Flexible continuous homogenizing technology

by **Mariusz Raszewski**

When discussing the area of homogenizing in general and continuous homogenizing in specific, the general idea has been that the continuous homogenizing oven produces a lower but still a more consistent quality than batch homogenizing. This enables the extrusion press managers to set their press speed at a higher level as the metallurgical properties in the metal are more or less equal between billets. With the same general thinking it is also proposed that disadvantages in using the continuous homogenizing oven in the process is the lack of flexibility. When feeding the oven with one size and/or one alloy a horizontal airflow oven has to be run with the same size and/or one alloy until it is possible to run the plant empty before introducing new diameters and/or new alloys. This results in a considerable reduction in the plant capacity. The alternative is to run the plant according to pre-determined recipes. The following article is describing the new technical solution of IUT vertical continuous homogenizing technology.

Seco/Warwick Thermal, based on acquisition of IUT Vertical continuous homogenizing technology, offers entirely new approach towards continuous homogenizing providing more versatile and flexible equipment (**Fig. 1**). The acquisition of IUT Vertical continuous homogenizing technology and IP took place in September 2010.

Vertical continuous homogenizing technology enables:

- Production flexibility
- Energy efficiency
- Production traceability
- Airflow control

Continuous homogenization furnaces are used by manufacturers of aluminum alloys billets which constitute an intermediate product in production of aluminum profiles. In view of great popularity and diversity of the final product applications in industries such as: aviation, transportation, including automobile and railway industry, constructions and road infrastructure and many others, continuous billet homogenization lines enjoy continuous interest on the market.

Historically no supplier on the market was able to deliver a continuous homogenizing plant that would fulfill customers' needs for production flexibility and consistency.

More and more customers wanted to be able to run an order-related production without being forced to follow pre-determined production schedules to achieve yearly capacity and/or to build up warehousing to support the inflexibility of the plant. The design of horizontal airflow continuous homogenizing furnaces could not cope with the new demands.

Former owner of the continuous homogenization furnace design, the IUT Sweden, was selected as supplier and started to analyze the customer situation and presented a new technical solution that gave the benefits that the customer required. With the new design the customer was able to optimize the process with the new benefits.

PRODUCTION FLEXIBILITY

As the market for aluminium is moving towards an increased use of re-melt scrap in the aluminium extrusion process, the need to cast and homogenize different alloys and sizes has increased. There is no longer time and resources to build up several homogenizing plants of the old format only able to handle a few diameters and similar alloys to achieve the throughput. It is necessary to build homogenizing plants that is able to process and homogenize all the scrap that is taken in and to produce the log diameters.

To support this development the homogenizing oven is built up in several heating zones. Because of this multizone design the system is inherently flexible as each zone is possible to control with regards to temperature and to the

step-time. This flexibility is further enhanced by the furnace´s optimizing control system that was developed in the first installation during the 1990's. The later furnace has a capability to process batches of different diameters and/or alloys. When running different diameters say 9, 10 and 12 inch diameters which normally would require emptying the furnace, the thermal furnace can process these diameters without leaving any empty saddles at all. This gives the customer an extreme advantage in production flexibility.

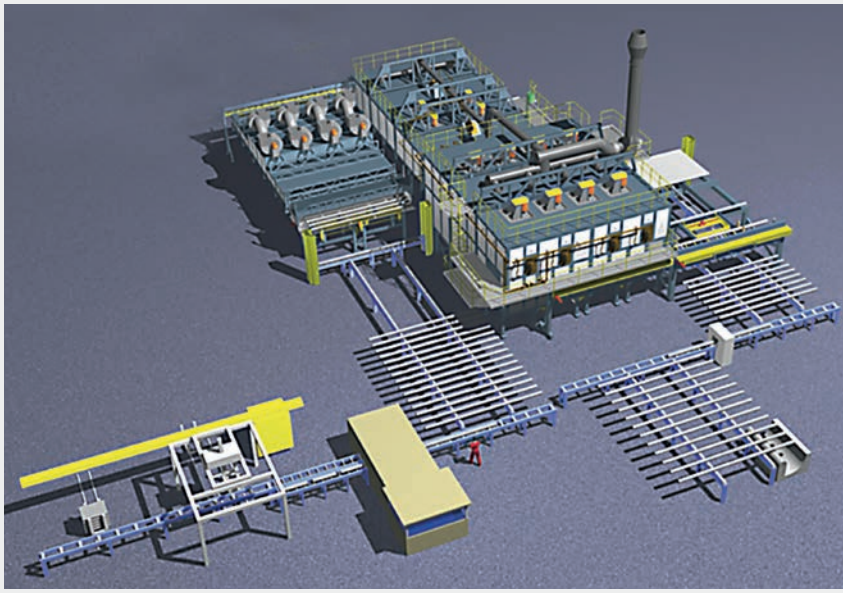

Fig. 1: Complete technological line for continuous log homogenizing

ENERGY EFFICIENCY

As the energy usage becomes more and more important, the focus on this was set from the early beginning of the furnace design. The continuous homogenizing furnace controls the energy usage and it is constantly checked and controlled during the homogenizing process. The highest possible throughput is reached without having to heat any empty saddles at all (**Fig. 2**). The energy that is used in the process is directed and dedicated to each and every billet specifically. The thermal continuous homogenizer uses an optional heat exchanger that recovers a considerable amount of the exhaust energy used in the process. High quality packing´s and good insulation technology keeps the wall losses to a minimum.

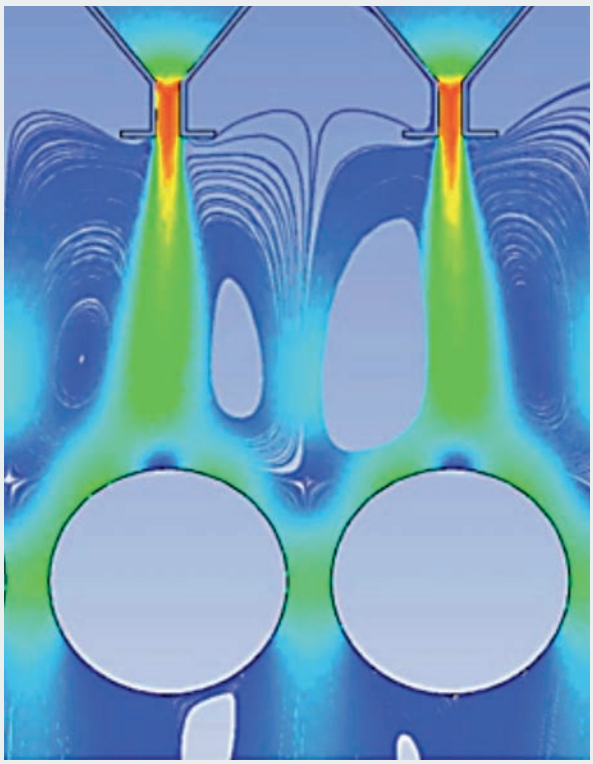

Fig. 2: Heat transfer

ENHANCED HEAT TRANSFER – VERTICAL AIR-FLOW

The high velocity air jet directed onto the top of each billet results in higher heat transfer coefficients. Because the furnace consists of multiple zones, it is possible to apply higher air temperatures in each zone without risking damage to the product. These higher air temperatures combined with higher heat transfer coefficient cause significantly higher convective heat transfer rates into the billets. Because it is possible to operate the zones hotter without compromising safety, radiation heat transfer is also enhanced. The improved heat transfer results in shorter heat-up times for small and large diameter billets.

Airflow control

In order to control and to predict the performance of the continuous homogenizing oven in the mechanical design phase there was a significant stress put on to avoid any "cold spots" and/or to under-use the oven as the process tool it is. Seco/Warwick uses computational fluid dynamics (CFD) which is a powerful tool to simulate and predict the flow pattern and hot air distribution within the convection furnace (**Fig. 3**). The engineers optimize the furnace design to activate the best possible performance.

PRODUCTION TRACEABILITY

The importance of keeping track of all billets individually and to trace each billet separately all the way from the casting pit to the homogenizer is extremely important if there is a process failure. With the homogenizing oven all

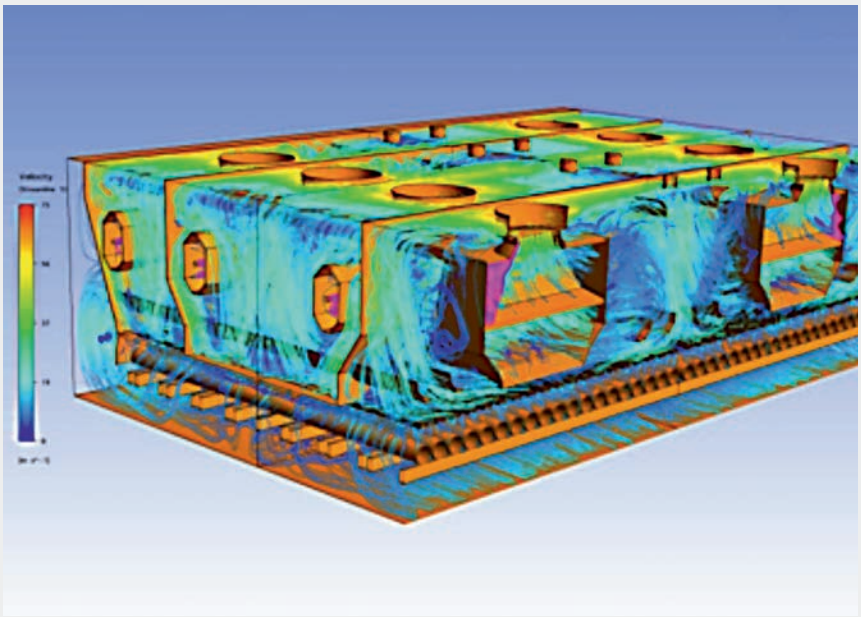

Fig. 3: Airflow analysis by using computational fluid dynamics (CFD)

billets are heat treated individually. At the same time the billets enter the system each billet is given an unique identification which is either stamped or printed on the billet. This information can later bring historical data (position, temperature, degree of transformation, residence time for each billet and information of how the heat treatment process was carried out). The system also makes reports on single billets and batches of billets available based on the captured data. The data and reports can be used to improve the process and to respond to customer questions and for support activities.

Super cooler

After the homogenizing process is finished and the logs exit the soak section they should be cooled at a high cooling rate. The reason for this is the re-crystallization from the alpha phase back to the beta-phase. To avoid losing good metallurgical properties after the homogenizing process the cooling sequence has to be done as close in time after the heating phase as possible.

The normal cooling rates that has been used in the industry is approximately around 400 °C/h. Together with a customer there has been developed the so called "super cooler", where the initial test results show that it is possible to achieve up to 1,100 °C/h in cooling rate. With a cooling rate as high as this it is said to be able to "freeze the alpha phase". With metallurgical properties close to the alpha phase it is estimated to increase the press speed by approximately 50 % or to be used in high quality extrusions.

Thermal continuous homogenizer and super cooler

The thermal continuous homogenizer adds a significant value to the market – total flexibility. As the market conditions constantly are changing and the need for a flexible production to continuously homogenize billets in different dimensions and/or alloys, the homogenizing oven with its technical level and flexible performance is well suited to take care of this development.

The zone-divided format of the oven allows for total control in each heating zone. This brings another aspect to the control aspect as it now is possible to step homogenize and to step-cool the billets in the process. All depends on the heat process and the metallurgical properties that is wanted.

CONCLUSION

The line itself represents entirely automated equipment unit which allows billets continuous heat treatment. The complete line includes: equipment for ultrasonic control of the billet section, heating and soaking in homogenization temperature chamber, billet technological cooling chamber and water aftercooling chamber as well as all types of reloading devices and mechanisms. In a typical production solution the whole thing is closed with a billet required size cutting device and a device for packing prior dispatch.

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