SIMETAL\textsuperscript{CIS} BF – Solutions for blast furnaces

Technology, mechanics, automation and electrical engineering – solutions from a single source for process and cost optimization
An investment in a blast furnace is an investment in the future. Well engineered and properly built facilities will operate efficiently and economically for many decades. The selection of the right partner with considerable plant-building experience is therefore perhaps the most important decision for long-term success.

You expect ...

- Solutions which allow lower-cost raw materials to be used while meeting the required hot-metal production and quality targets
- Well engineered equipment and refractories which minimize production downtime and maximize the blast furnace campaign
- Advanced process control and automation systems which ensure stable process conditions with minimum operator interaction
- Solutions which reduce emissions to the environment to below legal limits
- Immediate support when required and long-term service for the entire life-cycle of your investment
Your challenge: Reliable, economic and environmentally compatible hot-metal production

Global driving forces
As the worldwide iron and steel industry continues to expand, greater demands are being placed on limited raw materials. Costs for good quality iron ore and coal as well as transportation costs are steadily increasing, yet at the same time keen competition amongst steelmakers sharply cuts back profits. A trend which can be observed in developing countries is that as the standard of living rises, there is a greater need for high quality steel for use in automobiles and household appliances, etc. Environmental regulations are becoming more stringent and costly investments are required to keep emission levels to within legal limits. The ongoing discussions with respect to CO₂ reductions, while necessary and in the interest of long-term sustainable growth, place increasing pressure on energy consumers, in particular, the iron and steel industry.

No room for error
A key challenge for blast furnace operators has always been to assure a continuous and reliable supply of hot metal for the steel plant at uniform quality and at the lowest possible costs. Any interruption in iron production can lead to potential standstills in the downstream production and processing facilities, affecting sales, customer loyalty and market position. Downtime must be kept to a minimum while the blast furnace campaign life must be extended for as long as possible. Fluctuations in blast furnace operating parameters must be avoided for uniform product quality, which is only possible through the application of sophisticated automation and process control solutions.

An investment in the future
A blast furnace is an investment in the future. Expert advice is needed for the proper dimensioning of all equipment, systems and components to assure the desired production and quality results. This is particularly true for plant modernizations which must meet the new demands placed on plant performance, personnel safety, lower maintenance requirements and environmental compliance. It is obvious that only reliable and highly experienced engineering companies be commissioned with the implementation of such projects. Should, however, unexpected problems occur, it is also crucially important that you have quick access to expert support either for on-site assessments and consultation when required, or available remotely via data links on a round-the-clock basis.
Success in the harsh and competitive world of iron and steelmaking is determined by costs, quality and the flexibility to meet the rapidly changing demands of the market. Advanced technology and proven solutions is the key for long-term sustainable blast furnace operation. May we extend our invitation to you to work together with us to meet the difficult challenges of today and tomorrow.
Our solution:
Fully optimized solutions for all requirements on the basis of experience

**Total solution competence**
We fully understand the requirements of the blast furnace. With over 185 plants supplied worldwide to date, we have the background and experience to meet your specific needs. Siemens VAI offers a complete portfolio of blast furnace technology, meeting the highest demands of plant performance, operational reliability and environmental compatibility. Our solutions extend from new turnkey installations to plant upgrades, and include all mechanical equipment, electric and automation systems, media supply and auxiliary facilities for small to ultra-large blast furnaces with hearth diameters exceeding even 15 meters! This single-source capability, in combination with expert project management and dedication to quality workmanship, is the basis for fast project completion and production ramp-up to design capacity.

**Engineering and design excellence**
Blast furnace excellence begins with the design. A fully optimized free-standing, thin-shell and structurally sound structure is installed to withstand stress and cracking, even towards the end of a furnace campaign. The water-cooling system, the number and positioning of staves, the water-flow rate, instrumentation and heat-monitoring systems are all fully optimized to ensure a long furnace shell lifetime and minimal maintenance requirements. Operator safety is enhanced with a flat, virtually obstacle-free casthouse floor and by sensitive emission-control systems.

With the new SIMETAL® Gimbal Top® charging system, raw materials can be accurately and flexibly charged onto the top surface of the blast furnace burden, promoting a uniform gas flow and ideal smelting-reduction conditions. In combination with the SIMETAL® BF VAiron process automation and optimization system, which includes numerous process models and an expert system, lower-cost raw materials can be used and the coke consumption substantially reduced. The result is major savings in blast furnace operation.

**Environmental compatibility**
Total environmental compliance is achieved with the latest developments in dustcatchers, cyclones and wet scrubbers. With these solutions the dust-separation efficiency can be flexibly adjusted to maximize dust recycling to the blast furnace and hence iron recovery without exceeding permissible concentrations of zinc and other heavy metal components in the burden. At the same time, the quantity of sludge that must be treated and dumped can be efficiently reduced. With the proprietary slag-granulation system of Siemens VAI, a cement-quality product is produced that can be profitably sold on the market.

**Profit from experience**
Well engineered plants are the basis for long-term successful and profitable operations. We have the complete range of solutions and systems to meet all requirements of the blast furnace. Profit from experience and profit from expertise from the world’s leading supplier of blast furnace technology.
A major investment means that there is no substitute for an experienced partner. Every step in the ironmaking process, each plant section and piece of equipment, their optimized design and total integration required for a high-performance blast furnace all add up to ... Siemens VAI.

**Good reasons for Siemens VAI blast furnace technology:**

- Single-source supply for all blast furnace equipment and service
- Proven engineering solutions on the basis of unparalleled experience
- Fast and reliable start-ups to rated capacity
- Consistent production of high-quality hot metal using advanced automation systems
- Ultra-long furnace campaigns of over 20 years
- Comprehensive service support for the entire life-cycle of your plant
Our technology paths:
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Our supplies and services:
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Lifecycle automation support ............................... 29
Modernization/Life-cycle management ................. 30
All equipment supplied by Siemens VAI is designed to suit the harsh environment of modern ironmaking operations. Our goal is to meet customer demands for furnace designs for reliable operation, minimum maintenance and safe and easy replacement of equipment for negligible downtime.
Consistent and reliable ironmaking

The overall result is consistent, reliable and low-cost hot-metal production as proven in scores of operating plants worldwide.

Main benefits:

- Complete blast furnace supply and services
- Proven engineering for all equipment
- Fast and reliable plant start-ups
- Consistent production of high-quality iron
- High productivity and fuel efficiency
- World-class availability
- Ultra-long campaigns of more than 20 years

Siemens VAI is dedicated to excellence in the field of blast furnace technology. Our experience, capability and resources allow us to undertake any blast furnace project size. Tailor-made solutions are provided to meet the exact needs of any producer. These solutions incorporate the latest process, mechanical and automation developments to enable our customers to produce the highest-quality hot metal, at the lowest possible production costs.

Designed for endurance

The latest free-standing furnace shell design with access tower is offered. Existing support structures can be rebuilt. State-of-the-art mechanical design is based on comprehensive stress distribution analyses. The use of crack-resistant steel ensures the lowest possible maintenance requirements.

Rebuilds, relines and modernizations

Siemens VAI is well known for its ability to perform blast furnace rebuilds, relines and modernizations within extremely tight timeframes.

Modular blast furnace construction concepts have been perfected to minimize project duration and plant downtime for both furnace rebuilds and relines.

Unique concepts and approaches have been jointly executed with the customer, with Siemens VAI providing the blast furnace technical expertise.

Existing Siemens VAI furnaces can be demolished, and new furnaces manufactured, delivered, built and commissioned in less than twelve months.

Innovative techniques in project management and construction are employed to minimize interfaces at each stage of the project.

Blast furnace design features

Setting the standards in technology

Blast furnace No.3, CST, Brazil
General:
- Freestanding shell and tower
- Comprehensive assessment of shell-stress distribution

Throat armor and staves:
- Heavy-duty armor castings
- Replaceable front plates
- Cast iron staves with independent cooling
- Consistent furnace temperature profile throughout campaign

Stave cooling:
- Robust integrated linings with built-in stave pipings along furnace height
- Use of copper staves in high heat-flux zones
- Reduced costs using cast iron staves

Refractories:
- Erosion-resistant alumina in upper stack
- Silicon carbide in bosh and belly
- Erosion-resistant carbon hearth walls with ceramic pad

Cooling plate options:
- High plate density along furnace height
- Welded plates to ensure complete sealing
- High heat transfer via multi-path coolers
- Optimized water cooling

Furnace ancillaries:
- Taphole equipment
- Furnace instrumentation
- Hot metal and slag-handling systems
- Casthouse dedusting

Fuel injection:
- Coal injection

Process control:
- Online furnace monitoring
- Heat and mass balance models
- Burden and hearth-wear models
- Online kinetic process model
- Expert closed-loop control

Hot-blast system:
- Fuel-gas injection
- Waste-heat recovery
Furnace refractories
Safe, durable, reliable and economical

The choice of the right refractories and cooling systems at each zone of the blast furnace is critical for successful, economic and, above all, safe ironmaking operations.
Siemens VAI refractory designs have been developed over a century and are well proven with respect to their long productivity campaigns.
The latest designs and materials are applied in an integrated approach, taking into consideration the campaign lifetime, process operations, cooling requirements, plant layout and construction procedures.
The blast furnace hearth refractories normally determine the campaign life of a furnace. The correct material selection, specification, inspection and installation are decisive for a safe and trouble-free furnace hearth. Siemens VAI has extensive experience in this field, ensuring that your plant will have a long and trouble-free campaign.

A long furnace campaign is assured by:
- Detailed investigations and studies
- Use of modern design and materials
- Close and careful inspections
- Application of latest construction techniques
- Site supervision
- Refractory dry-out/warm-up/commissioning

All furnace refractories fully meet ISO standards and critical items such as hearth carbons and tuyere housing units are trial assembled.
Many different materials and designs can be supplied to suit the specific requirements of each furnace such as:
- Carbon hearths featuring micropore and supermicropore carbons
- Ceramic arrestor courses
- Erosion-resistant ceramic cups

Design and supply of refractories for other parts of the ironmaking plant are available such as:
- Hot blast systems
- Low maintenance trough and runner systems
- Dirty gas system and gas cleaning plant refractories
- Tuyere stocks
- Material-handling systems
- Heat and fire protection

Experienced engineers and supervisors will advise you to ensure the optimum selection of materials and equipment as well as their proper installation.

Main benefits:
- Long lifetimes for maximum furnace campaign
- Cost effective
- Carefully selected materials for each blast furnace zone
- Rapid installation

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Leak detection
Accurate leak detection on furnace-cooling systems is a critical aspect of successful plant operation and safety. Our closed cooling circuits incorporate an expansion vessel which, together with our advanced control philosophy, allows accurate monitoring and safe operation of the closed circuit.

Main benefits:
- Total furnace shell protection
- Maximized furnace working volume
- Minimum cooling element costs
- Low operating and maintenance costs

Together with the refractory lining, the blast furnace cooling system is critical for ensuring an ultra-long campaign life. Siemens VAI furnace cooling circuits feature advanced control systems, accurate leak detection and emergency back-up systems.

Cooling water circuit
The cooling-water circuit design focuses on protecting both the furnace shell and the individual water-cooled elements. Closed-loop pressurized water circuits with forced recirculation and water treatment allow the circuit to operate at the ideal water velocity. This combination ensures efficient cooling and allows the water chemistry to be monitored, therefore resulting in minimal fouling of the water mains. Other advantages of this design are low water and power consumption. Reliable and easily maintainable plate heat exchangers are connected to an efficient secondary cooling circuit.

Economic and effective
For the main body of the furnace, stave cooling or, if required, plate cooling options can be supplied. In order to provide the best solution, the latest furnace cooling designs utilize both copper and cast iron staves. The use of staves reduces the need to install large quantities of refractories in the furnace stack. Also, staves allow the furnace temperature profile to be maintained throughout the campaign. Copper staves are specially designed for use in the high heat-flux zones of the furnace and have been proven to be highly reliable and cost-effective.

Cooling of the underhearth with water is available with the tubes positioned either above or below the base plate of the furnace. Hearth-wall cooling is accomplished by either the use of a water shower, jacket or stave coolers.

Leak detection
Accurate leak detection on furnace-cooling systems is a critical aspect of successful plant operation and safety. Our closed cooling circuits incorporate an expansion vessel which, together with our advanced control philosophy, allows accurate monitoring and safe operation of the closed circuit.
The iron making industry is constantly faced with the challenge of achieving higher productivity whilst satisfying the challenges posed by ever tightening operating margins and stricter environmental controls.

Flexible burden distribution control is seen as one of the key tools in the iron making process, providing the operator with the means to control, influence and improve furnace operation.

This means of providing burden distribution is through an innovative design of concentric gimbal rings, through a system directly driven by hydraulic cylinders. This arrangement allows the chute angle and position to be continuously adjusted during the material discharge period.

The system provides customers the opportunity to generate any burden profile by directing the charge to any point on the furnace stock line.

**Solutions to suit customer’s operation and budget**

The SIMETAL\textsuperscript{CIS} Gimbal Top SGT3000\textsuperscript{®} & SGT6000\textsuperscript{®} product range are designed to provide highly competitive, elegant, simple and robust solutions proven on high temperature and pressure applications which we believe offer advantages over market alternatives.

The range developed is suitable for both new and existing furnaces with either bell or non bell charging solutions and is sized for small, medium or large volume blast furnaces including:

- Parallel feed – two or more hoppers for large and medium blast furnaces
- Central feed – single hopper for small to medium skip and belt charge furnaces

**Proven design with significant advantages when using a SIMETAL\textsuperscript{CIS} Gimbal Top**

**Operational:**

- High pressure furnace operation
- Improved charging flexibility
- Improved service life avoiding frequent interventions
- Stabilised operation with optimised fuel rates
- Increased fuel injection improving productivity
- Reduced heat load and extended furnace life

**Engineering:**

- Simple, robust lever mechanism with external drive cylinders
- Even wear, prolonging the life of the chute
- Avoids high-precision mechanisms
- A closed-circuit water cooling system
SIMETAL™ SF VAiron blast furnace automation

SIMETAL™ SF VAiron functions on the basis of advanced process models, artificial intelligence, enhanced software applications, graphical user interfaces and operational know how. A flexible reliable process control system is the backbone of modern blast furnace operation.

SIMETAL™ SF VAiron is the world's first expert system which allows for the control of the main parameters of the blast furnace without the need for operator interaction.

SIMETAL™ GSM Gimbal Top control

Siemens VAI has a long history of successful control and automation packaged plants in the Iron & Steel industry. Based on a unique blend of manufacturing and engineering excellence our software and process engineering specialists can produce successful solutions for all aspects of furnace operation.

The blast furnace SIMETAL™ GSM Gimbal Top is an automated, computer-controlled pressurised charging system designed to:

- Receive charges of ore, coke and miscellaneous materials in the holding hopper, independently of the distribution system below
- Release those discharges, as required, to a dynamic distribution chute located below the holding hopper
- Distribute material in prescribed patterns to the furnace stock line in accordance with a pre-determined charging matrix

Control of the distribution chute is by means of a proprietary control and feedback system, which is fully integrated into the overall furnace top charging software. The system provides a high level of accuracy and control for the gimbal movements and hence the positioning of the distribution chute.

The furnace top charging package is designed to compliment our complete range of automation solutions, from process automation up to sophisticated SIMETAL™ GSM BF VAiron optimization packages and expert systems.

This unique ability of Siemens VAI to provide the complete ‘mechatronic’ technology package offers the customer the potential to ensure high-performance blast furnace operation at low cost.
Charging equipment, supplied for both new and existing furnaces, is designed for high top-pressure operation and exact burden distribution over the complete stockline. Reliable operation and ease of maintenance are guaranteed. Environmental measures such as gas and dust recovery during hopper depressurization can be included.

For upgrading bell furnaces, the top-charging systems require only minimum modification to the skip or belt charging system.

**Main benefits:**
- High flexibility with low investments
- Accurate burden control with coke and charging of two size fractions of sinter
- Online analysis and sampling systems
- Wear-resistant equipment
- Excellent emission control
- Fully automated systems
External combustion chamber stoves

Siemens VAI has further developed its Krupp Koppers technology to be the state-of-the-art external combustion chamber hot blast stove. Particularly suitable for ultra high temperature operation at high blast volumes, these stoves can withstand a maximum dome temperature of 1,550 °C while providing hot blast temperatures up to 1,350 °C. The durability of the design is shown by the fact that many of the early stoves built nearly 40 years ago are still in operation today.

Reliable, powerful and efficient

Complete hot blast stove systems, featuring state-of-the-art design of stoves, refractories and water-cooled valves, are supplied by Siemens VAI. Both internal and external combustion chamber stoves are offered. These feature a high efficiency ceramic burner, ensuring low CO, SO₂ and NOₓ emissions. A fuel saving waste heat recovery system can be provided.

The optimum configuration will be installed to ensure a reliable supply of hot blast to the blast furnaces.

Internal combustion chamber stoves

The modern Siemens VAI internal combustion chamber hot blast stove is an economical alternative to the more complex external combustion chamber design. Suitable for a maximum operating dome temperature of 1,450 °C, these stoves will provide a straight line blast temperature of up to 1,250 °C.

The stoves incorporate a mushroom dome, which expands independently of the ring walls. A fully ceramic dividing wall constructed from interlocking panels minimizes gas leakage.

External combustion chamber stoves

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Hot blast stoves
Long life, high efficiency, reliability

Stove dome
Externally supported domes eliminate the problems of thermal expansion. They are designed so that they can be quickly constructed and are highly durable.

Dividing wall
With the use of special, large-sized refractory panels the problem of gas leakage across the dividing wall of internal combustion chamber stoves has been totally eliminated. References for this design with over 20 years of continuous service are available.

Stove rebuilds
Unparalleled experience in the design and supply of all blast furnace related equipment and technology provides Siemens VAI with a unique capability to rebuild stoves of any type and from any supplier. Examples of our innovative approach to stove rebuilds include maintaining the stoves temperature while replacing the ceramic burner and also double-skinning stove domes suffering from stress corrosion cracking.

Siemens VAI Technology provides:
- Consistent blast temperatures at high efficiency
- Complete turnkey stove installations
- Internal and external combustion chamber technology
- Integrated waste heat recovery
- Repairs with minimum operational disruption
- Upgrading of existing stoves from any supplier and of any type

Stove refractories
The refractories form the heart of a stove and must operate in a trouble-free manner for several blast furnace campaigns.
Siemens VAI can investigate and report on the condition of the customers existing stoves to plan future maintenance or correction work.

Chequers
The thin wall chequer design optimizes wall thickness, hole size and ease of manufacture to offer the smallest stove size practical while delivering unrivalled performance for a wide range of operating conditions.

Stove burners
High efficiency ceramic burners for both internal and external combustion chamber stoves. The mixing efficiency of the Siemens VAI burner is such that it can meet and exceed the most stringent emissions limits on external and internal combustion chamber stoves.
Main benefits:
- Low emissions using high efficiency burners
- Simple shapes help reduce installation costs/durations
- Both internal and external stoves can be offered
- Fully optimized designs well proven in decades of operating experience

Hot blast systems:
Reliable, proven designs for:
- Hot blast branches and main
- Mixing chamber (vertical pot and radial)
- Bustle main
- Tuyere stocks

Supply and inspection
Refractories are supplied to the highest quality according to ISO standards. Refractory suppliers who have passed a rigorous qualification procedure are utilized to ensure material quality.

Installation
Refractory designs have been developed which allow a rapid installation. Refractory work is supervised by experienced personnel to ensure that high standards are always maintained.

Dry-out and warm up
Stove heating up is carefully controlled over a number of days to prevent thermal stress damage to the refractories.

The range of services offered by Siemens VAI include, but are not limited to:
- Investigations and studies
- High-efficiency designs
- Reliable material supply
- ISO inspection standards
- Dry-out/warm-up/commissioning
- Hot inspection of existing stoves
Casthouse and blast furnace equipment

Reliability, durability, and high performance

As proven at numerous operating blast furnace plants around the world, Siemens VAI blast furnace equipment has a reputation for reliability, durability, and high performance. Supplied to suit the arduous conditions of the blast furnace environment, equipment is designed and analyzed using the latest stress analysis tools built and workshop-tested to the highest standards.

Casthouse equipment:
- Hydraulic clay guns
- Hydraulic or hydro-pneumatic taphole drills
- Trough cover manipulators
- Tilting runners for iron and slag
- Bar changers
- Jack dam drills

The hydraulic taphole drill provides optimum drilling performance, employing a combination of high rotational drilling torque with a rapid percussive rate at medium impact energy.

This provides efficient drilling operations, reducing the need for hammer operation and minimizing the potential for cracking of the taphole refractories.

Automation features include optimized drilling (continuous monitoring and adjustment of feed force and drilling rotation), and automatic taphole length measurement.

Clay guns are designed for high clay ramming pressures, fast slew and automatic operation. Automation features include ‘autoplugging’ for taphole closure, with pre-programmed adjustable ramming speeds, volumes and sequences, as well as taphole face monitoring and visualization/control of the hydraulic power system.

Casthouse and blast furnace equipment

Hydraulic clay gun

Hydraulic or hydro-pneumatic taphole drills
Blast furnace equipment:
- Tuyere stocks
- Bleeder valves
- Equalizing/relief valves
- Above-burden temperature probes
- Sub-burden gas probes
- Mechanical stockline recorders
- Moveable and fixed throat armor
- Stockline ignition lances
- Profilemeter

Main benefits:
- Use of only reliable, durable and well proven equipment
- Automated features and functions where applicable
- Drill operation with minimum hammering to preserve refractories
When considering their gas cleaning requirements, customers must select blast furnace equipment which ideally utilizes raw materials, maximizes the gas energy recovery and meets all environmental regulations.

Siemens VAI has a long and successful history in supplying environmental plants of all types. These include water treatment, dust recycling, energy recovery and clean gas distribution systems.

Projects undertaken range from the supply of new gas cleaning plants, which maximize the collection of dry dust, to the replacement and upgrading of existing equipment to state-of-the-art solutions.

Many developments since its conception have resulted in a simple, robust gas cleaning system, ideally suited for all blast furnaces, even with a high coal injection rates.
To accommodate the increased utilization of tuyere injectants, Siemens VAI has developed an excellent corrosion protection system based on careful material selection and internal coatings. The single or multi venturi scrubbers are suitable for all modern blast furnace sizes and also for alternative iron and steelmaking processes.

**Main benefits:**
- Full range of solutions for all gas cleaning requirements
- Optimized dust separation efficiency
- Fulfillment of strictest environmental emission limitations
- Proven solutions on the basis of decades of experience

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**Primary gas cleaning**

Siemens VAI offers tailor-made solutions for dustcatchers, cyclones or a combination of both systems. The entire scope of the blast furnace primary gas cleaning system can be provided exactly in accordance with the needs of the customer.

However, where there is a need to remove higher percentages of dust and to reduce the water treatment requirements, the dustcatcher can be replaced by a cyclone.

**Secondary gas cleaning**

Traditionally secondary gas cleaning typically consisted of two distinct phases. The first stage being a spray tower and centrifugal separator or venturi washers with a water separator. The second stage of the process would be electrostatic precipitators with final pressure control using “septum valves”.

Siemens VAI has developed a range of solutions which combine these two stages in to a single vessel. The cyclone optimizes the recycling of blast furnace dusts carried over in the offgas system. The conditioning tower cools the gas to its adiabatic saturation temperature and removes a large percentage of dust particles remaining after primary cleaning. The scrubber completes the gas cleaning process to a guaranteed dust content of less than 5 mg/Nm³, while controlling the furnace pressure to within 1.5% of its setpoint.

The Siemens VAI gas scrubber has developed since its first installation in 1981 to include the option of one or three annular scrubbing units. The primary and secondary cleaning equipment has been proven over many years on blast furnaces around the world. The solutions developed for new gas cleaning plants are also ideally suited for retrofitting into existing facilities.
Product quality
Final product quality is affected by granulation water quantity, temperature and pressure. Granulation plants provided by Siemens VAI are designed to deliver a cement quality product.

The granulating head can be either a fixed design or variable orifice to give a constant water to slag ratio. Both will produce a cement quality granulate.

Environmental protection
To further enhance the environmental suitability of the process, the granulation system can be fully enclosed. Vapours produced during the granulation process are condensed in a dedicated tower.

Continuous dewatering
For the mechanical type, initial dewatering takes place on the hydraulically driven screw conveyor. Dewatering continues at the rotating drum filters. Final dewatering then takes place either in dedicated silos or at a stockpile. The moisture content is reduced to below 12% after only two hours of storage.

For the pumping solution, all of the dewatering takes place in the dedicated silos prior to the pumping of granulation water back to the process. This system achieves the same moisture content as noted above.

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For the pumping solution, all of the dewatering takes place in the dedicated silos prior to the pumping of granulation water back to the process. This system achieves the same moisture content as noted above.
Excellent water quality
Recirculated water can be cleaned of fine solids and slag wool by the mesh roll filter. By extracting the fine slag material separately from the primary granulate, the process can operate unhindered by filter blockage. This is not the case for processes extracting both size fractions simultaneously. This is a key advantage of the Siemens VAI system in terms of availability and maintenance requirements.

Tailor-made solutions
Whatever the requirements or constraints of the plant, whether pumped type or mechanical type; screw conveyor with or without mesh roll filter arrangements; fixed or variable orifice spray boxes; partly condensed, fully condensed or open discharge; silo or stockpile storage Siemens VAI can provide the optimum slag-granulation solution.

Main benefits:
- Wide range of available solutions meeting all requirements
- Production of high quality material suitable for use in the cement industry
- Environmentally friendly production meeting all emission limits

Fixed spray box
Drum filter internals
In order to reduce the blast furnace coke rate and to improve furnace operations, complete and well proven coal injection systems are provided for new and existing blast furnaces. This energy saving solution is supported by a complete technology/technical support package.
Superior process features

Coal feedstock is conveyed to a coal preparation plant where tramp material is removed by screening and an over-head magnet. The coal is then crushed and simultaneously dried in a stream of hot gas or in a combined mill/drier, followed by extraction through the system by means of an Induced Draught fan. Coal with the correct product size distribution is drawn up through a velocity separator and captured in a bag filter unit. The final product is screened prior to transfer to a storage silo.

A proportion of the exhaust gases are recycled back to the hot-gas generator at the mill/drier. This control feature ensures that the total oxygen content of the hot gas, in contact with the coal, is kept below 12% to eliminate any chance of ignition of the milled coal.

The coal-injection system is comprised of lock hoppers and injector units. The coal flow rate to each tuyere can be independently controlled by a mechanical feeder.

A simpler system with less accuracy of flow control to each tuyere can be provided, using a splitter based system.

The equipment supplied by Siemens VAI features an availability in excess of 98% and accurate coal injection rates to within 2%.

Main benefits:

- Coal injection rates of over 220 kg/t hot metal
- Exact control of coal injection to individual tuyeres
- Waste gas recycling to reduce fuel costs
- Major coke rate savings
- Well proven in 20 blast furnace installations
Automation and process control

SIMETALCIS BF VAiron blast furnace automation – ironmaking at its best

In addition to engineering and technological expertise, Siemens VAI provides a complete range of automation solutions, from process automation up to sophisticated optimization packages and expert systems.

Experience makes the difference
Siemens VAI has a long history of successful control and automation projects in the iron and steel industry, from turnkey equipment supply to complete plant installations. Based on a unique blend of manufacturing and engineering excellence, Siemens VAI can provide:

- Consultancy for new projects or upgrades, feasibility studies or cost assessments
- Hardware design, procurement and supply
- Automation software from its concept to factory testing, employing highly qualified control engineers in worldwide locations
- Turnkey design, from engineering to procurement up to commissioning
- Advisory services for complete project implementation
- Maintenance, training and continuous technical support

Process control systems
Siemens VAI software and process engineering specialists provide the ideal solution for all aspects of furnace operation, often within the framework of very tight construction or rebuild programs. These include:

- Furnace top control on skip or belt charged tops with complex charging patterns and burden distribution
- Unique spiral charging system for bell less top to increase the portion of fines that can be charged
- Stockhouse control of sequentially batched materials with ‘in-flight’ weighing and material layering
- Gas cleaning control
- Stoves control for cyclic, parallel, lapped parallel and staggered parallel 4-stove operation
- Coal injection systems
- Casthouse operation and control
- Slag granulation
- Plant safety and shutdown sequences
To ensure high performance blast furnace operation at low cost, a closed loop optimization system known as SIMETAL\textsuperscript{CIS} BF VAiron was developed by the automation division of Siemens VAI. The development of this system was achieved through close co-operation with the ironmaking division of voestalpine Stahl in Linz, Austria. A similar expert system, developed by the Finnish company Rautaruukki Technology, was also acquired by Siemens VAI.

Furnaces which are running one of these two systems produce more than 10\% of the total world hot metal output! It was therefore decided to combine forces and to create a new advanced SIMETAL\textsuperscript{CIS} BF VAiron system which incorporates the strengths of both two systems.

SIMETAL\textsuperscript{CIS} BF VAiron functions on the basis of advanced process models, artificial intelligence, enhanced software applications, graphical user interfaces and operational know-how. Excellent process performance and significantly lower production costs are the proven results.

**Process information management**

The process information management system collects, prepares and stores all relevant data for subsequent use in, for example, customer site-wide information systems.

**Process models to “see inside your blast furnace”**

Precise control of the blast furnace is achieved on the basis of advanced process models, examples of which are shown on the following page.

**Closed-loop expert system**

SIMETAL\textsuperscript{CIS} BF VAiron is the world’s first expert system where the main parameters of the blast furnace to be controlled are carried out without the need for operator interaction. For example, control of the coke rate, basicity, the steam injection rate and even the burden distribution can be simultaneously and automatically executed in a closed loop mode to ensure stable and consistent process operations at low production costs.
SIMETAL® BF VAiron optimized operations

Expert system control

The SIMETAL® BF VAiron blast furnace automation and optimization package offers a tool box of proven process models.

Model results are used by the closed loop expert system to maximize the performance and efficiency of blast furnace operations.

Main benefits:
- Combined technological, operational and automation expertise from a single partner
- Fully automatic blast furnace operation possible
- Closed-loop burden distribution control
- Comprehensive metallurgical insight into the process
- Easy system integration into existing automation environment

The focus of the advanced models is to provide results, that are not only displayed but directly used for optimized process control by the Closed-Loop Expert System.
Siemens VAI automation provides a full spectrum of services to assure that the supplied automation systems operate at a constantly high performance level over the entire life-cycle of a plant. Individual service packages are combined to assist customers in utilizing the full potential of their plants. A team of highly skilled automation engineers are available to support the customer’s staff – from consulting and troubleshooting, up to the execution of all automation related maintenance activities.

Maintenance tools
Siemens VAI maintenance tools perfectly interact with the automation systems.
- Maintenance Planner allows effective scheduling and documentation of repairs, services, inspections and other modifications of equipment
- Incident Analyser provides long term storage of alarms and web enabled statistical reports
- Diagnosis Server identifies abnormal data patterns and also irregular production situations before they can cause a malfunction

Technology partnership
Our assistance goes beyond trouble shooting towards a continuous improvement of the customer’s blast furnace.
- Siemens VAI experts and operators discuss new developments and possible improvements in regular know-how exchange meetings
- Support during critical operational phases guarantees an optimal utilization of valuable production time of the blast furnace
- Tailor made training packages can be prepared for production oriented goals or for specific projects
- Automation system upgrades allow major performance improvements with minor investments

Emergency support
Siemens VAI blast furnace automation experts are available to advise, evaluate and solve all automation-related matters. Any issues will be solved as quickly and economically as possible using either remote connections, local experts or staff from other locations.

Spare parts management
Siemens VAI spare parts services range from the supply of single spare parts to single source responsibility for the entire spare parts supply. Our in depth know-how also guarantees optimal replacement solutions for obsolete components.

Main benefits:
- Fast automation and back-up support
- Continuously improving product quality
- Low maintenance costs
- Significantly increased plant availability

Life-cycle automation support
An on-going partnership
Siemens VAI are the specialists for the modernization of blast furnaces. Depending on the requirements and customer wishes, our competence extends from the upgrading or replacement of individual equipment items and components up to complete furnace rebuilds, including the existing tower structure. Activities are carried out keeping furnace downtime to an absolute minimum.

**Scope of capabilities**

Improvements include, but are not limited to:
- Increasing the working volume of furnaces and hence their operating capacity
- Installation of state-of-the-art furnace top charging systems
- Enlargement of hearth volume by increasing the hearth diameter and taphole to tuyere distance
- Supply and installation of stave cooled stack linings with integrated furnace stack monitoring
- Increasing the number of tuyeres
- Improved automation and control system (Level 1, 2 or expert system)
- Upgrading of gas cleaning system
- Improvement and repair of hot blast stoves
- Replacement of clay gun and taphole drill

When possible, multiple furnace stacks and tower modules are preassembled. Modules are sized to the main erection crane, crucial to a successful project. Rigorous quality standards are monitored throughout the entire assembly period. A 'just-in-time' philosophy across multiple work fronts is adopted when applicable. Modules are constructed complete with stairs, walkways and all pipe mains.

**Main benefits:**
- Modular construction philosophy
- Multi-discipline work including structural, piping and electrical activities
- Reduction of non-productive time
- Excellent access provided in support of safe working methods
- Proven quality benefits
- Use of mobile platforms, reducing scaffolding costs
Siemens VAI Life-cycle services

As a plant operator, you have conflicting needs. On the one hand, your performance is measured each quarter against short term profitability expectations. On the other hand, you have to think on a totally different timescale compared with the capital market. Depending on the lifetime of your plant, you have to take 15 years or more into account. At the very least, that's 60 full quarters.

But thanks to our comprehensive expertise and integrated approach to solutions, you benefit both short term and long term from our life-cycle services.

In the short term: Backed by our extensive experience with many reference plants, we provide you with the certainty of fast, dependable production start-up and shorter amortization periods.

In the long term: Our master plan guarantees competitive performance for your plant in every phase of its life-cycle. Whether we’re providing 24/7 technical support, optimizing maintenance, or making permanent plant improvements, we’re always working to ensure the cost effective operation of your plant.

Life-cycle management
Partnership never ends
Expertise from experience
Selected success stories

Blast furnace technology – Setting the standards

Customer: CST, Vitoria, Brazil
Type of system: Blast furnace No. 3
Furnace size: 3,617 m³ with hearth diameter of 12.5 m
Our solution: Turnkey plant on greenfield site
The result: Completion date – end of 2006
**Profit through quality**

**Customer:** Corus, Port Talbot Works, U.K.

**Type of system:** Blast furnace No. 5

- Furnace size: 2,560 m³ with hearth diameter of 10.8 m

**Our solution:** Modular construction to minimize erection program

**The result:** Successful blow in, less than a year after contract award – the world’s best time for a new blast furnace on existing foundations

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**Re-build engineering – geared for the future**

**Customer:** voestalpine Stahl, Linz, Austria

**Type of system:** Blast furnace 'A'

- Furnace size: 3,100 m³ with hearth diameter of 12.0 m

**Our solution:** Re-build engineering of blast furnace

**The result:** Completion date – 2004

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**Re-line in shortest time**

**Customer:** CSN, Volta Redonda, Brazil

**Type of system:** Blast furnace No. 3

- Furnace size: 4,250 m³ with hearth diameter of 13.5 m

**Our solution:** Turnkey contract for re-line of the blast furnace

**The result:** After a 98½ day shut down, the furnace was blown-in during August 2001
Completely Integrated Solutions with Siemens VAI
Integrated offerings for higher plant performance

Optimized processes
We lay the foundation for optimized processes with proven, leading products worldwide, including mechanical and technological engineering for metal production, rolling and strip processing as well as process control engineering, drive engineering and power supply. Integrated online and offline process models reflect decades of practical experience and help to ensure reliable, reproducible quality.

Our process engineering expertise fuses these products into complete plant solutions that also accommodate the upstream and downstream processes. These solutions are the basis for optimal resource use, minimized waiting times and reduced maintenance and spare parts costs, as well as wide flexibility with respect to raw materials and the resulting products.

Efficient production control
A further factor for competitive production is the quality of information processing. Production data must be consolidated and compared with planning data to ensure optimal production flow.

As a leading supplier for the metals industry Siemens VAI offers integrated information technology across all automation levels – from the sensor to the Enterprise Resource Planning system. Patented solutions, such as for smelting reduction plants, electric arc furnaces, hot strip mills, profile rolling or processing lines, enable systematic quality assurance, efficient logistics, flexible production planning and scheduling, end-to-end tracking and tracing from raw materials to the end product and back, and much more.

Maximized life-cycle returns
Services from Siemens VAI help to ensure high profitability for your plant throughout the entire life-cycle. Reliable project implementation by our specialists sets the course for quick start-up and repayment of funds as scheduled.

During the operating phase, preventive maintenance, standardized components and component design that meets the requirements of steel plants help keep maintenance costs low. A reliable spare parts supply – with in-house workshops for key components – ensures high availability. And modernization at the right time guarantees a high level of competitiveness and compliance with environmental regulations in the future.
Perfect integration of every aspect

Completely Integrated Solutions from Siemens VAI – your benefits from an integrated concept:

- High process quality, lower energy costs and increased throughput – by taking all process steps into account
- Reproducible high product quality and efficient use of charging materials – thanks to integrated process models
- High enterprise quality, low life-cycle costs and unique investment protection – through flexible production based on metal-specific MES systems, intelligent plant design and integrated planning.

Completely Integrated Solutions offer a comprehensive range of products and services, tailored and refined to the specific requirements of your plant.
The key to this approach is the close interlinking of plant construction, process engineering, electrical and automation engineering, sensors and actuators, as well as information technology and life-cycle services, seamlessly integrated by Siemens VAI.
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