Advanced equipment for precise heat treatment of high-strength aluminium alloys

AMAG rolling specialises in the production of high-strength aluminium sheets and plates and disposes over enormous competence with regard to the heat treatment of age-hardening aluminium products. Moreover, new advanced heat treatment equipment and new technologies open the way to previously untapped potential.

Investments for greater security and flexibility
The extensive investments of recent years have resulted in one of the most modern plant pools in the aluminium industry, which offers maximum production security and customer-friendly flexibility with regard to the realisation of complex, metallurgical demands.

The latest simulation tools for heat treatment
Irrespective of whether final or essential process-related, intermediate processing is involved, heat treatment is always targeted on achieving optimum product characteristics. Basically, all heat treatments have an effect on the microstructure of the material, whereby properties relating to customer-processing and use are influenced (mechanical properties, formability, corrosion behaviour, distortion, etc.). Heat treatment is a diffusion-determined process, which is why temperature and time are its most important parameters. In the case of heat treatable alloys, the classic heat treatment sequence consists of solution annealing, quenching and artificial ageing. Solution annealing is aimed at achieving the dissolving of soluble, heterogeneous alloying components in solid solution and their homogeneous distribution. The higher the temperature, the better the product characteristics, whereby the major danger is eutectic melting, which can lead to internal rejects. Therefore AMAG determines precisely the furnace parameters (temperature, time, quenching & quench-delay, heating and cooling curves, etc.) for the respective alloy composition, not only in the course of testing, but increasingly through the use of the latest simulation tools (e.g. Nougat) and thermal laboratory analyses (e.g. DSC). The parameters thus established permit a marked reduction in large-scale testing in order to verify the optimum range of parameters and their fixing for serial production.

Fulfilment of the strictest aviation industry demands
Not only is a precise knowledge of material behaviour needed in order to be able to near the feasibility limits, but also exact furnace temperature management. As is also the case with regard to other characteristics, the aerospace industry places the highest demands on equipment for the heat treatment of sheets and plates. Of these, the main two relate to temperature uniformity within narrow limits throughout the entire furnace and subsequently, stringent requirements relating to the entire temperature measurement chain and furnace control.

All of AMAG rolling’s registered furnaces fulfil the requirements for the production of aerospace products according to the internationally recognised and widely-used AMS 2750 standard and even stricter NADCAP (National Aerospace and Defence Contractors Accreditation Program) directive, which in the meantime are required by many leading aircraft manufacturers. However, it should be added that all other AMAG product groups, e.g. automotive, mechanical engineering, sport applications, etc. benefit from the strict requirements of the aerospace sector.

As a result of intensive teamwork with furnace producers, AMAG’s heat treatment expertise in both the metallurgical and engineering sectors flows into the company’s choice and design of advanced heat treatment equipment. This results in optimum furnaces, for AMAG’s product portfolio, specialized for sheet and plate production.

Please read the article concerning the latest investments relating to the operational furnaces.
Horizontal annealing furnace for solution annealing of plates
As a result of the systematic expansion of high-quality aerospace plate production capacity, two virtually identical horizontal annealing furnaces have been purchased for the batch solution annealing of heat treatable plates in the 2xxx (AlCu), 6xxx (AlMgSi) and 7xxx (AlZn) alloy groups. Both annealing furnaces are heated electrically and attain a temperature accuracy of +/-2°C, which surpasses even the strictest aerospace demands. This precision is due to the latest control technology and a specially optimised heat register. All heating and quenching parameters are stored in a database, for correct presetting of the furnace with the optimum parameter sets and prevents individual errors during the input of heat treatment data.

Following heating and the annealing soaking time, which is necessary from a metallurgical standpoint, the plates are quenched. During this process the plates are cooled from the annealing temperature to room temperature by means of individually controllable rows of high-pressure water jets. In the high-pressure section well over 1,000 m³/h of water are sprayed onto the hot plates by several thousand jets. Subsequently, the Al plates are air-dried in order to prevent surface corrosion and water-stains.

Owing to the fact that both horizontal annealing furnaces are of identical system design, it is possible to use a spare part pool, which simplifies repairs and thus facilitates reduced downtimes. Both furnaces were “Made in Austria” and were designed in conjunction with EBNER Industriefenbau in a far-sighted move, which has ensured that the systems offer expansion possibilities to deal with future increases in the need for heat treatment.

Artificial ageing furnace for plates
Apart from solution annealing, a major step in the production of heat treatable aluminium alloys is artificial ageing to a defined temper, whereby the alloying elements precipitate out of the quenched and “frozen” supersaturated solid solution.

In addition to tempers in line with specifications, AMAG has also developed customised tempers, which permit special combinations of characteristics and mirror the company’s special expertise in this field. The express and systematic response to customer requests, which extends to small batches, is also particularly clear within the context of the installed heat treatment equipment.

The second quarter of 2009 saw the successful commissioning of a new, HOFMANN artificial ageing furnace. As a result, a total of nine ageing furnaces of the same design are available for the artificial ageing of plates in the 2xxx, 6xxx and 7xxx alloy groups.

The furnaces are electrically heated and due to the use of the latest control technology and optimised air flow, which was specially optimised for AMAG rolling, offer temperature precision and uniformity that is far above the norm. The optimisation of air flow was based on the teamwork between Linz University and AMAG’s experts, which in addition to
of the quenching section and the transfer from the furnace. The experience of the company’s technology specialists has been systematically implemented in order to ensure that the highest quality demands relating to heat treatable sheet and strip products can continue to be met in future.

As flatness deviations always occur in the strip during quenching, the new CHT line was designed with an integrated, continuous stretcher. This allows the fulfillment of strict requirements relating to strip flatness for a wide range of thicknesses. In addition, integrated trimming shears can be set to tailor the strip to its end width directly in the line, which means that some products can be produced on a ready-to-pack basis.

Single-chamber, hood-type annealing furnace for coils and sheet bundles

From 2006-2008, four JUNKER hood-type annealing furnaces were commissioned for the artificial ageing and annealing of coils and sheet bundles. The strengths of this furnace concept lies in its flexibility as compared to conventional, multiple coil furnaces, as it offers the possibility for the completion of urgent orders with optimum use of capacity levels. The heat treatment systems, which allow enlargement on a modular basis, can be extended beyond their current status through the addition of further independent, single hood-type coil annealing furnaces.

The main heat-treated products consist of coils, although rings (slit coils) and sheet bundles can also be charged. Loading and unloading takes place by means of a hall stacking crane, whereby the entire charging process from coil handover to a shuttle is fully automated. Automatic fan speed regulation, and the latest gas burner technology with special control characteristics ensures maximum furnace temperature fluctuations of +/-2°C throughout a temperature range of 100-600°C. This allows the fulfillment of all demands regarding precision heat treatment such as artificial ageing, annealing and stress-relieving.

High air flow volumes and speeds with the appropriately dimensioned circulation capacity in combination with a patented air flow system, which was optimised in teamwork with AMAG, guarantees high-precision temperature management. As opposed to previous concepts, this system permits a marked reduction in heating speeds, temperature spread and heat treatment process times.

All furnaces can be operated using an insert gas atmosphere. It is also possible to cool the furnace by means of nitrogen and thus achieve high cooling gradients, which can be varied in line with process requirements. The regulation and control of the holding times and temperatures takes place automatically, whereby throughout the heat treatment process all that is required is on-the-spot surveillance, or monitoring via a client station.

By means of the optimisation of the process parameters of all the heat treatment steps along the process chain, AMAG’s specialists have been able to create previously unattainable property characteristics for various alloys to the advantage of customers worldwide.