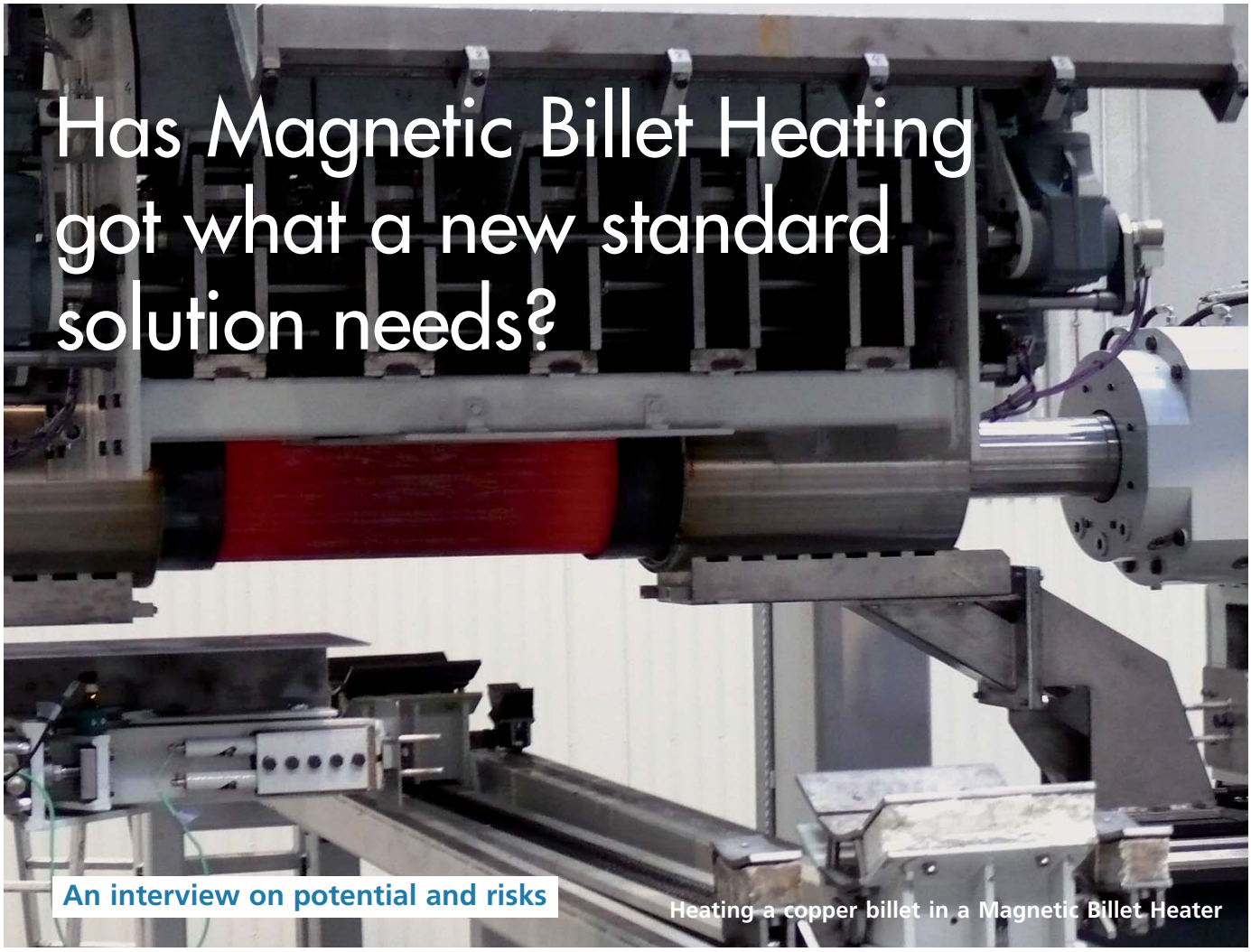
Has Magnetic Billet Heating got what a new standard solution needs?



An interview on potential and risks

Heating a copper billet in a Magnetic Billet Heater

*Heating billets for processing ranks among the most energy-consuming processes in aluminium extrusion. At the same time, customer specifications for semi-finished aluminium products become more and more exacting: automotive, aerospace, transportation, and building industries are among those using aluminium profiles with increasingly complex geometries and challenge suppliers to upgrade the mechanical properties and surface qualities of their products as well. As a consequence, growing attention is drawn to the process of heating billets for extrusion. HEAT PROCESSING (**HP**)* talked to Bardo Ostermeyer, Managing Director of the first-adopting extrusion specialist Weseralu at Minden, Germany, Karl Förster, Vice President Technology of Sapa Group, the world-leading manufacturer of aluminium profiles and Managing Director of its Bolzano subsidiary, and Werner Witte and Dr. Jürgen Kellers as representatives of the two companies which have jointly introduced the new billet heating system onto the market.*

HP: Two years ago, a new type of billet heating system was first put into operation at Weseralu's extrusion plant. The machine's functional principle was without precedent in heating technology. Why did you decide to commence?

B. Ostermeyer: As a matter of fact, there is not much of a difference between the functional principle of the Magnetic Billet Heater and an ordinary eddy-current brake in a truck. The groundbreaking aspect was the high-performance superconductor material the system employs. Combining both technologies produces a remarkably simple and effective machine. We expected it to provide a substantial competitive edge and this estimate has proved correct.

HP: Even though introducing a new technology always involves considerable operational and commercial risks?

K. Förster: It is important to identify new production trends early on and also study evolving market requirements in good time. Sapa has achieved positive results with this approach since the 1990s when we first introduced friction welding. For a market leader, maintaining a position at the top involves taking calculated risk. The accomplishment can later be read off the share in the market.

B. Ostermeyer: We took this kind of a calculated risk when we started out with magnetic billet heating: Installing the first heater worldwide was one thing but where long-term trials would have been the next step in the usual proce-

* by Stephan Schalm (Managing Editor) and Ursula Kollenbach

Bardo Ostermeyer, Managing Director of weseralu GmbH & Co. KG

dures of the industry we commenced full-scale industrial operation. What we banked on was Weseralu's long-standing cooperation with Bültmann as a machine manufacturer. We were closely involved in the engineering process of the project partners Zenergy Power and Bültmann and therefore already knew the machine quite well at the time.

HP: What is the functional principle of a Magnetic Billet Heater?

J. Kellers: In common induction heaters for industrial application an AC-powered coil surrounds the billet. However, when heating billets of highly conductive material these ovens loose roughly half their electric power input as waste heat through the coil's water cooling system. In a Magnetic Billet Heater, electric drives rotate the billet in the static field of a superconducting magnet. This process generates eddy-currents which heat up the material. With this principle each component takes the function it will fulfil most efficiently: Superconductors generate strong magnetic fields with a low power input and electric drives convert electric energy into mechanical rotation with very little loss.

Karl Förster, Vice President Technology of Sapa Group, and Managing Director of Sapa Profili Srl., Bolzano

HP: Did you find the heating process itself to be different with the new technology?

B. Ostermeyer: Heat penetration is fundamentally different from what we have known from conventional systems. The main problem of common AC-powered induction ovens is the skin-effect which occurs because the billets are heated by eddy-currents of 50Hz or 60Hz reflecting the frequency of mains. At this frequency level heat is generated close to the surface and takes considerable time to penetrate into the billet. The Magnetic Billet Heater produces low-frequency eddy-currents deep inside the material. This ensures a homogeneous radial distribution of heat in the billet from the outset. Rotational speeds between 240 rpm and 750 rpm translate into eddy-current frequencies of 4 Hz to 12.5 Hz. As a consequence, the heating process takes 80% less time and thermal stress within the material is reduced to a very low level. Apart from this, soaking time is no longer required before extrusion and different billet dimensions or alloys can be heated without adjustments to the coil.

HP: Magnetic billet heating is considered the first industrial application of superconductors?

J. Kellers: And with good reason. The efficiency factor of normal induction heaters is about 45% while the Magnetic Billet Heater delivers 83% efficiency. This kind of gain is not accomplished very often. Lower power consumption and improved heating quality obviously result in a better customer benefit. Similar effects can be observed with other superconductor applications such as power grid protection and ship propulsion as well as hydro and wind power generators. Magnetic billet heating was just the first application introduced onto the market.

HP: Could you describe the machine design?

W. Witte: The system is designed for heating two billets at a time. The machine bed is a welded steel construction on which two pairs of electric drives can horizontally slide in and out to accommodate billets of different length. These are hydraulically clamped in flanges. The superconducting magnet is mounted above the heating chamber. When rotating the billets, the drives overcome the strong braking torque exerted by the magnetic field and thus generate the eddy-currents which heat up the material. The power which is fed into the drives directly converts into thermal heat in the rotating billet.

HP: Industrial heating is not Bültmann's core business. Nonetheless you embarked on developing the Magnetic Billet heater with Zenergy Power in 2004 and completed it in very good time. What made the technology attractive for Bültmann?

W. Witte: Bültmann is a medium-sized special machines manufacturer. We work for customers who go for solutions which are specifically suited to their particular requirements. When new demands emerge, we are responsive because we want to be able to offer convincing solutions which have reached an advanced stage of development once the topic becomes relevant for our clients.

HP: Which trend do you respond to with the Magnetic Billet Heater?

W. Witte: We expect that conventional billet heating may become an issue in non-ferrous metal extrusion. The high power consumption of induction heaters can swiftly turn into a problem if we consider the foreseeable rise of energy costs. In discussions with our customers we also saw that, with the established technology, it becomes increasingly difficult to keep pace with the progress of productivity and quality requirements in the market of extruded semi-finished aluminium goods. For the future, it will be necessary to have a system which offers a homogeneous and precisely controllable heating process while consuming substantially less power.

HP: Weseralu has been running the Magnetic Billet Heater in full scale industrial operation for two years now. Has the changeover been a success?

B. Ostermeyer: We have now heated in excess of 250.000 billets with the new machine and our productivity in aluminium extrusion is 25% higher than it used to be with the induction heater we employed previously. Parallel to this, we have been able to perfect our performance in the field of complex profile structures. The improved microstructure of the extruded material and the fine finish of our products are further advantages we observe.

HP: What is the decisive factor for these improvements?

B. Ostermeyer: In fact, there are several factors coming together: First of all, the heating process itself takes less time which allows an optimized supply of material to the extrusion press. Then, the homogeneous cross-sectional temperature level of the heated billets allows for faster extrusion. And we can now build up exactly the axial temperature taper we need in the billets to keep the material at a constant heat level throughout the extrusion process. This facilitates breakthrough particularly when complex dies are used and the mechanical properties of the products also benefit from the isothermal extrusion.

HP: Has the introduction of magnetic billet heating had effects on the cooperation with your customers?

B. Ostermeyer: It certainly has. The technology helps us to further improve our position in the market as a specialist for complex profile geometries.

HP: Why did Sapa Group as the world's largest manufacturer of aluminium profiles take an interest in the new technology and why did you decide to go ahead with a first order so soon?

K. Förster: We were interested because we have been faced with a special challenge in our plant at Bolzano in Italy where we concentrate on adapting our manufacturing processes and products to the high demands of new tailored-to-suit aluminium hard-alloys. Another reason is that we process billets of very large diameters at Bolzano and thus homogeneous heating is an extremely important requirement. The test programmes we conducted with magnetic billet heating have made us very confident in this regard. We expect that, with the new heating process, we can avoid the disadvantages of the induction technology we presently employ.

HP: Are there general trends in the aluminium extrusion market and technology which make magnetic billet heating a favourable option from Sapa's point of view?

K. Förster: Aluminium extrusion is fundamentally a temperature process and process stability is essential for uniform quality and high productivity. We observe a steady growth of our client's demand for high-grade products. The same applies for specific quality criteria. We need to offer increasingly thin-walled profiles and at the same time enhance the strength of these products. With aluminium extrusion these targets are frequently opposed to each other and I believe that perfect and reproducible billet heating gives us the opportunity to reconcile both requirements.

HP: Did you obtain information on practical experiences with the technology from Weseralu?

K. Förster: I have known Mr. Ostermeyer for several years since we used to work for the same enterprise and could count on frank and expertly information where I had questions or concerns. Also, we were able to study the Magnet Billet Heater in operation and take measurements on several occasions which facilitated our decision taking.

HP: There was no previous experience to build upon when Weseralu installed the first Magnetic Billet Heater in 2008. How did the implementation project go off?

B. Ostermeyer: It could almost be described as a "plug and play installation". We were able to return to multi-shift operation within very short time. Compared to a conventional inductive oven, the Magnetic Billet Heater needs neither medium-voltage power supply nor reactive power compensation. Moreover, the complex water cooling system of conventional machines is no longer required. These factors greatly facilitate implementation and the Magnetic Heater is also a comparatively small machine which integrates well into an existing production layout.

HP: How did staff at Weseralu approve of the new technology?

Jürgen Kellers, Head of Sales of Zenergy Power GmbH

B. Ostermeyer: Wherever teams at the shop floor are used to dealing with high performance requirements in a professional and flexible way they obviously put corresponding demands on the production technology employed. The Magnetic Billet Heater had to earn its acceptance in full operation and it did. When we started out, it was certainly an advantage that the machine is both transparent and easy to operate.

HP: What are your experiences regarding the service requirements of the Magnetic Heater?

Werner Witte, Member of the Management Board, Bültmann GmbH

Magnetic billet heater operating at Weseralu aluminum profile extrusion plant

B. Ostermeyer: First of all, it is a benefit that we can alter billet dimensions or alloys without changing the induction coil. But since the design of the machine is technically very straight forward, our attention focussed on the one system that we did not know beforehand, of course. It includes the superconducting magnetic coil, the dry-cooling device which keeps it at its operating temperature and the tank which thermally encapsulates the magnet. The cold heads of the refrigerating system need servicing once in a year, but sudden coil outages which occur with conventional induction heaters are no longer an issue.

J. Kellers: That is in line with expectations: The superconducting coil is not subjected to thermal stress, vibrations or friction and hence operates almost free-of-wear. The dry-cooling system consists of standard components, which are commercially used in refrigeration technology and the machine is built with two cooling units rather than one. Everything else - the components of the drive, control and billet clamping systems - involves nothing but off-the-shelf standard industrial equipment.

HP: Sapa Group decided in 2009 to install its first Magnetic Billet heater at Bolzano. What made the plant your first choice?

K. Förster: The benefit of magnetic heating grows with the diameter of billets processed. Given this fact there was virtually no alternative for us in order to meet our exacting requirements in Bolzano. The second reason is that we operate two large direct-indirect extrusion presses with die and mandrel at the plant. When producing seamless pipes, the mandrel's position is crucial for obtaining uniform quality. If you use a mandrel with billets of up to 1,500mm in length, temperature within each billet must be absolutely uniform. Otherwise, the mandrel will inevitably buckle and cause measurement deviations in the product.

HP: Earlier this year Weseralu decided to convert billet heating for extrusion at Minden fully to the new technology. What are your reasons for once again acting as a forerunner of the industry?

B. Ostermeyer: We have achieved very convincing results with the first machine, both in product quality and power consumption, and we expect that we will be matching the state of the art of the industry even 10 or 15 years from now with this technology.

HP: Since the first magnetic Billet Heater was installed at Minden in 2008, no further system has been put into operation. What challenges are the manufacturers faced with at present?

J. Kellers: The international financial and economic crisis has led to a sharp decline in the aluminium industry's notably cyclical markets in 2008 and the first half of 2009. Of course, we were affected by the corresponding slow-down of investment activity. However, we have seen an encouraging upturn in the market during the first quarter of 2010 and our observations in this regard are in keeping with the statistical findings of the German Machinery and Plant Manufacturing Association.

W. Witte: At present we are handling orders for four new Magnetic Billet Heaters, all of which will be shipped this year. Two machines were ordered by the aluminium industry present, two others by the copper and brass industry. Subsequent to the first implementation, orders have faced us with the challenge of developing a heater design which can handle billets of up to 1,000kgs in weight with full reliability in industrial operation. Parallel to this, field profile calculation and prognostics have taken up considerable time. Now, however, the standardisation of components benefits greatly from this work which in turn helps us to reduce delivery times.

HP: Which are the crucial factors for the further development of magnetic billet heating?

K. Förster: At present, the investment is still higher when compared with the latest generation of induction heating systems. These additional costs will have to be reduced by larger production series. Moreover, there are no long-term experiences yet regarding the life time of superconducting coils in billet heating but I think that magnetic heating will make its way in the manufacturing of high-grade extrusion products.

B. Ostermeyer: Magnetic billet heating is particularly attractive for extrusion plants which employ complex dies and process a wider range of alloys. In my opinion it is crucial for success that technical expertise, components, and upgrades must be fully available in the market. And I am also convinced that, apart from experience in long-term operation, the increasing cost of energy will have a major influence on the adoption of the technology. ■