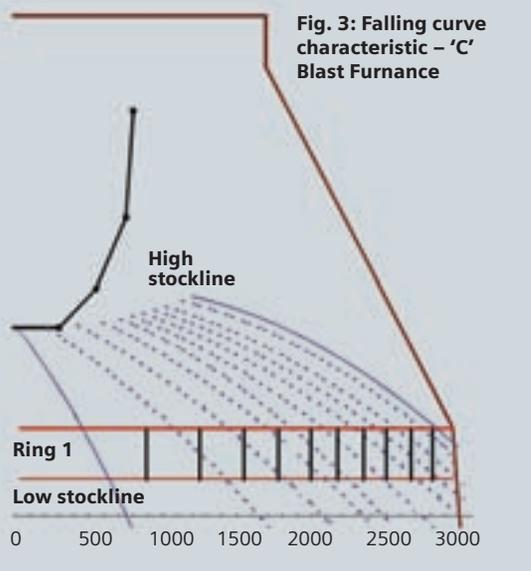


Fig. 4: Typical Charging Matrix



posed by the raw materials, the fuel rates currently being achieved on the 'C' furnace are superior to those in the remainder of Tata Steel's A-F furnace chain and comparable to the larger 'G' furnace with its working volume of 2,300 m<sup>3</sup>.

**Production is 10% above design with additional fuel savings of 30 kg/thm.**

#### General considerations for Gimbal Top charging systems

Seen from a higher viewpoint, Simetal Gimbal Top can help to optimize blast furnace operation in terms of fuel rate. To date, savings of approximately 30 kg/thm (5%) below the design basis have already been achieved. In addition to the total fuel savings, the improved burden permeability has allowed a higher proportion of nut coke to be used. The additional 20 kg/thm nut coke replaces lump coke and provides additional cost savings. The resulting improvement in gas utilization and permeability opens the possibility for increased fuel injection and subsequently for higher blast temperature and oxygen enrichment. This can yield productivity increases in the region of 10%.

Since Siemens VAI is uniquely able to deliver a complete technology package including all mechatronics, customers can achieve high performance blast furnace operation, potentially realizing additional coke savings in the region of 5 kg/thm. >>

sustained period of stable operation, the furnace is now producing in excess of its expected duty.

A typical charging matrix of CcCC/OO/CC/OO has been adopted, producing a charge volume of 13.1 m<sup>3</sup> for coke and a bed depth of 479 mm (wet) (see Figure 4).

Today after four months of production, hot metal production is routinely maintained at around 2,200 tons per day – some 10% above design levels – while top pressure remains at a reduced level of 0.39 bar. When considering the fuel rates for the furnace, continual improvements have been seen since start-up with a total rate of 540 kg/thm achieved with further fuel savings expected as the new furnace becomes fully established. Despite the potential limitations im-

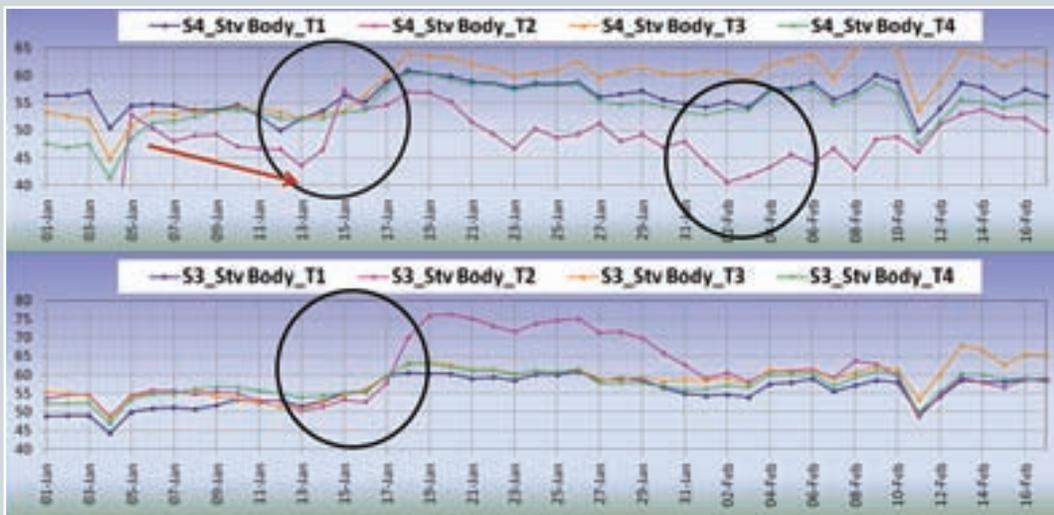


Fig. 5: Positive effects of sector charging

>> Owing to Gimbal Top's inherent flexibility, the distributor's control system can be programmed to provide any desired charging pattern, from common conventional patterns including ring, spot, center and segment or sector charging to the patented Siemens VAI spiral charging technique. During initial operation, Tata Steel used the flexibility of the system to "correct" two problems, thus using the system's inherent ability for true center and sector charging. When preferential gas flow up the walls of the furnace was identified, the problem was corrected by charging a coke center charge and within seven days a more acceptable center working was achieved. Also a decrease in the stove temperatures in the southeast quadrant of the furnace was noted. This problem was simply overcome by charging coke to this region of the furnace in a sector pattern. Again, within days the stove temperatures returned to a more acceptable level (see Figure 5).

The system is compatible with a wide range of Siemens VAI automation solutions (see Figure 6), from process automation to sophisticated VAIron optimization packages and expert systems that are based on process models, artificial intelligence, graphical user interfaces and operational know-how. Thus, the Gimbal Top system lends itself to seamless integration in factory automation networks.

The top charging system is designed for trouble-free operation: All maintenance can be performed during routine furnace downtimes. This ensures low life-cycle costs and avoids any losses of hot metal production.

Simetal Gimbal Top is suitable for either new furnace installations or existing furnaces where retrofitting to existing infrastructure with bell or non-bell charging systems is required. Solutions are specifically designed to minimize impact on exist-

## Interview

Investments to increase overall steelmaking capacity in India will begin upstream with the installation of new ironmaking facilities. Martin Smith, Manager of Blast Furnace Process Engineering at Siemens VAI UK, was involved in all of the recent Siemens VAI blast furnace projects in India, including the recent commissioning of the Gimbal Top at Tata Steel. In the following, he discusses various aspects of the blast furnace business of Siemens VAI in India. Excerpts:

*Where do you see advantages for Indian steel producers to work together with Siemens VAI to meet their upcoming blast furnace needs?*

**Martin Smith:** Compared to a local supplier, we bring along the experience acquired from decades of implementing blast furnace projects around the world, including India. We also have a very strong local presence, such as in Kolkata, focusing on metals technologies and the related automation systems. These factors are an unbeatable combination. We offer our customers cost-

effective solutions based on our state-of-the-art technology. I would like to emphasize that the Level 2 control system that our company has developed for the blast furnace is the most advanced of its type in the world. It comprises the most sophisticated models and control algorithms to optimize plant performance and minimize costs. This has been proven in more than 70 blast furnace installations around the world, including several in India.

*To what extent can the equipment and systems be supplied by Indian producers for a blast furnace project?*

**Martin Smith:** Siemens VAI has extensive experience in providing a totally cost-optimized package to our customers. In the most recent projects carried out in India, local engineering and supply has been maximized. Siemens VAI works with local engineering offices and partners as appropriate. Only key equipment and system packages were provided from outside of India.

*How can the demands of quality workmanship and tolerances be assured for the local supply portion?*

**Martin Smith:** In projects that involve a local supply portion, regular meetings are conducted with local engineering partners along with engineering supervision, when necessary. All equipment sup-

ing equipment and infrastructure. The full product range provides top charging solutions for low-, mid- and high-volume blast furnaces.

### A powerful plant update

Market demands force blast furnace operators like Tata Steel to maximize production, often surpassing rated furnace capacity and operating above design production levels. Under these conditions, charging equipment with inherent flexibility for raw-material handling has gained special importance as it helps to optimize productivity, minimize fuel consumption and enhance plant flexibility. Trial runs and first production data from the Siemens VAI Gimbal Top installation indicate that this charging technology is more than an interesting concept – it has proven to be a viable solution for today’s demanding steel production market. ■

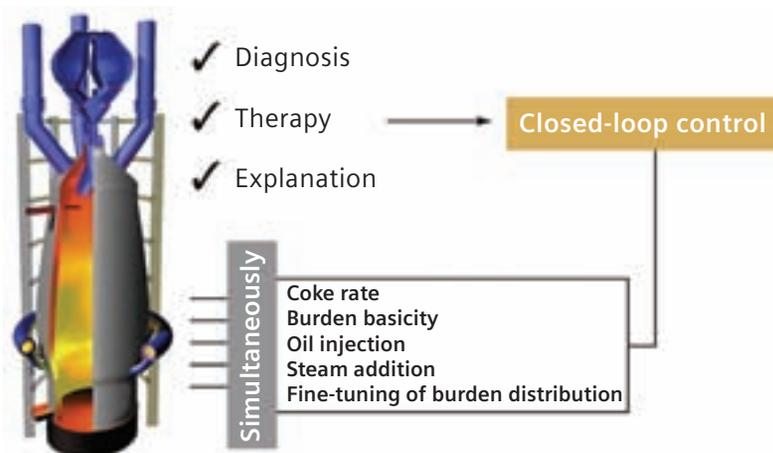


Fig. 6: Blast furnace automation and optimization

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plied by Siemens VAI undergoes thorough workshop testing, carefully monitored by company specialists. The whole package is then completed with the provision of advisory services for site assembly, installation and commissioning.

## We offer our customers cost-effective solutions based on our state-of-the-art technology.

*From project start to commissioning, what is your realistic estimate on how quickly a new blast furnace project can be implemented on a greenfield site in India?*

**Martin Smith:** We expect the projects that we are currently involved in to be completed within roughly 30 months from contract effectiveness to start-up. In some cases, these projects are being carried out jointly with our customers and local partners, and the actual time can obviously depend on factors outside our control.

*Do you see problems in connection with the financing of blast furnace projects in India?*

**Martin Smith:** In cases where 100% financing by the customer is a problem, we are also prepared to discuss tailored-made financial packages. These can include ECA (export credit agency) financing. Alternatively, financing can be arranged for smaller equipment packages on a pay-as-you-produce basis. Other innovative financing options can be discussed. ■



**Martin Smith, Siemens VAI UK, is optimistic about increased blast furnace business opportunities in India**

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Electric arc furnace  
at Lech-Stahlwerke

STEELMAKING &gt;

Innovative electrode controller with foaming slag manager

# Reducing Energy And Carbon Dioxide

One of the challenges in operating an electric arc furnace is a complete and stable covering of steel bath and arc. Intelligent electrode-control systems and the detectability and controllability of foaming slag in electric arc furnaces are topics that concern many arc furnace operators around the world. Thanks to Simelt FSM (Foaming Slag Manager), it is possible to control and achieve a uniform slag distribution, which leads to increased productivity, reduced carbon consumption, and lower energy consumption and CO<sub>2</sub> emissions.

For years now, the foaming-slag method is the established mode of liquid steel heating in electric arc furnaces. Along with its primary function of removing undesirable elements from the melted good, the foaming slag with its low thermal conductivity also shields the electric arc and thus protects the furnace's fireproof lining from the arc's radiant energy.

The optimum height of the foaming slag can be influenced by injection of carbon fines and oxygen, using lances or injectors. Today, these foaming agents are added automatically according to an operating diagram defined in advance. Whatever the case, this requires special attention from the furnace operator, since a free-burning electric arc can cause damages within a short period of time. The consequence is increased electrode consumption and undesired heating of the furnace walls, which leads to lower energy efficiency, longer process times and ultimately reduced productivity.

Normally the height of the foaming slag can be precisely and reliably inferred from the electric arc furnace's state variables during running operation. The problem with the measuring methods used up to now is that they are not precise enough for the automatic foaming-slag method, or cannot be used in the rough environment of a melt shop with the required degree of reliability.

#### Slag-level distribution controlled by FSM

Siemens VAI developed with Simelt FSM a measuring tool that determines changes over time and location in regard to the height of foaming slag in electric arc furnaces. It ensures uniform accumulation of foaming slag with a minimum of carbon and can be easily integrated in the electric arc furnace automation.

The slag level is not detected with a microphone or by analysis of the electrode current and its harmonic contents; instead, Siemens VAI is using sensors for structure-borne sound. Such sensors, mounted outside at the furnace panels, "listen" into the furnace like operators do (see Figures 3 and 4). With a newly developed algorithm for analysis of the sound transmission and based on results generated by the new software module, an additional dynamic and optimized carbon control was implemented to create a fully automated slag-level control.

#### Structure-borne-sound evaluation principle with FSM

The electric arc serves as the acoustic source for determining the height of the foaming slag. As the generation of the sound cannot be measured at the source itself, the current signal is used as a refer-

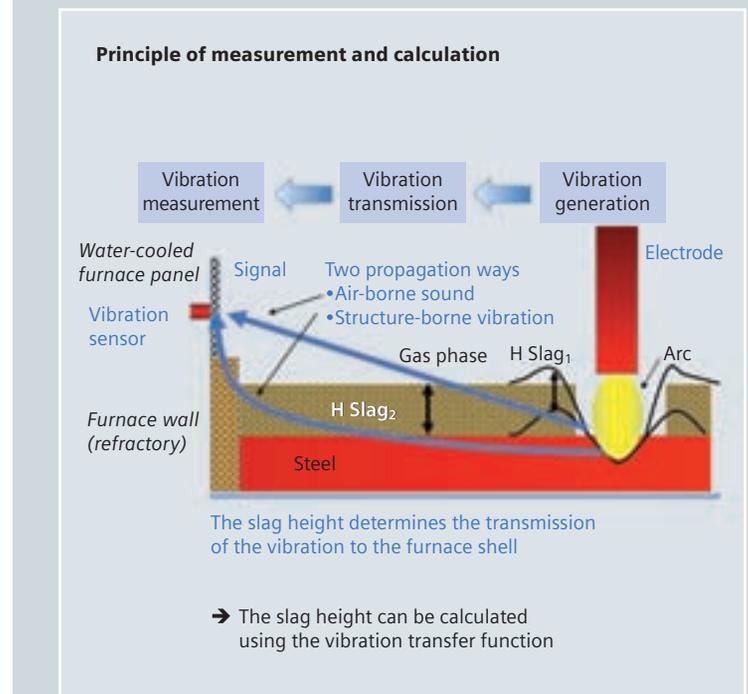


Fig. 1: Measurement principle for structure-borne sound evaluation

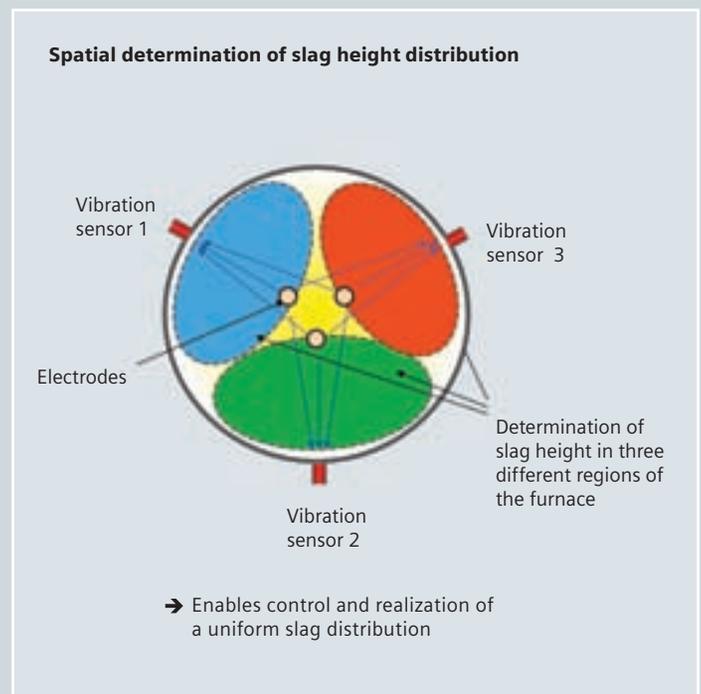


Fig. 2: Determination of the spatial distribution of the foaming slag height by using three sensors and observing the slag height in three different regions

ence signal for the subsequent evaluations. The signal at the furnace wall is nothing else than the damped source signal generated by the arc. The attention depends on the foaming slag height, as the vibration transmission path, partly through the gas phase and partly through steel phase, is strongly affected by the slag height, as shown in Figure 1. >>

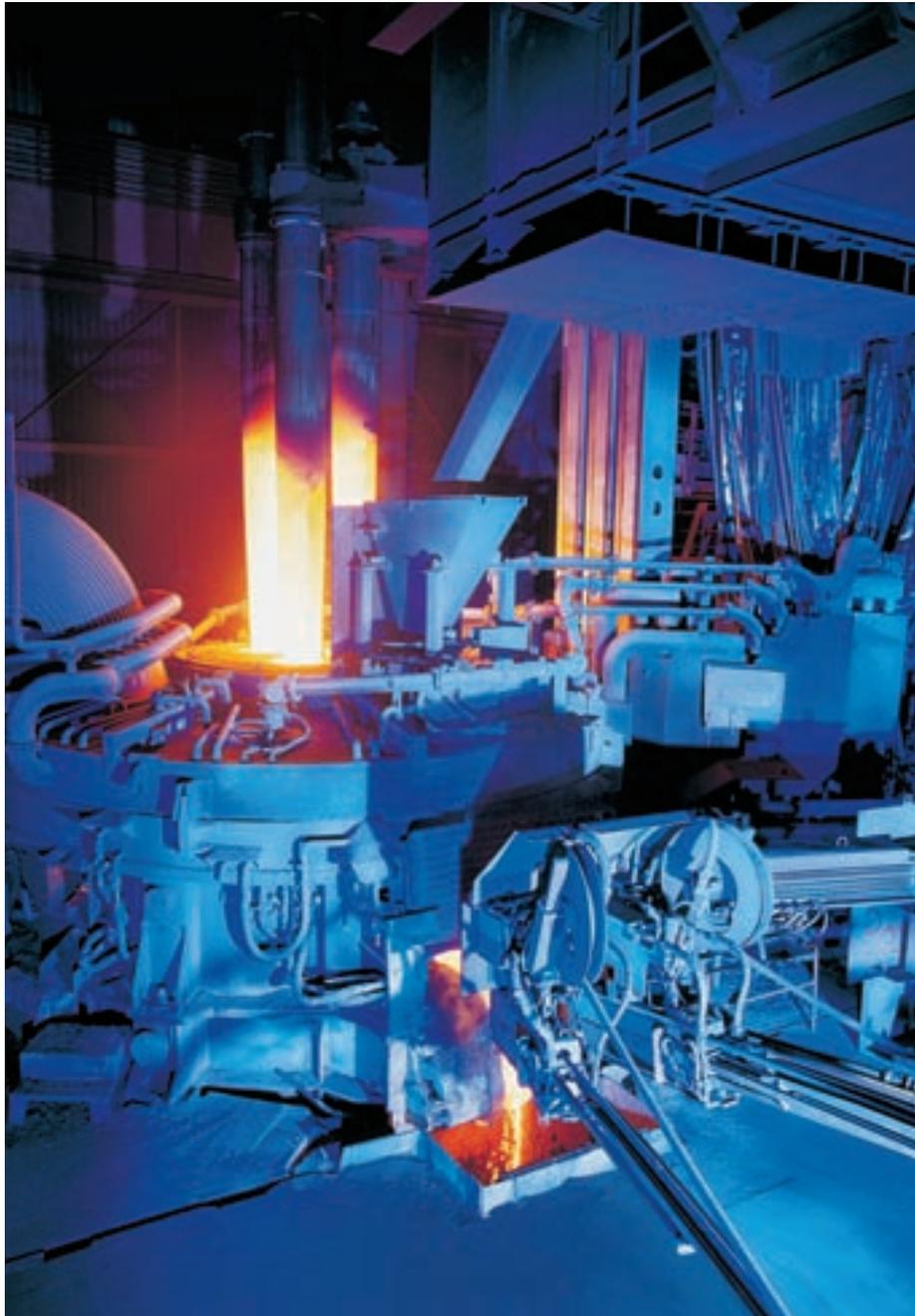


Fig. 3: Heat-protected sensor



Fig. 4: Naked sensor mounted on the furnace wall

>> The great advantage of this method is the ability to determine the slag height not only close to the electrodes, but particularly in the complete area between the electrodes and the furnace shell. This one-dimensional view is actually extended by the foaming slag manager FSM to a two-dimensional measurement of the slag height distribution. This is outlined in Figure 2, which shows that due to the mounting of three sensors opposite the corresponding electrodes, the slag height can be determined independently in three regions of the furnace. These independent three regions can be

shown in the visualization of the FSM outlined in Figures 5 and 6.

But the main advantage of the correct spatial measurement of the slag height is to regulate the carbon injection by an individual control of the carbon valves in order to achieve a uniform slag distribution within the furnace. For the regulation of the automatic carbon injection, a control system based on a fuzzy algorithm was developed. This allows easy implementation of appropriate membership functions for the slag height deviation from a reference value, carbon valve inputs and the definition of action rules. These

membership functions of the Simelt FSM leads to a quick adaption of the target value for the oxygen content in the heat, thus reducing or avoiding overtime due to adjustments of the oxygen concentration.

### Performance tests at Lech-Stahlwerke

First tests in 2008 and highly successful subsequent trials were performed in an electric arc furnace at the Lech-Stahlwerke in Meitingen, Germany. Based on the evaluated data, the new Simelt FSM reduces production costs up to €1 per ton molten steel, in some cases even more depending on the type of the electric arc furnace and the foaming slag handling. Due to reduced energy and carbon consumption, the system is also helping to reduce environmental impact, for example by lowering CO<sub>2</sub> emissions.

After these realized projects with the Simelt FSM control algorithm in operation, improved results could be observed as follows:

- Reduction of power-on time
- Minimization and optimization of the injected carbon
- Stable furnace operation due to arc stabilization
- Reduction of energy and specific energy
- Reduction of power-off time

Improved performance in power-on time, higher productivity and lower furnace wear are the results.

The Simelt FSM achieved a clear improvement in environmental compatibility of the furnaces in respect to, for example, raw-material savings and CO<sub>2</sub> emissions. This identifies the solution, in addition to its potential for savings, as a green product.

The Simelt FSM is either available as module of the Simelt electrode control system or as stand-alone product, which also fits with other controllers or furnace automation systems from third parties.

Recent investigations with structure-borne-sound sensors showing valuable information about the scrap melt period. Due to the observation of the arc furnace's waveform in combination with the structure-borne sound, the shielding of the furnace walls with scrap against the arc radiation can be calculated. Furthermore, this new development makes it possible to detect free-burning arcs on cold, heavy pieces of scrap. The obtained information can be used to control and optimize the power set point of the electric arc furnace. Improved performance in

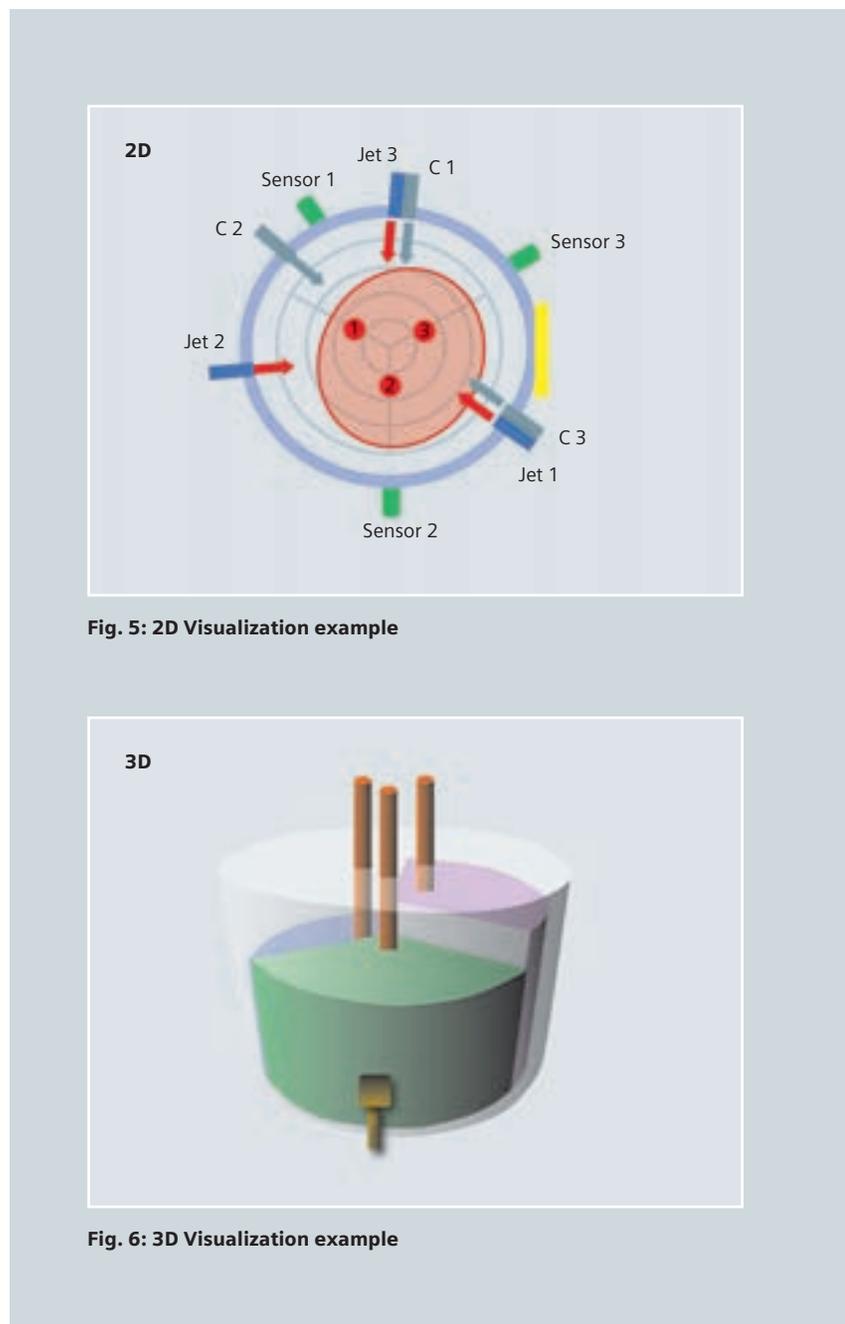


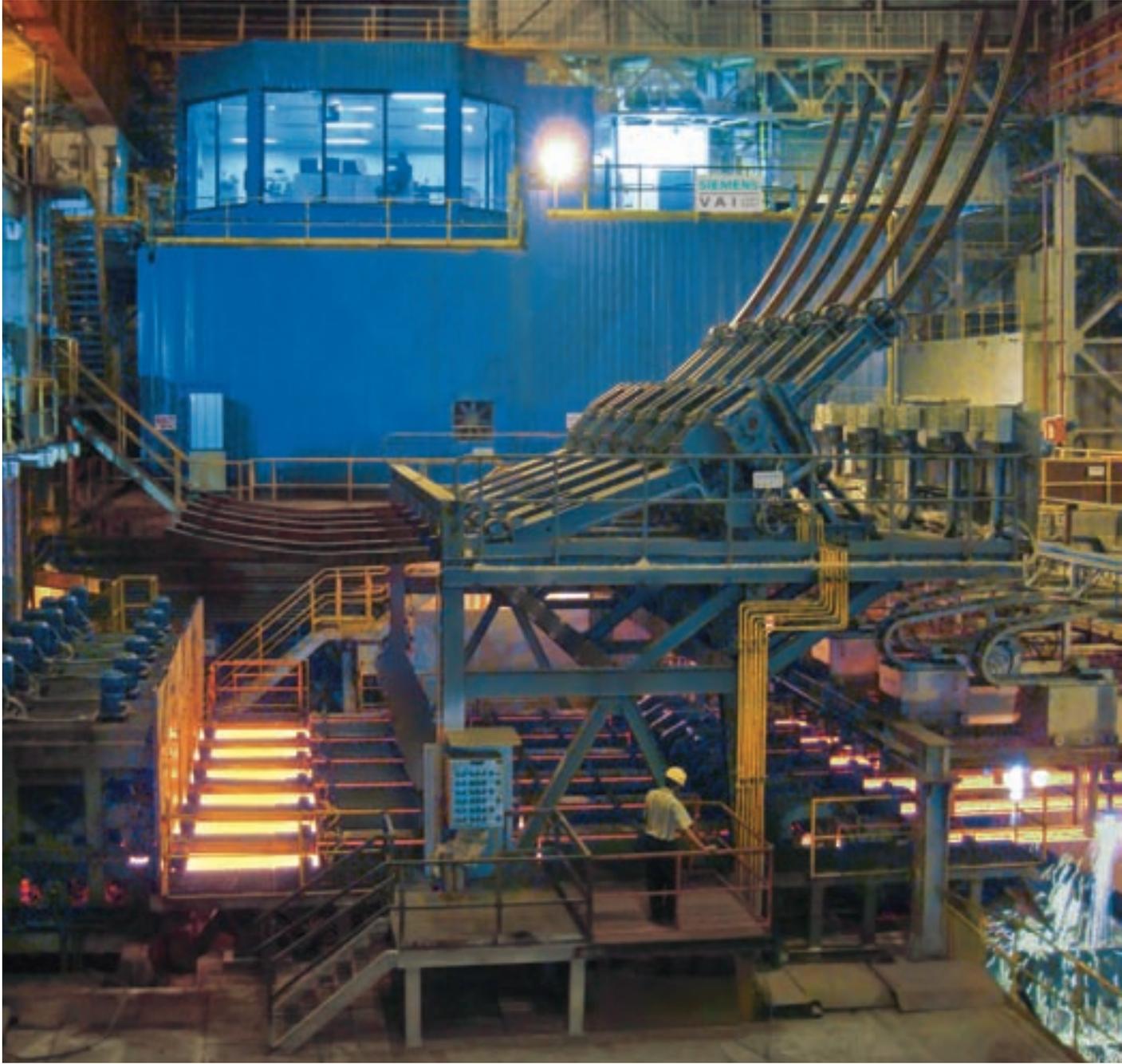
Fig. 5: 2D Visualization example

Fig. 6: 3D Visualization example

power-on time, higher productivity and lower furnace wear are the results.

With the inclusion of dynamic and condition-based scrap melting, a new and fully automated furnace system is on the horizon. This promises additional productivity, savings of resources and a further reduction of emissions in electrical steelmaking. ■

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Billet caster at  
Tata Steel

Review of continuous casting activities of  
Siemens VAI in India

# Technology for



# Winners

Ever since the supply of a billet caster to the Indian market in 1965, Siemens VAI has been a key provider of continuous casting machines in this region. Up until January 2010, projects for the installation of a total of 9 slab casters comprising 12 strands, and 22 long-product casters with 81 strands have been received from 19 steel producers throughout the country. During the past five years alone, Indian steel producers awarded Siemens VAI projects for the supply of ten continuous casting machines of all types with a total of 48 strands. This article presents several examples of recent Siemens VAI caster projects in India and explains why our company will continue to be an important supplier of continuous casting machines to Indian steel producers in the future.

**C**ontinuous casting technology from Siemens VAI is ideally suited to meet the needs of the rapidly expanding Indian steel industry. The casting machines are highly reliable and relatively simple to operate with the use of advanced automation systems that are well proven in hundreds of installations worldwide. User-friendly monitoring and control screens provide operators with a complete overview of all operational and quality-related parameters. Siemens VAI casters are characterized by their fast start-up and ramp-up times to full production. This is made possible thanks to maximum preassembly and pretesting in the workshops in addition to built-in Connect & Cast solutions. The combination of proven plant design, reliable equipment and performance-oriented technological packages are standard features of the machines, which help producers maximize productivity and production output, and assure conformance with defined quality requirements.

An extraordinary range of casting flexibility is possible with Siemens VAI casting machines on the >>

>> basis of innovative design solutions. These allow, for example, the fast adjustment of slab widths and thicknesses, and, in the long-product sector, the quick exchange of casting sections. This aspect of flexibility is particularly important in a growing market such as India where casters must be capable of responding quickly to continually changing market demands for product formats, steel grades and required steel quantities and qualities.

## Siemens VAI casters are characterized by their fast start-up and ramp-up times to full production.

The modular construction design of Siemens VAI casters and the use of highest-quality equipment and components minimize maintenance and servicing requirements. Spare, wear and exchange parts are delivered quickly and reliably whenever required. Producers can rely on fast response and support whenever required thanks to the strong presence of Siemens VAI in the Indian market and local manufacturing capability. Comprehensive training programs for operator and maintenance personnel are also offered to ensure proper and reliable caster operations and the longest possible service life. Should assistance be required in connection with product quality, mechanical equipment, automation or metallurgical aspects, a team of highly skilled casting experts is readily available and can be dispatched from Indian or other competence centers of Siemens VAI on short notice to provide support.

In the following, several project examples are briefly outlined that demonstrate the confidence and trust that renowned Indian producers place in continuous casting technology from Siemens VAI.

### SAILing ahead – seven new long-product casters

Major orders were recently received from Steel Authority of India Limited (SAIL) for the supply of long-product casters comprising 37 strands to the company's Bhilai Steel Plant (BSP), located in Chhattisgarh, and IISCO Steel Plant (ISP), located in West Bengal.

At BSP, engineering and equipment will be provided for two 6-strand billet casters, a 6-strand billet/bloom combi-caster and a 3-strand beam-blank caster. The new casters are part of a modernization and expansion program to eventually produce 7.0 million tons of steel per year at the site. The two billet casters will cast billets in square formats of 105x105 mm and

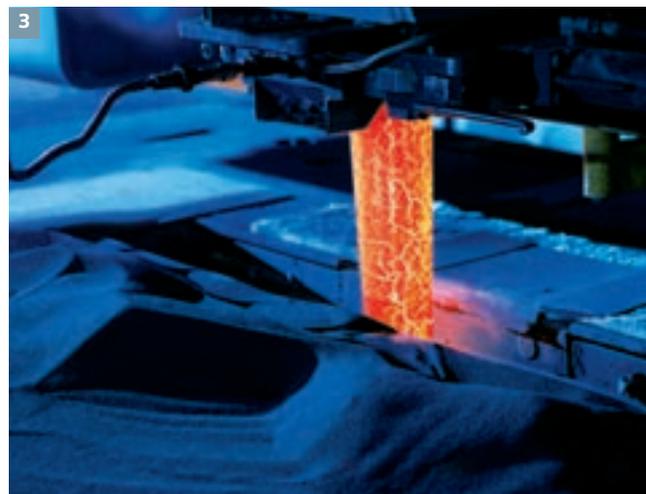


150x150 mm for the production of rebars and high-quality steels, including forging-quality, high-carbon, cold-heading, spring-steel, electrode-quality and alloyed construction-steel grades. The billet/bloom combi-caster with a billet section size of 150x150 mm and a bloom section size of 335x300 mm will cast mostly rail grades, but also carbon- and alloyed-steel grades. The beam-blank caster will produce sections with sizes of 405x285x90 mm, 620x440x100 mm and 1024x390x90 mm. The beam blanks will be directly charged in the hot condition to the rolling mill to minimize energy costs for rolling.

The equipment to be supplied includes ladle turrets, tundish cars, nozzle-changing devices for open-stream casting and stopper rods for submerged casting. Furthermore, DynaFlex hydraulic oscillators, DiaMold high-speed tube molds, electromagnetic mold-stirring systems, cassette-type withdrawal and straightening units, torch-cutting machines, an auto-



- 1 DynaJet spray nozzle for secondary cooling systems
- 2 Preassembly of billet caster molds at SAIL
- 3 Siemens VAI Smart Mold for slab casters



matic deburrer, a marking machine and cooling beds will be provided. The scope of supply also includes Level 1 and Level 2 automation, electrical equipment, the complete coolant and hydraulics systems in addition to advisory services for erection, commissioning and training for all four casters. The BSP caster projects are scheduled for completion in late 2011.

At ISP, Siemens VAI will supply two 6-strand billet casters and one 4-strand bloom/beam-blank combi-caster. The billet casters will be designed for open-stream and submerged casting for the production of rebars and high-quality steels respectively. Similar to BSP, the steel grades to be cast will be comprised of forging quality, high-carbon, cold-heading, spring-steel, electrode-quality and alloyed construction-steel grades. The equipment supply includes butterfly ladle turrets, cantilever-type tundish cars, nozzle-changing devices for open-stream casting, stopper rods for submerged casting, maintenance-free DynaFlex hydraulic oscillators, DiaMold high-speed tube molds, electromagnetic mold-stirring systems and Level 1 and Level 2 automation systems.

The bloom/beam-blank combi-caster is being designed to cast carbon steel and alloyed-steel grades. DynaFlex oscillators, electromagnetic mold stirring and air-mist cooling will be installed in addition to the electrical systems. Advisory services for erection, commissioning and training for all three casters will also be provided. The ISP caster projects are scheduled for completion in late 2011.

### Tata Steel – casting its future with proven technology

A long-term partnership can also be seen at Tata Steel where Siemens VAI received contracts in 2003 for the upgrade of three single-strand slab casters (Nos. 1, 2 and 3) at the company's steelworks in >>

>> Jamshedpur. The target of these upgrades was to improve both the quality of the cast slabs as well as overall productivity. This was achieved through the implementation of various modification measures and by the installation of technological packages in each of the three casters. The project included a new tundish-level control system, the LevCon mold-level control system, electromechanical stoppers (SAM) and actuators (VEMA) as well as a new secondary cooling spray system.

## This milestone project at Tata Steel will allow the company to better serve the high-quality long-product steel market.

The existing curved mold of Slab Caster No. 1 was replaced with a straight mold in a full-bow revamp to reduce the quantity of entrapped inclusions in the liquid steel. This led to a significant improvement in the slab quality of even the most demanding grades without compromising casting speed. A DynaFlex hydraulic mold oscillator was also installed. The rolled steel products now find use in high-end applications, such as for exposed automotive parts. The project was completed in 2004.

The specific target of the upgrades on Slab Casters Nos. 1 and 2 was to increase the casting speed of critical ultra-low carbon-steel grades up to a maximum of 1.75 m/min. The implemented measures improved overall production output and the project was successfully completed in 2005. Siemens VAI was selected for these projects due to its technical expertise and experience in the execution of similar revamping work carried out on other slab casters throughout the world.

In the long-product sector, Siemens VAI carried out a major upgrade in December 2005 on a 6-strand billet caster (No. 2) at Tata Steel's site in Jamshedpur. Within only 11 months following start-up, the caster produced over one million tons of billets, well above the nominal machine capacity.

On the basis of the excellent operational results, Tata Steel awarded Siemens VAI a second contract in 2006 for the installation of a new 6-strand billet caster (No. 3), also at the Jamshedpur steelworks. The caster was started up in October 2008, 23 months after the receipt of the contract. It is capable of casting a total of 1.4 million tons of billets per year in formats of 130x130 mm and 150x150 mm,

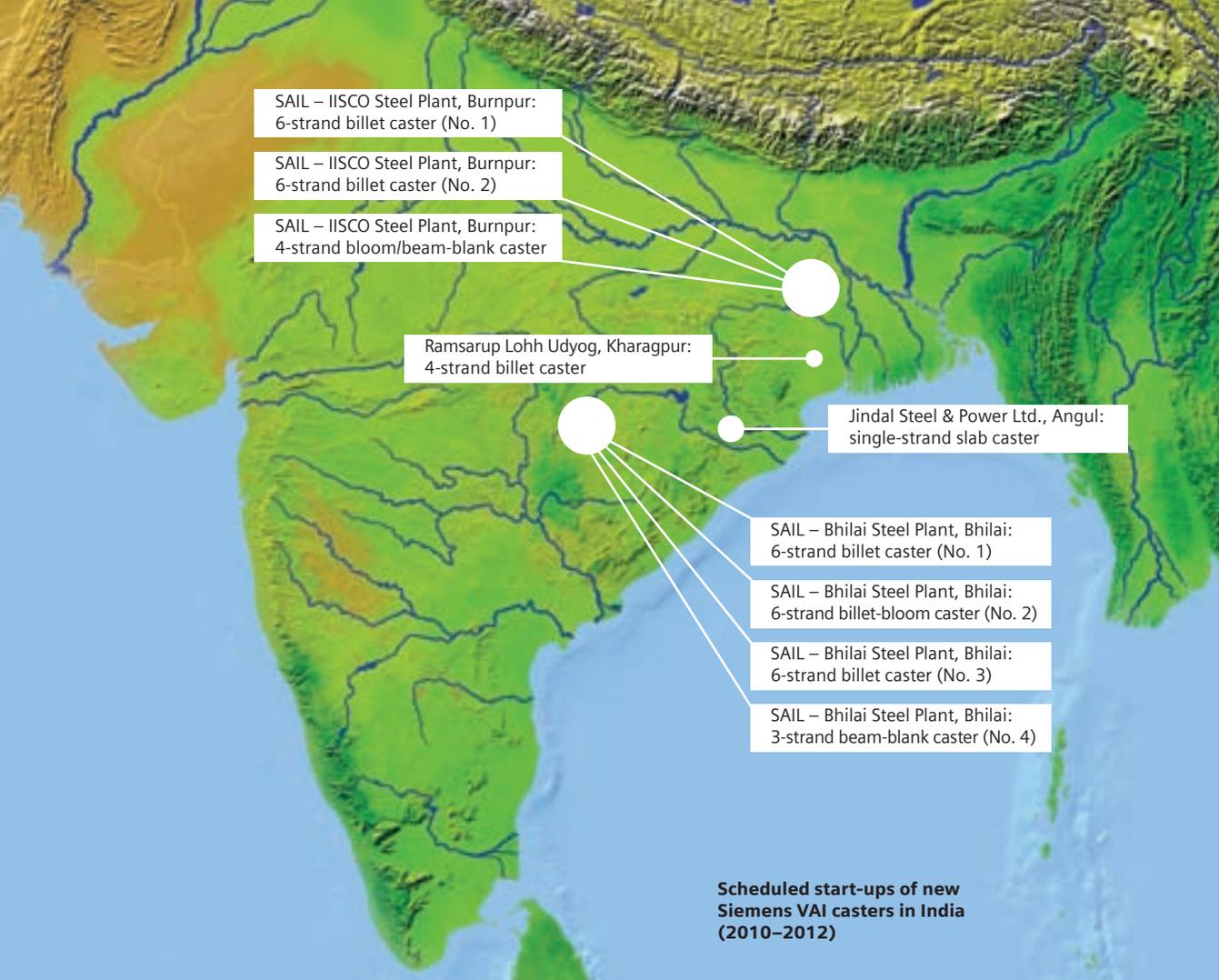
with provisions made to cast 160x160 mm billets in the future. The cast grades comprise low- and high-carbon steels, low-alloyed steels, tire-cord steel grades, spring steel, special bar quality (SBQ) steels and cold-heading steels.

Each of the six caster strands is equipped with all of the required systems and technological packages to meet the highest performance and quality demands. This includes DynaFlex oscillators for the online control of the mold-oscillation parameters, DiaMold high-speed-casting technology, submerged entry nozzles (SEN), mold and final electromagnetic stirrers, a Level 2 quality-control system in addition to automatic deburrers. This milestone project at Tata Steel will allow the company to better serve the high-quality long-product steel market.

### Jindal Steel & Power Ltd. – “steeling” the show with one of India’s most advanced slab casters

Siemens VAI was commissioned by Jindal Steel & Power Ltd (JSPL) to supply a new single-strand slab caster to the company's steelworks in Angul, in the state of Orissa. The slab caster will be part of a greenfield integrated production facility currently under construction at the Angul site where an annual steel output of six million tons is foreseen. The nominal capacity of the caster will be approximately 1.5 million tons per year with steel grades ranging from ultra-low to high-carbon steels as well as micro- and low-alloyed grades. Initially, production will concentrate on slabs for pipeline and plate applications, which will be rolled in a new Siemens VAI 5 m plate mill also being installed at Angul.

The slab caster will be one of the most advanced casters of its type ever to be built in India. In addition to engineering, all key process equipment, from the main casting-floor equipment up to the discharge facilities will be supplied in addition to electrics, Level 1 and Level 2 automation and hydraulic, lubrication and cooling systems. A wide range of technological packages, systems and other special equipment will be installed to ensure highest machine performance, operational flexibility and product quality. This includes the LevCon mold-level control, MoldExpert for enhanced break-out protection, DynaWidth technology to enable slab-width adjustments to be carried out during casting, and DynaFlex oscillation for the online adjustment of the mold-oscillation parameters for improved strand-surface quality. Optimal strand support and minimized strand bulging will be made possible using I-STAR Rollers (intermediately supported trans-axle rollers) installed throughout the strand-guiding system. An integrated quality-management system will further contribute to the con-



sistent production of highest-quality slabs. Extraordinary internal strand quality will be achieved with the installation of Smart Segments and the application of DynaGap Soft Reduction in the horizontal zone of the caster to minimize centerline segregation.

This impressive caster project will be jointly implemented by Siemens VAI groups based in Sheffield, U.K., Linz, Austria, and Kolkata, India. Start-up is scheduled for September 2011.

Siemens VAI has already installed a combi-caster for the JSPL steel works in Raigarh, which was the first caster in the world capable of casting beam-blanks, blooms and rounds.

#### Ramsarup – wired for performance

Finally, Siemens VAI is currently installing a new 4-strand billet caster at Ramsarup Lohh Udyog Ltd. (Ramsarup) in Kharagpur, West Bengal. The machine is scheduled for completion in late 2010. The billet caster will be capable of producing nearly 700,000 tons of billets per year in square formats of 130 mm, 150 mm and 200 mm with provisions for the future casting of round formats with a diameter of 200 mm. The caster is being equipped with DiaMold high-speed casting molds, the DynaFlex hydraulic-oscillation system, LevCon mold-level control, electro-

magnetic mold stirrers in addition to an advanced secondary cooling system equipped with dynamic flow control.

Ramsarup is one of the leading manufacturers of steel wire and TMT (thermomechanically treated) rebars in India.

#### Technology for success

The outlined project examples of past and present caster projects in India provide an overview of the capability and competence offered by Siemens VAI in the field of continuous casting technology. The scope of solutions and services ranges from consulting and service contracts, caster upgrades and revamps and extends to complete new installations of the most advanced casters on the market today. Siemens VAI with its staff of local experts looks forward to continuing its support of the Indian steel industry with the supply of the latest solutions for excellence in continuous casting. ■

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Review of the Long-Rolling business of Siemens VAI in India

# The Long Story In India

ROLLING >

**T**oday, the Siemens VAI Long Rolling business combines the rolling-mill technology of Morgan Construction Company, headquartered in Massachusetts, U.S.A., and Siemens VAI Italy. During the past three decades, manufacturers of long products in India have profited from the reliable equipment and processing experience of these companies. Advanced and cost-effective solutions have enabled producers to expand their product ranges, increase rolling rates and improve quality. During these three decades, the equipment installed by Siemens VAI accounts for approximately 4.6 million tons of long-product rolling capacity in the form of rods, bars, sections and rails. Another 4.8 million tons will be added to this figure in the next few years, once the installation and commissioning of several new mills have been completed. These new facilities are being located in either existing steel plants or at greenfield sites. The equipment being supplied ranges from billet-charging and -discharging sections to the installation of complete rolling lines, including the coil and straight-bar cooling and handling areas of the mills.

Several recent examples of Siemens VAI long-rolling projects in India are outlined in the following.

## A world-class slit-rolling bar mill – Tata Steel

A new single-strand bar mill was started up at Tata Steel Ltd. in Jamshedpur in 2006. It is designed to produce rebar products ranging in diameters from 8 mm to 16 mm. It includes 16 no-housing stands for the roughing and intermediate trains, a two-way slitting unit, two six-stand No-Twist Mills, water boxes, dividing shears, a high-speed rotary entry system (patented) to the cooling bed, the cooling bed itself equipped with a cold shear, and bundling and strapping equipment. This combination enables the latest technique to be employed for rolling rebar, since the rebar is finished rolled as a single-strand without product twisting. The mill is designed to produce 600,000 tons of rebar annually; however, production targets were exceeded several times during commissioning. Provisions have also been made for future expansion. >>



With the ever-increasing need for infrastructure in India, the demand for long products is steadily growing, in particular for reinforcement bars and rods, wire, tubes, pipes and other building materials. These products play a critical role in the industrialization of a country since they are widely used in both the construction industry and in machine manufacturing. The comprehensive portfolio of solutions and services offered by Siemens VAI for long-rolling manufacturing will continue to play a decisive role in helping Indian producers maximize plant performance and product quality.



>> This mill is one of the fastest and most efficient in the world for slit rolling in straight lengths, with yields in excess of 95% in the rolling line. Tata Steel enjoys the reputation as the best-quality supplier of rebar in the construction sector.

**Superior quality at highest outputs – JSW Steel Ltd.**

Siemens VAI recently installed a rod mill and a bar mill, including the complete automation, at the JSW Steel Ltd. plant in Toranagallu, in the Bellary District of Karnataka state. The mills were built adjacent to a new electric steelmaking plant under construction at the existing steelworks as part of a campaign to expand the site’s steel output from 4.0 million t/a to 7.0 million t/a. These are the first mills that Siemens VAI has supplied to JSW Steel as it enters the long-products market.

The rod mill is one of the largest-capacity single-strand rod mills in the region and was the first to include a Reducing/Sizing Mill (RSM) in India. It is designed to produce 600,000 tons of wire rod per year in diameters ranging from 5.2 mm to 22 mm and has a maximum finishing speed of 120 m/s. With RSM technology, JSW Steel is now able to produce a level of quality unparalleled in the region, which is a clear market differentiator for the company.

The high-speed bar mill, which includes the installation of 2-way slitting technology, has a production capacity of approximately one million tons per year. It is configured for a product range that includes plain

bars, rebars, round-corner squares and angles. The Siemens VAI mill is among the fastest in the market today and is one of the largest-capacity single-strand mills ever built in the world.

**Two mills for Jindal Steel & Power Limited**

A project is now underway to build two mills for Jindal Steel and Power, Ltd. (JSPL) on a greenfield site in Angul, in the state of Orissa. The two mills will be identical to those installed at JSW Steel. In addition to mechanical and auxiliary equipment, Siemens VAI will also supply complete automation.

The combined output of the mills will provide the Jindal Group – the parent company of both JSW Steel and JSPL – with unmatched productivity and quality products. The scale of these projects is unprecedented and clearly demonstrates the capabilities that Siemens VAI has developed in the region, both for project management and customer support. The projects are also a display of the confidence that the Jindal Group has placed in Siemens VAI technology.

**Special mills for special product applications – Vizag Steel**

To meet increased demand for steel in the local market, Vizag Steel commissioned Siemens VAI in 2007 to build a complete two-strand wire rod mill at Visakhapatnan, in the state of Andhra Pradesh. This government-owned facility will produce 600,000 t/a of special-quality wire rod with diameters ranging from 5.5 mm to

ROLLING >

1 Powered splitter for bar separation in high-speed finishing lines, Tata Steel



2 Finishing blocks and quenching line of high-speed bar mill, Tata Steel



3 Bar-cooling bed with high-speed rotary-entry system, Tata Steel



4 No-Twist finishing block for high-speed bar rolling, Tata Steel



20 mm. The products will be used in the automobile, wire-drawing and fasteners industries, among others. This mill will complement a 4-strand Morgan rod mill already built for Vizag in the mid-1980s and will play a major role in the company's plan to increase production by 6.3 million t/a.

Another part of the expansion at Vizag Steel is the addition of a single-strand bar mill with an initial capacity of 750,000 t/a and a future planned capacity of 950,000 t/a. This mill will produce round bar with diameters from 20 mm to 45 mm at a maximum rolling rate of 200 t/h at speeds of up to 16 m/s. Carbon- and quality-steel grades will be rolled. The mill will be equipped with 18 stands in HV arrangement followed by a 3-stand sizing group. Two finishing lines are provided: The first one is for straight bars and includes a 132 m long cooling bed, cutting station with a 1,000-ton cutting force and handling area. The second finishing line is for bar-in-coil products and includes three Garrett reeling stations

and a coil-handling area. Both lines are equipped with flexible thermo-processing systems.

The contract was awarded on a full-turnkey basis. It includes electrics, automation and balance-of-plant supply. In addition to the goal of increasing production, the project enables Vizag to improve its cost efficiency and strengthens its position in the specialized market of special bar quality (SBQ).

#### Rolling of stainless rods too – Viraj Profiles

In 2003, Siemens VAI supplied a rod and bar-in-coil mill to Viraj Profiles Limited for rolling and processing alloyed- and stainless steel bars. The coil conveyors are equipped with a cooling-control system, which includes a quenching system when austenitic stainless grades are produced. This avoids the precipitation of chrome carbides. This mill is one of the very few long-rolling mills in India capable of rolling stainless steels.

#### A wealth of experience – non-ferrous rod mills

Siemens VAI has also been highly successful in supplying mill equipment for the rolling of non-ferrous rod – both copper and aluminum. In a long-term partnership with Southwire Company, headquartered in Georgia, U.S.A., Morgan has supplied more than 80 non-ferrous mills throughout the world in the last 45 years. Non-ferrous mill equipment was first supplied to the Indian market starting in the late 1980s at Hindustan Copper Company. This was followed by Tdt Copper Ltd and Indo Gulf in the 1990s. Rolling systems at these installations typically produce rod in an approximate size range of 8–16 mm at rolling rates of 12–20 t/h.

Most recently, in 2009, Siemens VAI supplied two rod mills to Vedanta Aluminum Limited, located in Jharsuguda, in the state of Orissa. The systems were designed to roll electrical conductor aluminum at a rate of 8 t/h.

#### A reliable partner for the Indian steel industry

The long-rolling projects described above serve as examples of the many mills that Siemens VAI has installed or is in the process of building in India. On the basis of its vast experience in all aspects of engineering and supplying long-rolling facilities, Siemens VAI is in an ideal position to support India in its efforts to modernize and expand its production capacity in the coming years. ■

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ROLLING >



High-reduction mill in operation during endless production mode



Machine and system design for endless strip production

# Performance At Its Best

In our last article, the general principles of the ESP technology were presented. In this issue of metals&mining we will give a more detailed review of the equipment, technologies and operations that have made this new technology such a success. The article highlights the benefits of the successful combination of two significant forces – the designer and the operator – which in this case means the combination of Arvedi's specific production and technological experience with Siemens VAI's ability for plant design and construction. The article starts with equipment highlights, followed by the all-important control philosophies given by the automation systems and concludes with some of the fundamental practices performed by the operators of the plant.

**T**he equipment in an Arvedi ESP plant has the task of solidifying, reducing, reheating, transporting, cutting, descaling, measuring, cooling and coiling the product as it journeys from liquid steel to finished coil. The equipment must accommodate conventional casting and rolling practices as well as new features related to high casting rates, long operating times, prolonged temperature exposure and the direct connection between casting, roughing and finishing operations.

## Equipment highlights

### Casting machine

The combination of strand thickness and casting speeds determines the caster configuration. Only a low-head bow-type caster with a vertical mold and appropriate strand support system for a long metallurgical length fulfill the requirements for ESP operation. This design allows the future extension of the caster for even higher speeds. The ultra-high casting speed, liquid core reduction, the low thickness and endless >>

>> operation influence the process parameters and design features of the caster and demand highly reliable and flexible machine components.

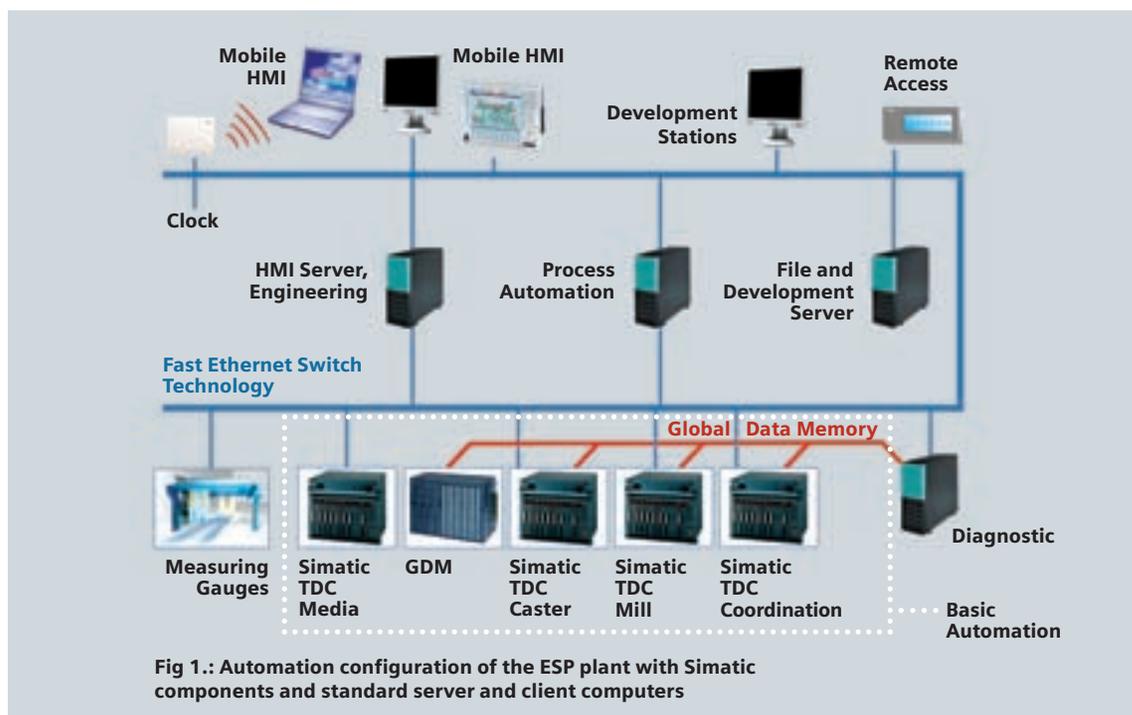
The conditions affecting the casting process and design:

- High steel flow rate
- Ultra-high casting speed
- Flexible strand thickness – mold exit 90–110 mm and strand guide exit 70–90 mm
- Direct link of the cast strand to the high-reduction mill creates a fixed relationship of speed and operational temperature in the high-reduction mill

The low-head caster has a metallurgical length of 17 m and a bow radius of 5 m.

ESP plant that contribute to the successful operation of the process: for the casting machine the special funnel-shaped mold, developed and operated by Arvedi over the last 20 years and the hydraulic oscillator, one of Siemens VAI's proven and widely known technologies. The electromagnetic brake and the strand support design (segments) are further examples of the important technologies included in this line.

Besides the mold system and roll gap profile, spray cooling is also very important for stable casting at a high steel throughput. Therefore, a powerful global cooling system using more than 3 l/kg was designed. The cooling arrangement is split into two parts.



Operating with a high mass flow for a long time requires a smooth and stable solidification process, which is determined by proper liquid steel flow, stable bath level, homogenous lubrication by mold powder, uniform heat extraction and homogeneity of shell growth. The interaction of the submerged entry nozzle geometry, mold cavity shape and electro-magnetic brake determines the fluid flow pattern in and below the mold.

Lubrication between the shell and copper plates is determined by proper mold powder, oscillation practice and cooling conditions.

There are many features of the equipment in an

High cooling efficiency is ensured by high-pressure water cooling at high flow rates in the bender and bow segments to strengthen the young strand shell and by special wide spraying water nozzles spaced close to the strand surface. In the lower part of the machine, from the straightener to the last segment, air-mist cooling at standard pressure and flow rates enables a wide operating range, mainly to provide a strand with sufficient heat for the first high-reduction mill stand.

The Dynacs Level 2 model calculates online the thermal history of the strand and controls water flows to adjust to the surface temperature required for subse-

quent rolling steps. Calculated and pyrometer-scanned strand temperatures at the machine exit are continuously delivered to the high-reduction mill.

### High-reduction mill

The high-reduction mill is located after the continuous casting machine and consists of three 4-high rolling stands. The main emphasis in the design of this equipment is on reliability and trouble-free operation. High thermal loading due to casting sequences of up to 12 hours of continuous operation requires the equipment to be designed in such a way as to not suffer deterioration, i.e., to be immediately available for starting the subsequent sequence. Work-



roll material and roll cooling were critical considerations for the designers as the equipment not only is in operation for long periods of time but also has to withstand a high temperature rise at the start of operation. The stripper design was specifically engineered to ensure good contact and to allow maximum efficiency of the roll cooling water.

Internal components are also under extreme exposure to heat, and tables, aprons, guides and rollers are all internally cooled or shielded by water-cooled panels.

Another consideration was the slow rolling speed, due to the direct connection with the casting machine. This has resulted in frictionless roller bearings being

applied to the back-up rolls as well as to the work rolls. To control the profile of the strip, the work-roll bending system that was implemented gives a positive and negative direction and can accommodate the inverse strip temperature profile specific to the Arvedi ESP process.

### Pendulum shear and pusher/piler device

The pendulum shear is used (1) to disconnect the dummy bar from the cast strand, cutting the transfer bar into pieces for removal by means of the pusher/piler equipment, (2) for sample cutting, if required and (3) for emergency cutting.

### Low energy consumption due to use of the internal energy of the hot cast strand

The induction heater units are located after the rotary shear, before the finishing mill, and allow the operator to adjust the temperature of the product in many different ways. The equipment is made up of a series of induction coils (10–12) designed in a closed box construction. Each unit has an installed power of 3 MW and collectively can raise the temperature of the product by more than 200°C. As the product passes through the center of the heater, the temperature of the material is increased by induction.

### Finishing mill

The finishing mill gives the product its final reduction and the geometric quality of the product (thickness and flatness). To achieve this, the machine is equipped with all modern actuators, i.e., hydraulic AGC gauge control, work-roll bending, work-roll shifting, dynamic work-roll cooling, hydraulic loopers and a precise drive system.

In addition to these standard features, the finishing mill requires further operational considerations, such as:

- Quick work-roll change to facilitate work-roll change during casting and pusher/piler operations
- Constant pass line adjustment giving more flexibility with work-roll availability (after grinding)
- Roll bite lubrication to maximize and extend the working life of the roll

### Laminar cooling

The main consideration for the laminar cooling equipment is related to the cooling strategy required for the specific product and the resulting layout. Equipped with flow-controlled high-flow cooling headers as well as switched headers, with the microstructure target cooling model all cooling strategies can be accommodated (dual-phase, >>

>> accelerated cooling and standard cooling). The cooling line is equipped with tilting headers designed to facilitate easy removal of the product in the case of stoppage.

Increased laminar cooling-line performance is provided by an advanced cooling-line model and microstructure target cooling.

#### Coiling area

This section consists of a high-speed shear and downcoilers where the strip is coiled weighing up to a maximum of 32 tons. The integration of technological automation systems and packages developed by Siemens VAI is a decisive factor for achieving the desired production and product-quality parameters.

#### The control philosophy behind the automation systems

Since the ESP process spans a line from the caster to the downcoiler adopting either batch or endless operation, additional features compared to a normal hot-strip mill have had to be integrated into the typical basic and process automation structures. Some of the main features of these systems are as follows:

- Caster models including break-out detection and prevention for stable casting at all speeds
- Advanced model predictive temperature control
- Endless-strip shape control using flatness-measuring rolls
- Setup for 3-stand high-reduction mill, 5-stand finishing mill with laminar section and coiler capable of batch mode as well as endless mode
- Material tracking and speed ramp generation for endless and batch mode with a mass flow control that can be switched hitchless from forward to backward control mode
- High dynamic control for fast reaction to mass flow disturbances and geometrical changes
- Fast hydraulic gauge control to minimize thickness and wedge variation during set-point changes
- Minimum tension control for high-speed shear with optimized cutting sequence via pinch roll control to ensure no tension impact on the finishing mill

The complete picture of features in the automation system is highlighted in Figure 2 and indicates where they are effective.

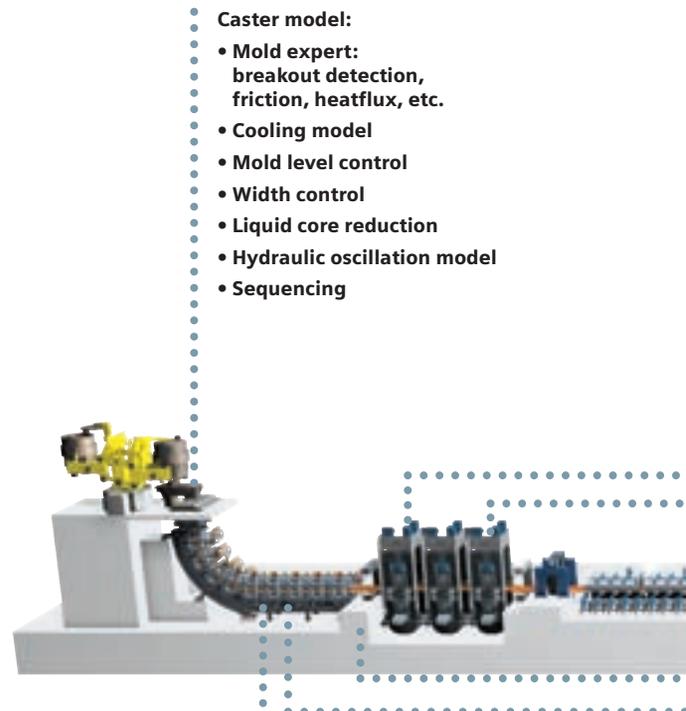


Fig 2.: Overview of automation functions and features in the ESP plant

- Caster model:
  - Mold expert: breakout detection, friction, heatflux, etc.
  - Cooling model
  - Mold level control
  - Width control
  - Liquid core reduction
  - Hydraulic oscillation model
  - Sequencing

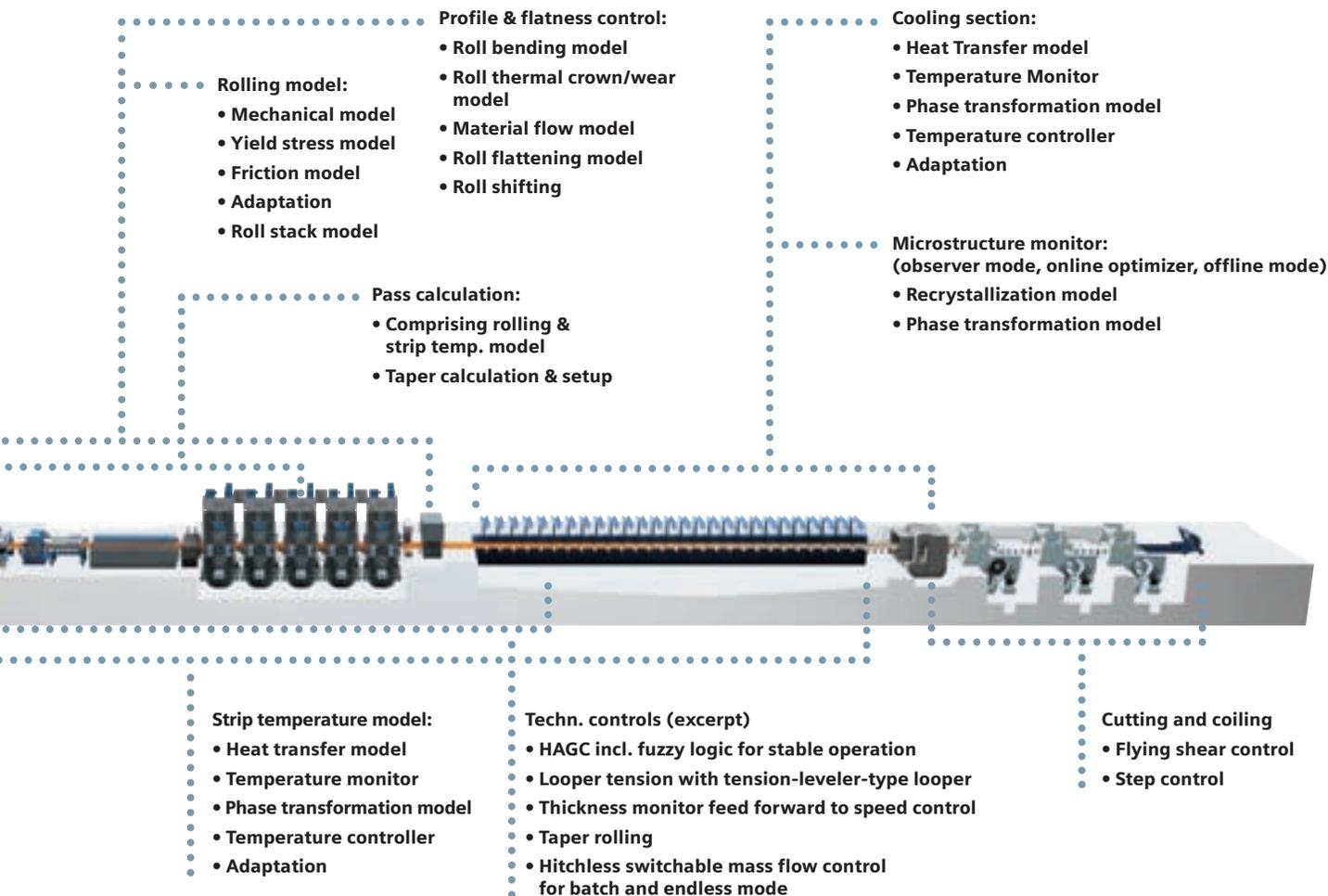
- Caster control:
  - Drive control
  - Oscillation control
  - Cooling control
  - LCR gap control
  - Width control
  - Sequencing

#### Automation overview and equipment

Due to the endless production process, the need for availability exceeds that of other plants, since no system failure is allowed during the rolling of the endless strip, which can last several hours. Therefore, the automation system chosen is from the Siemens Simatic family, which uses the state-of-the-art industry standard S7 SPS system and, for fast controls, the powerful Simatic TDC control system.

Arvedi ESP enables production of large amounts of ultra-thin strips.

The information backbone of the system is a standard industrial Ethernet that provides communication with open protocols such as TCP/IP. For fast interconnection of the basic automation controllers, including the main drive control, the Global Data Memory system (GDM) is used. The standard Profibus DP interconnects the field



devices with the basic automation, providing a proven concept of distributed IO interfacing in the process.

To provide operators throughout the plant with a modern machine interface, Arvedi ESP uses the industry standard WinCC with the Siroll standard implementation that provides a good overview with twin terminals (two screens for one client) for a larger display area and easy and fast diagnostics.

### Temperature control in the finishing mill and cooling section with a model-predictive control

A comprehensive strip-temperature model computes the temperature profile along the entire plant in real time over several layers (see Figure 6).

To make sure that the influences on the finishing mill and cooling section are taken into account and the optimum actuator setting is selected, the Siemens VAI model predictive temperature control is used in the finishing mill and cooling section.

With this layered model, a clear comparison is possible between the pyrometer-measured surface

and the model value. The model-predictive control takes the data of the incoming strip and precalculates and monitors the temperature course in order to use the optimum setting of all available actuators and sets the actuators in such a way that the integrated deviation of the actual temperature and the target value will become a minimum at the selected control points.

By using the internal energy of the hot cast strand, energy consumption is lowered.

For the cooling section, not only the model-predictive control is applied as described, but in a 200 ms time cycle the temporal cooling course along the entire cooling section as well as the phase fractions are calculated. This is the basis for the microstructure target cooling that is applied to ensure the right >>

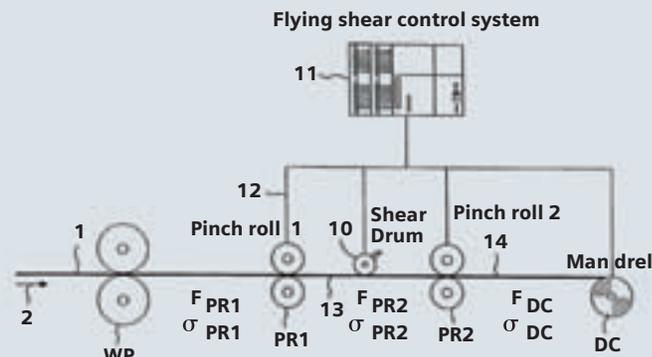


Fig. 3: Scheme of the tensionless cut with flying shear in front of the coiler

- >> phase composition at set points in time and location to ensure optimal quality and to support the production of complex phase steels.

#### Profile and Shape control for endless strip production

The shape and the profile in an Arvedi ESP process requires specific measurement equipment and actuators to be able to control the shape and profile for endless rolling, since there is no unloaded time between strips to move the rolls for profile adjustments.

### Cold-rolling technology ensures flatness of ultra-thin gauges.

Because the strip is under tension most of the time, a planicim tension roll is installed after the last stand of the finishing mill to ensure flatness feedback with control from the first to the last coil using the Siflat flatness control algorithm.

With Hot Planicim Roll and the multichannel profile gauge, the profile and flatness model – using a new material flow model – calculates the setup for all pieces, with online optimization to ensure that the set-ups of the actuators can be changed when the

material set-up geometry varies with minimum changes.

Based on several support models such as the bending model, the material flow model, the roll thermal wear model and the optimization algorithm, the PFC system works together with the in-bar controls, realized in the TDC fast controllers as well as the thermal wear and crown model, describing the roll shape due to thermal growth and wear.

#### Fast hydraulic gauge control for minimum material losses during gauge change

In contrast to the batch mode in standard hot-strip mills, in an endless plant it is necessary to change the thickness while the strip is in the mill. To make sure that the thickness performance is at its best as well as to avoid big transition lengths, the hydraulic gauge control must not only be actuated very precisely at the right point, but must also act very fast.

This is achieved by precise point tracking and a function that closes the gap always in the same strip area to avoid off-gauge material losses (see Figure 4).

The results achieved in the plant in Cremona with this thickness control are excellent (see Figure 5).

#### High-speed shear with minimum tension cut control

At the end of endless strip production, it is necessary

to cut the endless strip into coils of the desired length and weight.

Therefore, the high-speed shear in front of the downcoiler has to deal with two challenges:

- Cut precisely at the position where one coil ends and the next coil begins
- Accurate electrical synchronization of the shear blades with a maximum deviation of less than one degree, controlled by automation and drive control so that no mechanical synchronization is necessary

The shear is arranged between two pinch rolls. With these two pinch rolls the tension versus the finishing mill and the tension versus the coiler pinch roll is controlled to provide zero tension at the shear and to avoid strip snapping at the shear (see Figure 3).

## Increased geometrical strip quality is possible thanks to real endless operation.

### Operation

For all plants to operate well and efficiently, the operators must understand the operational limits of the equipment. In the ESP line, due to the casting and rolling process being directly connected, any change in one area will influence what happens in the other. For this reason the operators in all pulpits are connected verbally and electronically by the integrated automation. This relationship is demonstrated when the casting speed is changed and the downstream rolling program is adjusted automatically due to the changing temperature of the product as it exits the last rolling stand.

Operational input is also shown again in the finishing mill work-roll shifting strategy. Because there is no break in the rolling process, the work rolls are shifted dynamically to increase their service life. The Level 2 model calculates how much and how fast the rolls will move. The calculation is not only based on physical limits but also on such things as roll material, rolling lubrication and data, which are derived from operational knowledge of the plant.

The coming together of two significant forces such as designer and operator result in the benefits of trouble-free implementation, efficient commissioning and fast start-up. The important results obtained on the ESP plant show how the successful cooperation between Accaieria Arvedi and Siemens VAI has made Endless Strip Production a common term in the field of hot-strip production. ■

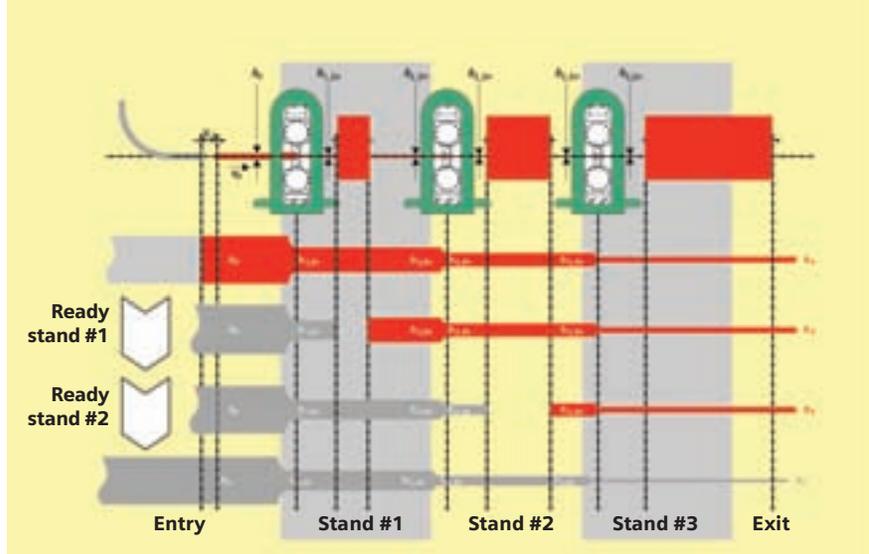


Fig. 4: Principle of fast gauge changes on minimum length: precise tracking and fast actuators

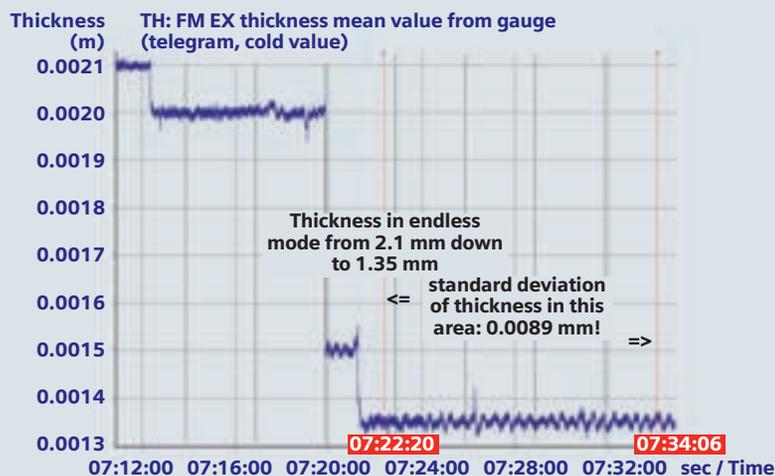


Fig. 5: Excellent thickness results from the start: sequence of thickness changes during test sequence

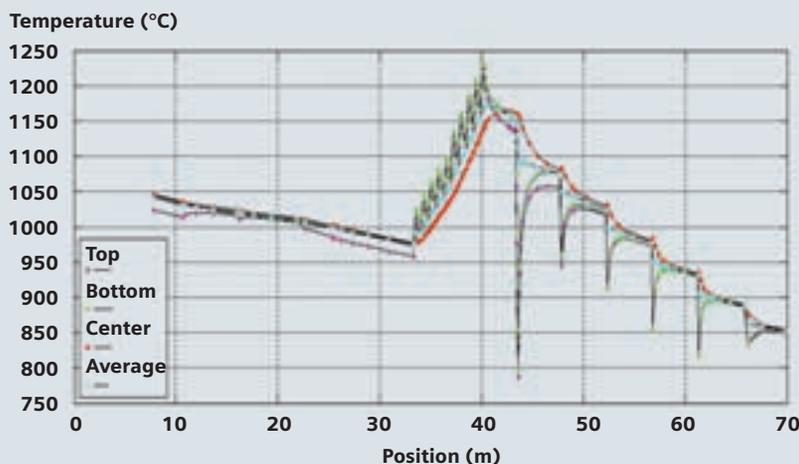


Fig. 6: Calculation results of the bar temperature at the top and bottom surface and center from the high-reduction mill exit up to the finishing mill exit, including bar heater

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Investments in plate mills secure India a spot on the world stage

# Don't Stop Rolling Now

Despite the challenges of the steel industry in recent months, India is starting to reap the fruits of investments made before the downturn: the 5.0 m Essar Plate Mill in Hazira has produced its first plate, and the first coil was produced at the plate-steckel mill of Welspun Gujarat Stahl Rohren. These events reaffirm India's intention to be a major player in the production of rolled plate products.

**T**he projects, which have come to fruition within only a matter of weeks of each other, have marked a significantly busy period of project engineering for Siemens VAI and a notable milestone in Indian plate-making history.

The plate mill at Hazira, designed to produce predominantly pipe-grade steels with a capacity of 1.5 million tons per year, produced a 4.9 m wide plate – the widest ever rolled in India. This is a considerable achievement, especially given that it was accomplished within 24 hours of the mill roll's first turning. This accomplishment is a clear measure of the skill, dedication and level of collaboration between the project team and the client.

**Siemens VAI commissioned three plate mills in three weeks towards the end of 2009.**

Siemens VAI was responsible for process-equipment design and supply of key pieces of equipment, including a 5.0 m finishing-mill stand, a plate-cooling system, a hot leveler, a full set of plate shears and a cold leveler. In addition, Siemens VAI supplied the complete Level 1 and Level 2 automation systems.

While Hazira continues to produce plates from the mill line, the shear line won't be complete until mid-



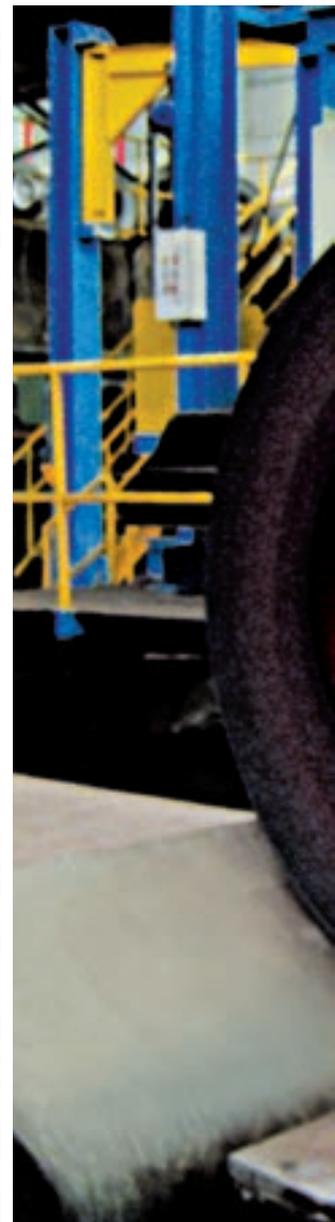
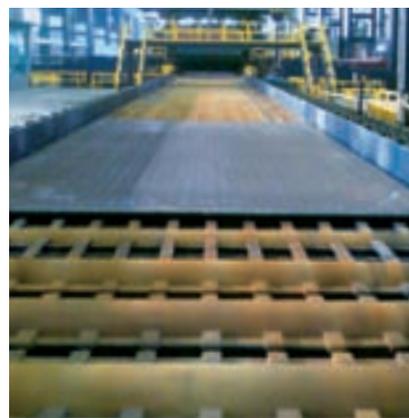
The first plate was rolled in Hazira on October 3, 2009



The plate mill team celebrated the early start-up of the plant

The first coil at the Welspun Plate-Steckel Mill

The widest plate ever rolled in India: the Hazira 5.0 m Plate Mill rolled a 4.9 m wide plate in November 2009



2010. Then, the Hazira plate mill will be one of the largest, most modern and efficient in India.

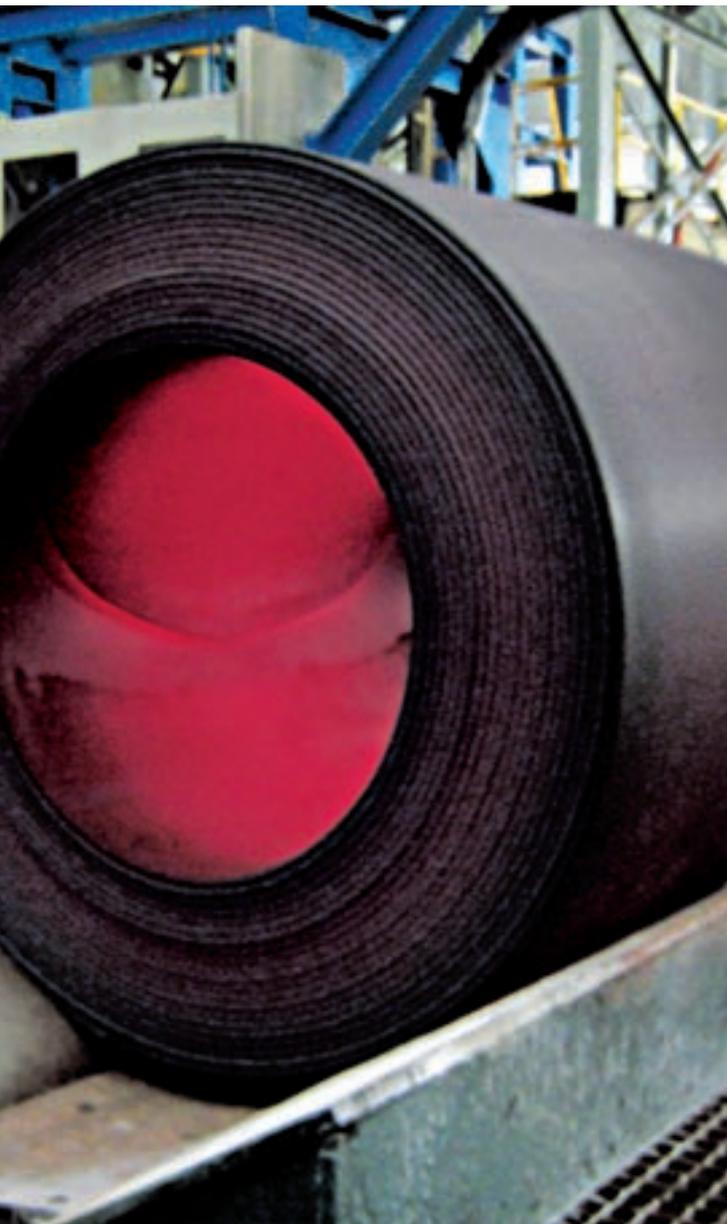
#### Another first in India

Almost simultaneously, Welpun Gujarat Stahl Rohren also made history rolling the first coils on the purpose-built one-million-ton-per-year plate-steckel mill in Anjar, in the Indian state of Gujarat. In fact, it was the first plate-steckel mill to be built in India.

The mill has been producing plate both for commercial sale as well as internal supply to the company's pipe-making plant. Since its start-up, additional equipment – such as the steckel coiler furnaces and rotary crop shear –



Engineering design for both the Hazira and JSPL 5.0 m Plate Mill Finishing Stands



were installed, and the mill rolled its first coil in September 2009.

Big milestones in India are not just limited to these companies. For a 5.0 m plate mill under construction for Jindal Steel & Power Limited, Siemens VAI is supplying the complete mechanical equipment design, key equipment and automation and electrics. And then there are the successes outside the Indian subcontinent. About the same time as the plate mills described above went into operation, a new 5.0 m mill in Dongkuk, South Korea, and the 5.0 m Shagang Plate Mill No. 2 in China were started up. There are also a number of other 5.0 m and smaller plate mills being commissioned by Siemens VAI all over the world.

#### Concluding remarks

These recent achievements are the result of the significant investments that have already taken place in India. Furthermore, they are a reminder of the continuing emergence of the Indian plate producers and the important role they are playing in plate production on the world stage. ■

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A long history of support for hot-strip mills in India

# Local Competence for A Fast Response

Since the end of the 1950s, Siemens has continuously provided expertise for hot-strip mills in India. In fact, Rourkela was the first hot-strip mill in the country to be commissioned with Siemens solutions and components. With a strong local setup that provides engineering excellence as well as commissioning expertise, Siemens India as a local supplier also provides service to hot-strip-mill customers. As a result, engineers can be at the customer's door-step on short notice to handle service requests.

ROLLING >



**Bhushan CSP: team after first coil with members of Siemens India and Siemens VAI**

Since commissioning and setting up India's first hot-strip mill in Rourkela with AC/DC drives and analogue controls in 1961, Siemens has become a long-term player as a reliable equipment and solution provider for hot-strip mills in India. Local customers including SAIL and private companies such as Bhushan Power and Steel, ISPAT, Tata Steel and JSW rely on the latest technology and solutions Siemens has to offer for hot rolling.

Strong local competence is another Siemens VAI strength and one of the main reasons Bhushan Steel and Strips Ltd. selected Siemens VAI as the provider for the electric and automation of the hot-strip-mill project that is just now starting up in the state of Orissa. For Jindal Stainless Ltd., whose complete hot-strip mill from Siemens VAI will go into operation in the near future, local competence was also a deciding factor. As a leading global player, Siemens VAI is poised to take



**Bhushan HSM, commissioning of the RM control panels**

advantage of market opportunities by offering proven world-class solutions. With main offices for the metals industry in Kolkata and Mumbai and local branches in nearly every city in India in which steel is produced, Siemens is truly close to the Indian steel industry.

#### **Bhushan HSM: competitive electric and automation equipment**

In Meramandali, in the Indian state of Orissa, Bhushan Steel and Strips Ltd. (BSSL) is currently building an integrated steel plant designed to produce up to three million tons of steel per year. Siemens VAI is supplying all the electrical equipment, drives, and basic and process automation from the furnace exit to the coil conveyor, including all technological control systems and process models providing highest strip quality results. BSSL intends to roll a mix covering high-strength, low-alloy steel, double and multi-phase steel grades, and stainless steel in thicknesses of between 1.6 mm and 20 mm and a maximum width of 1,680 mm in this hot-rolling mill.

This requires an efficient power supply with state-of-the-art transformers with low losses and excellent load characteristics. The synchronous motors of the main drives for the roughing and finishing mills are supplied with the voltage source converters of the type SM150, which need no static VAR compensation to ensure power quality. With the non-salient pole motor type, excellent dynamics are provided for the high requirements in hot-strip mills regarding fast responses in mass-flow control to keep the hot-rolling process stable, also at low thicknesses.

The Siroll HM automation system provides a unified hardware architecture as well as fast digital control to provide the best quality possible for the geometrical performance of the strip product. The newest microstructure target cooling is implemented in the cooling section. This provides phase composition information over the length of the cooling section in real time from the built-in phase model. For quality-assurance purposes, the microstructure monitor developed by Siemens will be used, which allows important mechanical key characteristics of the material to be determined online during the rolling process.

#### **Jindal Stainless: a plant completely supplied by Siemens VAI**

Jindal Stainless Ltd. (JSL) is the leading stainless steel producer in India. In the course of an expansion and investment program, JSL decided to build a new 1,800 mm wide hot-strip mill in Kalinganagar Durubi, Orissa. JSL has ordered from Siemens VAI the complete equipment for this plant including the plant layout, the mechanical equipment, the drives as well as the entire basic and process automation. With this plant, JSL will be able to produce a wide range of steels, especially stainless steels of the AISI 200 series, 300 series and 400 series as well as carbon steel. Plant construction began in November 2009, and the first strip is expected in late 2010.

In the framework of this project, Siemens India is delivering some parts of the supply, including engineering, commissioning and customer training as well as supervision and commissioning resources. Experts from the engineering and commissioning teams in Kolkata and Mumbai will participate in making fine adjustments to the technological models and control systems.

Altogether, local engineers are increasingly taking on responsibility for projects at the Bhushan CSP mill, Bhushan hot-strip mill, JSL and Essar, working on Siroll based solutions, latest Sinamics drive systems and TDC/Simatic S7-based automation. With Siemens India's many decades of experience in project business, overall site management, supervision of installation work and commissioning, coordination is another area where the local office takes the lead.

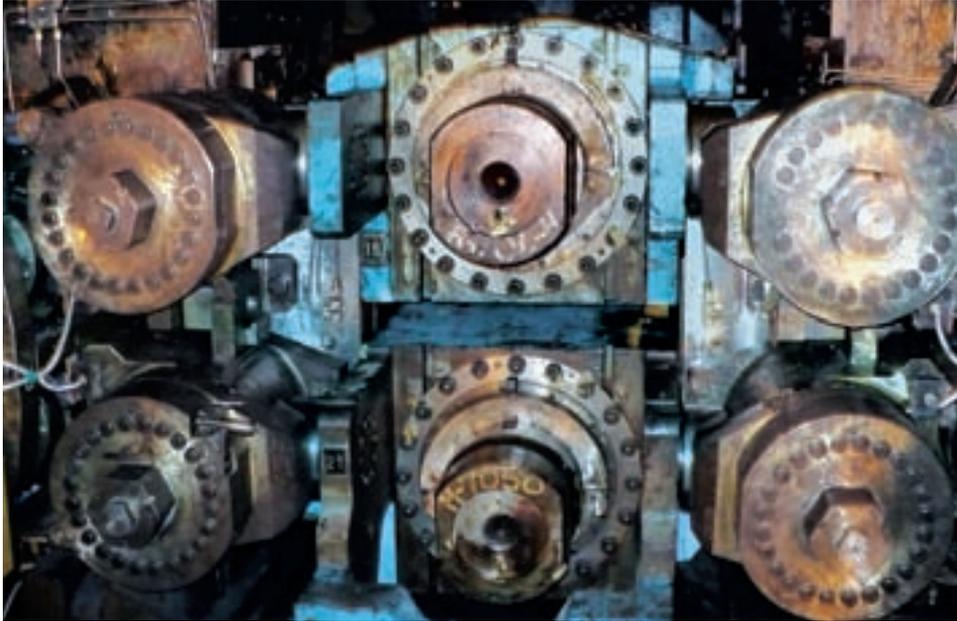
This strong local setup enables Siemens to provide the knowledge needed for competent service, also after the start of the mill and during its entire life cycle. ■

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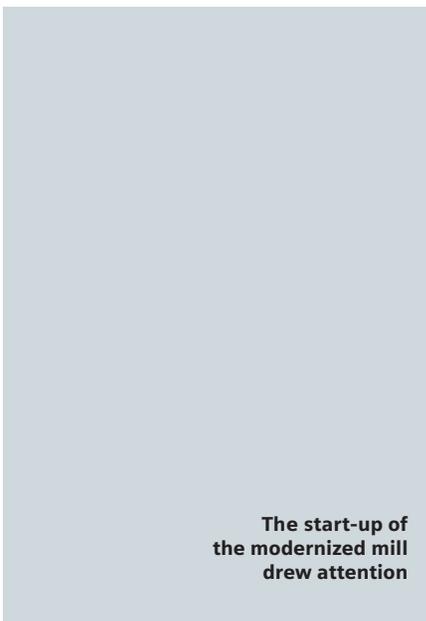
Modernized mill stand

Plant availability and product quality increase at SAIL's hot-strip mill in Bokaro

# Making the Most of Summer Shutdowns

For the revamp of its 7-stand finishing mill in Bokaro, Steel Authority of India Limited counted on the expertise of Siemens VAI. A portion of the order depended on local engineering expertise.

ROLLING >



The start-up of the modernized mill drew attention



In July 2005, Siemens VAI was awarded a contract by Steel Authority of India (SAIL) to modernize the hot-rolling mill at the company's steel plant in Bokaro. The order included a local portion, which was executed in cooperation with Siemens VAI India and included engineering, equipment supply, erection and commissioning. SAIL, India's leading steel producer, relies on Siemens VAI technology and know-how for the revamp of the 7-stand finishing mill of the 2,000 mm hot-strip mill originally supplied by NKMZ.

The modernization was performed in two steps during shutdowns in summer 2007 and 2008, upgrading three mill stands in the first phase and four mill stands in the second phase.

The modernization included the complete inline machining of mill-stand housing windows of the finishing stands F6 to F12 (seven stands) and renewal of all lateral and bottom mill-stand liners made of compound/stainless steel. New work-roll bending and shifting systems were installed. The well-proven Siemens VAI bending-block design supports the installation of the work-roll shifting system. The bending cylinders are guided inside the fixed bending blocks within telescoping sleeves. The block design ensures high reliability and low maintenance and operational costs. The shifting mechanism allows axial shifting of the work rolls. Having been upgraded, the SmartCrown work-roll contour allows adjusting the crown of the rolls to the requirements for profile and flatness. For the current project the shifting mechanism is mechanically locked. This allows the use of conventional ground rolls with a new barrel length of 2,200 mm. Shifting technology together with the automation upgrade can be activated any time without modification of the installed shifting mechanism.

## With the upgraded mill the quality parameters for automotive sheets can be achieved

New lifting rails for the work-roll change were installed and parts of the changing platform were adapted to suit the new equipment. The tracks were replaced to allow the change from wheels to more reliable gliding shoes on the work-roll chocks. Existing backup roll chocks were reused. Siemens VAI provided the design for the new work rolls, which allows grinding with chocks. ■

### Scope of supplies and services

- Inline machining of the complete 4-high finishing mill (7 stands, 14 housings)
- Engineering and supply of new Siemens VAI-type bending and shifting blocks (Mae-West)
- Engineering and supply of new compound steel wear liners
- Engineering for work rolls
- Engineering and supply of new work-roll chock assemblies including new bearings
- Engineering and supply of new lifting rails and adaption of work-roll change platforms
- Engineering and supply for adaption of hydraulic piping
- Implementation of new equipment functions into existing automation system
- Required commissioning spares
- Erection
- Commissioning

### Plant data

Capacity	4,000,000 t/a
Strip thickness	1.5–16.0 mm
Strip width	700–1,850 mm
Max. coil weight	max. 32 t
Spec. coil weight	max. 20.0 kg/mm
Work-roll diameter	750–810 mm
Backup-roll diameter	1,460–1,610 mm

### Steel grades

- Carbon steel
- API grades up to X70

### Benefits

- Increase in mill availability and production capacity
- Improvement of housing window geometry resulting in reduction of damage and unscheduled downtimes
- Improved work-roll bearing design and service life
- Integration of state-of-the-art work-roll shifting and bending systems
- Improved process control to ensure quality parameters suitable for automotive sheets
- Flatness improvement

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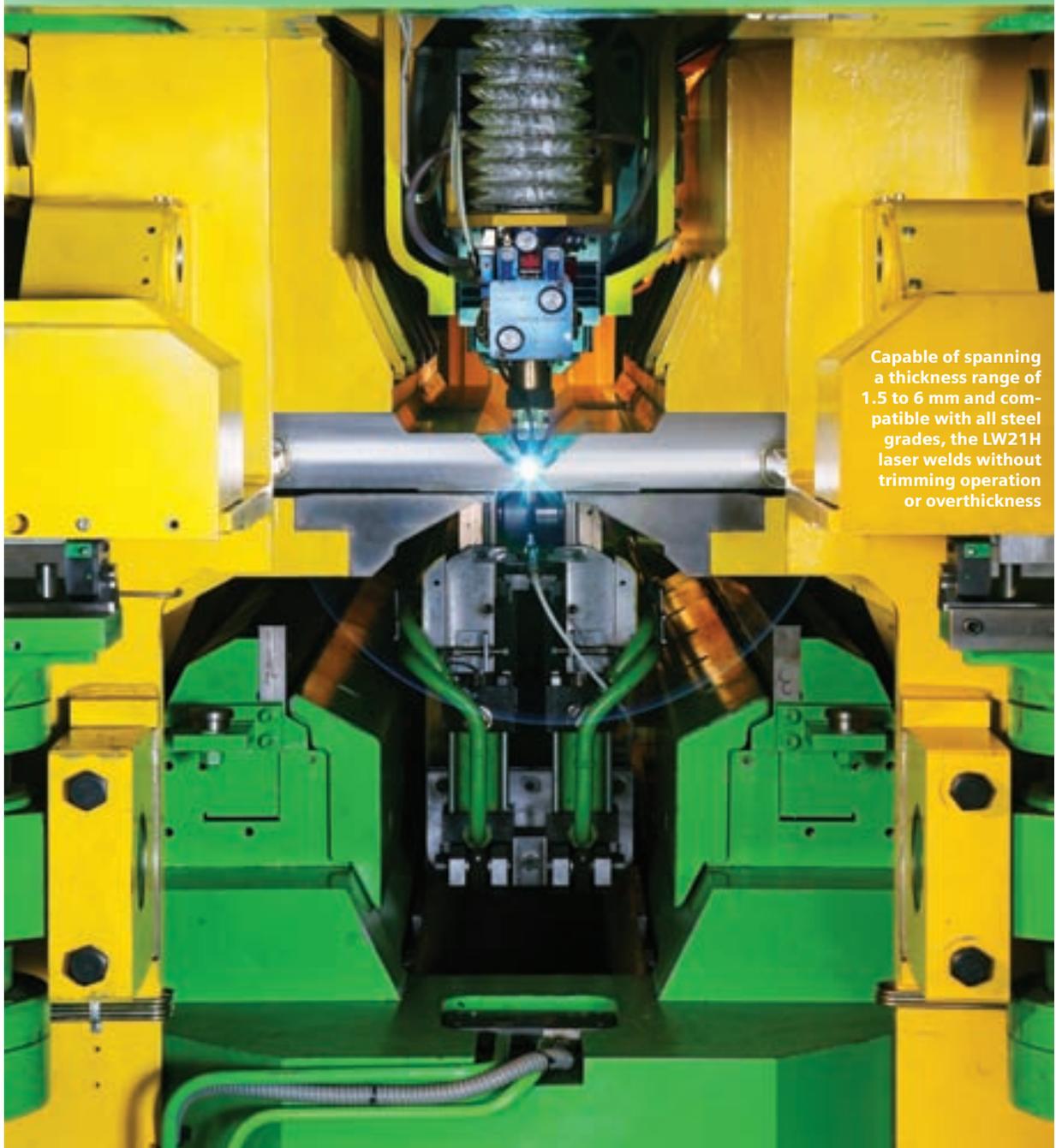
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New coupled pickling line and 6-high tandem cold mill (PLTCM)  
for SAIL in Bokaro, India

# Gearing Up for The Future

ROLLING >



Capable of spanning a thickness range of 1.5 to 6 mm and compatible with all steel grades, the LW21H laser welds without trimming operation or overthickness

Continuing market growth in India is driving the country's largest vendor of cold-rolled products to upgrade its production output and widen its product range for new applications.

In a move to expand its product offering for new and demanding applications, Bokaro Steel (BSL), a company of Steel Authority of India Limited (SAIL) and one of the largest producers of cold rolled products in India, decided to increase its production by investing in a new cold-mill complex in India's state of Jharkhand. The background to this step is BSL's intention to provide advanced cold-rolled products for car chassis and household appliances.

### Challenging requirements

BSL already operates two cold-rolling mills at its Bokaro location. Due to the increasing demand for cold-rolled flat products, a new cold-mill complex is being added to produce high-quality steel grades for applications in the automotive industry. Set to meet highest-quality standards in terms of strip flatness, strip surface, strip cleanliness and dimensional tolerances, the new mill will produce high-strength steel grades (HSS) like IF steel for drawing qualities, dual phase steels (DP) and high-strength low-alloy steels (HSLA), in addition to low-carbon steel.

### A winning combination of technologies and services

Following intense competition among major suppliers and leveraging its experience and capability to execute major projects, Siemens VAI won BSL's contract at the beginning of 2008. The contract comprises a broad package of technologies: a coupled pickling line and tandem cold mill (PLTCM) plus an electrolytic cleaning line and a new hot-dip galvanizing line, all implemented as a turnkey package. Siemens VAI delivers the full palette of products and services: design and engineering, all mechanical, hydraulic and electrical equipment as well as automation, training and process support of operation personnel, plus erection and commissioning. The line features a laser welder LW21H, a turbulent pickling section, horizontal loopers and side trimmers, a 6-high tandem cold mill, a carousel coiler and an automation system with a Siroll Siflat contactless flatness measurement device.

### Mechanical setup

In detail, the mechanical side of the new mill will contain two pass lines for smooth and robust mate-

rial feeding as well as a Siemens VAI heavy-gauge laser welder specially designed to handle next-generation steel grades. Capable of spanning a thickness range of 1.5–6 mm and compatible with all steel grades, the laser welds without trimming operation or over-thickness, ensuring rollable welds for flawless downstream production.

The pickling section uses polypropylene tanks with a high-turbulence flow design coupled with a fully automatic pickling liquor analysis and control (Siroll Paplac®) package. Based on comprehensive sensor data and process models, the system ensures high coil pickling quality by controlling pickling, rinsing and fume exhaust modules for optimized acid and energy consumption. Tight process control also ensures highest productivity and lowest operating costs. Due to pickling speed management and a model-based, optimized addition of fresh acid, acid sampling and laboratory analyses are eliminated.

The new cold-mill complex is set to produce high-quality steel grades for the automotive industry.

At the heart of the plant is the five-stand tandem cold mill that uses a 6-high mill design in all stands. The stands contain high-speed hydraulic gap-control cylinders and Siroll SmartCrown contour systems for perfect strip flatness as well as the Siemens VAI AGC package for precisely controlled strip thickness. A rotary shear and a carousel coiler at the mill's exit ensure endless coiling.

### A flexible and powerful automation system

The plant's Siroll CM automation components tightly match the mechanical equipment and include cold-mill-technology control systems as well as all process automation and drive systems. To ensure tightly controlled strip thickness for customers in the automotive industry, the automation solution leverages the core elements of the technological controls – Advanced Mass Flow Control for exit thickness and roll eccentricity controls at stands 1 to 4, plus a flatness measurement and control system that compensates strip flatness deviations at stand 5.

Behind stand 5, a contactless Siroll Siflat flatness measurement unit avoids any negative effects on the strip usually caused by measurement rolls so >>



**Siroll Siflat Contactless  
Measurement Device  
for PLTCM**

>> that no additional spare measurement rolls need to be stocked. The device reliably measures the tension distribution in the strip and uses it to always ensure the best possible roll gap. Based on the actual flatness deviations, an intelligent multivariable control algorithm generates optimized correction signals for all the mill's flatness actuators: work-roll (WR) and intermediate-roll (IR) bending, IR shifting with SmartCrown profile, tilting and selective cooling.

**Siroll CM is a completely concerted mechanic, electric and automation package.**

Based on analytical mathematical models, an on-line rolling-process control function calculates the plant's operating parameter set points during the

ongoing production operation. In order to continuously match rolling conditions (material-hardness fluctuation, friction changes, etc.), the automation system is constantly adapting its internal parameters. This is done using a long-term inheritance process based on neural networks. The optimized interaction of exact process models and fast closed-loop control systems even allows rolling critical sections of strip at the weld-seam section in fully automatic mode with minimum off-gauge length and tension variations (flying gauge change).

The Siemens VAI automation solution's hard- and software uses Simatic PCS7 as the underlying engineering and control system for plant operation and fault diagnosis, and high-performance Simatic TDC and S7 programmable controllers. These components provide maximum computing power for sequences and technological controls. The main AC motors are controlled by Sinamics SM150 converters. Based on IGCT (Integrated Gate Commutated Thyristor) technology, these medium-voltage source converters provide excellent response time and quiet operation.

### Plant data

Mill type	PLTCM
Pickling line	High-turbulent
Tandem cold mill	5-stand, 6-high
Annual capacity	1,300,000 t
Installed power	34,000 kW
Rolling speed	1,200 m/min max.
Tandem exit cutting speed	300 m/min
Mill exit type	carousel coiler

### Production data

Material	IF, CQ, DQ, HSS
Entry strip thickness	1.6–5.0 mm
Exit strip thickness	0.25–2.0 mm
Strip width	800–1,560 mm
Coil weight	31 t
Coil diameter	2,000 mm



The non-contact Siflat flatness measurement unit avoids any negative effects on the strip usually caused by measurement rolls

### Siemens VAI project management makes it happen

With mechanical and electrical mill components and work being performed in both India and Europe, project management is a challenging task. In line with the international split of deliverables, a mixed team of specialists both from Siemens VAI and external contractors from Europe and India are cooperating on the project. In this context, Siemens VAI's soft skills and comprehensive experience from other international projects (such as in China) is proving its benefits. Later, this will ensure good partnership for a future life-cycle management between SAIL and Siemens VAI, since Siemens VAI engineers located in India are fully participating in the design and engineering of the mill.

### Successfully meeting requirements

In delivering a completely integrated mix of equipment and automation, Siemens VAI is giving its client full control over the mill's productivity, output quality and availability – the key factors for profitability. Tight control over the plant's energy con-

### Siemens VAI is a reliable project-management and life-cycle partner.

sumption, its use of process media and all of its operating procedures ensures that strict requirements for safety and environmental protection can be met. Advanced mill stands provide enhanced flexibility, even extending the plant's product mix to high-strength steel grades. ■

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New galvanizing and cleaning lines for India's largest steel maker

# High Tech for High Standards

In an effort to serve the dynamically growing steel market in India, Steel Authority of India Limited is enhancing the capacity, flexibility and quality of its strip-product output.

**T**he future holds growth for India's steel production: from today's 55 million tons, output is expected to grow to 120 million tons by 2015. To take advantage of this trend, Bokaro Steel (BSL), located in the Indian state of Jharkand, is set to increase its annual production of flat products to 1.2 million tons per year.

BSL's plans call for the addition of a new cold-rolling mill (see p. 60) and two separate strip-surface-treatment lines to process the PLTCM's strip output, a hot-dip galvanizing line and an electrolytic cleaning line, all of which are scheduled to go into service in 2011.

The worldwide expertise of Siemens VAI is meeting the steel demands of the Indian market.

#### High surface-quality requirements

The reason for the production expansion is that BSL wants to enter new markets. New applications for automobiles, household goods and infrastructures markets call for more process flexibility, new metallurgical properties, high strip-surface quality and cleanliness. To meet these needs, the galvanizing line has to

contain an annealing furnace with several heating zones that can implement various thermal profiles for strip recrystallization.

#### Combining worldwide expertise with local resources

After a round of competitive tendering, Siemens VAI won the BSL contract for engineering, supply, erection and commissioning of a hot-dip galvanizing and an electrolytic cleaning line as well as for a cold-rolling mill in early 2008. Apart from technological reasons, a main factor for BSL's decision to choose Siemens VAI was the mix of local and international sourcing. Close cooperation between Siemens VAI and its regional subsidiary Siemens VAI India as well as Siemens India enabled smooth and seamless plant implementation. The ability to offer a local organization to manage project execution for all project aspects such as detail engineering, local sourcing, manufacturing follow-up, and on-site activities during erection and commissioning promises benefits for both the vendor and the client.

#### Hot-dip continuous galvanizing line with vertical furnace

The new hot-dip galvanizing line (HDGL) is designed for an annual production capacity of 380,000 tons, consisting of 300,000 tons of galvanized sheets >>

Continuous galvanizing line





Siroll DAK B dynamic air knife

>> and 80,000 tons of galvanized-coated product. The galvanizing line covers strip widths from 800 mm to 1560 mm and strip thicknesses from 0.25 mm to 2 mm.

Galvannealing involves heating zinc-galvanized steel strips so that iron diffuses into the zinc coating, improving the welding process and easing paint coating especially for applications in automotive production and construction.

The production line uses a vVv-type layout, comprising an entry looper, a furnace and an exit looper, all in a vertical design. This design concept has proven its benefits for the production of cold-rolled steel strip to highest surface-quality standards. Strip processed in this way is used in the automotive industry (especially for body panels and outer-covering parts) and for household appliances such as white goods.

The HDGL line consists of the following elements: A LW21L laser welder that provides high welding quality and product flexibility helps to avoid strip breakage, ensuring high line uptime and availability. Next is a high-efficiency strip-cleaning system

that offers high cleaning efficiency in removing any soil and dirt from the strip's surface and preparing the strip for optimum zinc adhesion. The system consists of a v-shaped hot-dip dunk tank, a first scrubber, an electrolytic tank and another scrubbing unit, a cascade rinse tank and a dryer.

## High-efficiency technologies help produce the highest quality.

A subsequent strip-loop tower acts as a line buffer and ensures a continuous galvanizing process at the required speed. Finally, a vertical annealing furnace forms the heart of the line; it controls high strip-surface quality and determines the strip's mechanical properties. During the annealing process, the strip's structure is made to recrystallize, and any oxides on the strip surface are reduced.

A number of furnace stages for pre-heating, heat-

ing, soaking, cooling and finally adjusting to the zinc bath temperature prior to the strip dip in the zinc pot ensure that the thermal profile is applied under precise control. Further important criteria for delivering perfect product quality over a wide range of steel grades are the capability of ensuring a homogenous temperature distribution across the entire strip width and precisely adjustable temperatures over the entire strip length inside the furnace. For automotive and high-strength steel grades, the vertical furnace features highest precision and controllability, offering suitable annealing cycles for almost any type of steel grade.

A Siroll DAK B dynamic air knife wipes off excess zinc from the strip, ensuring uniform coating thick-

ness and homogeneity, and decreasing zinc consumption. The unit has provisions for a future upgrade to a Siroll DAK E system that offers a transverse coating thickness control mode for even higher coating quality. Next in the sequence is a skin pass and tension leveler, which perform roughness transfer and yield erase during strip elongation for optimum strip flatness. This is followed by a post-treatment station that applies a chemical solution to the strip, thus protecting it against white rust.

The galvanizing line is complemented by a Level 1 and Level 2 mechatronic and automation system that was jointly developed by Siemens VAI and Siemens India. Additionally, the line contains space provisions for future expansion with a side trimmer section.

### Electrolytic cleaning line

The new electrolytic cleaning line (ECL) is designed for an annual coil output of 370,000 tons. Its main purpose is to remove dirt (oil and iron fines) from strip after the rolling process. Coil input is from the Siemens VAI PLTCM. After cleaning, output coils are delivered to the batch annealing facility.

The cleaning section uses the same v-shaped Siemens VAI tanks as the galvanizing line and consists of the following machine groups: a lane with a single pair of reels, a ML21M mash-lap welder, a cleaning section (essentially the same as in the galvanizing line), and a single-tension reel lane. The line shares many components with the galvanizing line, offering cost benefits for line maintenance.

### Meeting quality and cost targets

The two surface-treatment lines ensure high strip-surface quality and process flexibility for a wide range of steel grades that will help BSL to serve new markets.

Since engineering, delivery and construction supervision as well as start-up for both mechanical and electrical equipment and all the automation are provided by Siemens VAI, process risks are minimized. Furthermore, comprehensive project management carried out by Siemens VAI ensures that schedules are met so that the plant will be operational in time and after only a short start-up phase. ■

## Plant data

### Hot-dip continuous galvanizing line

Equipment – Level 2	HDGL
Annual capacity	380,000 t
Process speed	max. 180 m/min
Entry & exit overspeed	max. 250 m/min

### Production data

Material	IF, CQ, DQ, HSS, DP, TRIP
Strip thickness	0.25–2.0 mm
Strip width	800–1,560 mm
Coil weight	31 t
Coil diameter	2,000 mm
Product	GI & GA

### Electrolytic cleaning line

Equipment	EGL
Annual capacity	370,000 t
Process speed	max. 270 m/min
Entry & exit speed	max. 270 m/min

### Production data

Material	IF, CQ, DQ, HSS, DP, TRIP
Strip thickness	0.25–1.5 mm
Strip width	800–1,560 mm
Coil weight	31 t
Coil diameter	2,000 mm
Product	Cold-rolled coils

#### Author

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#### Contact

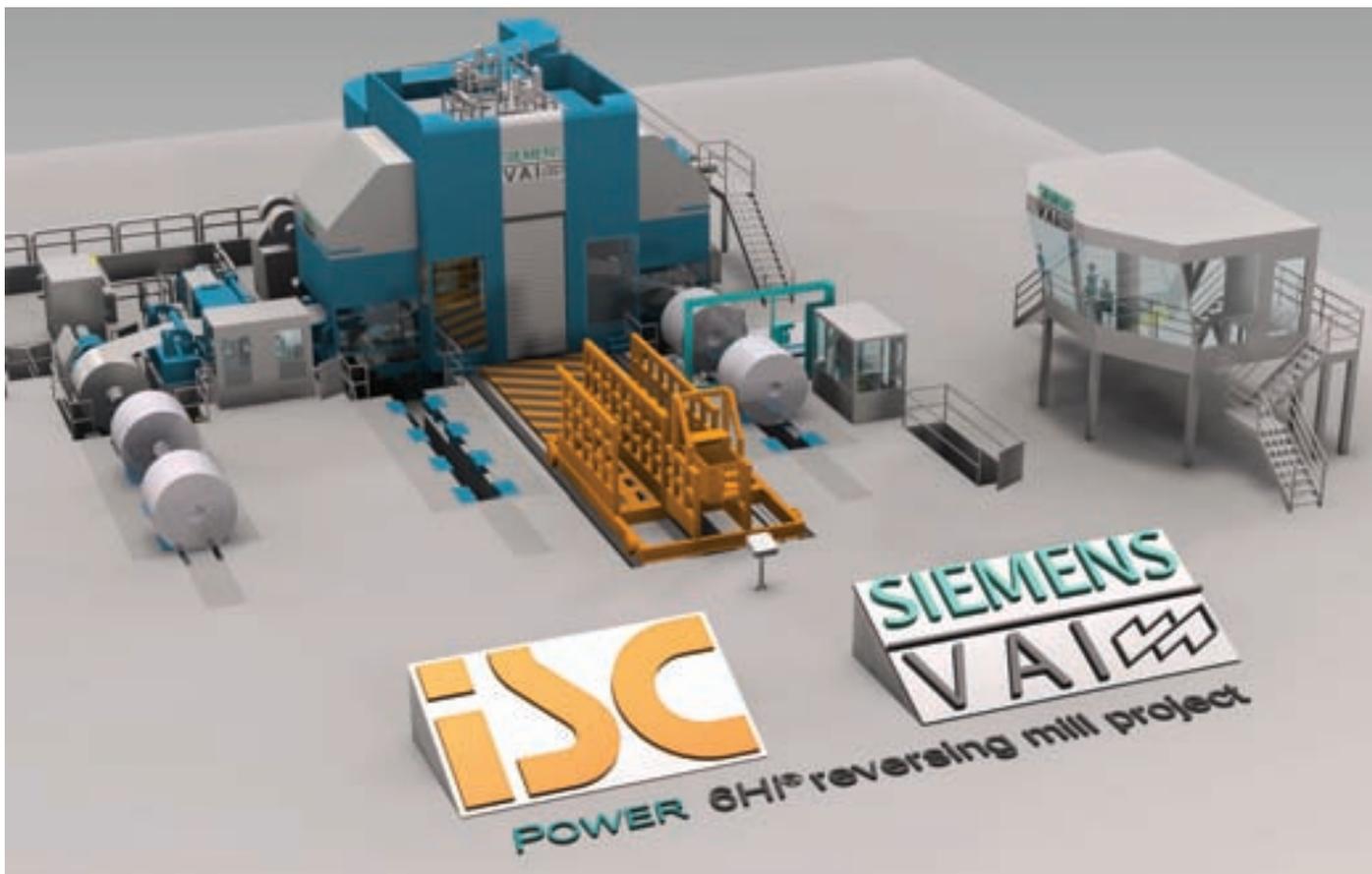
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New 6-high reversing cold mill for Indian Steel Corporation Ltd.

# Triple Capacity With a Quality Hike

Siemens VAI received a contract from Indian Steel Corporation Ltd. to supply a new reversing cold mill at the Gandhidham works in the Indian state of Gujarat. The mill will not only increase production capacity of the Gandhidham complex – it will also be a source for premium-quality products.

ROLLING >



3D model of a Siemens VAI reversing cold mill

Indian Steel Corporation Ltd. (ISC), part of the Ruchi Group of Industries, runs a cold-rolling-mill complex in Indore, Gujarat. The existing complex produces 200,000 tons of cold-rolled, plain and galvanized sheet metal and coils per year. The additional mill constructed by Siemens VAI will have

an annual capacity of 450,000 tons of flat steel spanning a thickness range from 0.25 mm to 2.5 mm and will primarily produce quality steel products for the auto-body manufacturing and construction industries. The new plant is scheduled to go into service in the second half of 2010.

### Demanding criteria

ISC's call for tenders included several key criteria: The company wanted a cold-rolling mill that would be able to process strips with a much wider yield-stress range and better quality than possible with conventional mills. Also, the new mill was to offer a great degree of flexibility for a wide range of strip thicknesses. And last but not least, the prospective contractor had to be able to offer a full spectrum of products, technologies and services, and proven competence for a project of this scale.

### The solution

The 6-high reversing stand delivered by Siemens VAI is designed for quick work-roll changing (QWRC) and features fast hydraulic capsules for automatic gauge control (AGC), intermediate roll shifting as well as work-roll and intermediate roll bending. Integrated in the stand is a Planicim roll, which measures strip flatness at the exit side and uses the measurements for automatic flatness control to ensure good strip flatness and high surface quality.

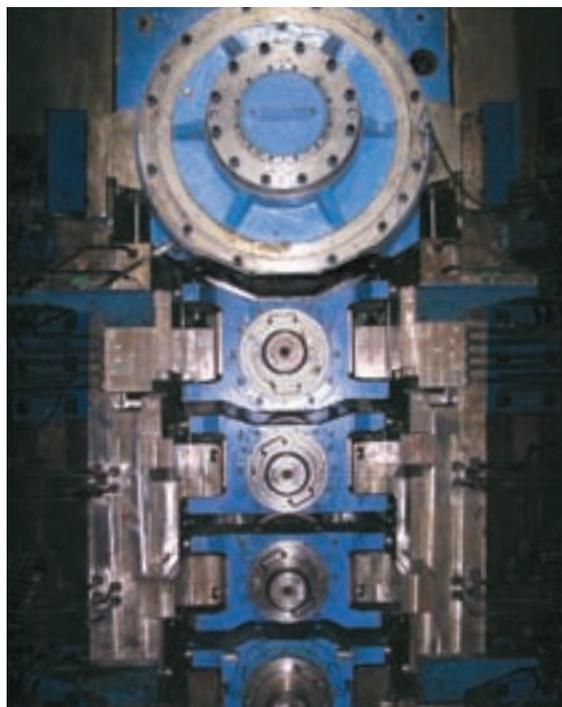
## The 6-high reversing cold mill is designed for premium quality products and capacity increase.

The plant's automation is based on the Siemens Siroll CM concept for cold-rolling mills. This high-speed basic automation system (Level 1) ensures perfect control of the rolling parameters for consistently high product quality. The mill setup module of the process automation (Level 2) is self-learning, which increases operational flexibility and enables the mill to roll a wide range of products from mild to high-tensile steel with optimum running costs. Siemens India is supplying all synchronous motors and Sinamics LV converters for the mill stand and coilers as well as the basic automation system for the complete mill.

Siemens VAI is in charge of the design, engineering and provision of mechanical equipment along with the whole automation system. Also, Siemens VAI is responsible for the supervision of installation and commissioning of the entire mill.

### A winning combination

The mill's flexible and future-oriented equipment and automation based on standard Siroll CM solu-



6-high rolling mill stand

tions ensures high strip quality from the very first coil. Numerous references for 6-high reversing/tandem mills also prove that Siemens VAI solutions offer the flexibility to venture into new material-property ranges, like those that may be required in the automobile sector. Moreover, this is made easy by an advanced automation system that implements an optimized interaction of exact process models and fast closed-loop control systems to provide a maximum of control over strip quality and metallurgical strip properties. ■

### Plant Data

Start-up	2010
Mill type	Single-stand, 6-high
Annual capacity	450,000 t
Thickness	0.25–2.50 mm
Width	1,650 mm
Coil weight	35 t
Rolling speed	1,200 m/min
Mill power	6,000 kW

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## Non-contact flatness measurement for strip rolling

# Look, But Don't Touch

Increasing demands on rolled strip quality makes good flatness an essential requirement. However, strip flatness is not only important as a quality feature; it is also vital for the rolling process, as flatness errors lead to an inhomogeneous tension distribution across the width of the strip, increasing the risk of strip breaks. A reliable strip tension distribution measurement helps to avoid this problem.

ROLLING &gt;

**W**hen it comes to cold rolling, the first contact between material and machine determines the quality of the end product. If the roll gap profile has not been adapted exactly to the strip profile, a non-uniform pressure distribution across the strip width will result. This non-uniform pressure distribution leads to differences in elongation across the strip width – commonly called flatness errors.

High strip tension may cover up this problem until the strip is finished. But then, flatness deviations become visible in the form of wavy edges, a wavy center, quarter buckles and camber. Flatness errors can also cause other problems like lateral strip shift, pinching, and strip breaks. These will reduce strip speed and productivity, and ultimately impact the user's bottom line.

In conventional systems, flatness is gauged using a contact-based radial force measurement that relies on a deflector roll with integrated force transducers. This technique suffers from several shortcomings: Measurement accuracy depends on the roll's surface quality. Calibrating these systems is time consuming, and they need intensive maintenance that possibly requires stocking additional spare rolls.

### A non-contact, highly reliable alternative

Alternative, non-contact measurement involves periodic excitation of the strip and measurement of the excitation amplitudes across the strip width. In the Siroll Siflat system, a periodically modulated vacuum between the strip and a sensor plate below the mill stand's pass line applies an excitation force onto the strip. A row of non-contact eddy current sensors then measures the strip's local oscillation amplitudes.

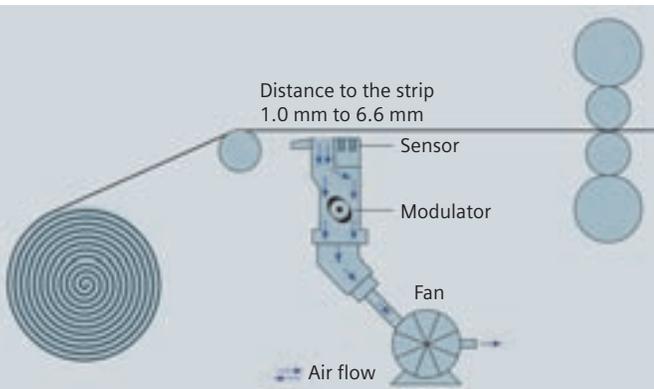
Siroll Siflat consists of a speed-controlled fan to create the vacuum, air pipes from the fan to the measurement device, a speed-controlled modula-



Siflat non-contact flatness measurement

tor, a sensor plate with perforations for air flow and sensors for measuring excitation amplitudes, plus electrical equipment for electronic evaluation and drive controls.

The system automatically adapts its excitation force to the process and works with the same exci-



**Functional principle: the modulated air stream excites the strip under tension**



tation amplitude for all strip dimensions through the entire range of strip tensions. Thus, the sensors are always working with the optimum stroke, regardless of material thickness and tensions, ensuring a wide measurement range.

In contrast to conventional methods that take a dis-

tributed sampling over one revolution of the roll, the system takes a consistent set of measurements from all sensors at once. This increases the quality of measured values since these values are not influenced by short-term tension variations.

As the process is independent of rolling speed, measurements can even be made when the mill is stopped. With up to ten samples per second, the system has a very short response time enabling it to instantly correct critical flatness errors, thereby greatly reducing waste. This is a significant advantage especially for reversing cold mills because most flatness errors appear immediately after start of the pass.

### Improved processes, reduced costs

The benefits of the Siroll Siflat approach include both process improvements and reduced operating costs:

The quality of flatness measurements improves substantially if the edge positions are known. Therefore, the system includes high-quality edge detection as a standard function. Additional sensors ensure high resolution and provide accurate strip width measurements.

## The benefits of the Siroll Siflat approach include both process improvements and reduced operating costs.

Since the system has no contact with the strip, it is not influenced (1) by disturbing forces that are generated by the bending action of the flatness roll under tension, (2) by the bending work as the strip runs over the roll or (3) by forces due to strip shift (especially when rolling asymmetric strip profiles).

The non-contact nature of the measurement approach reduces the risk of damaging the strip surface, thus ensuring higher surface quality. Also, this guarantees that there is no wear, thus ensuring a long system service life and low maintenance costs. Additional spare rolls are not required. And finally, the system can be calibrated quickly without prolonged downtimes. ■

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New continuous annealing lines for the production of a broad range of steel grades

# Siemens VAI Team Meets the Challenge

Driven by the automotive industry, the worldwide demand for microstructurally engineered steels is continuously growing and leading to higher equipment requirements. Therefore, Siemens VAI designed a new type of continuous annealing line for high throughput rates and yields, significant energy savings and the production of high-quality products with perfect strip-surface quality, tight tolerances, uniform mechanical properties and excellent flatness.

PROCESSING >



**B**ased on its Siroll PL philosophy, an in-house Siemens VAI team developed state-of-the-art key components for modern, reliable and profitable high-quality continuous annealing lines (CAL). This new type of CAL is focused on low-carbon Al-killed steels, IF-steel for drawing qualities, high-strength steels, advanced high-strength steels, dual-phase steels (DP), low-yield-ratio steels (LYR), transformation-induced plasticity steels (TRIP) and the newcomers as per complex phase, partial-martensitic and martensitic grades with thicknesses between 0.25 mm and 2.5 mm and widths of 900 mm up to 2,000 mm. Through careful and fully automated temperature control in combination with rapid cooling, a broad range of steel grades can be produced, particularly for automotive and stainless steel applications. Building on its success with the MaSteel project, Siemens VAI is currently preparing new annealing lines for Wuhan Iron and Steel's Cold Rolling Mill No. 3, for Tianjin Tiantie Metallurgical Group Steel Plate Ltd. Co. and for Xinyu Iron and Steel Co., Ltd.

## Main line features

Siemens VAI continuous annealing lines, with an overall annual capacity of about 600,000–1,000,000 tons, operate at a maximum process speed up to 420 m/min. These lines comprise an automatic entry section with an entry coil-car transportation system, a double-entry pass line, a mash-lap welder followed by a vertical cleaning section including hot alkali dunk tanks, two stages of brushes, electrolytic dunk tanks and rinse tanks. A double vertical entry loop-er to maintain a constant process speed precedes a vertical radiant tube annealing furnace that provides recrystallization annealing and temperature cycles for tuning material properties.

High-speed cooling by recirculating gas is then used to quench the strip at intervals greater than 100°C/sec. An intermediate double vertical looper sized to allow the temper-mill roll change decouples the surface-treatment section consisting of a combination temper mill and tension-leveler unit. An exit looper and the exit section comprising a side trimmer, inspection station, electrolytic oiler, flying shear and two tension reels, as well as the exit-coil transport system, are located downstream.

The automation and drive concept features a matched Level 2, Level 1, drives and HMI for very accurate tension control, highly responsive drives, optimized sequences and intuitive diagnostics. Automation is handled throughout the plant by Simatic S7 programmable controllers using standardized application modules as part of the integrated Siroll PL solution, ensuring easier commissioning as well as maintenance and service work.

### Special features make the difference

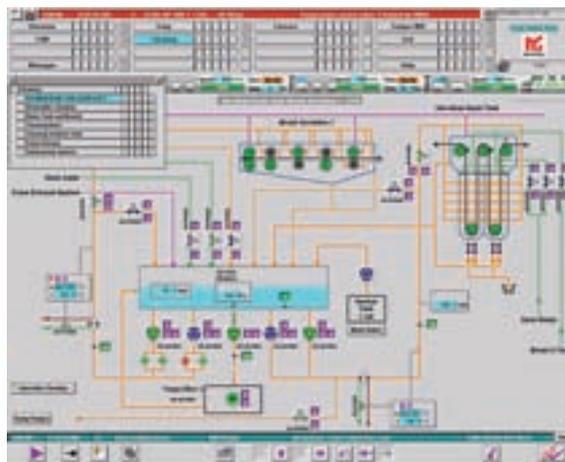
The core technology is contained in the key strategic special equipment, which is essential to the final product quality. First among these packages is the special duty welder ML21M, because of its unrivaled ability to weld advanced high-strength steel in a reliable weld joint. It features higher welding force, higher current and better feedback control of welding parameters.

The skin-pass mill and the tension-leveler equipment serve to meet the very strict specifications for surface roughness, mechanical properties, yield point erase and flatness of the final product. Providing a solution with the best results for automotive and stainless steel applications with respect to roughness transfer, modification of the metallurgical properties and flatness improvement was the challenge to be performed.

Based on Siemens VAI experience, the recommended solution is a quarto temper mill (with two possible work roll sizes – a large one for good roughness transfer on low-yield-strength steel grades and a small one for increased elongation capacity on high-strength steel grades) combined with a tension leveler permitting individual optimization of the performance parameters. Compared to a 6-high mill, this solution leads to very high strip properties (due to actuator interaction) with unmatched flatness performances. In addition, with elongation and roughness functions dissociated from the flatness function, the commissioning period can be reduced and operation is much easier.



Overall Equipment Efficiency (OEE) module



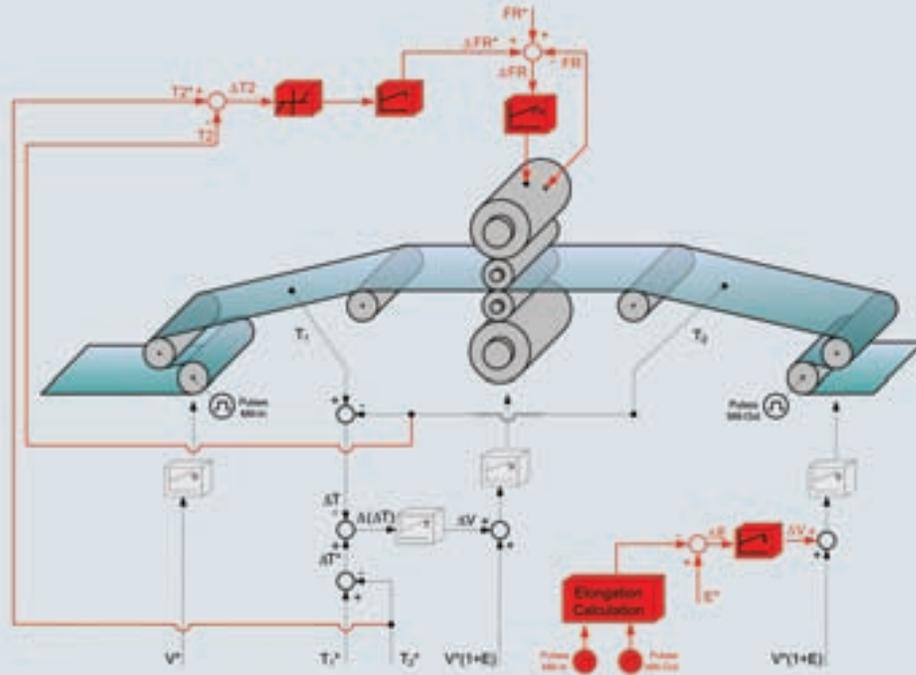
Typical HMI screen

### Automatic quality control

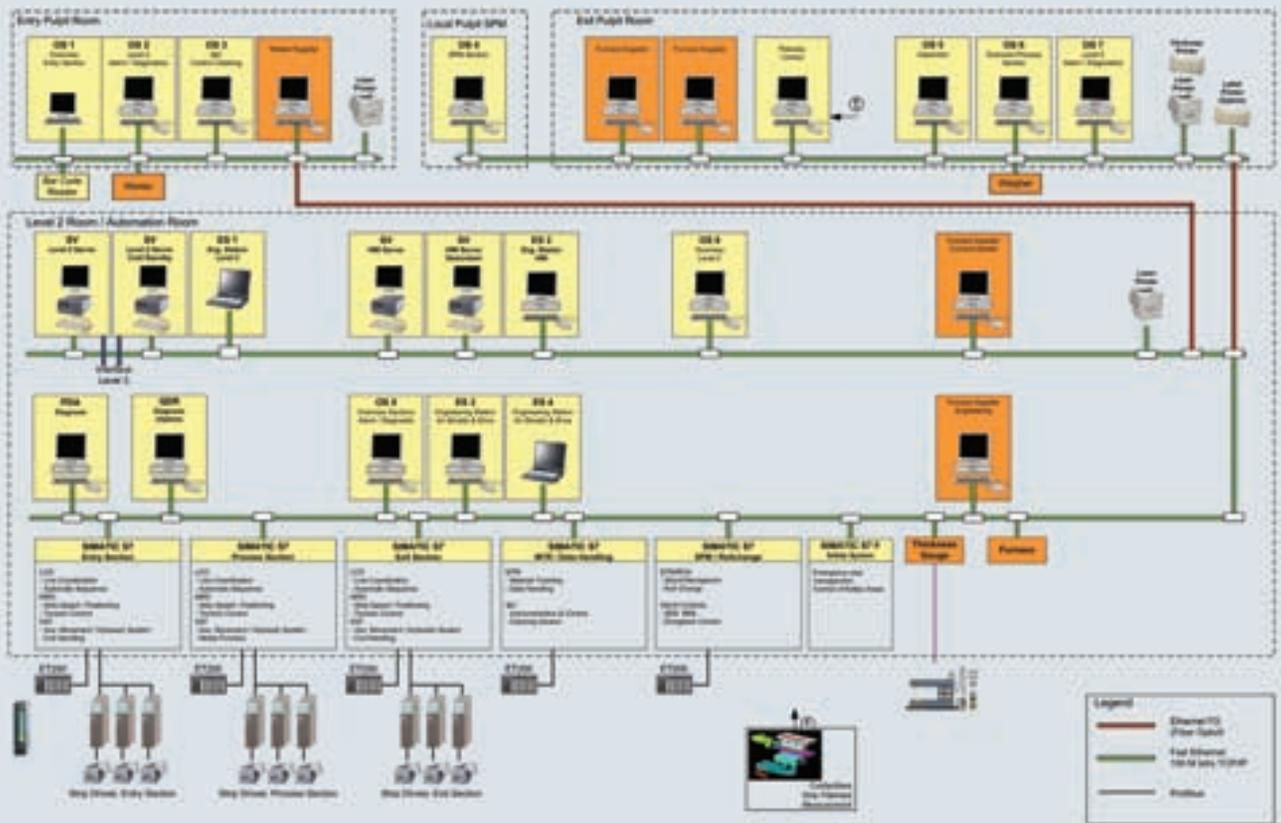
The quality of the strip surface is determined by the Siroll SIAS X-Line automatic surface-inspection system. This unit detects and classifies surface defects and issues strip-related reports, which enable the grading and sorting of products in accordance with customer requirements. In addition, the SIAS X-line surface-inspection system has a new width-measurement function with pixel accuracy (0.5 mm). This new functionality is able to not only detect holes and edge cracks but also to measure the product width in order to optimize edge trimming, and features location of edges with sub-pixel accuracy, geometric compensation of optics, CCD sensor and camera positioning, and compensation of strip vibrations and tension changes.

### Drive system

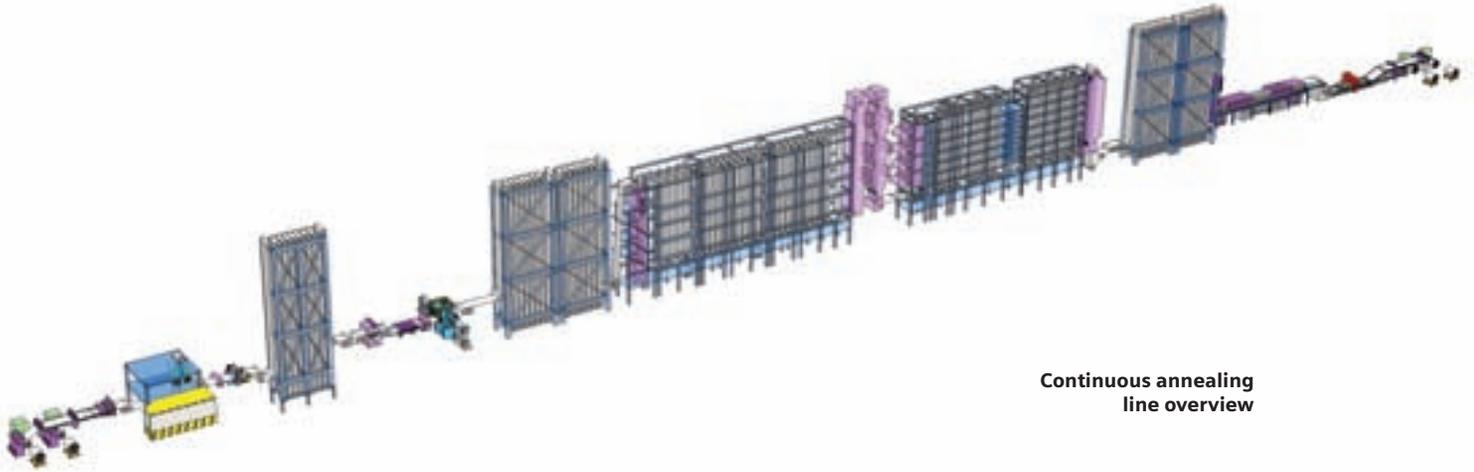
Sinamics, the advanced-technology frequency converters for AC drives, achieves the excellent dynamic performance required in processing-line drive applications. The AC-drive solution ensures high reliability, significant savings in maintenance costs combined with an increase in efficiency. The modular-voltage-source DC-link converter system has an innovative >>



Elongation control with mass flow



Example of automation overview



**Continuous annealing line overview**

>> digital control system and uses common DC-bus operation for sections of the drive systems in the plant.

#### Basic automation system (Level 1)

The Siemens VAI basic automation uses Simatic S7-400 programmable logic controllers (PLCs) for the different functions, such as sequential controls and the function module FM458 for high-speed technological controls. This enables easy fault-finding due to the clear division of the tasks. Moreover, the online programmability allows delay avoidance caused by rebooting the system. As a consequence, the design of the Siemens VAI automation system ensures an excellent reliability and high availability. The link to the plant takes place through intelligent terminal boxes (remote I/Os), which are connected to the central controller by bus cables using the standardized Profibus. The Profibus allows easy connectivity to additional equipment and controls, like weighing equipment or a coil binder.

#### Skin-pass mill controls

The targets of the skin-pass mill after the annealing process is not only to suppress the yield point elongation of the annealed strip but also to provide the strip surface with a defined roughness and to improve the stripe shape and flatness. For these reasons, materials that require a good flatness or surface must be temper rolled. The elongation has the most important influence on both the yield point, whereas tension and bending affect the strip flatness. The Siemens VAI skin-pass-mill control system comprises the following functions: constant roll-force control mode, elongation control with roll-force mode (for roughness transfer), roll-force and tension mode, and mass-flow mode. In elongation control via mass-flow mode, the elongation is controlled by the exit-side strip drive and is consequently affected by the accuracy of the speed controllers for the strip drives. Compared to the

roll-force mode, the Siemens VAI mass-flow mode enables the achievement of a significantly more exact elongation value and a unique surface roughness.

#### Process automation system (Level 2)

Expertly designed tracking modules and process models are a prerequisite for optimized production. The tasks of process automation start when the production data from Level 3 is received, generating the necessary production set points and tracking the strip through the line according to basic-automation information, and then reporting the finished material back to the Level 3. The input data, as well as the quality-relevant measured values, are administrated via an Oracle database that also contains the technological tables used for strip tensions and skin-pass-mill settings.

#### Strengthening competitiveness by monitoring effectiveness

Siroll PL now includes a high-potential solution to monitor the effectiveness of the line and the involvement of the people. The goal of Overall Equipment Efficiency (OEE) is to fight every loss, such as downtime, under speed, none quality, etc. Efficiently displayed in the HMI system on Level 2, the OEE module informs not only the operators about production efficiency but also give them the means to compare their performance with past values via records and graphs. With minimum manual input, the fully customizable OEE module ensures better operator involvement as the operators acquire a deep knowledge of the process, follow the indicators, qualify the stoppages and spread best practices within the teams. ■

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Exploring aluminum rolling mills in India

# Opportunities for Modernization

Due to the large natural reserves of bauxite and a wide range of established aluminum smelting, casting and rolling plants, India is in a strong position to increase its productivity of aluminum rolled products. Upgrading existing plants provides opportunities for improved quality and productivity while keeping investment costs down.

**T**he perimeter of the Indian subcontinent is dotted with bauxite reserves: in the east in the states of Gujarat, Maharashtra and Kerala; in the west predominantly in the states of Madhya Pradesh, Jharkhand and Orissa; and in the south in Andhra Pradesh and Tamil Nadu. Due to these natural reserves, the country has built up a significant aluminum process and rolling industry since the 1960s, with many new mills added in the 80s, 90s and at the turn of the millennium.

Today 30 different aluminum rolling companies with 37 rolling plants provide a total rolling capacity of 550,000 tons annually. India currently ranks number 9 out of the 71 aluminum-rolling countries worldwide and is looking to increase its capacity in the next few years.

Current rolling facilities cover a broad range starting with small plants providing one to two tons per year with a single hot and/or cold 2-high pull-over mill up to the large semi-automated plants with 4-Hi hot and cold mills providing up to 90,000 tpa. With the exception of one, all plants specialize only in hot and/or cold rolling or only foil rolling. India has 17 hot, 50 cold and 38 foil mills. A few of these plants

are currently idle, though plans are in place to modernize and restart them in the near future.

## Obtaining faster rolling speeds

Many mills have only manual gauge adjustment due to their age, and most cold and foil mills do not have any flatness control at all. These limitations restrict the maximum rolling speed, reduce the finished quality and keep productivity low. Furthermore, existing roll load is commonly set using slow screw mechanisms rather than fast modern hydraulic roll-load cylinders. Roll bend, a standard feature in modern mills used to improve flatness, is not available in many existing mills.

With the goal of increasing capacity, Indian rolling companies are looking to optimize their existing facilities. Siemens VAI provides a wide range of products and services designed to achieve faster rolling speeds coupled with accurate gauging and optimum flatness, leading to higher productivity and quality. Targeting the very heart of the rolling process, Siemens VAI provides modern high- and medium-pressure hydraulic systems that are custom designed to suit each mill. Siemens VAI also includes engi-



**Delivery of a Top-Hat cylinder**



**Bauxite mines in India**

neering services to ensure that the modern hydraulic systems supply optimum roll load and roll bend. Depending on the size of the mill housings and maximum required roll gap, either a “Pancake” or a “Top-Hat” style roll-load cylinder can be provided. Pancake cylinders are usually engineered to fit at the top of the mill enclosure underneath the roll-load screws and have a short stroke. Their primary objective is to provide fast gauge response during the rolling process when controlled by the Siroll Automatic Gauge Control. Top-Hat cylinders provide a complete replacement for the existing roll-load screw mechanism and have the benefits of the Pancake cylinder with the added advantage of a full-length stroke, enabling the work rolls to be opened fully as well as simplifying maintenance by removing existing screw mechanisms and drives.

#### **Integrated solution for flatness**

Flatness control requires a high-quality multi-zone shape sensor at the exit of the mill with an automatic flatness-control system acting upon the roll-bend cylinders for course control. Fine control is achieved through zone-specific cooling of the work and back-

up rolls using kerosene. The Siemens Siroll Air Bearing Shapemeter (ABSM) Rolls and ISV Spray Bars provide an ideal sensor and actuator package interfaced with the Siroll AGC/AFC control system to supply an integrated solution for optimum high-speed, gauge and flatness control (AGC and AFC). The hydraulic, automation, measurement and spray bar systems described above – coupled with modern Siemens automation – represent a brief overview of some of the products offered by Siemens VAI. These systems, together with a wide range of Siemens Sinamics AC drives, enable existing mills to be utilized beyond their original design capacity, providing aluminum producers with a cost-effective solution to increase both quality and productivity. ■

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Planned maintenance for smooth plant operations

# Cost-Effective Predictive Maintenance

Downtimes in a production system and the cost of bad-quality products caused by malfunctioning are very expensive. Therefore, many companies recognize the importance of designing and implementing a predictive maintenance (PDM) system. Aside from ensuring the most efficient maintenance possible, a PDM system increases equipment utilization and productivity, reduces spare-parts inventory and eliminates failures. In fact, every dollar invested in predictive maintenance generates savings of around \$20.

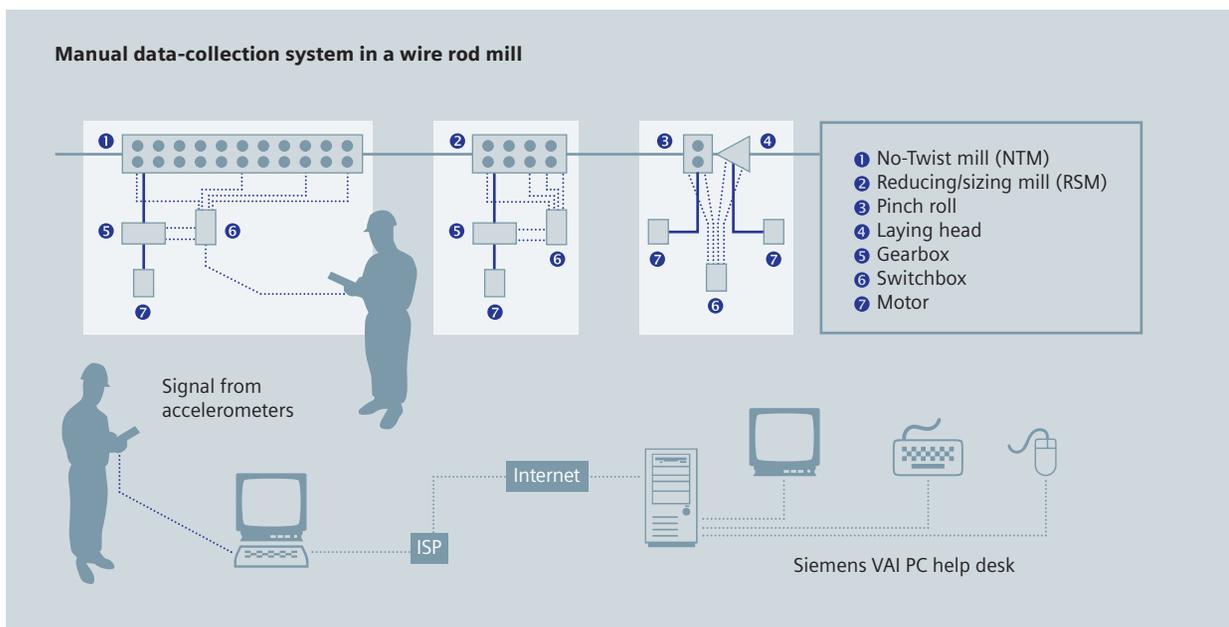
SERVICES ^

**T**he goal of predictive maintenance is to perform maintenance exactly when the equipment needs it – not earlier nor later than necessary. In steel plants, this calls for a careful analysis of critical equipment. Many failures give advanced warning through changes in machine or system parameters, such as vibration and temperature. PDM programs use noninvasive, online techniques to predict the failure of a machine or system.

### Vibration monitoring

Vibration-data monitoring is one of the most effective predictive technologies to monitor critical equipment. Vibration data is collected manually us-

ing portable data collectors or online. Siemens VAI provides the equipment and the training for customers to collect data themselves in a cost-effective manner. Data are typically collected periodically and stored in the data collector, extracted onto a memory stick and sent via e-mail to Siemens VAI predictive services team. Our experts analyze the data and generate a report within 24 hours, with valuable feedback and suggestions to help predict problems in advance. The data-collection-monitoring program can be easily implemented with Siemens VAI assistance, because the equipment and training are standardized. This predictive technology provides an exceptionally cost-effective solution with no interrup-



tions to mill operations. Some examples of critical equipment in a wire-rod/bar mill and a hot-strip mill are displayed in the figures.

### Acceptance limits

Knowledge of equipment is critical for setting adequate acceptance limits for each component. An understanding of equipment design and historical operating characteristics are essential for good predictive-maintenance operation. Also, it is necessary to establish baseline levels that will identify correctable problems before they escalate. Baseline levels are unique to all types of equipment and operating conditions. Historical trends compiled with equipment-rebuild records inform about relative equipment conditions. This information is extremely valuable and allows Siemens VAI predictive services to generate regular condition reports with proper prediction and resolution of problems.

### Case study 1: predictive maintenance in an Austrian wire-rod mill

voestalpine Austria Draht, a client of Siemens VAI predictive services, collects vibration data from its rod-mill equipment on a monthly basis. One of the findings in the January 2009 report was damage in the outer race of a cylindrical roller bearing in one of the driven bevel shafts in the No-Twist mill. During the analysis, Siemens VAI experts detected high-frequency vibration at multiples of 81,594 cpm, close to the outer-race defect frequency of the GA bearing on the driven bevel shaft, modulated by side-band vibration at the bottom line-shaft speed. Siemens VAI recommended inspection of the line shaft bearings/couplings and the gear for looseness and an inspection of GA bearing for wear/damage.

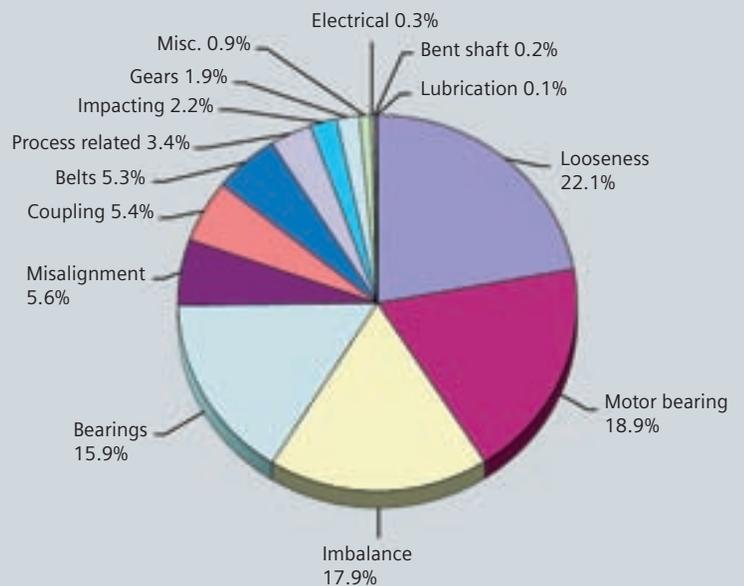
The GA bearing refers to the cylindrical roller bearing closer to bevel gear in the driven bevel shaft. The maintenance managers at voestalpine Draht were very impressed with the accuracy of the Siemens VAI analysis and they replaced the GA bearing on a weekend and found distinct damage on the outer race after disassembling the bearing.

### Case study 2: predictive maintenance in a North American hot-strip mill

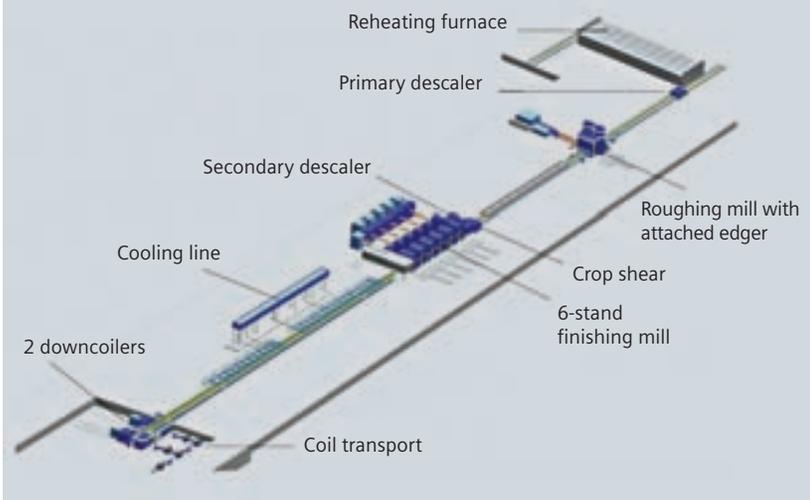
A North American flat mill has been using Siemens VAI vibration monitoring for the last ten years. Some of the equipment being monitored in the hot-strip mill includes furnace combustion fans, roughing-mill motor bearings and edger drives, descaler pumps, booster pumps, roll-cooling-water pumps, finishing-mill main drives and several rotating equipment in the downcoilers.

Siemens VAI has identified a number of problems and their root cause all the way up to identification of

**Historical data for hot-strip mill**  
Category distribution – 1,575 cases detected



**Vibration monitoring in a hot-strip mill**



the source component. There have been 1,575 findings in the two-star (medium danger) to four-star (dangerous) range. Of these, 35% were bearings, 22% mounting looseness and 18% imbalance situations. The pie chart shows the full detail of the problems. In cases like these, trend analysis is extremely powerful because it allows early action. The flat-mill owner can significantly reduce maintenance and operational costs and increase mill utilization by avoiding catastrophic failures. It is also possible to ensure that parts are available in advance and to better plan maintenance and personnel training. ■

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Metals Academy:

# Know-how For Success

As a supplier of metallurgical plants, expertise at Siemens VAI covers the complete process chain. In order to meet changing requirements over a plant's entire life cycle, it is essential to keep business-specific knowledge up to date and to develop new competence. The Metals Academy provides support through appropriate training content for all Siemens VAI employees – whether new to the career or established professionals – as well as its customers.

SERVICES >



**T**he Metals Academy is an important element of the Siemens VAI service portfolio. Founded in fiscal 2008, courses were offered already in that first year. The main focus is on training that covers engineering, technology and support in the areas of operations, service and maintenance. Our customers also profit from the solutions-based training, since their operations and maintenance staff can attend different training sessions. In order to offer a broad range of courses, the Metals Academy works closely with different internal and external partners. The training offering is constantly being extended and adjusted based on welcome feedback from employees and customers.

## Our offer to you

Courses cover:

- Engineering
- Technology
- Operations and practical examples
- Processes and tools

The courses on offer have until now covered a wide range of topics. One important component is the metals-specific automation and drive training, which was developed and is carried out with an internal partner. These courses provide the opportunity to train customers to use Siemens VAI-specific Simatic PCS7 and Simatic TDC solutions.

In the area of drive technology, in several two-week practical sessions participants from all over the world learn about commissioning Sinamics SM150 large drives using real-life examples. The training focuses on

the advantages of changing from older to newer drive technology in rolling mills, which offers customers not least of all shorter downtimes during reconstruction.

## The training offering is constantly being extended and adjusted.

Another international training session was held during the five days of the Power Days 2009. A total of 15 participants from Thailand, Singapore, Belgium and Germany attended, as well as representatives from headquarters in Linz and Erlangen. The first part – Network Planning – was all about laying networks in industrial facilities in the steel and rolling sector. Instructors conveyed well-founded basics in network topology from hookup to the public network all the way down to low-voltage main distribution, planning criteria, network calculations, safety projects, cable calculations, transformer selection, EAF-switching stations and SCADA (supervision, control and data acquisition) systems, among others.

Power Quality, the second part, addressed the distinctive features of steel and rolling mills in regard to system disturbances and the selection of corrective measures such as filter circuits, SVC (static var compensation), SVC PLUS and other special applications. Participants were presented with an overview of the product portfolio with special focus on the core products that make up Simetal PQ as well as current R&D projects. There was also the possibility to see a demonstration of online monitoring of a SVC facility (remote access). During an excursion to a Siemens transformer plant, participants were instructed on furnace transformers. The final highlight was a visit to the Siemens SVC/HVDC valve production site in Nuremberg.

A two-day training session based on the requirements of service execution center Germany, attended by 65 participants at three different sites in Germany, focused on metallurgy and process engineering in the production of iron and steel. Led by Dr. Thomas Matschullat (Technology & Innovation MTEA), the course started with raw-material preparation, iron creation in blast furnaces and through direct reduction, steelmaking in the converter and electric arc furnace, foamed slag regulation, secondary metallurgy, the casting process and metallurgical basics. The seminar was rounded off with a detailed review of energy and environmental technology as well as excursions supported by Thyssen Krupp Bruckhausen and DillingerHütte.



**The Metals Academy at Siemens VAI offers a whole range of courses for employees and customers**

Gerlinde Djumlija and Dr. Konrad Krimpelstätter (Technology Rolling Mill) held a two-day training session for over 40 participants covering rolling-mill technology and process engineering in cold-rolling mills. The topics included the overall production chain of cold-rolling mills, the differences of hot- and cold-rolling mills, layouts of different mill types like tandem cold mills, cold reversing mills and skin-pass mills, 4- and 6-high mill-stand technology and core equipment, the SmartCrown process, work-roll bending and shifting, off-line pass-schedule calculation and throughput calculation.

## Courses on offer cover a wide range of topics.

The topics covered in this article represent only part of the Metals Academy's activities. Plans for the current year call for deepening understanding in the regions for the Siemens VAI portfolio in order to ensure better life-cycle customer care along with technology training in metals technology. At the moment, content is being defined and further developed. Courses executed by Metals Academy will be announced. ■

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## Double Recognition

More than 40 entries competed for the 2009 Siemens Environmental Award in the Products & Solutions category. In the end, Siemens VAI climbed to the top of



the winners' podium with the first prize for its Simetal Meros solution including selective waste-gas recirculation (SWGR). In combination with SWGR technology, the sinter-off-gas scrubbing system Simetal Meros eliminates 99% of particulate matter, over 97% of heavy metals, and more than 90% of sulfur dioxide from the sinter

**The winners of the 2009 Siemens Environmental Award: Dr. Alexander Fleischanderl (Vice President Environmental Technology, 2<sup>nd</sup> from the left) and Andreas Jungbauer (General Manager Sales ESP, 5<sup>th</sup> from the left)**

off gas. The waste-gas recirculation process lowers the waste-gas volume by up to 40%. In addition, the entire technological package uses about 10% less fuel for the sinter process, reducing the carbon footprint accordingly.

The jury honored Siemens VAI with another award for the Endless Strip Production (ESP) system developed jointly by Siemens VAI and Arvedi. Arvedi ESP is a combined thin-slab casting-rolling line that needs 45% less energy than conventional continuous casting and rolling mills because the strip is still hot when it undergoes the subsequent processing steps.

With these two innovative solutions, Siemens VAI proves once more that investing in environmentally compatible technologies not only helps lower emissions but also leads to a lasting reduction in energy and raw-material demand. ■

## Siemens VAI Employee Honored by WISCO



**Ian Whitley, Siemens VAI UK, accepts "Most Honourable Foreign Expert Award" from Hu Wang Ming, Vice President of WISCO**

In February 2010, Siemens VAI UK project manager Ian Whitley received the "Most Honourable Foreign Expert Award" from Wuhan Iron and Steel (Group) Corp. (WISCO). The award was presented at WISCO's annual award ceremony, which was held in the city of Wuhan in Hubei Province, China. Whitley was chosen in recognition of his enthusiasm and cooperation with WISCO personnel during the work related to the 4.3 m plate mill project at Wuhan Iron & Steel Group Echeng Iron and Steel Co., Ltd (Egang). With the receipt of this award, Whitley has also become a lifetime honorary employee of WISCO.

Ian Whitley's dedication and commitment has strengthened and enhanced the relationship between Siemens VAI and this important Chinese steel producer. ■

## More information

You can find further information and company press releases at our online portal [www.siemens-vai.com](http://www.siemens-vai.com).

# Events: Upcoming Conferences and Fairs

- APR 06 – 08** 9<sup>th</sup> WORLD COPPER CONFERENCE, Santiago de Chile
- APR 12 – 13** CIS STEEL AND RAW MATERIALS MARKET, Kiev, Hyatt Regency, <http://www.steelsemis.com>
- APR 12 – 16** wire 2010 – Int. Fachmesse für Draht & Kabel, tube 2010 – Int. Rohrfachmesse, Düsseldorf, <http://www.messe-duesseldorf.de>
- APR 12 – 16** EXPOMIN, Santiago de Chile
- APR 12 – 18** 2009 SATEC (Sino-American Technology and Engineering Conference), <http://www.cie-usa.org>
- APR 14 – 17** BRAZIL STEEL CONGRESS, Sao Paulo, <http://www.acobrasil.org>
- APR 14 – 17** METEF – FOUNDEQ, Montichiari, Brescia, Garda Exhibition Centre, <http://www.metef.com>
- APR 15 – 16** STEEL TRADE 2010, Singapore
- APR 18 – 23** IRTC – International Rolling Technology Course, Oxford, <http://www.indauto.com/irtc>
- APR 19 – 21** 2<sup>nd</sup> WORLD LEAD CONFERENCE, Düsseldorf, Radisson Blue Scandinavia Hotel
- APR 19 – 22** INT. SYMPOSIUM ELECTRICAL ENGINEERING OF ARC FURNACES, Nuremberg, <http://www.stahl-akademie.de>
- APR 19 – 25** BAUMA 2010, Munich
- APR 20 – 23** EXPOMIN, Chile
- APR 21 – 23** STEEL MARKETS, Singapore, [www.abc-asia.com/steel](http://www.abc-asia.com/steel)
- APR 27 – 29** 6<sup>th</sup> ANNUAL EUROCOKE SUMMIT 2010, Lisbon, Sana Lisboa Hotel, <http://www.eurocoke2010.com>
- MAY 03 – 06** AISTECH 2010 – The Iron & Steel Technology Conference and Exhibition, Pittsburgh, David L. Lawrence Convention Center, <http://www.aist.org>
- MAY 04 – 06** 16<sup>th</sup> IRON ORE SYMPOSIUM, Prague, Intercontinental Hotel
- MAY 05 – 09** MTA MALAYSIA, Kuala Lumpur, Putra World Trade Center, <http://www.allworldexhibitions.com/industry.asp?id=9>
- MAY 08 – 12** CISA – MM CHINA 2010 concurrently the 6<sup>th</sup> CHINA INT'L STEEL CONGRESS, Beijing, Metal + Metallurgy Expo, <http://www.steelcongress.com/en/index.asp>
- MAY 12 – 15** LAMIERA 2010, Bologna, Bologna Fair, <http://www.lamiera.net>
- MAY 13 – 15** 12<sup>th</sup> ASIA PACIFIC CONFERENCE OF GERMAN BUSINESS, Singapore, Ritz-Carlton, Millenia Singapore, <http://www.apk.sg>
- MAY 17 – 20** SEAISI Conference & Exhibition, Vietnam, <http://www.seaisi.org/>
- MAY 18 – 19** SAUDI ARABIA CONFERENCE, Riyadh, Al Faisaliah Hotel
- MAY 23 – 26** 41<sup>st</sup> ABM STEELMAKING SEMINAR, Rio de Janeiro, tbd, <http://www.abmbrasil.com.br/seminarios/>
- MAY 24 – 27** METALLURGY LITMASH, Moscow
- MAY 25 – 26** 2<sup>nd</sup> ANNUAL ALUMINIUM CONFERENCE, Berlin, Hotel Concorde, <http://www.aluminium-conference.com>
- JUN 02 – 05** MANUFACTURING SURABAYA, Surabaya, <http://www.allworldexhibitions.com/industry.asp?id=9>
- JUN 07** GDMB Gesellschaft für Bergbau, Metallurgie, Rohstoff- und Umwelttechnik e.V., Hamburg
- JUN 06 – 10** 6<sup>th</sup> ECIC 2010 – EUROPEAN COKE AND IRONMAKING CONFERENCE, Düsseldorf
- JUN 09 – 11** ALUMINIUM CHINA, Shanghai
- JUN 09 – 12** MACHINE TOOL INDONESIA, Surabaya, <http://www.allworldexhibitions.com/metal>
- JUN 13-15** COPPER 2010, Hamburg, Congress Center, <http://www.cu2010.gdmb.de>
- JUN 13 – 15** 4<sup>th</sup> International Conference on Tribology in Manufacturing Process, Nice, Cemef, <http://www.ictmp2010.net>
- JUN 21-23** WORLD ALUMINIUM CONFERENCE 2010, Oslo, Radisson Blu Plaza, <http://www.worldaluminiumconference.com>
- JUN 23 – 26** 11<sup>th</sup> CHINA INT. METAL & METALLURGY EXHIBITION, Guangzhou, <http://www.metalspain.com/china.htm>
- JUL 04 – 09** 4<sup>th</sup> International Conference of Recrystallization and Grain Growth, Sheffield, <http://www.rex-gg-2010.org>
- JUL 06 – 09** MTA VIETNAM 2010, Ho Chi Minh City, <http://www.allworldexhibitions.com/industry.asp?id=9>
- JUL 26 – 30** 65<sup>th</sup> ABM Congress, Rio de Janeiro, Hotel Intercontinental
- JUL 26 – 30** 18<sup>th</sup> INT. FEDERATION OF HEAT TREATMENT AND SURFACE ENGINEERING (organized in parallel to 65<sup>th</sup> ABM Congress), Rio de Janeiro, Hotel Intercontinental
- SEP 07 – 09** 9<sup>th</sup> INT. STAINLESS & SPECIAL SUMMIT, Rome, The Westin Excelsior
- SEP 12 – 15** EUROMAT 2011, Montpellier, <http://euromat2011.fems.eu>



The next issue of metals&mining –

## Solutions for Quality and Company Workshops

Fulfillment of the required quality parameters is of paramount importance in all industrial and manufacturing sectors, particularly in the metals industries. Quality has its price, and defects have their costs. Indeed, it is generally far more costly to correct defects or errors and their consequences than to “do it right” from the beginning. If a defective product has to be resupplied, it will cost more than double the original production price in addition to other direct and indirect costs arising from penalties, customer dissatisfaction, tarnished reputation and potential loss of market shares. In the next issue of metals&mining, a wide range of Siemens VAI solutions will be presented showing how quality targets can be met during each step of the iron and steel production process right up to the finished product.

The second focus topic of the next issue will be on the references and capabilities of Siemens VAI workshops worldwide. Utilization of local, in-house manufacturing resources combines the advantages of competitive product pricing with assured quality control from Siemens VAI. Customers additionally benefit in that orders for plant components and spares can be serviced more quickly, and the proximity to producers is the basis for immediate support whenever required. Interviews with customer personnel from renowned quality-steel producers as well as examples of various plant and project references will round off the next issue of metals&mining.



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