SMS group

X-Pact®

CONVERTER BOTTOM STIRRING

MINIMUM EFFORT – MAXIMUM BENEFIT

YOUR REQUIREMENTS

Intended advantages of installing converter bottom stirring are:

- Low iron content in the slag
- Low dissolved oxygen in the melt
- Low aluminum consumption for deoxidation
- Reduced production costs and higher yield

Availability

Availability of the bottom stirring system is required for the production of a range of high-quality demanding steel grades and is essential for the process economy. Therefore, proper functionality of the stirring has to be ensured over the entire BOF campaign. In recent times, the prolonging of the BOF refractory campaigns has been the aim of producers all over the world.

Any-time retrofit

Retrofit of existing bottom stirring installations, resulting in:

- Proper functionality over entire converter campaign
- Optimization of stirring flow rates
- Optimization of stirrer location

OUR SOLUTION

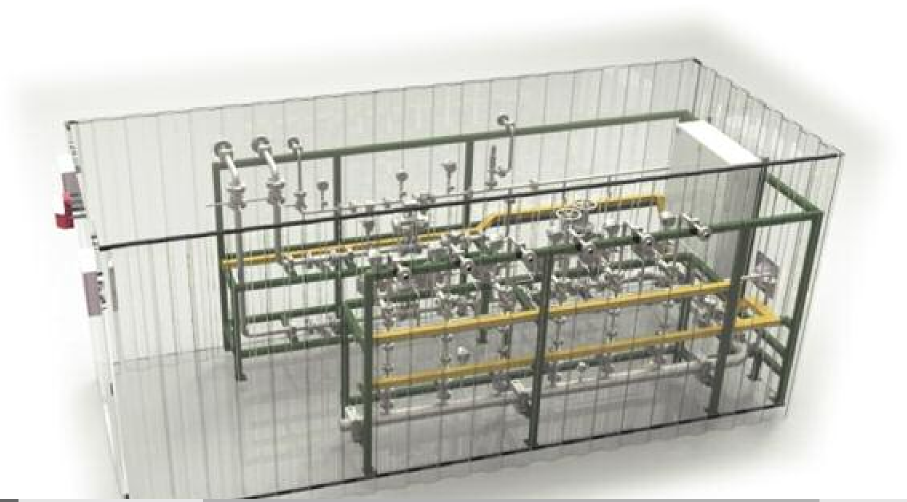
Minimum Effort – Maximum Benefit

The required amount of mechanical equipment and instrumentation is quite small in relation to the benefit. SMS bottom stirring systems are in operation in converters featuring heat weights up to 400 t. The equipment mainly comprises a valve station, the pipelines running to the converter, a rotary joint in the trunnion pin, the pipelines to the converter bottom and the bottom stirring bricks, as well as the automation package.

Existing converter plants can as a rule be retrofitted without any major effort. A bottom stirring system has a payback time between four and eight months.

Process

Using the bottom stirring process, inert gas (N_2/Ar) is introduced into the melt through bottom stirring bricks, improving the process conditions by optimized mixing. The flow rate and type of stirring gas depends on the process phase and steel grade. A faster and better approaching of the metal slag equilibrium will be achieved.



Bottom stirring system.

Equilibrium and mixing time depend on type, number, location of stirrers and flow rate. Stronger stirring shifts the thermodynamic equilibrium to the desired direction and reduces the mixing time. A shift-over from nitrogen to argon may be required, depending on the final steel chemistry. The valve station as the central part of the bottom stirring system allows individual flow control per individual purging plug.

Optimization of gas consumption

For optimization of flow control range, an additional inlet pressure control is installed. The combination of pressure control in the feeder line and individual flow control in the stirring lines maintains constant flow rates of the individual stirrers, thus avoiding clogging of porous plugs by viscous slag. Suitable instrumentation provides the operator with an indication of the porous plug condition.

Safety

Fail-safe philosophy is provided for the feeding lines (gas switch-over in case of low inlet pressure) as well as individual streams (fail-safe open in case of media and power failure).

Reliable design

Space optimization and short installation time are ensured by a prefabricated valve rack.
Two variations can be supplied, either:

- as a walk-in solution mounted in an industrial-standard container, completely prefabricated with power distribution, lighting, ventilation and oxygen monitoring sensor for fast and easy installation
- alternatively as a skid for room installation in converter areas.

The focus is placed on minimum maintenance with reliable instrumentation arranged for easy accessibility. All valve racks are prewired with easy connection to automation platforms.
A pressure test on the assembled rack before shipment ensures proper and fast commissioning.

X-PACT® AUTOMATION

The converter bottom stirring system is controlled via a PLC installed either as a stand-alone unit with individual HMI station or provided for integration into new or existing networks.

Flexible operation

Depending on the selected steel grade, the software follows stirring patterns (setpoint parameter tables) for argon and nitrogen flow rates during the complete heat as a function of the total blown oxygen quantity.
The setpoint changes and control action take place in automatic mode without operator interaction, based on field signals.
During tapping, deslagging and charging, predefined flow rates ensure reduced refractory wear and high life-time of the porous plugs.
Signal exchange with higher-level automation systems (Level II) is provided.

Stirring bricks

The state-of-the-art stirring brick design must ensure long service lives thanks to low erosion speed, advanced spalling resistance and flexible brick length. SMS offers integrated solutions combining state-of-the-art equipment design, process technology and refractory materials.

TECHNOLOGICAL HIGHLIGHTS

Optimum stirrer positioning

A key parameter for the effectiveness of the bottom stirring system is the location of the bottom stirring bricks with respect to the oxygen jets.

Optimization of the stirrer location has to consider the following:

- Impact of the oxygen jets under various process conditions (lance tip design; variability of lance height)
- Aspect ratio of melt height to converter diameter
- Influence on refractory wear

Using the latest CFD (Computational Fluid Dynamics) simulations, SMS has the capability to optimize the stirrer location by considering the complex conditions in the BOF converter. The stirring system can be customized according to the client's specific needs and conditions.

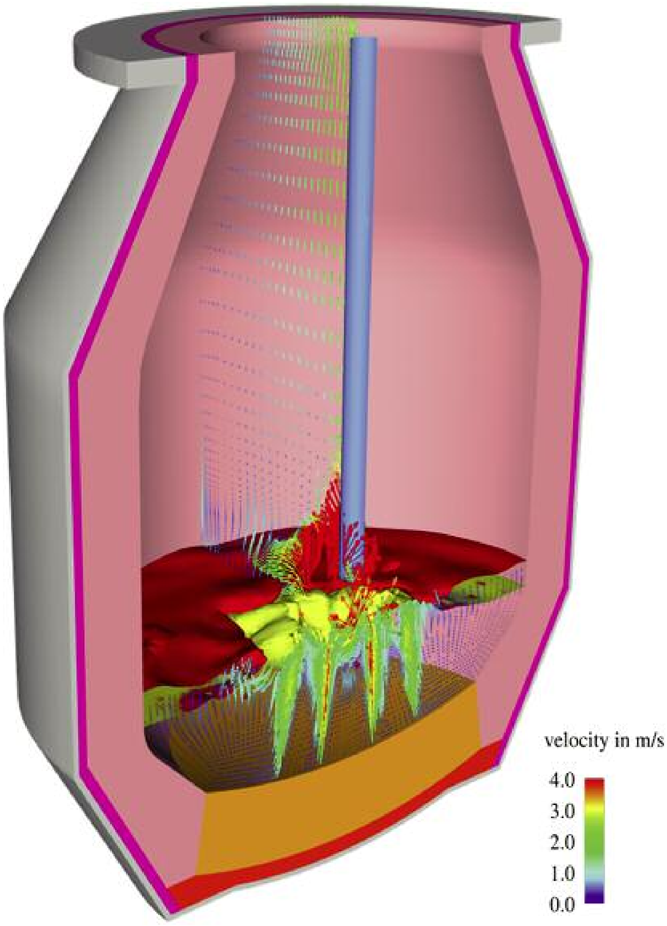
Latest Development: Alternating stirring technology

SMS has developed and patented the alternating stirring practice. Groups of stirring elements are controlled with alternating high and low stirring gas flow rates. Statistical evaluation of process results over several campaigns, after implementation of the technology in a world-class BOF shop, has shown that there is potential to reduce the argon cost by 30 % without negative influence on the metallurgical results.

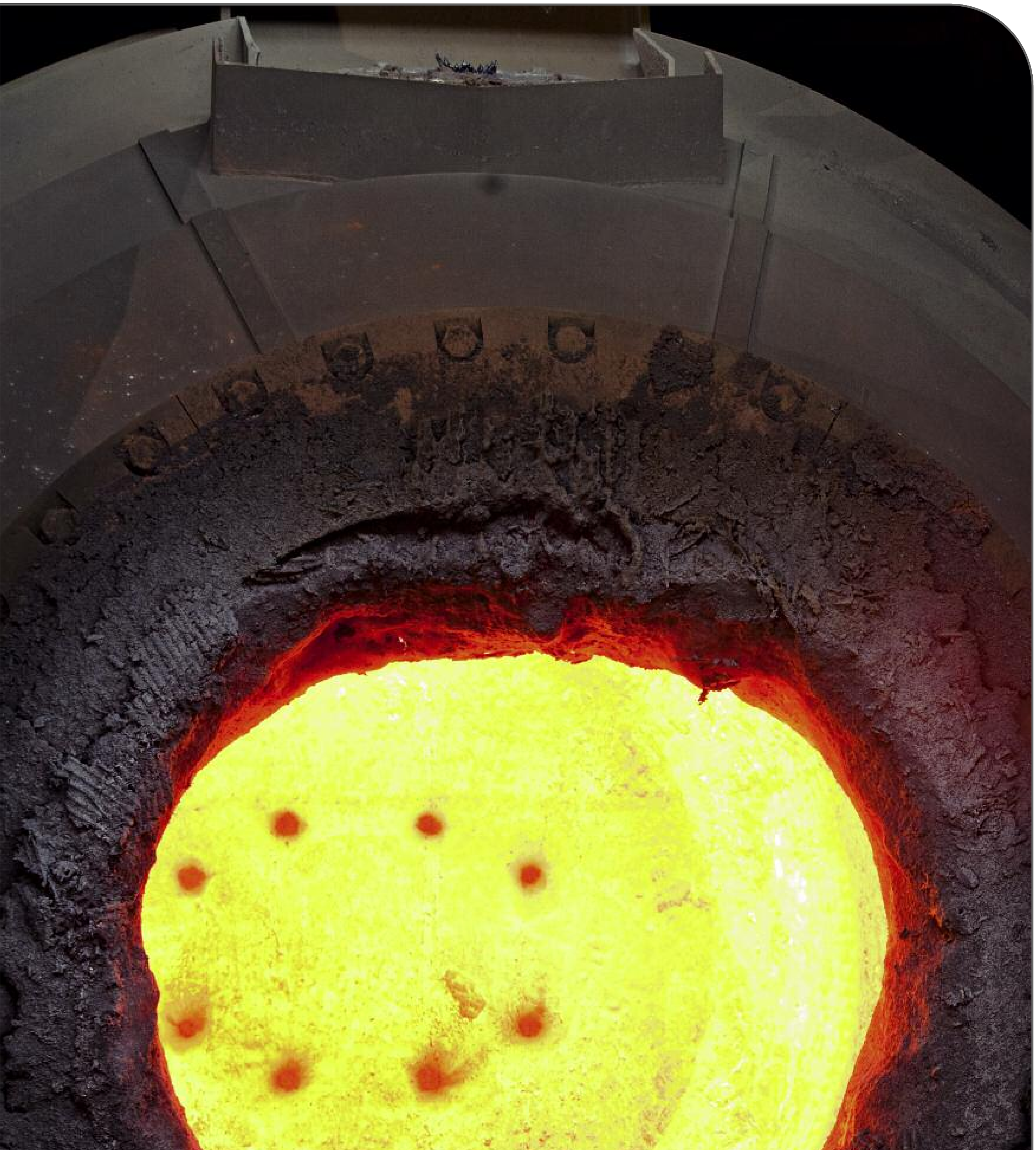
SMS scope and services

Scope and services include:

- Required equipment (hardware and software) for implementation of the converter stirring system into the existing BOFs
- Type, number and arrangement of stirring bricks
- Optimized setting of the bottom stirring process parameters



CFD simulation.



Converter bottom stirring.

YOUR BENEFITS AT A GLANCE

Advantages for steel quality

- Improved castability of certain steel grades thanks to lower aluminum input during tapping.
- Decrease in the free oxygen content leads to a higher micro-cleanliness of the melt.

Advantages of the steelmaking process

- Decrease of iron oxidation, improvement of yield
- Improvement of manganese yield
- Improvement of dephosphorization
- Reduction of deoxidizing agents and alloy consumption
- Lowest carbon content
- Cost improvement

The above features are directly related to reduced production costs, with pay-back for the investment in a reasonably short time-span.

Decrease of iron oxidation

Using bottom stirring, the iron content in the slag (%Fe) can be controlled at a low level throughout the converter process. Low iron losses to the slag in combination with the decreased tendency of slopping (smoother blowing behavior) permit an increase in total yield.

Improvement of manganese yield

The bottom stirring process assists in approaching the thermodynamic equilibrium. Lower manganese distribution ratios ((%MnO) in slag / [%Mn] in steel) can be achieved, leading to a higher manganese yield and lower consumption of expensive manganese alloys during secondary metallurgy.

Virtual reality: bottom stirring process.

Improvement of dephosphorization

The bottom stirring process improves the conditions for dephosphorization of the steel. Lime dissolution in the initial blowing phase is accelerated and the thermodynamic equilibrium is quickly approached. Final phosphorus contents can be further decreased by post-stirring of the melt.

Reduction of deoxidizing agents and alloy consumption

In the conventional BOF process, the oxygen content during decarburization is well above equilibrium, whereas equilibrium is practically achieved in the combined process using inert gas stirring. After completion of the oxygen blowing, equilibrium is reached very quickly. The low oxygen content at the end of process results in a reduced consumption of deoxidizing agents as well as in improved steel cleanliness.

Lowest carbon content

The stirring gas causes a reduction in the CO partial pressure, which results in a significantly lower final carbon content as compared to the LD process. Using post-stirring, final carbon contents as low as 0.02% can be achieved.

Cost-improvement

The bottom stirring process is an effective measure for decreasing the production costs. The savings are achieved mainly as a result of the lower iron content in the slag and the decreased free oxygen content in the melt. The reduced iron content in the slag and the lower slopping tendency improve the total yield by up to 1.5%. Specific consumption of the lime required for the dephosphorization can be reduced by up to 5 kg/t. The decrease in iron oxidation leads to a reduction in specific oxygen consumption of 0.5 to 1 Nm^3/t.

The lower free oxygen content at tapping signifies savings of up to 0.4 kg/t of aluminum. The reduced manganese loss saves 0.3 to 0.7 kg of FeMn/t.

The results vary according to specific production, different steelmaking conditions and the product portfolio in melt shops. Various converter plants which adopted the bottom stirring process in the period from 1988 to 2013 have demonstrated that operating cost savings of 1.50 to 2.00 €/t provide a return on investment within four to eight months. The exact period depends on converter capacity, on the number of rinsing bricks installed, and on the annual production.

Item	Process result **without** Bottom Stirring Technology	Process result **with** Bottom Stirring Technology	Remarks
Iron content in slag	20 - 23 %	15 - 18 %	[%C]: 0.04 - 0.06 in steel
Carbon oxygen product: [%C] * [ppm O]	30 - 35	22 - 25	Typical
Phosphorus distribution: (%P)/[%P]	30 - 50	70 - 110	(%P): content in slag [%P]: content in steel
Manganese yield	20 - 30 %	40 - 50 %	[%Mn]: 0.3 - 0.4 % in hot metal

Summary of process results.

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MEETING your **EXPECTATIONS**

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