ADVANCED STOVES OPERATION WITH SIMETAL BF VAiron[1]

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Abstract

The stoves system of a modern blast furnace is the most important single energy consumer in the ironmaking area and it offers significant energy saving potentials at most of the producers. The challenge for each plant operator is optimizing the energy input while keeping the blast temperature at the setpoint for given targets of the blast flow rate and the wind time. Additionally the stoves system must have a defined energy reserve in order to allow the operator to increase the blast output temporarily. Siemens VAI's answer to these challenges is the Stoves Control Model which is offered as a standalone package or as part of SIMETAL BF VAiron. The first part of the paper describes the main control modules of the process model. Based on an online energy balance of the stoves system the required energy input until the end of the gas phase is computed which results in the setpoints for the mixed gas flow rates. The self-tuning algorithms are outlined and the required instrumentation is listed. The second module is an online combustion calculation which finally gives the necessary mixed gas enrichment for reaching the target blast temperature. The second part of the paper gives an overview of the installation of the Stoves Control Model at blast furnaces #1 and #4 at voestalpine Stahl Donawitz in Austria. The topologies of the stoves systems are shown and the control modules are described. Additionally we give long term performance results of the stoves models. The paper concludes with an overview of other recent installations of the control model worldwide with various layouts of the stoves systems.

Keywords: Blast furnace; Stoves; Process optimization; Control model; Performance data.

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1 TECHNOLOGICAL SOLUTIONS FOR IMPROVING HOT STOVES EFFICIENCY

The blast-heating process is one of the largest energy consumers in a steelworks and also one of the leading sources of CO2 emissions to the atmosphere. Specific blast volumes for European blast furnaces vary in the range 700 – 1400 m³ (STP)/tHM. If we assume a typical value of 1000 m³ (STP)/tHM, and if we further assume that this blast air is heated from an average 'cold' blast temperature of 150 °C to 1200 °C than the theoretical energy requirement is 1.5 GJ/t HM. In practice, a typical overall stove efficiency of around 80 % means that some 1.9 GJ/t HM would be consumed. The World Steel Association estimates that the total energy consumption for the integrated BF-BOF steelmaking route varies in the range 19.8 – 31.2 GJ/t and so hot blast generation accounts for 6 – 10 % of this total.(1,2) It is worth considering how enhanced stove operation might contribute to lower specific energy consumption and lower emissions.

A full process evaluation that looks at the entire blast furnace performance and takes into consideration various criteria such as stove capabilities, plant energy balances and other economic factors can determine the optimum solution for each location. Siemens VAI has developed several techniques that allow blast furnace operators to increase the efficiency of their stoves and thereby lower fuel costs.(3)

1.1 Reduced Energy Requirements with Waste-Heat Recovery

Typically 18 % of the total heat input into the stove exits through the chimney as waste gas. A waste-heat recovery (WHR) system can reclaim around half of its energy loss. The WHR process is based on recovering a portion of the sensible energy of the waste gas and using it to preheat the blast furnace gas (BFG) and/or combustion air. The recovered waste gas heat reduces the total amount of energy required by the stoves and allows the temperature of the stove burner flame to be increased, which significantly lowers the required enrichment gas rate. The two types of Siemens VAI's layouts of WHR systems are the direct system with heat pipes (gas/gas system) and the indirect system with oil pipes (gas/oil system).(3)

Combustion air requirements decrease with the installation of a WHR system. This decrease is a result of the reduction in the enrichment gas rate, which requires more oxygen per unit of energy than the leaner blast furnace gas. Siemens VAI offers initial stove simulation computer modeling to determine the potential benefits of a proposed WHR system.

1.2 Cost Reduction with Stove-Oxygen Enrichment

The flame temperature required to meet the dome temperature setpoint can be achieved by adding pure oxygen to the combustion air instead of using enrichment gas, which significantly reduces the combustion air requirements. Each Nm³/h of oxygen replaces nearly 5 Nm³/h of combustion air. Although the required flame temperature can be reached with the enriched combustion air, the total heat input is reduced when the enrichment gas is removed, and the additional heat input is made up by firing additional blast furnace gas.

The net impact is a decrease in the enrichment-gas firing rate, an increase in the blast furnace gas firing rate, and a significant decrease in the combustion air flow rate. The total quantity of flue gas is only reduced slightly because the BFG components CO and H2 require less oxygen per unit of energy release compared to

a richer gas like natural gas. Since the total flue gas flow remains relatively constant the convective heat transfer coefficient in the stove checkers is constant as well.
The project economics depends on the stove blast rate, hot blast temperature, stove capacity and oxygen pricing compared to the costs for the BFG and enrichment gas. The capital costs include the oxygen supply skids, spargers and local piping tie-ins as well as the changes to the stoves firing control system. Consideration also has to be given to any requirements for increasing oxygen production at the supplier's plant.

1.3 Improved Performance of Older Stoves by Stove-Oxygen Enrichment

Stove oxygen enrichment can help to improve stove performance, namely by allowing the hot blast temperature to be increased in old, damaged stoves with excessive pressure drops that limit the hot blast performance. Stove oxygen enrichment can help when 1) the stoves cannot be fully heated during the firing cycle, indicated by final waste gas temperatures below the design maximum and 2) stove firing is limited because the combustion air fan cannot deliver enough air to compensate for the stove pressure drop, as indicated by surging fan operation and/or high stove pressure drops. The required amount of combustion air to fire the stove at a given heat input level is reduced accordingly.

1.4 Modification of Existing Control Systems

Stove energy efficiency can be improved by modifying existing control systems which is part of the service portfolio of Siemens VAI.(4,5) Many current systems provide stove firing control routines to 'automatically' control the BFG, enrichment gas and combustion air flow rates to meet the heat input, dome temperature and enrichment gas setpoints. However, these setpoints often require significant operator input which may lead to divergent operating concepts from operator to operator. There is therefore an increased risk of unstable operation, elevated energy consumption and higher overall operational costs. Opportunities to garner large savings by reducing dome temperature and enrichment gas usage are often overlooked when a stove is operated below its maximum design capacity.
As a first step simple modifications to existing control systems can be made to improve the efficiency of stoves. With the modified control system, which is basically a spreadsheet based on Siemens VAI stove modeling results that is added to the control screen, the operator inputs the basic requirements such as the hot blast temperature, blast rate, heating value of the BFG and cold blast temperature. The spreadsheet than calculates all the firing setpoints for the operator to utilize. The Siemens VAI spreadsheet model also provides a correction function to assist the operator in making setpoint corrections when actual measurements are known to be incorrect. As the next process improvement step an online model based optimization package can be installed, which is described in detail in the following chapter.

2 MODEL BASED OPTIMIZATION OF THE STOVE HEATING PROCESS

2.1 Introduction

Level 2 automation systems have the capability to detect faulty measurements and make setpoint corrections to optimize the stove heating process. These systems also focus on maximizing the hot blast temperature while minimizing energy consumption and operating costs. Thermal models are used to determine the required heat input and flame temperature requirements. In particular, the models determine the minimum dome temperature necessary to develop the required hot blast temperature, which allows the amount of expensive enrichment gas to be minimized. The models also monitor the energy input and output trends to fine tune stove operation and thus protect a stove from over- or underheating.

2.2 Control Concepts

Modern Level 2 control systems such as the SIMETAL BF VAiron Hot Stoves Control Model combine short-term direct control and longer self-tuning control as illustrated in Figure 1.

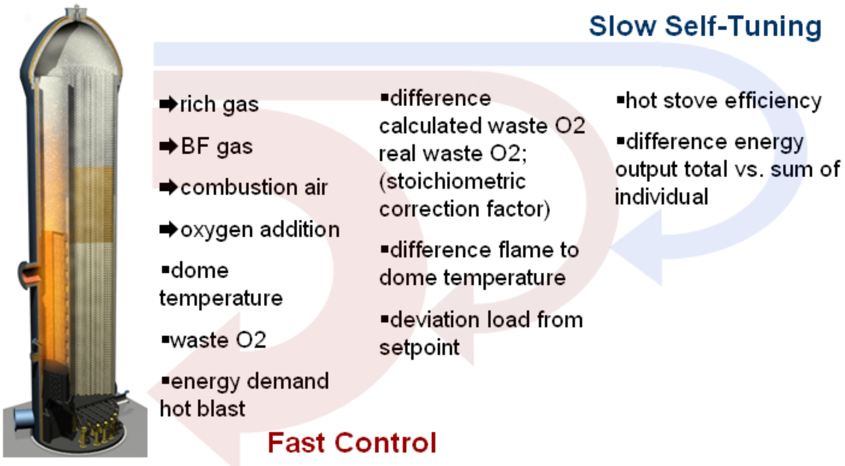


Figure 1. Siemens VAI automation of hot blast systems with self-learning control.

Rapid control is used to correct the firing rate with respect to maintaining the proper stoichiometric ratios, heat input rates, dome temperature, waste gas temperature and oxygen, etc. Rapid control also reduces CO_2 emissions and maximizes stove efficiency. An intermediate feedback control system allows measurement errors to be determined as the basis for carrying out accurate firing corrections. Long-term trends are monitored to optimize stove efficiency performance. The self-learning behavior enables measurement errors to be identified and corrected.
In the following sections the implementation of these control concepts in the SIMETAL BF VAiron Hot Stoves Control Model is outlined.

2.3 Online Energy Balance

Every minute the model sums up the energy input and energy output individually for all stoves. The energy input calculation is based on the measured BFG, combustion air and enrichment gas flow rates and temperatures. The energy output results from the calculated blast flow rates and temperatures as well as the calculated waste gas flow rates and measured temperatures. The calorific values of the heating gases as well as the flow rates and energy contents of the waste gas streams result from a combustion calculation. The final result of the online energy balance module of the SIMETAL BF VAiron Hot Stoves Control Model is the actual energy content (the so-called 'Load') of each individual stove i at any point of time t $L_{act,i}(t)$.
At the end of a stove cycle the actual load $L_{act,i}(t)$ is partially reset to 0. This happens at the end of the blast phase for stoves systems in serial operation mode and for the stove which remains in the blast phase when a new stove starts its blast phase for stoves systems in parallel operation mode. Additionally, the long-term average stove

efficiency is calculated at the end of a stove cycle. Figure 2 shows typical trends of the calculated actual load.

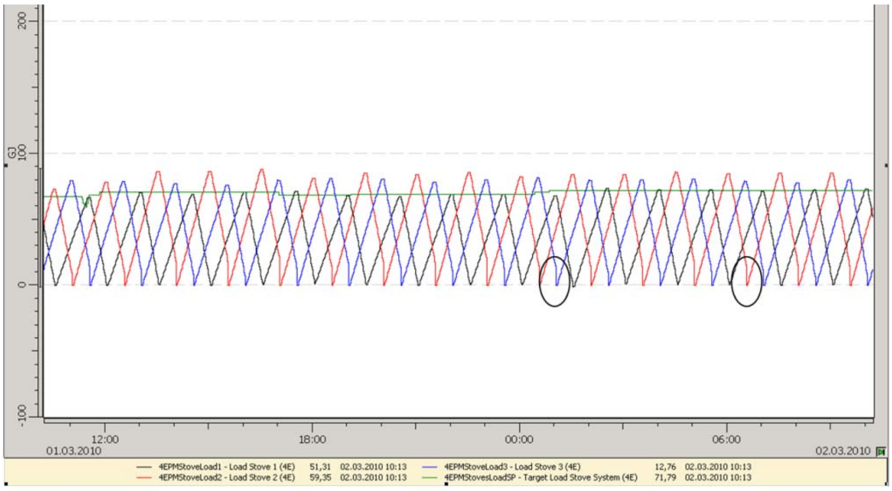


Figure 2. Actual load trends for three stove system with markup of significant load reset at the end of the blast phase

2.4 Calculation of Heating Gas Flow Rate Setpoints

The target load $L_{target,i}$ at the end of the gas phase for each individual stove i is calculated based on the target blast temperature, the target blast flow rate and the target blast time. Therefore at any point of time t the required energy input until the end of the gas phase can be computed as $\Delta L_i(t) = L_{target,i} + E_{reserve,i} + \Delta E_{reserve,i} - L_{act,i}(t)$ where $E_{reserve,i}$ denotes an operator defined energy reserve parameter to be kept in the stoves system to allow the operator to increase the blast output temporarily and to account for possible disturbances. The additional energy reserve parameter $\Delta E_{reserve,i}$ for each individual stove i is self-tuned based on average values and long-term trends of the maximum waste gas temperature at the end of the gas phase and the minimum silica interface temperature at the end of the blast phase.

The remaining gas time for the energy input of $\Delta L_i(t)$ is defined by the target blast time and the operation mode (serial, parallel) of the stoves system, and with the individual stoves efficiency and the short-term average of the calorific value of the of the heating gas the heating gas flow rate setpoint is computed. Finally, based on the projected waste gas temperature at the end of the gas phase the heating gas flow rate setpoint is corrected. The SIMETAL BF VAiron Hot Stoves Control Model recalculates the heating gas flow rate setpoint for an individual stove i when stove i or another stove starts the gas phase, and when the target blast parameters, the operator defined energy reserve $\Delta E_{reserve,i}$ or the average of the calorific value of the of the heating gas changes significantly.

2.5 Calculation of Blast Furnace Gas Enrichment Setpoints

The SIMETAL BF VAiron Hot Stoves Control Model supports individual and central enrichment systems with natural gas, coke oven gas and/or BOF gas.

From the target blast temperature a target dome temperature $T_{dome,target,i}$ for each individual stove is calculated based on a constant offset plus a factor proportional to the change of the dome temperature with the actual load $dT_{dome,i}/dL_{act,i}$. This term accounts for a change of the dome temperature setpoint based on a change of the target blast flow rate, and it is self-tuned at the end of the stove cycle. Finally, the dome temperature setpoint $T_{dome,target,i}$ is transformed into a flame temperature setpoint $T_{flame,target,i}$ by adding a constant temperature loss in the combustion chamber for each individual stove. The target flame temperature $T_{flame,target,i}$ together with the setpoint of the oxygen content in the waste gas and the oxygen content of the combustion air are the inputs to an inverse combustion calculation, i.e. the model computes the required heating gas composition setpoint which leads to this target flame temperature.

The enrichment setpoints are calculated cyclically every 5 minutes. Siemens VAI provides offline tools for the evaluation of the offsets between the target blast temperature and the target dome temperatures as well as the temperature losses in the combustion chambers.

2.6 Calculation of Combustion Air Flow Rate Setpoints

The SIMETAL BF VAiron Hot Stoves Control Model calculates the air to gas ratio which is required for the given setpoint of the oxygen content in the waste gas at the beginning of the gas phase. This result is an output of the cyclic online combustion calculation which is part of the *Online Energy Balance* module described above.

From the start of the gas phase until the target dome temperature is reached the model adjusts this stoichiometric air to gas ratio based on the deviation between the actual and the setpointed oxygen content in the waste gas every minute, this functionality is implemented as a PD control. As soon as the target dome temperature is reached the control of the combustion air flow rate is passed to the faster Level 1 control system to keep the dome temperature within limits.

2.7 Simulation of Possible Working Area of Stoves System

An important information for the blast furnace process engineer is the calculation of the limits of the possible area of operation of the stoves system with respect to blast time and blast temperature for a given target blast flow rate. Figure 3 gives an impression of the result screen of this optional module of the SIMETAL BF VAiron Hot Stoves Control Model.

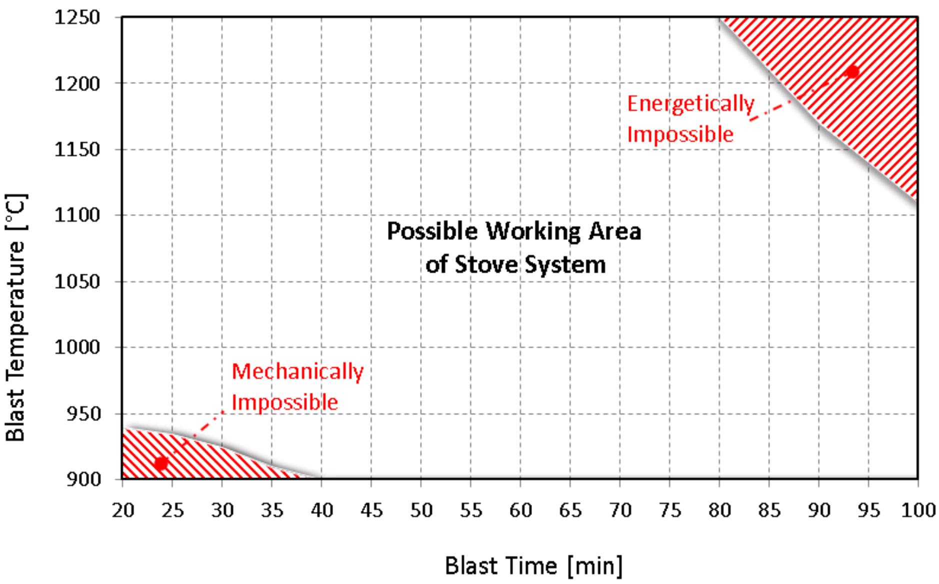


Figure 3. Simulation of the limits of the possible area of operation of a stoves system.

The working area of the stoves system is limited 1) by the energetically impossible part of the (blast time, blast temperature) surface which is the parameter zone with an energy deficit and 2) by the mechanically impossible area which is defined by the minimum gas flow rates and the maximum waste gas temperature. The simulation computes the waste gas temperature at the end of the gas phase based on parameterized characteristics of the waste gas temperature trends.

The simulation can be started in online and offline modes and the target blast flow rate can be selected within a minimum-maximum range. In the online mode the results of the last evaluation of the *Online Energy Balance* module and the active limits for BFG, enrichment gas and combustion air flow rates and the actual minimum and maximum waste gas temperatures are used as the inputs for the simulation. The *Stoves System Possible Working Area* simulation in offline mode gives the engineer the possibility to compute the effects of changes of the major input data and limits on the shape of the allowed area on the (blast time, blast temperature) surface.

3 STOVES OPTIMIZATION AT voestalpine STAHL DONAWITZ WITH SIMETAL BF VAiron

3.1 Topology of the Hot Stoves Systems

Voestalpine Stahl Donawitz GmbH in Austria operates two blast furnaces (BF1 and BF4) of similar size with a hearth diameter of 8 m, whereas BF1 has a working volume of 1205 m³ and BF4 has a working volume of 1343 m³, the nominal daily hot metal production is 2000 t for each furnace.

Figure 4 below shows the schematic layout of the stoves systems at voestalpine Stahl Donawitz. BF4 uses 3 stoves (so-called ‘E Stoves’) with internal combustion chambers which are fired with blast furnace gas individually enriched with natural gas and combustion air with ambient temperature. BF1 has 2 groups of stoves, the 2 ‘A Stoves’ with external combustion chambers are fired with blast furnace gas only and preheated combustion air which is provided by the 2 ‘C Stoves’ with internal combustion chambers which are fired with blast furnace gas and combustion air at ambient temperature. The stove changeover happens at fixed times for all three stove groups.

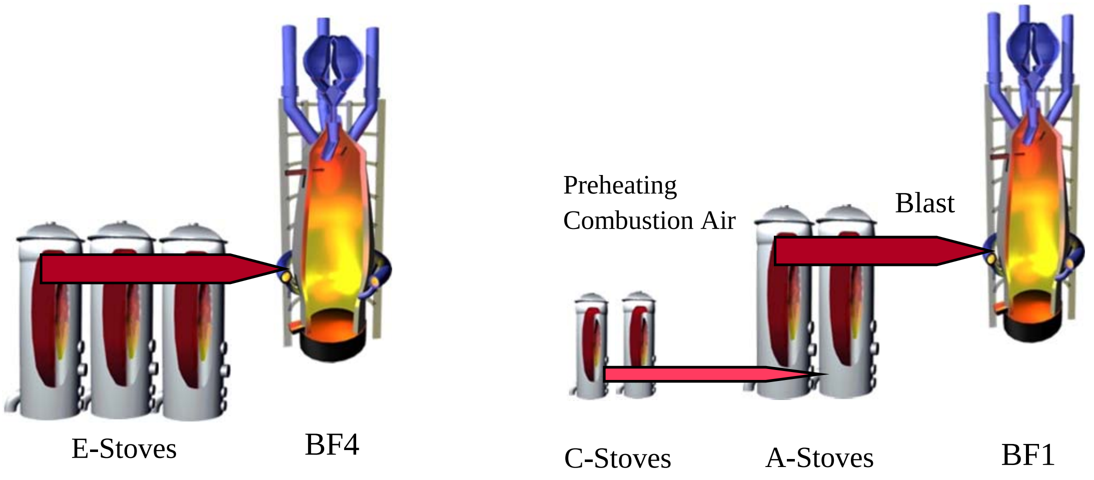


Figure 4. Schematic layout of the stoves systems of voestalpine Stahl Donawitz in Austria.

The basic data of the three stoves groups are summarized in Table 1 below.

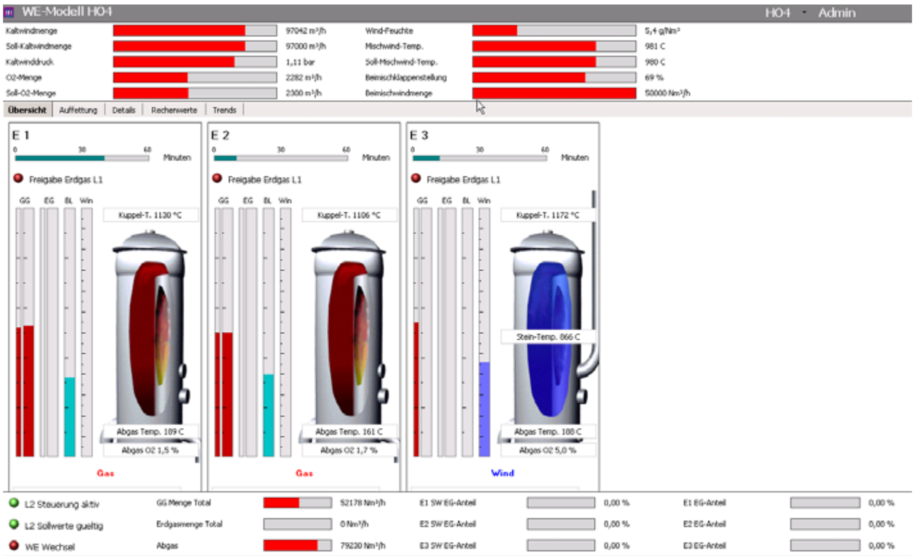
Table 1. Basic data of the stove groups of voestalpine Stahl Donawitz

Blast Furnace	Stove Group	Type	Heating Gases	Blast Output (nominal)
BF4	E Stoves (3)	Internal combustion chamber	Blast Furnace Gas Natural Gas (individual enrichment)	Maximum 120.000 Nm³/h 1.100 °C
BF1	A Stoves (2)	External combustion chamber	Blast Furnace Gas Preheated combustion air (from C Stoves)	Maximum 120.000 Nm³/h 1.200 °C
BF1	C Stoves (2)	Internal combustion chamber	Blast Furnace Gas	Combustion air for A Stoves Maximum 50.000 Nm³/h 900 °C

This complicated scheme of the stoves systems resulted in the development of advanced stoves optimization concepts.

3.2 Stoves Optimization Concept HO4

For the E Stoves of BF4 the standard concepts of the SIMETAL BF VAiron Hot Stoves Control Model have been reviewed and applied without major modifications. The control model is fully integrated in the Level 2 system, and Figure 5 shows the user interface of the hot stoves model, this application is fully configurable based on the installed instrumentation and the list of calculated setpoints.



Kaltwindmenge 97042 m³/h
Soll-Kaltwindmenge 97000 m³/h
Kaltwinddruck 1,11 bar
O2-Menge 2282 m³/h
Soll-O2-Menge 2300 m³/h
Wind-Feuchte 5,4 g/Nm³
Mischwind-Temp. 981 C
Soll-Mischwind-Temp. 980 C
Beimischklappenstellung 69 %
Beimischwindmenge 50000 Nm³/h

Kuppel-T. 1130 °C
Abgas Temp. 109 C
Abgas O2 1,5 %

Kuppel-T. 1106 °C
Abgas Temp. 161 C
Abgas O2 1,7 %

Kuppel-T. 1172 °C
Stein-Temp. 866 C
Abgas Temp. 108 C
Abgas O2 5,0 %

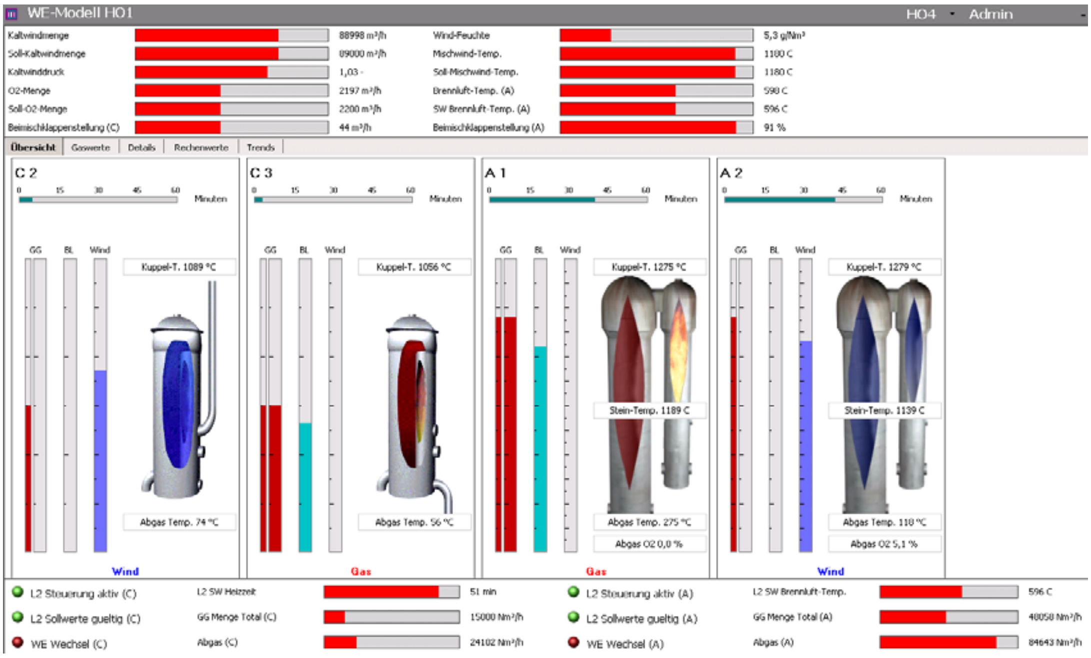
L2 Steuerung aktiv
L2 Sollwerte gueltig
WE Wechsel
GG Menge Total 52178 Nm³/h
Erdgasmenge Total 0 Nm³/h
Abgas 79230 Nm³/h
E1 SW EG-Anteil 0,00 %
E2 SW EG-Anteil 0,00 %
E3 SW EG-Anteil 0,00 %
E1 EG-Anteil 0,00 %
E2 EG-Anteil 0,00 %
E3 EG-Anteil 0,00 %

Figure 5. User interface screen of the control model of the E Stoves of voestalpine Stahl Donawitz BF4.

3.3 Stoves Optimization Concept BF1

Basis for BF1 optimization have been 2 standard Siemens VAI hot stoves models, one for the A Stoves and one for the C Stoves. Each model can be operated in automatic model separately as well as together.

For the A Stoves of BF1 which are fired with blast furnace gas and preheated combustion air the *Calculation of Blast Furnace Gas Enrichment Setpoints* module was adapted such that based on the target flame temperature the inverse combustion calculation computes the setpoint for the temperature of the combustion air. Energy balances for A Stoves are based on actual combustion air temperatures delivered from the C Stoves.



Kaltwindmenge	88998 m³/h	Wind-Feuchte	5,3 g/Nm³
Soll-Kaltwindmenge	89000 m³/h	Mischwind-Temp.	1180 C
Kaltwinddruck	1,03 -	Soll-Mischwind-Temp.	1180 C
O2-Menge	2197 m³/h	Brennluft-Temp. (A)	598 C
Soll-O2-Menge	2200 m³/h	SW Brennluft-Temp. (A)	596 C
Beimischklappenstellung (C)	44 m³/h	Beimischklappenstellung (A)	91 %

C 2: Kuppel-T. 1089 °C; Abgas Temp. 74 °C

C 3: Kuppel-T. 1056 °C; Abgas Temp. 56 °C

A 1: Kuppel-T. 1275 °C; Stein-Temp. 1189 C; Abgas Temp. 275 °C; Abgas O2 0,0 %

A 2: Kuppel-T. 1279 °C; Stein-Temp. 1139 C; Abgas Temp. 118 °C; Abgas O2 5,1 %

● L2 Steuerung aktiv (C)	L2 SW Heizzeit	51 min	● L2 Steuerung aktiv (A)	L2 SW Brennluft-Temp.	596 C
● L2 Sollwerte gueltig (C)	GG Menge Total (C)	15000 Nm³/h	● L2 Sollwerte gueltig (A)	GG Menge Total (A)	40050 Nm³/h
● WE Wechsel (C)	Abgas (C)	24102 Nm³/h	● WE Wechsel (A)	Abgas (A)	84643 Nm³/h

Figure 6. User interface screen of the control models of the C Stoves and A Stoves of voestalpine Stahl Donawitz BF1

The individual control model of the C Stoves of BF1 is using this calculated temperature setpoint of the combustion air sent by hot stoves model for A Stoves as its ‘target blast temperature’. A complete new feature of Siemens VAI’s hot stoves model is to calculate a setpoint for the heating time within a heating phase for a stove. In case the calculated setpoint of the BFG flow rate is below the minimum flow rate the heating time of the stove on gas is reduced, i.e. the stove is bottled up starting from the time when the required energy input has been reached until the scheduled switchover time. Automatic bottling can be executed in automatic mode as Donawitz Level 1 engineers implemented appropriate changes in the Level 1 controls and the interface to the Level 2. The following figure shows the control model result screen for the C Stoves (left) and A Stoves (right).

3.4 Performance Results

The control models for BF1 (C Stoves and A Stoves) have been designed and developed in 2009 in close cooperation between voestalpine Stahl Donawitz and Siemens VAI. The systems have been tuned under a test computer environment which was connected to the blast furnace online data over a period of 3 months, therefore the models have been commissioned and put into automatic operation within a period of only 2 weeks in 2010.

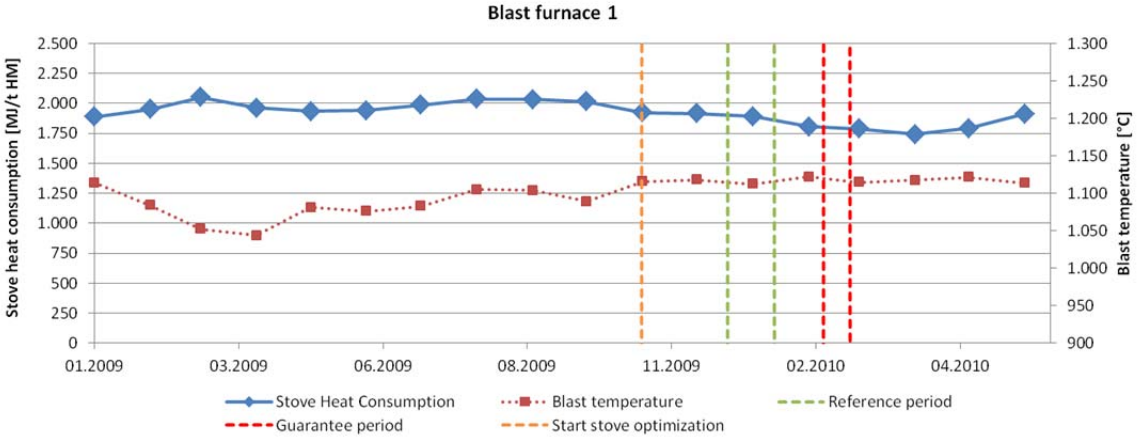


Figure 7. Implementation of stove optimization at voestalpine Stahl Donawitz BF1.

Immediately after implementation of the control model the stove efficiency significantly improved: While hot blast temperature was kept constant the blast furnace gas consumption was decreased (Figure 7). The main reason for this improvement was that operators were supplied with the optimum BFG flow setpoint by the system.

At that time the natural gas enrichment for the E Stoves of BF4 has not been installed yet, therefore the control model was started in automatic mode with blast furnace gas as the only heating gas. The improvement of stove efficiency at BF4 during and after implementation is shown in Figure 8.

After the installation of the natural gas enrichment in 2011 the system was tuned under the test environment and subsequently put into automatic operation within a short period as well.

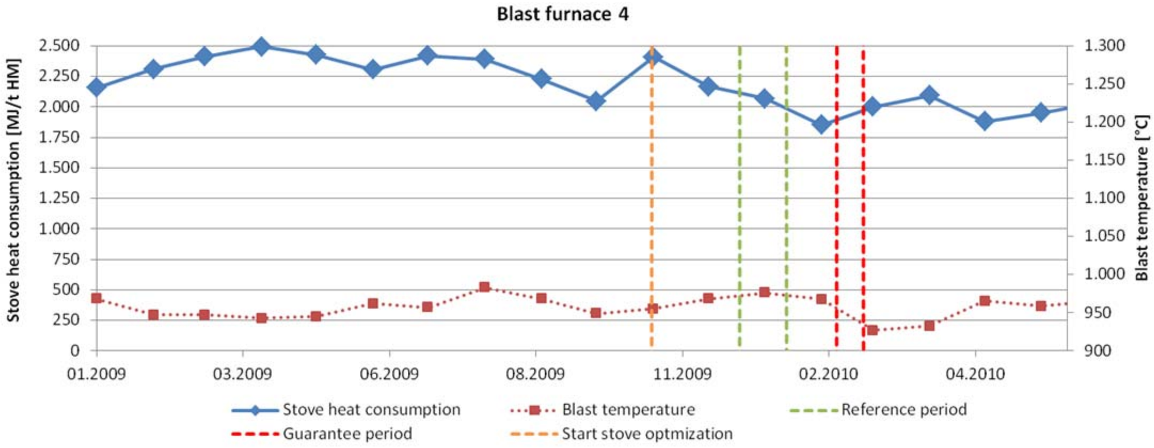


Figure 8. Implementation of stove optimization at voestalpine Stahl Donawitz BF4

After full implementation in February 2009 the guarantee test was performed. Stove efficiency in manual operation (reference periods) and full automatic operation (guarantee period) were compared (table 2). The increase in efficiency due to installation of the stove optimization was between 2 and 8 % and exceeded voesalpine’s expectations.

Table 2. Stove efficiency figures achieved during guarantee test

Stove system	**A**	**C**	**A&C**	**E**
Reference period #1	88,8	75,8	84,1	75,9
Reference period #2	86,5	74,4	81,6	75,3
Guarantee period	90,0	79,0	86,7	84,2
Efficiency increase	+2,35%	+3,9%	+3,85%	+8,6%

4 INSTALLATIONS OF THE SIMETAL BF VAiron HOT STOVES CONTROL MODEL

Siemens VAI offers the hot stoves control model as part of SIMETAL BF VAiron blast furnace optimization system,(6,7) or as a standalone package.

Besides the installation at voestalpine Stahl Donawitz in Austria which is presented in detail in this paper the following table lists the basic data of recent interesting stoves optimization projects.

The following table should give an impression of the various mechanical and operational conditions which the Siemens VAI hot stoves model had to cope with recently. Therefore each installation needs an intensive discussion with the blast furnace operation team followed by project dependent adaptations to the control algorithms in the engineering phase. Additionally, a safety concept for the fully automatic takeover of the stoves setpoints by the Level 1 control system and the switchover between Level 1 and Level 2 control modes is developed in closed cooperation between the customer and Siemens VAI.

Table 3. Siemens VAI hot stoves control model project overview

Company	**Plant(s)**	**Model Startup**	**Stoves Operation Mode**	**Main Characteristics**
voestalpine Stahl Linz, Austria	HO A	2006 with expert system	4 stoves, external combustion chamber. Staggered parallel mode with temperature based changeover control.	Central enrichment with possibility of two rich gases (converter gas and natural gas) at the same time.
ILVA SpA, Taranto, Italy	AFO 5	2007 with expert system	4 stoves, external combustion chamber. 50/50 parallel mode with temperature based changeover control.	Individual enrichment with natural gas. Stove changeover initiated from SIMETAL BF VAiron Hot Stoves Control Model. Limitation of BFG flow rate, therefore an adaptive energy distribution algorithm was developed.
ILVA SpA, Taranto, Italy	AFO 2 AFO 4	2009 standalone 2012 standalone	4 stoves, internal combustion chamber. 50/50 parallel mode with time based changeover control.	Central enrichment with coke oven or natural gas. Stove changeover initiated from SIMETAL BF VAiron Hot Stoves Control Model.
Arcelor Mittal, Indiana Harbor, USA	IH 7	2011 integrated into existing expert system	4 stoves, external combustion chamber. 50/50 parallel mode with time based changeover control.	Central enrichment with natural gas. Oxygen enriched combustion air.
Enakievo Metallurgical Works, Ukraine	BF 3	2012 with expert system	3 stoves, Kalugin shaftless type Temperature and time based changeover control.	Central enrichment with natural gas.
Ternium Siderar, San Nicolas, Argentina	AH 1	2013 with expert system	3 stoves, internal combustion chamber. Temperature and time based changeover control.	Central enrichment with coke oven gas.

5 SUMMARY

Siemens VAI's Level 2 automation package for blast furnace hot stoves contains a control model of the newest generation. The basic control principles and the implementation details have been outlined in this paper.
The SIMETAL BF VAiron Hot Stoves Control Models are customized for each individual customer as explained based on the installations at voestalpine Stahl Donawitz in Austria and ensure optimum plant operation 24 hours a day permanently reflecting the experience of the best operators and process engineers. Shift independent and smooth model based stoves operation reduces the energy input to the stoves system, increases the hot blast temperature and ensures constant delivery of hot blast with the target temperature and the target flow rate.
In the paper the new optimization concepts and achieved benefits for voestalpine Stahl Donawitz are presented. The ease of the system usage and the fully automatic execution of the stoves setpoints in the Level 1 control system lead to a long-term system acceptance and sustainable benefits for the customers.

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