



Steelmaking Automation

Setting reproducible high quality standards

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SIEMENS
V A I 

Automation expertise

Completely integrated solutions for steelmaking plants

The challenge:

In the booming metals market steel producers meet capacity limits, while demands on products and processes are ever increasing: Customers, such as the automotive industry, permanently ask for enhanced chemical and physical steel properties. Top grade steel quality is in high demand and absolutely crucial for entering high-margin market segments. As a result, steel plants have to operate at an extremely high efficiency and availability to produce the required quantities. As a consequence of globalization, many steel producers operate globally, and that requires greater expenses for coordination and a high degree of transparency.

The requirements described above must be met in order to ensure a competitive edge for your steel plant. Entire production routes, that may even be linked globally, have to be optimized. Achievement of a sustainable profit life-cycle management of the applied technology and solutions is a must.

Our solutions:

Steelmaking today is unthinkable without sophisticated automation. Siemens VAI automation systems, based on decades of combined engineering, plant-building, operational, metallurgical and automation experience, are the key to high-tech steelmaking for high quality products at low production costs. These systems include:

- Completely integrated solutions for the entire iron and steel production route
- Both integrated and stand-alone solutions for all automation levels
- Modular-designed, expandable and upgradeable automation packages
- In-house experience in software and hardware engineering for fastest project implementation and start-up
- Solution-oriented service for all stages of the project, from feasibility studies to start-up and client training
- Unique features include the optimized "plug and play" SIMATIC components which are linked to the controllers and models for continuous optimization of the process, along with the flexibility to add or exchange these in the plant





Good reasons for Siemens VAI steelmaking automation

- Integrated automation solutions for constantly high, reproducible steel quality
- Comprehensive, consistent operator guidance and process information throughout the complete steel production route
- Standardized production operations yielding homogenous steel quality that fulfils certification requirements
- Increased productivity through optimized steel melting and refining processes for shorter treatment durations
- Minimized production costs using process models for optimized material usage and energy input

Advanced systems for maximized benefits

Experience makes the difference



Leading automation solutions ...

Siemens VAI steelmaking automation

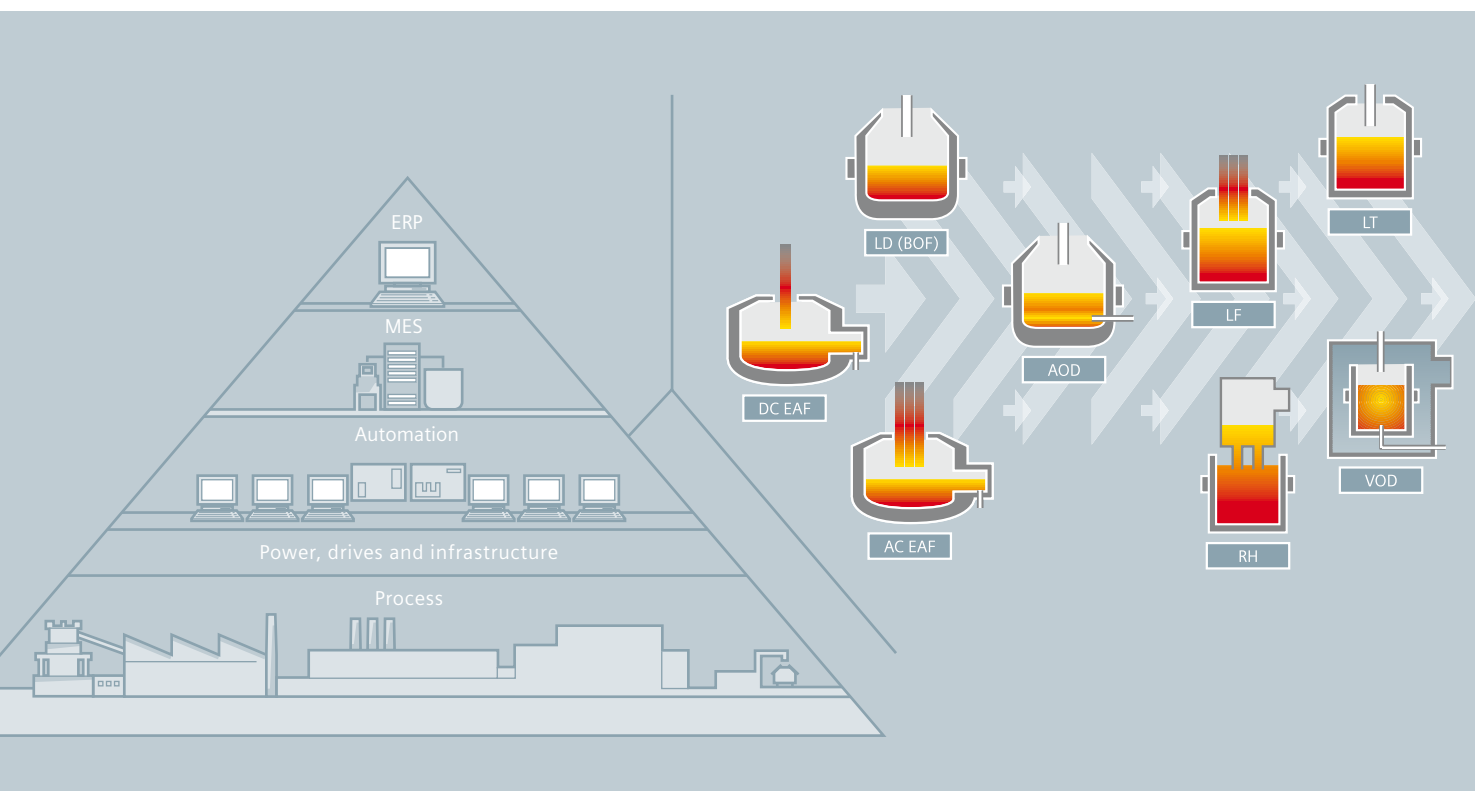
Siemens VAI steelmaking automation supplies state-of-the-art solutions for maximum performance and product quality throughout the entire steel plant.

The unique advantage of this integrated approach is that it covers the aspects of process stability, product quality and operation flexibility, while safeguarding efficiency and profitability throughout the entire plant life-cycle.

Decades of experience with steelmaking technology, combined with extensive automation expertise, is the basis for highly advanced automation systems for every

plant unit. Proven solutions for power supply, drives, technological packages and process optimization enable smooth production and the intelligent use of energy and raw materials. And forward-looking service concepts ensure continuous high availability of plant and equipment.

Your investment is protected by our standardized overall design with clear-cut interfaces. As a plant operator, you can absolutely rely on Siemens VAI steelmaking automation, including upgrading or expanding automation scenarios as well.



... on all plant levels for each steel production unit

Process optimization models

SteelExpert is the comprehensive group of process models that perfectly images and optimizes the process of steelmaking in different production units.

SteelExpert Supervision, a set of online models, is monitoring the metallurgical and thermal process, cyclically calculates the actual condition of steel bath and slag. This provides the analysis and temperature of steel bath and slag at any time and setpoint model calculations are always based on the actual situation.

The extensive group of setpoint models results in SteelExpert Setpoint, which is responsible for determining the required supplies of raw materials, gas volumes and/or energy for different treatment steps.

SteelExpert Prediction performs a simulation of the complete production process – using the results of supervision and setpoint models. It provides a forecast of the progress and the final condition of the heat, it also predicts all required additions and actions and serves to optimize the production process.

Whereas the models are adjusted specifically to the special requirements at different production units, the principle of SteelExpert combining the features of prediction, supervision and setpoint models for perfect quality is applied throughout the entire steelmaking automation.

VAI-Q Steel

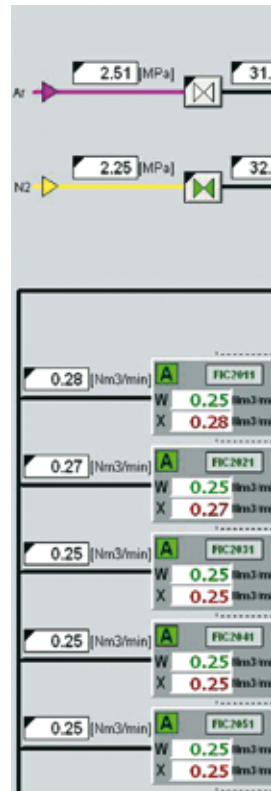
Siemens VAI provides automated quality control systems for the entire steel production route under the family name VAI-Q.

VAI-Q Steel interacts seamlessly with the Siemens VAI process models and guides the operators step by step through steelmaking and refining. Starting from a simulation for the planned production route, it dynamically reacts to changing production situations and adapts the required treatment actions based on the current situation.

Comprehensive quality information, as a guide for the operators, is displayed in the individual pulpits as part of the process computer screens. The decisions of the system are based on an integral view of the entire steelmaking and refining process.

LD (BOF) converter automation

Intelligent solutions to conquer the market



1st hot metal charging at Jiangsu Shagang, Zhangjiagang, China

LD (BOF) process control

Siemens VAI automation solutions for process control (level 1) cover the entire LD (BOF) steelmaking process, including:

- Oxygen lance control system
- Converter tilting drive
- Substance measuring system
- Bottom stirring – single line control
- Additive and alloy weighing and control
- Waste gas cooling and cleaning
- Gas recovery and analyzing
- Slopping prevention system
- Secondary dedusting
- Interlocking and alarm system
- Human machine interface

Bottom stirring

Bottom stirring using inert gas offers advantages in metallurgical and operational aspects. In particular, the process kinetics are significantly improved and the decarburization reaction at low carbon content is forced.

Individual gas flow control offers an optimum of working safety and operational convenience:

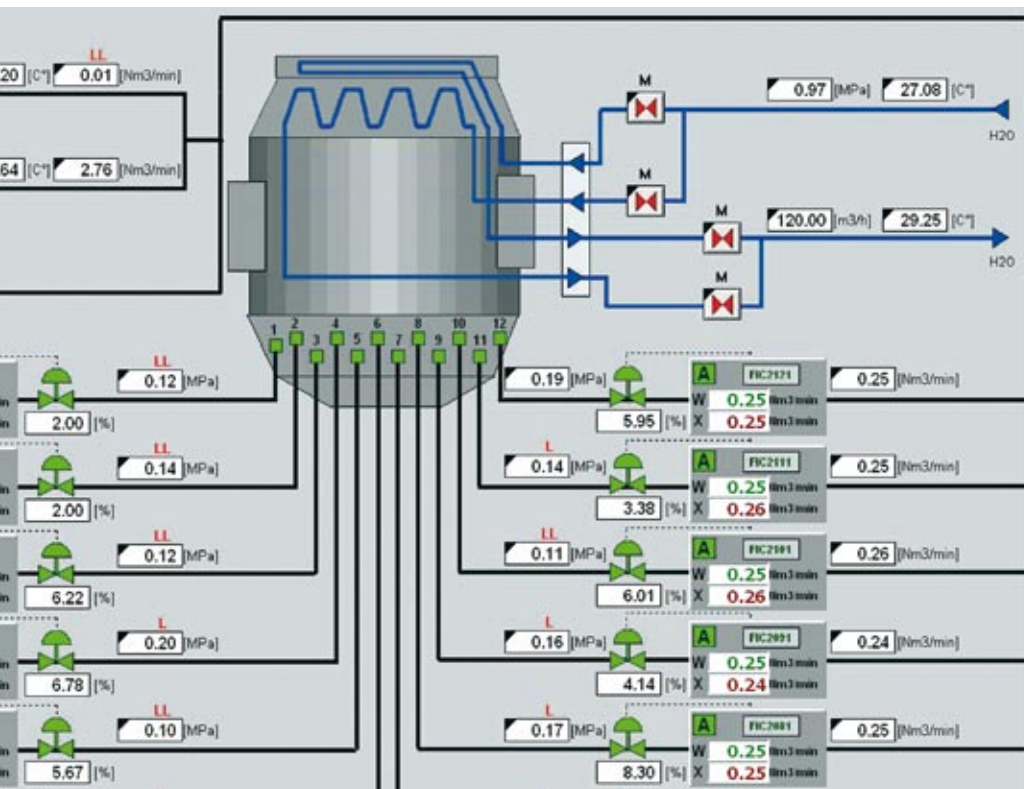
- Uniform distribution of the gas flow among each stirring element ensures an even cooling effect and thus prevents a different wear behavior of individual stirring elements.
- Failure of a stirring element is compensated by those stirring elements still in operation, so that a constant efficiency of the bottom stirring process is maintained.
- Reading of gas flow and gas pressure as well as indication of valve positions allows a permanent control of each stirring element.

Main benefits:

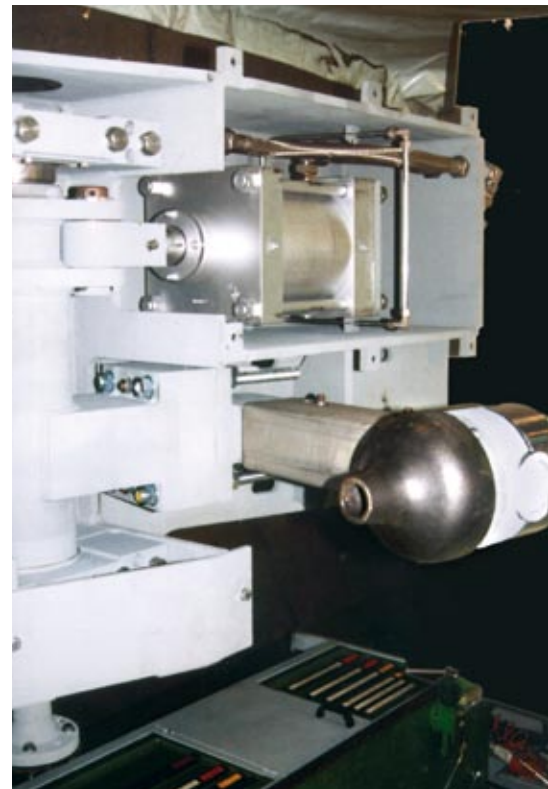
- Yield increase of more than 1 %
- Fast and accurate adjustment of tapping temperature
- Reducing the carbon content to 0.02 % without the need of vacuum treatment
- Lower phosphorous and oxygen levels
- Reduced flux quantities (more than 10 %)
- Tolerance to a wide range of hot metal compositions



Bottom injection of inert gas for best performance and a long life



Bottom stirring process control



Pneumatic slag stopper for more cost savings

Sublance system

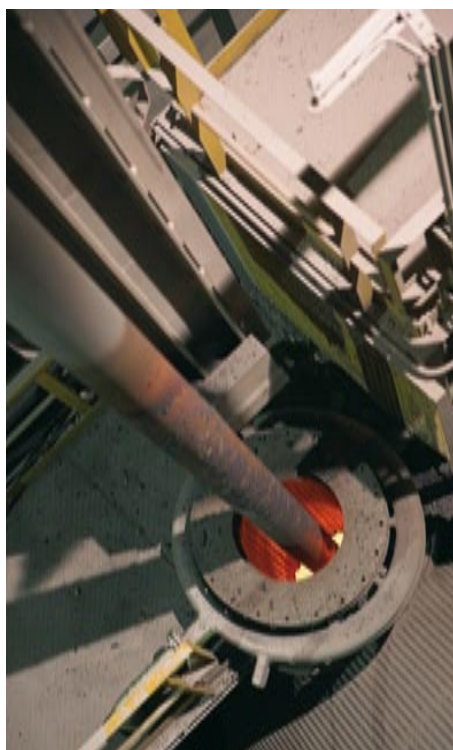
The sublance system is used for measuring temperature, carbon content and oxygen activity of the steel bath, as well as for taking steel samples without the need to interrupt the oxygen blow.

Instrumentation and drives ensure excellent position accuracy and operational safety. Closed-loop process control of the sublance allows fully automatic in-blow or end-of-blow measurements.

The process optimization model SteelExpert dynamically supervises and controls the oxygen blowing process based on the in-blow measurement. By determining the ideal blow-end-point, significant operational savings and improvement of productivity are obtained.

Main benefits:

- Reduced charge to tap time
- Improved hitting rate
- Increased iron yield
- Reduced oxygen consumption



The sublance, a central part of dynamic process control

Pneumatic slag stopper

In order to avoid carry-over slag from the converter getting into the ladle at the end of tapping, a cast iron nozzle is slewed into the tap hole from the outside through which retaining gas is blown. Sealing is performed pneumatically and thus not influenced by irregular tap hole wear and slag consistency. Reliable sealing can be done with any type of slag.

Slag detection and actuation of the slag stopper in regular operation is made automatically by means of the "IRIS" (infrared indication of slag) system. This system evaluates the infrared radiation differences of steel and slag, respectively, which are recorded by an infrared camera.

Main benefits:

- Lower cost of deoxidation agent
- Higher ferro alloy yield
- Lower refractory consumption
- Lower rephosphorization rate
- Less inclusions

LD (BOF) process optimization

Maximized performance through dynamic modeling



Dynamic supervision of blowing process

LD (BOF) converter automation

Siemens VAI automation for LD (BOF) steelmaking not only considers the vessel-specific process functions, but also takes into account the relevant parameters of the charging materials, including hot metal preparation, scrap yard management and scheduling logistics. Process optimization (level 2) solutions are based on advanced algorithmic equations, which accurately represent the complex thermodynamic-metallurgical reactions. The solutions are particularly suitable for a wide range of operating conditions, e.g. variable scrap to hot metal ratios, minimum slag practice and varying phosphorus content.

Dynamic process models

- Based on the hot metal weight, analysis and temperature, SteelExpert HM Desulph calculates the necessary material type and weight for achieving the desired sulphur content in the hot metal.
- SteelExpert Prediction simulates the complete LD (BOF) process before the heat is actually started and determines the optimum blowing and stirring strategy, as well as the exact time and portioning of vessel additions.
- Taking into account the hot metal temperature and analysis, SteelExpert FCC (first charge calculation) determines the required quantities of different scrap types, as well as the amount of hot metal to be charged to the LD (BOF) vessel.

- Based on the actual data of hot metal and scrap charged to the LD (BOF) vessel, SteelExpert SCC (second charge calculation) automatically calculates the required oxygen volume and vessel additions to achieve the desired steel quality.
- SteelExpert Inblow uses the information from a substance measurement for a refinement of SteelExpert SCC by a calculation of heating/cooling agents and remaining oxygen for an improved hitting rate.
- SteelExpert Reblow is applied in the rare event of necessary reblowing. It determines the required oxygen volume and vessel additions for various reblowing reasons.
- SteelExpert Alloy determines the types and amount of alloying materials to be added during tapping in a cost-optimized way.



LD (BOF) pulpit at Taiyuan ISCO, China

- SteelExpert Supervision cyclically calculates the actual condition of steel bath and slag from charging end to tapping start.
- DYNACON
If a continuous off-gas measurement (analysis and flow) is available, DYNACON is applied as a supplement for SteelExpert Supervision. It dynamically calculates the optimum moment for blow end to achieve the target carbon content of the steel from the off-gas information. Thus DYNACON is saving valuable time due to the uninterrupted blowing process and therefore unimpaired decarburization rate. The combination of the supervision model and DYNACON is a convincing approach for increasing carbon and temperature hitting rates with low investment, maintenance and operational expenses.

A proven solution for off-gas measurement is LOMAS®, which carries out continuous gas analysis during the combustion process at high temperatures and dust loads, and in corrosive and reducing environment conditions. The analysis from the installed mass spectrometer is transmitted in two-second intervals and directly utilized in the dynamic process control.

References

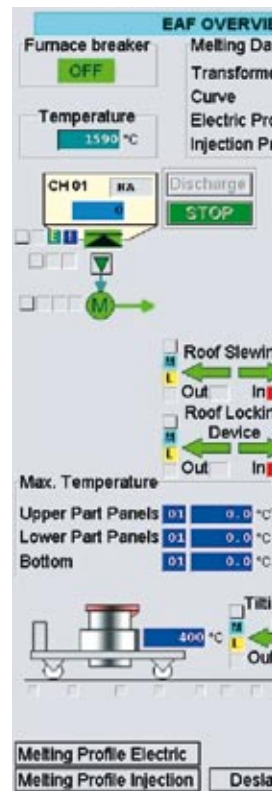
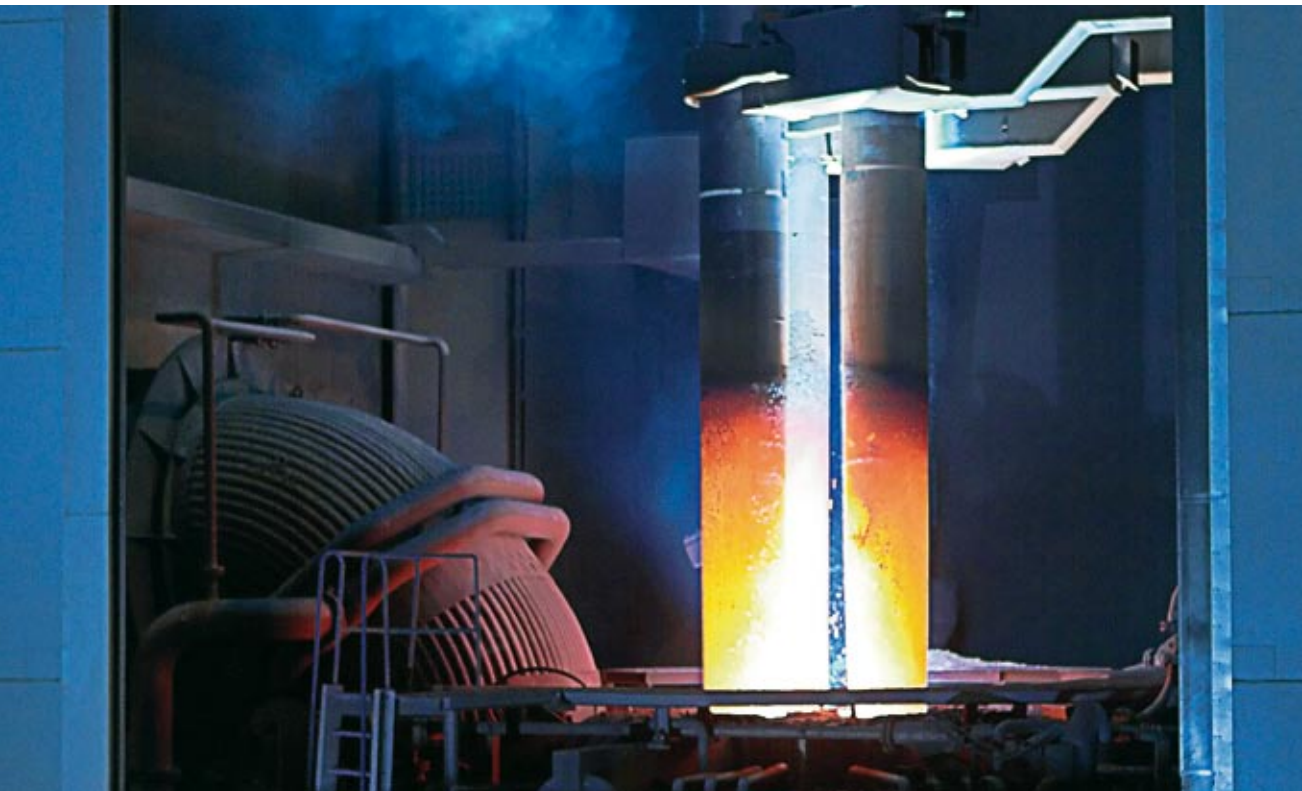
- Nanjing ISCO, China
- Taiyuan ISCO, China
- US-Steel Kosice, Slovakia
- Maanshan ISCO, China
- Mittal Steel Vanderbijlpark, South Africa

Main benefits:

- Temperature deviation reduced by 40 %
- Carbon deviation reduced by 45 %
- Reblow rate reduced by up to 60 %
- Increase in production by up to 10 %

EAF automation

Power under control in carbon and stainless steelmaking



Making the most efficient use of electrodes – with our fully automatic electrode control system

EAF process control

EAF process control

A modern and powerful process control system assures a safe and user-friendly plant operation even under difficult conditions. It provides high reliability and availability to pave the path for a smooth process.

The Siemens VAI automation solution, based on the SIMATIC PCS7 combines the advantages of PLC-based automation systems – such as proven quality and stability, low hardware costs, fine-grained scalability, reliable process control, user-friendly operation, clear visualization and powerful engineering tools – with specific technology solution packages that are tailored to the customer needs.

In order to comply with the special requirements of the iron and steel industry, special software modules and typical software solutions are used. These standard modules, which can be retrieved as tested function units from a software library, further increase productivity.

The structuring with uniform system tasks contributes to increased process reliability and high operating efficiency.

The Siemens VAI basic automation uses high-speed microprocessor based systems for technological controls and sequential controls. The automation system is divided into several automation units, which are coordinated to execute the required tasks. Each automation unit is connected to the associated electrical periphery (generally using remote IO connection) for sensing and actuating.

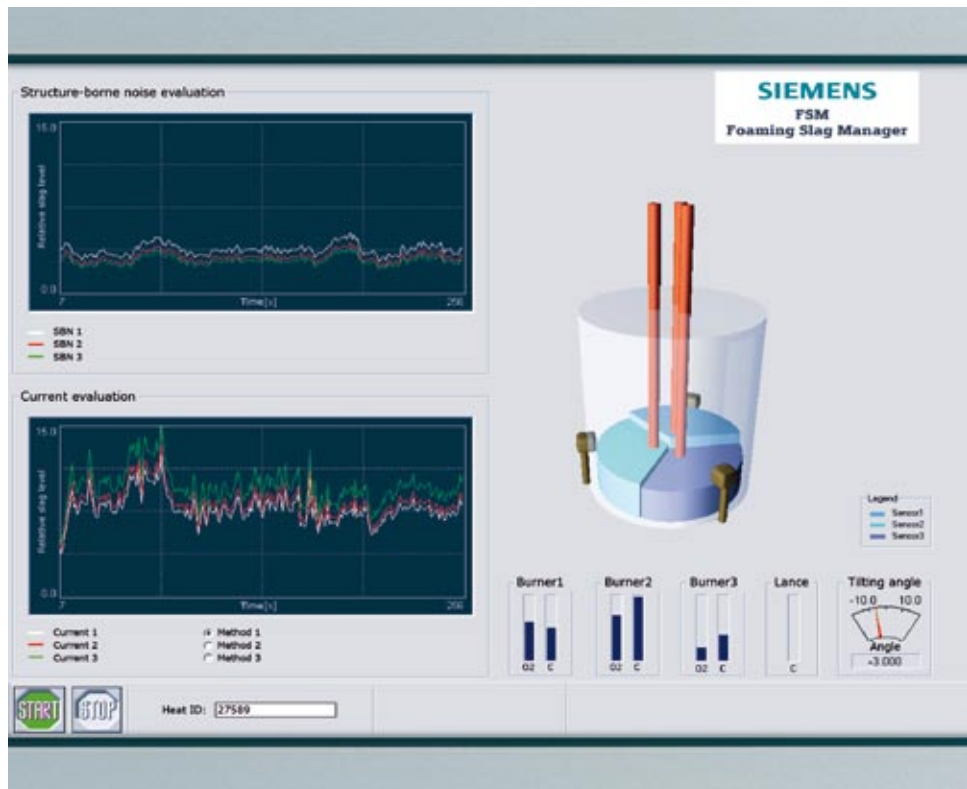
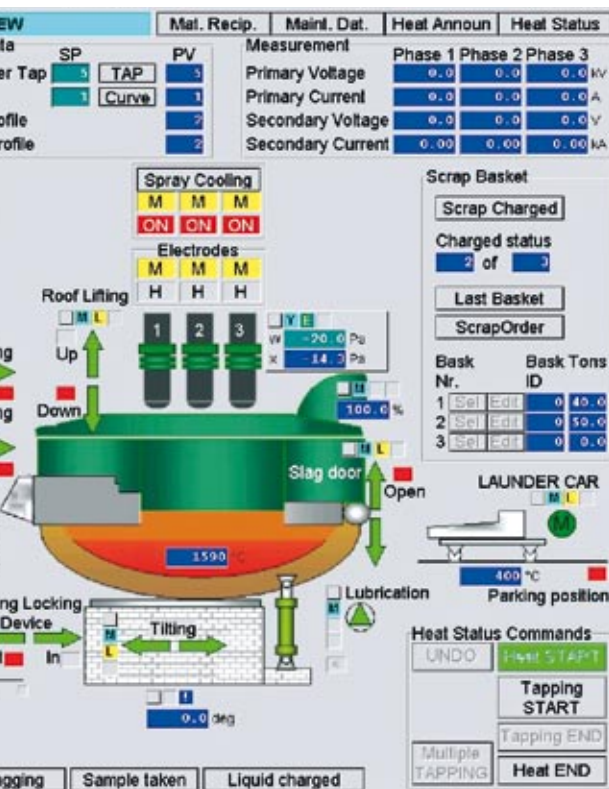
The task of the operating and monitoring system (HMI Human Machine Interface) is the preparation of the increasing quantity of information about the process in a way that the operator receives a clear and easy-to-understand representation of the plant. The HMI system supports a simple and systematic operation of the electric arc furnace.

Fully automatic electrode control

Siemens VAI provides a fully automatic, end-to-end solution for electrode control in three-phase electric arc and ladle furnaces. It regulates and dynamically adjusts the electric arc and makes the most efficient use of electrodes.

The solution relies on artificial intelligence to optimize the melting process. It also includes an optional meltdown control module with melting programs to ensure accurate reproduction of the melting process to ensure maximum furnace productivity.

The electrode control and its add-on units are based on our proven SIMATIC S7 technology; they can be integrated into any system environment and architecture. This technology has been successfully used in more than 300 applications worldwide.



Foaming slag monitor

Main benefits:

- Dynamic control parameters and reduced energy consumption for melting performance and more efficient use of resources
- Higher productivity and reduced stoppage times through fast electrode removal and automatic remelting programs
- Graphic input and display of all control parameters
- Extended furnace life by preventing furnace hot spots
- Amortization within less than six months

Foaming slag manager

A sensor system based on structure-born noise is the new approach to evaluate the amount of foaming slag in the electric arc furnace. In regards to trends and reproducibility, this method has proved to successfully follow the real foaming slag situation in the arc furnace.

Three structure-born noise sensors, each assigned to one electrode segment, are used to record vibration signals. The foaming slag level is calculated based on the combination of structure-born noise and current signals.

With the detection method, operating personnel are in a better position to check the quality and reproducibility of process control in the foaming slag phase with a high degree of accuracy. The process can be optimized with regard to stability, process time and power consumption on this basis.

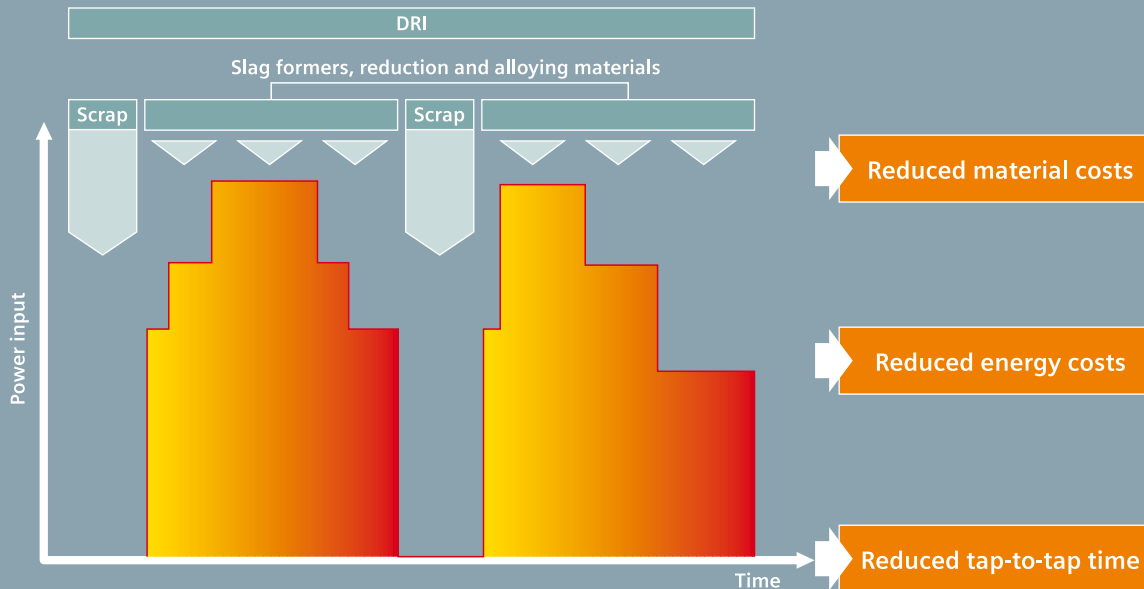
The system also offers a reliable basis for closed-loop foaming slag control based on exactly determining the slag level and supplies signals for triggering the carbon/oxygen lances or coherent burners installed in the furnace.

Main benefits:

- Multi-dimensional spatial recording of the foaming slag over the time
- Real time control of burners and injection devices based on actual melting conditions
- Shortened tap-to-tap time through optimized formation of foaming slag

EAF process optimization

Improved performance for higher profit



Optimized melting profile with SteelExpert



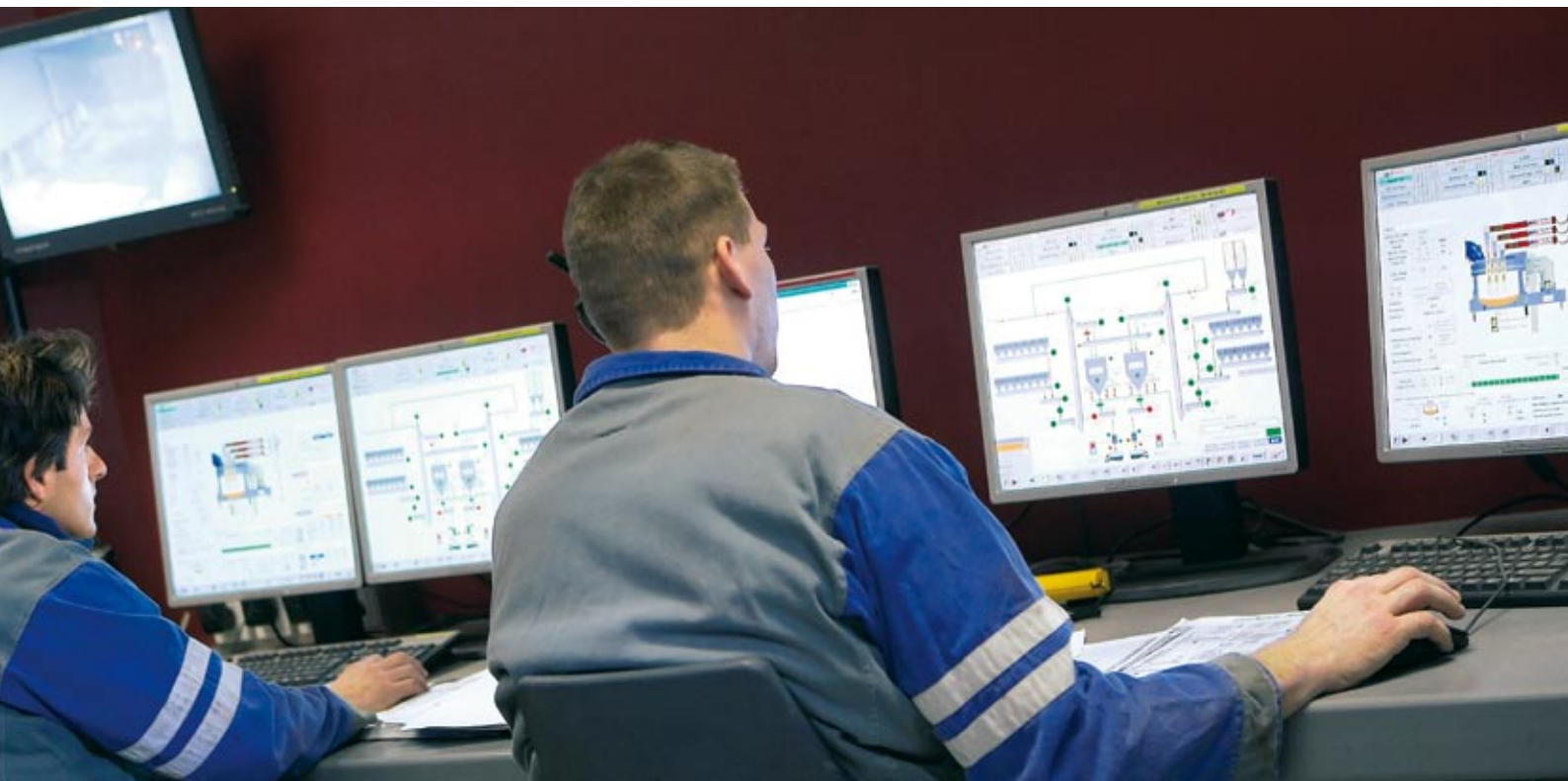
EAF automation

Siemens VAI automation solutions in EAF steelmaking are ideal for new as well as existing plants of any size, regardless of the furnace supplier. They optimize production of a wide range of steel grades, including carbon steels, stainless steels and special steels while accommodating variable charging ratios of scrap, DRI (Direct Reduced Iron) and hot metal.

This leads to fewer steel treatment correction steps, a minimum number of downgraded heats and exact adherence to tight production schedules as the basis for just-in-time delivery to downstream processing plants.

Dynamic process models

- SteelExpert Prediction for EAFs performs a precalculation of the complete heat, tracing the defined melting practice. It gives a preview of the melting process and steel condition at tapping and automatically adjusts power profile and material additions to optimize the process.
- SteelExpert Charge is the setpoint model for proper scrap bucket loading. The cost optimizing calculation selects the scrap types and determines the required quantities as well as the total amount of DRI to be added.
- SteelExpert Slag determines the slag forming agents with respect to a given minimum slag mass and aim basicity.
- SteelExpert Alloy calculates the cost-optimized quantities of alloying additives for the furnace or the tapping ladle.
- SteelExpert Temp determines the amount of electrical energy necessary for melting the prepared and charged materials and for heating the steel bath up to tapping temperature, considering the energy input from blown oxygen.
- For stainless steel production, SteelExpert Reduction calculates the necessary amount of FeSi for reduction of oxides from the slag.
- For furnaces with continuous DRI feeding facilities, DRI Feed Rate Control dynamically controls the DRI feed rate targeting a constant steel temperature, taking into account the DRI temperature.
- Power Demand Control provides on-line monitoring of power consumption and transmission of predicted power consumption targeting the prevention of peak loads and high tariff rates.



EAF pulpit at Carinox, Charleroi, Belgium

Main benefits:

- Reduction of tap-to-tap time by up to 10 %
- Reduction of energy consumption by up to 5 %
- Reduction of alloying material costs by up to 5 %
- Reduced energy costs by avoiding peak tariff rates

References

- Edelstahlwerke Südwestfalen, Siegen, Germany
- Taiyuan ISCO, China
- Carinox, Charleroi, Belgium
- Outokumpu Stainless, Tornio, Finland
- Rocky Mountain Steel Mills, Pueblo, USA



EAF scrap charging

Stainless steelmaking converter automation

Refining the quality of steel



AOD converter at Carinox, Charleroi, Belgium

Stainless steel converter automation

Siemens VAI solutions for stainless steel converters cover the complete range of available refining technologies, such as AOD and K-OBM-S. Intelligent control of the converter process is performed by the application of a number of dynamic process models.

The automation solutions focus on ensuring an optimum metallurgical and process technological performance with respect to steel quality and operational costs.

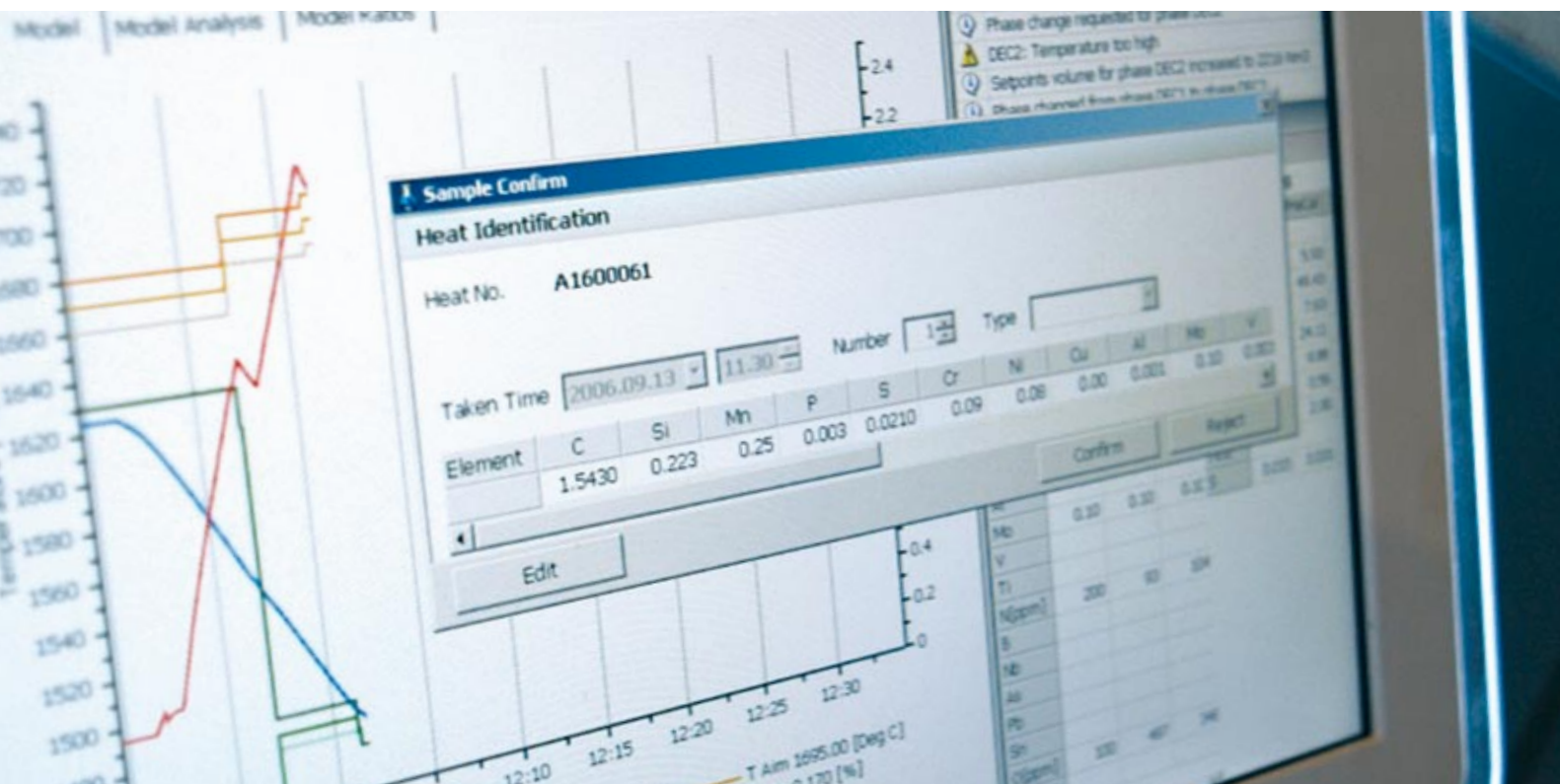
Dynamic process models

- To assure top quality stainless steel production, SteelExpert Prediction simulates the complete AOD process before the heat is actually started using various setpoint models:
- SteelExpert Alloy calculates a cost-optimized mixture of alloying materials and scraps to reach the target analysis and weight of the steel bath.
- SteelExpert Slag calculates a mixture of slag forming additions to reach optimal slag basicity for the AOD process.
- SteelExpert Decarb determines the necessary blowing volumes and flows for various decarburization steps.
- SteelExpert Reduction finally calculates the amount of reduction agents and the necessary process time for complete reduction of the slag.

- In addition to online tracking of the complete steel and slag condition during the entire AOD process, SteelExpert Supervision automatically optimizes the duration of the decarburization steps, based on the actual process information from level 1 and on sample or measurement data.

In the rare case when correction measures are necessary, a set of additional setpoint models is available:

- For desulphurization in two-slag practice, SteelExpert Desulph determines the required material weights for the intermediately deslagged steel bath.
- SteelExpert Reblow can be started for various reasons to correct the steel temperature and/or analysis. The necessary addition materials and gas volumes are determined based on sample data or measurements.



AOD online model display

- During final adjustment the steel weight, temperature and analysis can be accurately adapted to the planned steel quality by the addition of alloying materials and/or scraps according to the specification of SteelExpert Adjust.

Main benefits:

- Improved and assured steel quality
- 15 % reduction of process gases and reduction agents
- 10 % decrease of refractory costs
- Increase of productivity up to 1 heat per day

References

- Taiyuan ISCO, China
- Carinox, Charleroi, Belgium
- Böhler Edelstahl, Kapfenberg, Austria
- Ugine & ALZ, Genk, Belgium
- Acesita, Belo Horizonte, Brazil



Process supervision with SteelExpert

Secondary metallurgy automation

Excellent solutions for premium steel quality



VOD plant at Wuyang Steel, China



RH vacuum degassing

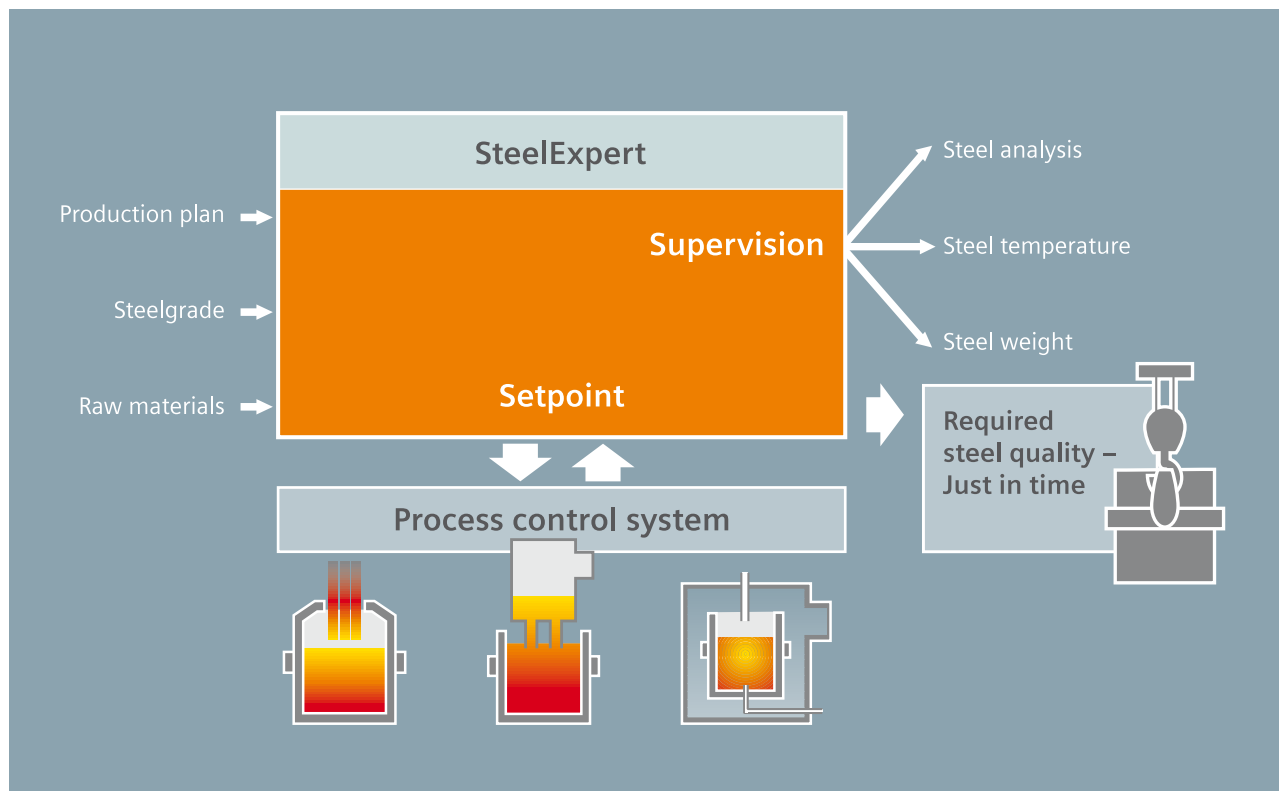
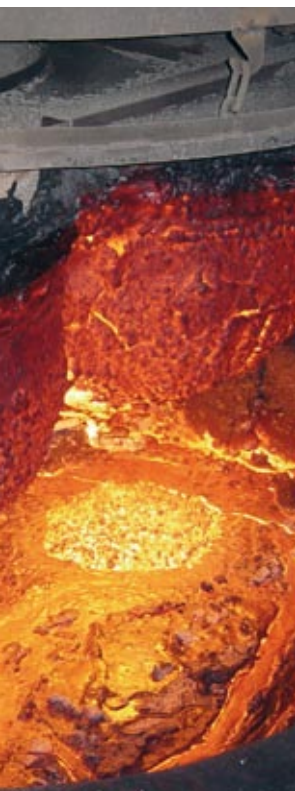
Secondary metallurgy automation

In order to satisfy the requirements for high product quality and lowest production costs, final adjustments in steel chemistry and temperature are carried out in secondary metallurgical facilities. Meeting narrow tolerances and a fully automatic production sequence from steel-making to casting is only possible with the support of sophisticated automation systems. Depending on required steel grade and quality demands, Siemens VAI automation systems handle all types of process variants and operational procedures for ladle treatment facilities and furnaces, as well as vacuum degassing plants.

For exact coordination of secondary metallurgical and continuous casting operations, especially for meeting the requirements of sequence casting, the heat pacing function can be applied.

Dynamic process models

- The precalculation model – SteelExpert Prediction, previews the theoretic course of the complete treatment and automatically adapts the treatment practice to the heat-specific requirements. Depending on the plant's technical equipment, the model optimizes the scheduled treatment steps and inserts additional actions if necessary.
- SteelExpert Alloy, SteelExpert Deox, SteelExpert Desulph and SteelExpert Shape calculate the materials to be added during the different treatment steps for final adjustment of the steel analysis on a cost-optimized basis.
- SteelExpert Temp calculates the energy required for reaching the target steel bath temperature and thereby defines the appropriate duration of electrical or chemical heating. In the opposite case, Steel Expert Cooling supplies a setpoint for the amount of cooling agent necessary.
- For vacuum degassing plants equipped with an oxygen blowing lance, SteelExpert Oxygen calculates the total amount of oxygen needed for forced decarburization.
- If stainless steel is finalized in the vacuum degassing plant (VOD), SteelExpert Reduction is applied for an optimized reduction phase.
- For vacuum degassing SteelExpert Supervision additionally controls the removal of hydrogen, nitrogen, oxygen and carbon from the steel bath according to the vacuum level and the metallurgical treatment.



SteelExpert for secondary metallurgy

Main benefits:

- Reduction in energy costs by up to 3 %
- Reduction in alloying material costs by up to 10 %
- Reduction in treatment time by up to 5 %
- Elimination of return heats

References

- Taiyuan ISCO, China
- Lechstuhlwerke, Meitingen, Germany
- Edelstahlwerke Südwestfalen, Siegen, Germany
- Carinox, Charleroi, Belgium
- Usiminas, Ipatinga, Brazil
- Wuyang Steel, China



Ladle furnace at Carinox, Charleroi, Belgium

Expertise based on experience

Selected success stories with steelmaking automation

Competence in figures. Especially in the field of steel automation, where increased productivity, higher capacity, lowered operating costs and reducing emissions count more than anything. These are results with which our customers can measure their success – and ours as well. Have a closer look, and you can judge us by these examples of successful projects.



Carbon and stainless steelmaking under one roof

Customer: Taiyuan ISCO, China

Automation for: 2 x LD (BOF) converter, 2 x EAF, 2 x AOD converter, 2 x Twin LF, 1 x RH plant

Our solution: Integrated automation systems for complete carbon and stainless steel production lines in the new steelmaking plant no. 4 at Taiyuan, including electrical equipment and instrumentation, process control and optimization.

The result: Standardized production operations for constantly high and reproducible quality in steel. Full automation functionality right from the first heat assures comprehensive operator guidance and process information throughout the entire production routes. Process optimization models assure maximum productivity and high hitting rates with minimum material costs and energy consumption.



Improved steel quality at reduced production cost

- Customer:** Mittal Steel Vanderbijlpark, South Africa
- Automation for:** 3 x LD (BOF) converter, hot metal desulphurization, 2 x LF, 1 x argon station, 1 x RH plant
- Our solution:** New process optimization system for existing oxygen steelmaking plant.
- The result:** Analysis and temperature values meet the target performance figures, whereas raw material costs for converter additions and alloying materials and expenses for temperature probes were significantly reduced.



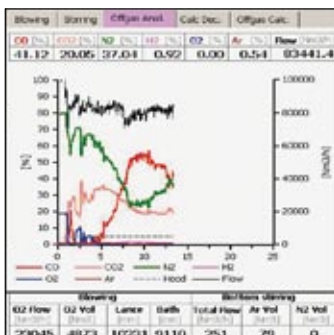
Comprehensive automation for stainless steel meltshop

- Customer:** Carinox Ugine & ALZ Group, Arcelor, Charleroi, Belgium
- Automation for:** 1 x EAF, 1 x AOD converter, 1 x LF
- Our solution:** Integrated automation systems for new stainless steel meltshop, including electrical equipment, instrumentation, process control and optimization.
- The result:** Uniform automation systems of all levels and uniform HMI throughout the entire production route, optimized stainless steel production, through advanced tracking and prediction methods.



Competitive EAF steelmaking with process optimization

- Customer:** Edeltahlwerke Südwestfalen, Siegen, Germany
- Automation for:** 1 x EAF, 2 x LF, 1 x RH plant, 2 x VOD plant
- Our solution:** Modernization of hardware and software of the existing level 2 system (process optimization) for the electric steelmaking plant.
- The result:** State-of-the-art software engineering technology for easy maintenance and expandable systems. Improved HMI to support plant operators and reduce manual reporting; detailed data recording for process evaluation.



Automatic blow end control

- Customer:** Maanshan ISCO, China
- Automation for:** 3 x LD (BOF) converter
- Our solution:** Dynamic process control system with optimization model DYNACON based on continuous off-gas measurement.
- The result:** Accurate determination of the blowing end point in the converter process, thus avoiding over-blowing of oxygen for higher steel yields, lower deoxidation costs and shortening of tap-to-tap time.



Improved optimization algorithms for high quality

- Customer:** Georgsmarienhütte, Germany
- Automation for:** 1 x LF, 1 x VD plant, 2 x stirring station
- Our solution:** Installation of a new process optimization system for existing secondary metallurgical treatment facilities, including tapping alloying model for the EAF.
- The result:** Accurate acquisition of actual process data, better quality evaluation methods, a standardized automation environment and improved process optimization algorithms to successfully meet the overall project targets.

**For further information,
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Order No.: E10001-M3-A13-V2-7600
Printed in Austria
Dispo No.: 21661 K-No.: 28103
SPS SVAI-07-00333 PA 05071.5
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