



## EDITORIAL

Dear valued friends,

In our fast-changing world nobody can afford to rest and rely on merit of the past. We all must face the challenges of today and the future.

We can conquer the challenges with big measures, for example modernisation of the furnace or components (see page 2), but also with a continuous improvement process.

One of the guiding principles at the Badische Group is that potential for improvement lies everywhere. Recent results of this principle are the development of a smart control for ladle preheating and a system for detection of water leakages (see page 6).

But the decisive factor is the importance of people. Only the combination of people and technology makes steel production successful. On one hand people must be recruited, trained and motivated (see page 5), on the other hand people must accept technology as a "member of the steelmaking team" (see page 3).

We at Badische Group are honoured to be a part and have you as a member of the steelmaking family.

With the best personal greetings,

Andreas Volkert and Florian Glück,  
Managing Directors

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## Technology Supporting and Protecting People

### New BSE Concept "EAF Operation of the Future" Premiered at METEC Exhibition in Düsseldorf

Actually, the new BSE concept "EAF Operation of the Future" is not a completely new concept. It is a proven concept, reflecting the success and experience of BSW, the mini-mill of the Badische group, renowned worldwide for its high productivity and efficiency. The concept emphasises the essential combination of people and technology under the motto: "Industry 4.0 is good, but don't forget the people".



The new concept was presented to the steel industry in the course of the METEC exhibition in Düsseldorf / Germany in June. The BSE stand was a gathering place for steel industry experts, discussing and finding solutions for today's and tomorrow's challenges of the steel industry. Beside the environmental challenges, the main challenge consists of **finding an optimum balance of people and technology**. Because the best technology is useless without the right people setting up, operating and maintaining it.



Discussing the future of EAF operation with customers at the stand

Since people are the most valuable asset in steel production, the BSE stand and the new concept featured three persons as key visuals representing the topics **Best Practice, Safety and Efficiency**:



New key visuals Safety and Efficiency

At BSW, the mini-mill of the Badische Group, dangerous or inefficient tasks of the operators are being eliminated, thus the **people focus on tasks that require human intelligence, creativity and skills**, e.g. continuous process improvement and exception management, which happens every day especially with scrap-based EAF operation.



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# Massive Reduction of Energy Consumption and Power-On Time

## Comprehensive EAF Modernisation Project for Efficiency Increase at Fujian Fuxin Special Steel / China

**NEW**

**F**ujian Fuxin Special Steel Co. Ltd. (called hereafter Fuxin) operates one 160 tons electric arc furnace at Zhangzhou / China, producing two main grades of stainless steel in different operating mode. In order to improve its furnace efficiency in a coordinated and sustainable way, Fuxin has been cooperating with BSE.

### Project Approach

In April 2017, BSE conducted a technical assistance in the field of **active power input increase** at the EAF. Fuxin was pleased by the BSE expertise and by the outcome of the technical assistance. Subsequently, BSE proposed to Fuxin a package for efficiency increase featuring a set of measures to **reduce power-on time and energy consumption**. The mutually elaborated concept, different site visits and a visit to BSE/BSW in Kehl by the Fuxin project team increased the confidence in BSE, hence in 2018 Fuxin awarded BSE with the order for implementation of the proposed measures.

### Scope of Supply

BSE provided engineering (including calculation of high-current electric components with the BSE unique Finite Network Method) and supplied the following key components:

- ⊙ New current conducting copper-steel electrode arms
- ⊙ Modification of high-current system
- ⊙ New ELARC electrode regulation
- ⊙ **Electrode mast positioning system**
- ⊙ New Tiltable Virtual Lance Burners
- ⊙ Modification of existing Lance Manipulator with lifting / lowering device

The cooperation also included BSE/BSW experts supervising the installation works and accompanying the start-up process at site, taking place in July 2019

### Results / Benefits

The modernisation of the EAF has resulted in a massive increase of efficiency and reduction of consumption figures – as to be seen in the following table, comparing the performance for both steel grades (SG) before and after installation / start-up of the new equipment.

|                        | SG#1   | SG#2  |
|------------------------|--------|-------|
| Power-on Time [min]    | - 3,4  | - 3,1 |
| Electr. Energy [kWh/t] | - 60   | - 37  |
| Electrode Cons. [kg/t] | - 0,35 |       |



*Installation / start-up of electrode arms, equipped with specially designed loop for improved harmonic level*



*Operator's view on the modernised EAF*

### Mast Positioning System

The modernised EAF at Fuxin is also equipped with the new mast positioning system, which BSE developed together with BSW, the mini-mill of the Badische Group.

The system uses **flow transmitters in the supply line of each electrode mast cylinder**.



Combined with a smart logic, a good signal can be provided to feed the regulating system and support its performance.

- ⊙ Accurate indication of each mast position
- ⊙ Evaluation tool to check and assess the regulation behaviour between regulating valve and electrode arm
- ⊙ Investigation tool in case of electrode breakages
- ⊙ Possibility to check and measure the regulation speeds of each arm
- ⊙ Eliminates the usage of electromechanical travel sensors (encoders), which usually are difficult to maintain in the harsh EAF environment
- ⊙ Damage by scrap or dust eliminated

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# Robots Replace Dangerous Tasks of Operators, Being Accepted as a Team Member

## Implementation of BSE MultiROBs for Multiple Applications at Deutsche Edelstahlwerke / Germany

**B**elonging to the SCHMOLZ + BICKENBACH Group, Deutsche Edelstahlwerke is a renowned producer of stainless steel and operates two EAF based meltshops at Siegen and Witten. DEW, in cooperation with BSE, have been implementing robot technology for multiple applications at their EAFs and billet sample facilities in order to reduce the risk for operators, improve the quality of billet sampling and increase process standardisation.

Due to many different steel grades produced at DEW, flexible, precise and reliable systems are essential. BSE's practical experience in different robot applications, high flexibility and close collaboration from the very beginning were the key reasons for DEW to realise the projects with BSE. Furthermore, BSE is the only robot supplier with a safety concept that does not require a physical safety fence around the working area of the robot.

### TempSamp EAF (Siegen)

The existing equipment for temperature measurement and sample taking at the EAF at Siegen plant could not provide enough flexibility regarding different steel bath and sill levels as well as slag practice. Therefore, DEW was looking for an appropriate tool for automatic temperature measurement and sample taking, which should also be able to operate simultaneously with the existing BSE lance manipulator. The BSE MultiROB was installed in 2017 and has been fulfilling all these requirements since.

### Billet Sample Cutting

Another MultiROB was installed in 2017. It performs automatic cutting of (one or multiple) billet sample slices of different shape from different billet sizes and steel grades (see article in BSE Newsletter 2017-1).

### TempSamp EAF (Witten)

The performance of the MultiROB at Siegen plant convinced DEW to order another robot for temperature measurement and sample taking for the EAF at Witten plant. The MultiROB has replaced the manual task of operators, so the **operators now can focus on tasks that require human intelligence and skills.**

Equally important to the technical performance is always the **high acceptance of new equipment by the operator and maintenance team.** The team at Witten was especially enthusiastic and appreciative. The team welcomed the robot as a full member by even giving it a human name.



Temperature measurement before  
(all manually by operators) ...



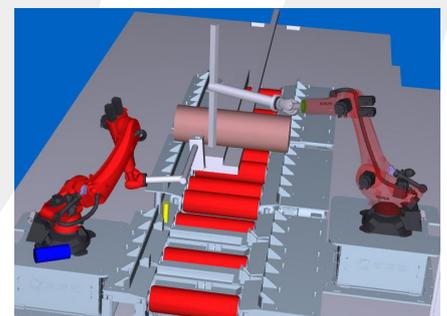
... and afterwards  
(automatically by the MultiROB)

### Robot with Multifunctional Cabinet

DEW requested a spare robot that can be used for both applications (TempSamp and billet sample cutting) at Siegen plant. So, beside delivery of one spare robot, BSE designed and delivered a multifunctional cabinet. In case of failure or damage, each of the installed MultiROBs can be dismantled and completely replaced by the spare robot or cabinet within very short time.

### Billet Sample Taking

Beside the application of billet sample cutting, there is also the need for automatic billet sample taking, marking and storing. Since the applications have to run simultaneously, BSE worked out a concept for **two coordinated MultiROBs.** After a detailed investigation on-site and exchange of ideas with the DEW team, BSE elaborated a computer simulation featuring all movements of both MultiROBs.



Simulation of two opposite MultiROBs performing simultaneously the billet sample taking (left) and cutting (right)

The simulation was successful, thus DEW ordered a new MultiROB for billet sample taking. The robot was delivered to DEW for comprehensive testing at site. The start-up of the new robot is scheduled for the first quarter of 2020.

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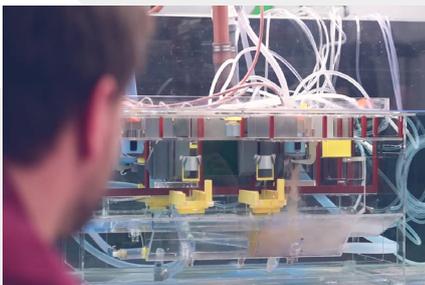
## Analysis – Implementation – Compliance

### Improvement of Building Ventilation with Fluid Dynamic Model Study and Subsequent Engineering Projects at Stomana Industries / Bulgaria

**B**eside compliance with environmental regulations, a proper building ventilation improves the working conditions inside the building and the overall meltshop performance. In 2018 Stomana Industries started a cooperation with BSE in order to analyse and improve the building ventilation at their EAF meltshop in Pernik / Bulgaria. The first step of the cooperation was the execution of a Fluid Dynamic Model (FDM) study with consecutive engineering projects, based on the results of the study.

#### Fluid Dynamic Model

The FDM study was performed by the BSE subsidiary company Bender Corporation, using a scaled Plexiglas replica of a meltshop. The model was submerged invertedly in a tank filled with fresh water. The heat sources are simulated by using salt water, which is injected at each source according to the existing equipment layout. The benefit of the FDM study is that the position of exhaust points flow rates adjusted and building geometry can be quickly modified, which allows to try and verify multiple solutions during workshop with the customer personnel.



Fluid Dynamic Model study enabling the simulation of all heat and dust sources influencing the building ventilation

After an **on-site investigation** in Bulgaria, the initial situation was simulated and consecutive tests were performed together with Stomana personnel witnessing the **test at BSE**. The results were compiled in a **final report** with the proven recommendations for the improvement of the following areas:

- ⊙ Increase the total building exhaust flow rate during charging and tapping
- ⊙ Separate the furnace aisle from the ladle aisle by installation of partition wall and modification of canopy hood
- ⊙ Controlling the emissions from the ladle furnace and auxiliary equipment by local exhaust systems



Fluid Dynamic Model of Stomana meltshop with simulated emissions from EAF

#### Engineering Projects

Due to the excellent partnership and project execution experience during the FDM study, BSE was also entrusted with the conceptual engineering and basic / detail engineering for further hardware components.

The implementation of the proposed modifications required a **conceptual engineering (CE)** study in order to determine the arrangement of the future emission control system capable to deliver the total required exhaust flow rates, which was determined based on the secondary emission control system requirements established during the FDM study together with the Direct Evacuation Control (DEC) system requirements calculated in the course of the CE study.

One of the key measures determined during the FDM study was the implementation of a tapping shed at one of the electric arc furnaces in order to divert emissions from the tapping into the furnace aisle. BSE was awarded with the **basic engineering** for this **tapping shed**. This measure allows to evacuate all emissions generated during furnace operation directly from the furnace aisle and prevent dispersion of tapping emissions across the ladle aisle. Another area for improvement was the improvement of the ladle furnace local evacuation. BSE was also responsible for the **detail engineering** for modification of the **ladle furnace roof**.

#### Results / Benefits

The measures derived from the FDM study have improved considerably the conditions inside the meltshop and eliminate fugitive emissions from the building. Since the model of the meltshop is stored at BSE, it is relatively easy and cost effective to conduct some additional tests in case of changes in the operations or compliance with environmental regulations today and in the future.

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Download Movie FDM  
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# From Zero to Hero – How to Become a Highly Productive Steel Plant within 3 Years

## Long-Term Consulting Cooperation with Abul Khair / Bangladesh

In 2015, Abul Khair group was the first company in Bangladesh to build up a mini-mill for rebar steel, aiming to become a world-class steel plant and the leader of rebar sales in Bangladesh. In order to stabilise production at the beginning and continuously increase productivity and cost efficiency, Abul Khair entered a long-term, comprehensive consulting cooperation with BSE.

### Project Background

Abul Khair's new meltshop at Chittagong is equipped with two DC furnaces (85 tons tapping weight each), two ladle furnaces and one billet caster. The furnace is charged with a mixture of scrap, HBI, and pig iron due to the low density of the available scrap types. All material for the production of steel are imported to Bangladesh from all over the world.



Abul Khair's production facilities



New meltshop with DC furnace

The initial production results in 2015 were already promising. But for stabilisation and continuous improvement of production, appropriate measures had to be defined, challenges met and bottlenecks solved. One of the main challenges was education and training of the employees, recruited from the low experienced local population.

### Scope of Services

As a first step of the cooperation, a team of BSE/BSW experts came to Chittagong for a detailed **on-site investigation** of facilities, processes and organisation. Beside hands-on recommendations being implemented immediately, specific measures were concluded in an action plan.

The next step was the execution of one **strategy seminar** and one **management seminar** at BSE/BSW premises in Germany. In the course of the seminars, the measures of the preliminary action plan were discussed, completed and mutually agreed. This action plan has been serving as a road map for further development.

With the main direction set for future development, one **operation/maintenance seminar** was conducted at BSE/BSW. The seminar consisted of classroom training and discussions with BSE/BSW experts as well as extensive observation of production facilities and processes at BSW.



Seminars taking place in classroom and at BSW production site

Subsequent to the seminars, BSE assisted Abul Khair in implementing the measures of the action plan and checking their progress. BSE/BSW experts made several **follow-up visits** to Abul Khair on specific topics, e.g. optimisation of EAF energy input and handling of raw material.



Exchange of experience from steelmaker to steelmaker

### Results / Benefits

The cooperation has paid off for Abul Khair. The increase of productivity and reduction of consumption figures in all relevant areas were impressive. The following EAF key performance indicators show the improvement after the first year and third year of the cooperation.

|                        | 1 year | 3 year |
|------------------------|--------|--------|
| Heats per Day [#]      | + 8    | +12    |
| Tap-to-Tap Time [min]  | - 12   | - 32   |
| Electrode Cons. [kg/t] | - 0,05 | - 0,28 |
| Active Power [MW]      | + 5    | + 9    |

BSE is proud having contributed to this veritable success story of Abul Khair.

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# Continuous Improvement of People and Process plus Stepwise Investment in Technology

## News and Projects at Badische Stahlwerke (BSW) – New Tool for Reliable, Accurate and Easy Detection of All Water Leakages

**NEW**

**A**fter another successful production year 2018, BSW installed a new state-of-the-art Continuous Casting Machine (CCM), replacing the old CCM#1 that had been in operation since 1968. Beside this big investment step and continuous improvement of people and process, BSW has been investing in further smart technology for increase of safety (enhanced detection of water leakage in the EAF) and efficiency (optimisation of ladle preheating).

### Production Review 2018

In 2018, BSW performed another successful production year. The strategy was rather to **focus on efficiency** (lower operation time and reduction of electrode consumption in particular) than on total production. Therefore, the **annual production of 2,13 million tgb** in 2018 was lower than the record of 2,37 million tgb in 2016. But due to **continuous process optimisation**, many consumption figures reached a new record low, for example the average specific energy consumption at the EAF with 343 kWh/t.

### New CCM#1

2018 marked also the last year of the continuous casting machine #1 at BSW. Since the start-up in 1968, more than 30 million tons of steel had been casted with the old CCM#1. It is an excellent example for pushing machine life limits by conducting proper maintenance and modernisation projects. The new CCM#1, featuring **6 strands**, was installed during the winter shutdown 2018/2019. While only the key components were supplied from OEMs, **BSW was responsible for complete engineering, manufacturing of the surrounding equipment and coordination of the erection works**. The successful start-up took place in February 2019.



*BSW project team after successful start-up of new CCM#1*



*CCM with state-of-the-art technology and 6 strands for higher productivity*

### Water Leakage Detection

Water leakage detection in the EAF is an important safety topic, because cooling water infiltration in the furnace can cause catastrophic explosions or decomposition of refractories, which leads to dangerous steel breakout through the lower shell. Beside the safety factor, such incidents are also an economic risk for steel producers due to the related production loss and high repair cost.

Therefore, BSW and BSE developed the new **Smart Leakage Detector**, an efficient tool that is able to detect also small water leakages (down to 1,5 m<sup>3</sup>/h, 25 l/min) on a consistent basis and without permanent care of the system. The tool has proven its reliability and efficiency on many occasions under real meltshop condition.

### Smart Leakage Detector

Small water leakages in the EAF are particularly dangerous, because they can neither be detected visually in an easy way nor detected by conventional systems.

The Smart Leakage Detector by BSE is able to **detect small but dangerous water leakages**. It features an advanced measurement technology together with a mathematical online analysing algorithm that indicates small leakages and alarms the operator on the HMI system.

- ⊙ Integration into HMI system enables warning to the operator or forcing an EAF stop via PLC signal
- ⊙ Early warning gives the operator a scope of actions to avoid catastrophic explosion
- ⊙ Increased safety for employees and reduced risk of equipment damage
- ⊙ Very high availability (no maintenance required)
- ⊙ Improved delay analysis and process understanding

### Ladle Preheating

The preheating of idle ladles is widely considered as an auxiliary process without the necessity of an advanced control of the used burner equipment. BSW however sees a considerable potential for energy saving in setting up different heating profiles as well as using advanced valve rack technology and visualisation.

BSE deliver the hardware and software for the enhanced ladle preheating system. The start-up is planned for the winter shutdown 2019/2020.

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