EDITORIAL

Dear valued friends,

With the statement „From Steelmaker to Steelmaker” – reflecting our policy for more than 30 years – BSE successfully participated in the METEC 2015.

This world event for steelmaking technology and process innovation provided the appropriate forum to also introduce BSE’s new developments and product enhancements. Each is a result of our and BSW’s motivation to strive continuously for improvement with an increase in automation and work-safety.

You all are cordially invited to see all these products in operation here in Kehl, to share with our steel plant people their experience and to discuss with us about how to jointly support your path of continuous development for the long term and sustainable success of your operation.

With the best personal greetings
T. Rummler

Innovation from steelmaker to steelmaker

Presentation of new BSE products at exhibitions/
Mutual development with BSW steel plant

Beside major investment steps in new technology, it is crucial for any steel plant to continuously find ways to increase efficiency, reliability and maintainability of existing technology. For decades, BSE and BSW – the mini-mill of the Badische group and one of the world’s most productive Electric Arc Furnace steel plants – have been following this strategy, having developed various innovative solutions in an around the electric arc furnace.

Product development

The product development is based on the daily exchange of operational experience with BSW [1] and the feedback from customers worldwide.

The ideas are discussed, selected and transformed into prototypes, first on screen (2), then installed as hardware products at BSW.

Now, the real challenge comes when the products have to prove their efficiency, reliability, operability and maintainability during several months of 24/7 operation (3).

Further optimisation and fine adjustment is done mutually by BSE engineers and BSW personnel (4).

As a result, only the best products pass this tough procedure, generating innovative yet reliable solutions from steelmaker to steelmaker.

New products

- Tiltable VLB (Virtual Lance Burner with new tilting function to meet different process requirements)
- New features for MultiROB (automatic cartridge exchange, thermal camera for furnace inspection)
- New design of Electrode Arms (with copper / steel)
- LM.3 (New Lance Manipulator equipped with self-igniting burner)

Product presentation

A selection of the new products was presented in the course of the AISTech conference in May in Cleveland / USA. The BSE booth at the METEC in June in Düsseldorf / Germany featured a full-scale exhibit of the Tiltable VLB, meeting the interest and demand of many steelmakers.

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Increasing the performance of a shaft furnace with efficient and flexible energy input

Stahl Gerlafingen, a subsidiary of the Beltrame Group, is the biggest recycling company in Switzerland producing reinforced steel and profiles. They operate one 80 tons AC shaft furnace in Gerlafingen/Switzerland and were looking for a productivity increase.

Project approach
One measure to reach the aimed productivity increase was a substantial upgrade of the chemical energy equipment by replacing the existing water-cooled door lance with new sidewall oxygen injectors. After having observed the operation at BSW and seen the efficiency and reliability of the chemical energy equipment, Stahl Gerlafingen decided in favour of the new Tiltable VLB. The Tiltable VLB features the proven VLB technology with a new tilting motion to meet different process requirements:

- Increase of productivity
- Reduction of power-on time
- Elimination of water-cooled door lance
- Reduction of refractory consumption

Scope of supply
- 3 x Tiltable VLB with copper boxes
- Main oxygen valve rack for three lines
- Reuse of existing secondary oxygen and gas lines
- Integration of VLB control and visualisation system into existing infrastructure
- Supervision services at site

Results / Benefits
In January 2015, the installation of the new equipment was completed within schedule, followed by the start-up, operation/maintenance training and process optimisation. The results showed a significant process improvement at reasonable consumption levels:

<table>
<thead>
<tr>
<th></th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elec. energy [kWh/t]</td>
<td>336</td>
<td>319</td>
</tr>
<tr>
<td>Oxygen [Nm³/t]</td>
<td>32,0</td>
<td>34,6</td>
</tr>
<tr>
<td>Natural gas [Nm³/t]</td>
<td>7,6</td>
<td>8,5</td>
</tr>
<tr>
<td>Power-on time [min]</td>
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<td>26,8</td>
</tr>
<tr>
<td>Yield [%]</td>
<td>92,8</td>
<td>92,7</td>
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Temperature measuring with fully automatic cartridge exchange for highest operator safety

Successful installation of new MultiROB at Outokumpu Avesta (Sweden)

Due to safety reasons the operators at the Outokumpu steel plant in Avesta/Sweden are not allowed to stay on the furnace platform during EAF operation. Therefore, Outokumpu opted for a robot solution for temperature taking with automatic cartridge exchange.

The BSE MultiROB is based on a standard industrial robot upgraded with special equipment and features for operation within hot and rough meltshop conditions (e.g. heat protection of all relevant parts, usage of heat resistant cables).

Results / Benefits
In summer 2014, the robot was installed with the start-up taking place in August. The high expectations and guarantees (robot availability of 99 % and exchanger availability of 98 %) were reached at once, thanks to the winning combination of BSE know-how and local expertise of Outokumpu personnel. The operators and maintenance personnel were trained in the course of the start-up phase. The personnel and responsible managers have been appreciating especially the reliability and easy maintainability of the robot.

Due to the performance and high acceptance of the installed robot, Outokumpu is considering also an upgrade of the robot with a sample taking function.

Cartridge exchange
The automatic cartridge exchange is carried out by means of a cartridge rack with special functions for deposing/gripping of the cartridges and self-adjusting of the lance tip in case of deformation:

- After each measurement, the used cartridge is stripped and deposited in a small container (1).
- Then the lance tip is checked by two swinging plates with different hole sizes positioned in a row (2).
- If the lance tip passes both plates without swinging, the new cartridge is picked up directly from the gripper.
- If the first plate with a hole swings, the lance tip is inserted in the self-straightening device (3).
- If the second plate with a hole swings, the lance tip is moved within a U-shaped sensor to be automatically compensated in 6 dimensions.
- After the automatic compensation the lance picks up safely the new cartridge.

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New combination of proven technologies for further increase of productivity and efficiency

New solutions for chemical energy input for special applications

Lance Manipulator LM.3
The DC EAF at the ArcelorMittal plant in Belval is using a fin-type bottom anode that requires special care during the start of the first heat after replacement. BSE together with ArcelorMittal engineers have developed an innovative solution to this challenge.

The solution for ArcelorMittal Belval features a Lance Manipulator that is equipped with a new burner unit, conventional consumable lances plus an additional TempSamp unit.

The consumable lances provide further metallurgical applications (e.g. oxygen injection for refining).

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Special LM
The customer in Europe had resumed operation of several small EAF’s for special metallurgical applications. As a consequence, the very old equipment for injection of additives had to be replaced.

The customer entrusted BSE with the engineering and supply of a special lance manipulator for this purpose. The swivel arm of the manipulator is equipped with two independently movable lance guides for injection of additives with consumable lances or sample taking.

The manipulator was installed and started-up in June 2015, allowing the customer new levels of injection efficiency and reliability since.

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Winning combination of Badische philosophy and state-of-the-art vacuum technology

New BSE vacuum technology with customised mechanical pump sets including all auxiliaries as package units

Vacuum degassing with mechanical pump sets for steel degassing plants is a well-known and proven technology in many steel plants worldwide. More than 25 years of experience of the newly formed BSE project team in vacuum pump technology complemented with Badische equipment philosophy results in highest efficiency, reliability and maintainability of BSE vacuum technology services.

Example: 70 tons VD tank degasser

The selected mechanical pump set has a suction capacity of 90,000 m³/h at 0.67 mbar. The selection on the suction capacity is based on the steel plant’s requirements and process cycle. In general, the suction capacity of pump sets has been increased during the last years. This example is based on the supply of multiple three-stage modular units, which would be operated in parallel in order to provide the required overall vacuum pumping capacity. Additional pumps can be added as an option for increased suction capacity and to ensure the production in the unlikely event of a pump failure (hot-spare-standby).

As all pumps are driven with frequency converters, a full control on suction speed is possible. Depending on the programmed control features the user can reduce the pump frequency to minimise suction speed, e.g. to avoid slag-foaming. A programming of pre-programmed pump-down ramps is possible. The system offers full suction capacity control! To reach maximum pump-down performance, the pumps are operated by use of matched and specially parameterised frequency converters. The total suction capacity will be generated by two modules.

The filter working under vacuum conditions demands certain precautions. A combined vacuum dust cyclone entrance in the vacuum filter with nitrogen backwash has been developed. The guiding design principle has been to reduce gas temperature and to separate dust as early as possible in the system using a cyclone type separator, which allows reducing dust load on the filter cartridges. It must be completely airtight to avoid any air leaks into the system. After degassing is completed, the filter cartridges must be isolated and back-washed with inert gas in order to avoid ignition (and destruction) when air enters at the start of the next degassing cycle. The maximum permissible inlet temperature for the vacuum filter cartridges is 250 °C.

The new vacuum pump technology can be easily fit in existing rooms or space that will be available after the old steam ejector pump or steam boiler is dismantled. The reference layout below shows one possible arrangement.

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Using pump modules from all well-known pump suppliers ...

... and high temperature filter systems for maximum efficiency and operation safety
Completing the furnace revamp with modern and top-performing electrode arms

Installation of electrode arm with new copper/steel design at Swiss Steel

After the major revamping of the 90 tons AC-EAF at the meltshop in Emmenbrücke in 2013, the current conducting electrode arms became the weakest part of the furnace. The old copper-plated arms were more than 20 years old and showed several cracks in the corners. Swiss Steel decided to replace the old arms with the newly designed electrode arms from BSE.

Project approach
The new BSE electrode arm design - mutually developed by BSE and BSW - features direct cooling of a 10 mm conducting copper layer without any welding in the edges. The split-design of the copper shoes was another argument for the new design, against the traditional copper-plated design. The final design of the electrode arms for Swiss Steel was a result of investigations on-site, discussions with Swiss Steel management and technical personnel, considering all special requirements. The design of the new arms was made in such a way to be compatible with the existing arm fixing to the columns, with the connection of the high-current cables, and with the reuse of the existing current loop on phase n°2.

Results/Benefits
The installation was completed during the annual summer maintenance shutdown. The startup of the new arms system went smoothly. Electrical measurements made before and after the installation of the new arm system showed at least similar performances of the arc furnace with possibilities of further optimisation.

Concept of Electrode Arm with Copper/Steel Design
- Electrode supporting arm with core-superstructure made out of steel
- The casing as conducting part made out of edge copper plates instead of copper-plated steel
- Eliminating the “edge” problem by using a shape-bent hull of same material thickness
- Direct cooling of the copper mantle
- Available in monolithic design or in flange design for easy maintenance and flexible use of electrode holders

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Extended training services continuing the success story of classic BSE consulting

5th Anniversary of BSE Academy – Review / Preview of courses

Closing the gap between general theoretical training and specific equipment training in order to provide the essentials of day-to-day needs for efficient plant operation. The approach of classic BSE consulting services was extended in the year 2010 by establishing the BSE Academy. Time today for a review of seminars, courses and special offers for upcoming courses.

The BSE Academy has made accessible the know-how of Badische Group also to individuals from different companies by providing open courses on specific steelmaking topics all over the year. Steelmakers from all continents have participated in BSE Academy courses, strengthening their technical and organisational skills as well as exchanging their experience with participants from other steel mills.

Concept of BSE Academy

- Impartment of theoretical knowledge and practical skills for steelmakers
- Aiming for different levels of qualification and for everyone involved in the steelmaking process
- Seminars conducted by steel industry experts with hands-on experience – from steelmaker to steelmaker
- Understanding your needs with our extensive industry know-how and contact to most existing mini-mills in the world
- Conducted in real steel plant atmosphere either at Badische Group production sites or at customer site

Look. – Listen. – Do!
The motto of BSE Academy

Upcoming courses

The upcoming open course “Process Metallurgy”, taking place from October 12-14, 2015, provides knowledge in theory and practice dedicated to EAF steelmaking. Especially aiming for junior managers and fresh graduates, the course answers the basic questions and delivers the necessary technical information needed to manage a steelmaking facility.

BSE offers a special anniversary discount of 25% for participants of this upcoming course.

Register and download full programme at www.bse-kehl.de

Participants of the open course “Dedusting Principles”

Learning “Preventive Maintenance” at BSW maintenance shop

Observation of BSW production including discussions with BSW steelmakers

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“Being a newcomer in the steel industry, this seminar allowed me to get a very good global overview of the job. The opportunity to see at the plant what has been taught is a great advantage.”

Participant of open course “Process Metallurgy”
Successful steelmakers must consider and master all influential key factors

BSE consultancy for individual packages – Selection of recent projects

Maintenance

How shall maintenance support and cope with new output targets in the steel plant?

Like many steelmakers, Outokumpu Avesta (Sweden), a dedicated stainless steel producer, has been looking for an answer to this question. Therefore, Outokumpu entrusted BSE to conduct a study in order to assess the maintenance with the target to have an objective status of maintenance organisation and procedures.

Another major topic of the study was the re-introduction of a 5-shift system, comprising all steps from the selection of adequate personnel to the setup of specific maintenance procedures. Beside the general maintenance organisation, the recommendations of BSE included also further topics such as downday planning/execution and delay reporting.

Outokumpu maintenance managers and BSE experts developed together a set of measures, based on the proven methodology of BSW mini-mill and special requirements of Outokumpu plant.

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Noise reduction

How to create a less noisy environment for the resident population and the own personnel?

Due to its location close to residential areas, Nanjing Iron & Steel Co. (NISCO) (P. R. China) has been working on the noise reduction of its production facilities. BSE is supporting NISCO with a comprehensive noise study. Beside analysing the situation and showing potentials for improvement, BSE shall elaborate concrete measures for noise reduction. The study consists of an on-site investigation for:

- Location and measurement of all relevant noise sources
- Calculation of noise levels
- Suggestions for noise reduction measures

Examples of noise dispersion and noise reduction measures

The kick-off meeting took place in June 2015 at BSW in Germany, where the responsible personnel of NISCO gained detailed insight into the noise reduction programme of BSW. The on-site investigation is scheduled for September 2015.

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Logistics

How to solve and avoid logistic bottlenecks for an optimum scrap handling?

Hod Assaf Industries Ltd. (Israel) operates a 70 tons EAF based steel plant with a designed capacity of 300.000 tons per year, having increased continuously the productivity over the last few years. As everywhere, scrap is a problem: not only the quality and the density get lower, but also the costs of the scrap push to sometimes difficult compromises.

Therefore, Hod Assaf asked BSE to analyse and optimise the existing scrap yard logistics. Based on an on-site investigation and computer simulations of the material flow, BSE gave recommendations with concrete measures on every aspect of scrap handling. The logistic study also included the basic engineering of a recommended modified scrap yard layout – usually done by means of aerial pictures, giving an excellent overview of the main areas and existing/recommended machinery.

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