EISENMANN

Heat treatment of aluminum parts

EISENMANN Heat treatment systems

Easily recyclable, lightweight aluminum is considered a material with a bright future, particularly in the automotive industry. For reasons of strength, however, heat treatment will almost always be indispensable to bring such mechanical properties as yield point, tensile strength and elongation to the desired level.

Aluminum alloys which can be age-hardened are heat treated in three stages: solution annealing, quenching and ageing.

Solution annealing takes place at a temperature of roughly 535 °C over a period of several hours. This produces aluminum hybrid crystals in which the alloying constituents, such as silicone and magnesium, are completely dissolved.

The purpose of quenching (normally in water at approx. 80 °C) is to "freeze" this condition and prevent precipitation of the alloying constituents dissolved in the hybrid crystal.

This is then followed by ageing over a period of several hours at temperatures between 140 and 200 °C. The required mechanical strength is achieved through segregation processes in the crystal. The actual heat treatment process is now complete. In the subsequent cooling zone, the products are cooled for the following production stages, such as machining.

Fig. 1: Lifting station feeding the annealing furnace in an all-automatic roller plant for aluminum wheels

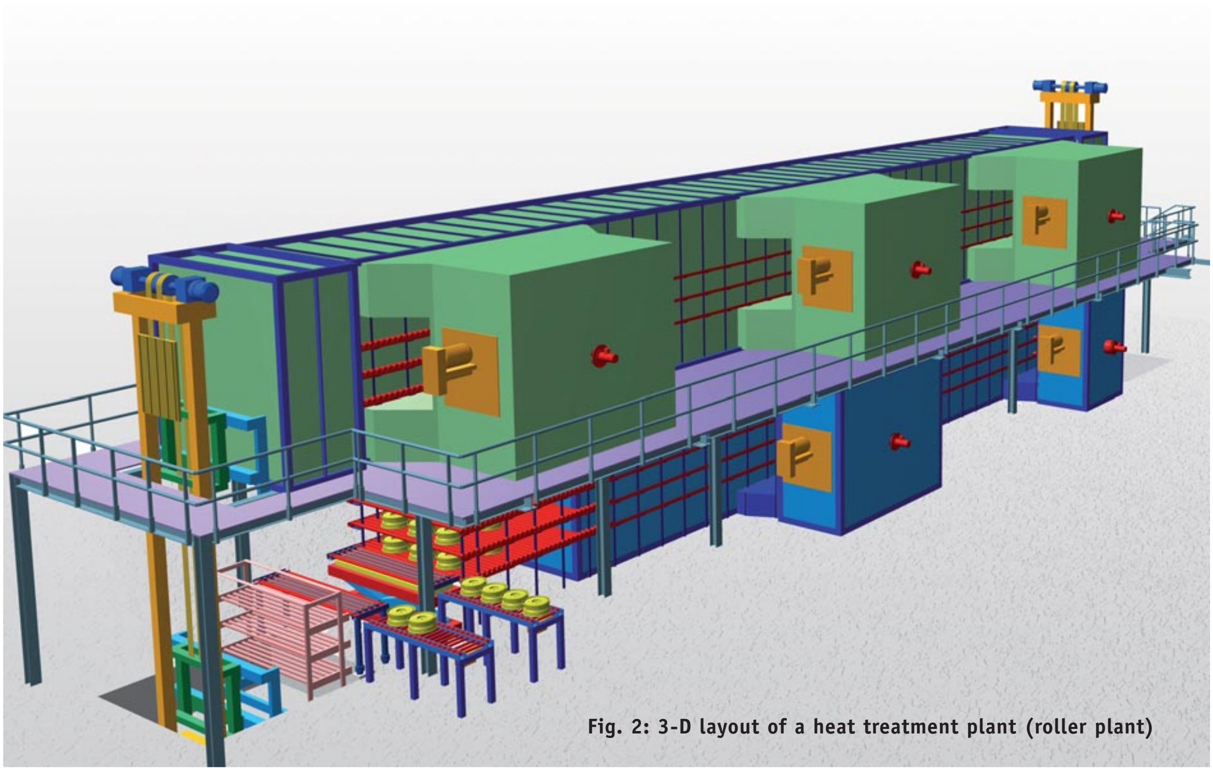

Fig. 2: 3-D layout of a heat treatment plant (roller plant)

EISENMANN Roller plants

Fig. 3: Mirrored arrangement of heat treatment plants for car wheels with workpieces delivered via roller conveyors

Automatic operation for efficient wheel production

The concept selected by EISENMANN (Figs. 2 and 3) is characterized by its compact, space-saving design. The ageing furnace and solution annealing furnace are located one above the other, while the quenching basin is situated below the outlet of the solution annealing furnace.

Two lifting stations are further important components of the heat treatment facility. One supplies the annealing furnace, while the other is assigned to the solution annealing furnace outlet and quenching basin. Roller conveyors are used to deliver and remove the workpieces.

The wheels are transported directly on rollers, on three levels one above the other. Baskets are not needed. Apart from the workpieces, there are only transport rollers inside the (pass-through) furnaces. Drives and bearings are located outside, with consequent benefits for the material.

After being X-rayed, the blank wheel castings enter the heat treatment area in a single layer on roller conveyors. Setting patterns are created and the 3 levels of the lifting station filled accordingly. These setting patterns are adjusted by the controller in line with the wheel sizes. The lifting station enters the solution annealing furnace from below, raising the loosely fitted furnace cover at the same time. The wheels are transferred in three layers. The lifting station then descends, placing the furnace cover in the right position.

During the annealing process, the wheels are continuously transported by the roller conveyors.

At the solution annealing furnace outlet, the wheels are taken over by lifting station II and immersed in the quenching basin (Fig. 5). They are then transferred to the ageing oven. At the end of the process, the three layers are separated at the lifting table and the wheels transported in the direction of mechanical processing in a single layer.

The coating process following the subsequent machining process is also an EISENMANN domain. The company has installed nearly 80 wheel coating plants worldwide to date, more than any other manufacturer.

Heat treatment plants from EISENMANN are particularly appreciated by almost all leading manufacturers of aluminum wheels. Particularly the roller systems described above have already been installed in about 60 plants.

Significant advantages of roller plants

- No baskets, therefore no loading/unloading staff
- No maintenance and replacement of baskets
- No fork-lift traffic in this area

Moreover, the material flow within the entire wheel production area can be automated at any time.

Particularly in the furnace areas, roller conveyors allow drives and bearings to be located at ambient temperature outside the high-temperature furnaces (Fig. 4). There is consequently no wear due to high temperature. In addition, inspection and maintenance can both be carried out during production.

The A-locks of the elevated solution annealing furnace are also advantageous, for there are no driven gates and therefore no wear and no need for maintenance. Heat losses are also minimized by this design. Finally, it must also be mentioned that all wheel layers are uniformly quenched, as the quenching basin is located directly below the annealing furnace (Fig. 5).

Fig. 4: Roller drive (center) and bearing are located outside the furnace

Fig. 5: The quenching basin is located directly underneath the annealing furnaces

EISENMANN Push-through plants

For high throughput rates and large wheels

Particularly at very high throughput rates with wheels measuring more than 18 inches, the roller conveyor plant very soon comes up against size limits. Only four 20 inch wheels are possible per row on account of the limited roller length. Such plants also involve structural heat losses due to the roller conveyors.

Two objectives have been achieved with the new plant type

- **Shorter plant – less space required**
- **Less heat loss – lower energy consumption**

(Fig. 6 shows a version where both furnaces are located on ground level, but the furnaces can also be stacked. Instead of being transported through the furnaces on rollers, the wheels are now transported in stackable product carriers (Fig. 7). Such a push-through plant can basically be made much wider than a roller conveyor plant. Six 20 inch wheels can now be loaded in one row on the product carrier.

Fig. 7: Outlet of the ageing furnace (push-through plant)

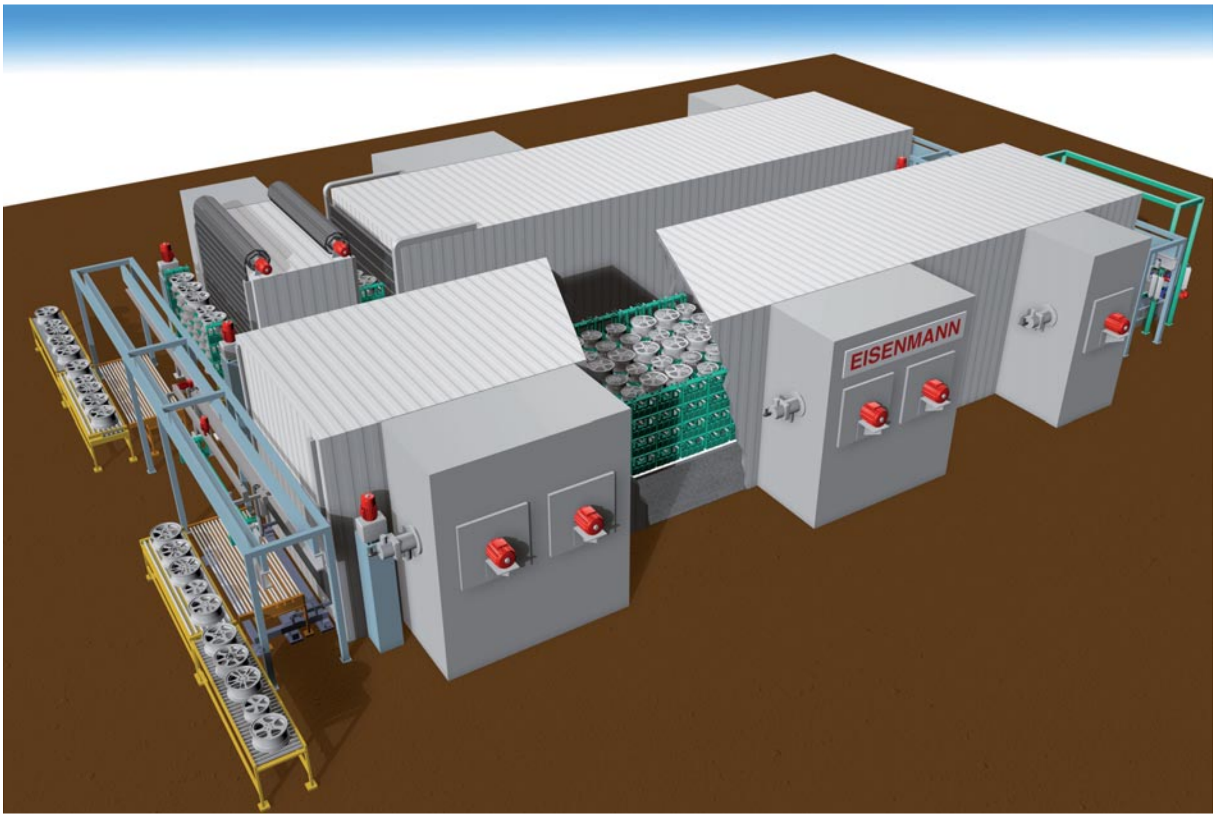

Fig. 6: 3-D layout of a heat treatment plant (push-through plant)

A special feature of push-through plants is that only the wheels are immersed in the water for quenching after solution annealing. The product carrier is not immersed and therefore not quenched.

Significant advantages of push-through plants

- **An unquenched product carrier retains its dimensional stability. There are no problems in transport, loading and unloading due to deformed product carriers.**
- **The energy stored in the product carrier can be used as a source of heat in the downstream ageing furnace, providing almost the entire heat required in the heating zone of the furnace.**

Fig. 8: Unloading station with quenching basin

Transport through the plant

A product carrier is automatically loaded with wheels via a roller conveyor in front of the solution annealing furnace. The fully laden product carrier is then placed in the furnace by a telescoping lift. The product carriers are stacked four high. The stacked product carriers are transported through the solution annealing furnace by a pusher operating in push mode.

At the end of the solution annealing furnace, the work-holders are removed from the furnace individually by a telescoping lift. The wheels are separated from the work-holder and immersed in the quenching basin (Fig. 8).

On emerging from the quenching basin, the wheels are tilted to drain off all remaining water. Then they are loaded back onto the (unquenched) product carrier. The reloaded product carrier now proceeds to the ageing furnace where it is loaded into the furnace by a telescoping lift. Once again, the product carriers are stacked four high.

At the end of the ageing oven, the stacked product carriers are transferred to a cooling zone to cool the wheels.

The product carriers are unstacked at the end of the cooling zone. The wheels automatically leave the product carrier via a roller conveyor.

The unloaded, empty product carrier returns to its position in front of the solution annealing furnace, where it is re-loaded with the next untreated wheels.

The right concept for your needs

The smaller area required and lower specific energy consumption of a push-through plant are particularly advantageous when working at high throughput rates and with large wheel sizes. With a throughput of 3000 20-inch wheels per day, a push-through plant occupies roughly 30% less space than a roller-type plant.

Another advantage of this plant type is that only a small pit approx. 300 mm deep is needed in the area of the quenching basin. The plant can consequently be installed more or less at ground level without major foundations.

Specific gas consumption has been reduced significantly in relation to the existing roller-type plants.

Specific areas of application exist for both plant types. The most suitable plant type in each case depends on several factors:

- **Hall area**
- **Hall height**
- **Throughput rates**
- **Wheel sizes**
- **Process times**

Other applications

Although aluminum wheels predominate in EISENMANN's list of references for heat treatment plants, they are by no means the only workpieces made of aluminum to feature there. Since the early 1990s, heat treatment plants have been built for a whole variety of diecast and extruded parts.

Depending on the job in hand, there are plants involving several process stages (e.g. wheel production plants) or plants with ageing furnaces only to simplify artificial ageing. Here too, the prescribed process temperatures and times must be maintained with utmost precision (Fig. 9).

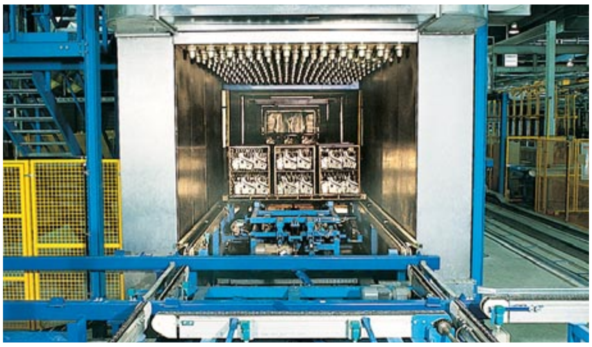

Fig. 9: Artificial ageing furnace with 4 temperature zones and downstream cooling zone for diecast aluminum parts

For workpiece handling, EISENMANN uses the entire spectrum of its own materials handling portfolio to deliver the best solution in each case. Batch furnaces for crankshaft housings, C-pillars or tie rods of aluminum are fed via lifting and traversing trolleys with multiple product carriers, for example. Other batch furnaces are equipped with carrying chain conveyors to accept workpieces in skeleton containers.

Integral pillars and other chassis parts are continuously transported through the heat treatment plant on roller conveyors in an upright position on special pallets.

Baskets are sometimes indispensable for efficient transport of the workpieces. The carrying chain conveyors used in these cases are supplemented by roller conveyors, lifting tables, stacking facilities, etc. (Fig. 10).

Fig. 10: Aluminum sections are transported through this ageing furnace in a wet chemical treatment line in baskets stacked two high

Sometimes, transport can be combined with upstream wet chemical treatment (washing, pickling, conversion coating) of the workpieces. In these treatment lines (which also belong to EISENMANN's portfolio), the baskets are transported by lifting and traversing trolleys.

Finally, it must be mentioned that the heat treatment plants for the first "All-aluminum Car" are also supplied by EISENMANN. In addition to plants for microstructural reinforcement of the semi-finished products (diecast parts, extruded parts), ageing facilities have also been delivered directly to the OEM.

One of the lines with carrying chain conveyors is used for ageing the aluminum components transported in baskets, while the aluminum bodies mounted on skids (Fig. 11) are aged in the other.

Fig. 11: Inlet of the ageing furnace for aluminum bodies mounted on skids

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