

Drop quench furnaces

For solution heat treating of aluminium components, by **Keith Watkins***

Drop bottom quench solution treatment furnaces are primarily used for solution treatment of aluminium parts prior to forming. The requirement is a quick quenching of aluminium parts usually within five to 10 seconds so that the material arrives at ideal precipitation hardened condition. When heated evenly to a temperature of up to 550°C, a solid solution of copper is formed in the aluminium structure which flows throughout the microstructure. The furnaces are of inverted type with charge lifting and lowering facility to accommodate the high speed quenching including de-clamping, door opening and quenching. The furnaces can be of standalone type with charge carrier loader and quenching tank moving on the floor or floor mounted with charge carrier loader and quench tank/s sliding into a pit. As the requirement is very fast quenching they are fully automated by the use of PLC and SCADA. These furnaces can also be used for continuous ageing cycle ranging from 16 - 24 hours time. Various quench media such as water, glycol or other polymer oils as per process

requirement are used. Areas of application are generally used in aerospace industries for solution treatment and ageing of structural parts, also in forging industries for aluminium alloy forgings.

Aerospace aluminium components sometimes require solution heat treatment combined with rapid water quenching. Drop Quench furnaces are specifically designed for just such applications.

Conformance to NADCAP (AMS2750E) is essential for aerospace applications and any furnace must meet temperature control, uniformity and data recording requirements. Furthermore, the water quenching time must meet seven to 10 seconds to full immersion of the components.

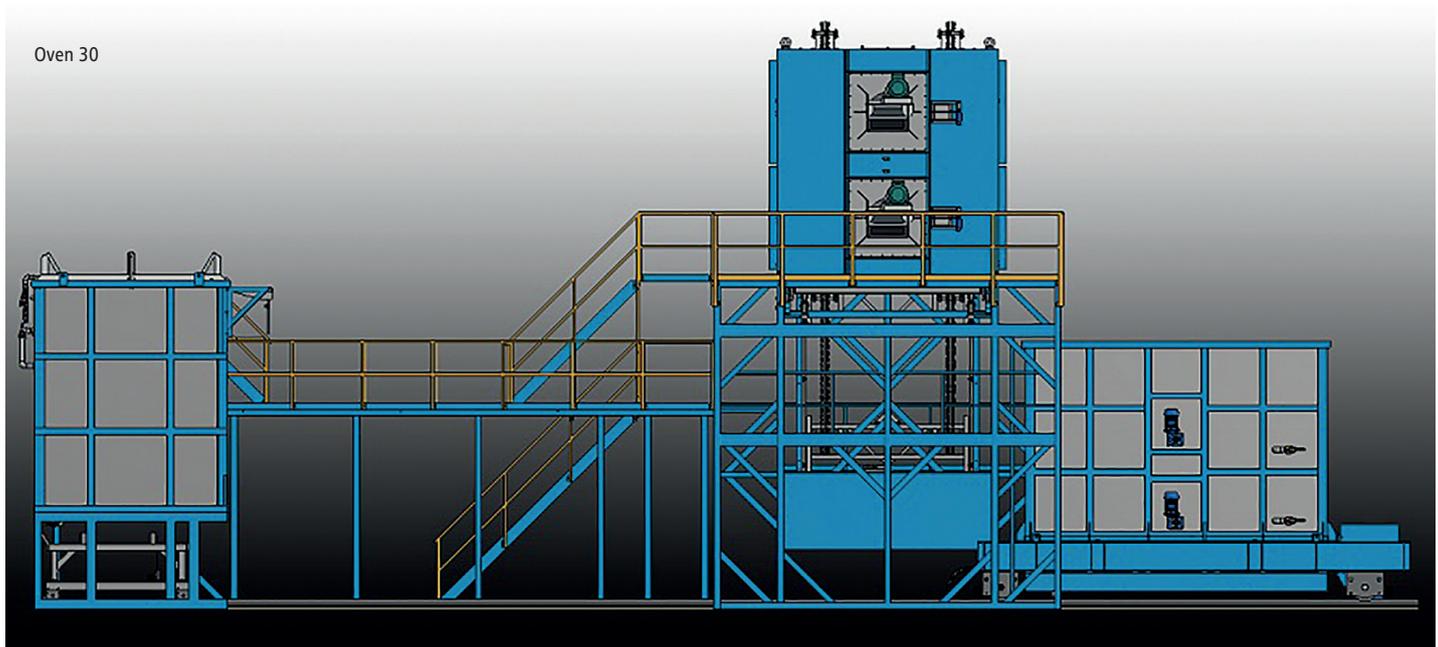
The typical drop quench furnace is designed with the heating chamber elevated above rails, which carry a water quenching bath. The bath can be moved from underneath the furnace-heating chamber to accommodate loading and unloading the component-charging basket. For certain applications a glycol based water solution is used for quenching. When glycol is utilised, it is

common to have a separate rinse tank to clean the components of the glycol solution. Usually, the rinse tank is fitted with a spray system for the purpose of rinsing. Spraying is effective, as it prevents glycol returning to the product surface one rinsed.

Drop quench furnace have a typical maximum operating temperature of 650°C and as processed for solution heat treatment at 475-530°C, annealing at 360-450°C and precipitation hardening at 120-175°C. In some applications the precipitation process will be carried out in a separate furnace, mounted alongside the drop quench.

Heating is provided by nickel chrome sheathed rod elements positioned behind the side duct sheets and isolated from the working area to prevent heat radiating directly on to any part of the furnace charge, in the case of electrically heated equipment, otherwise gas burners are employed.

Process times may range from 20 minutes for annealing processes and up to 14 hours for hardening. Charge sizes may range from around a 1m cube up to a 3m



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cube. In some instances, special furnace may be designed and built, which are capable of treating very large components, such as aluminium plate sections and long extruded products in special alloy.

Within the furnace high velocity air is circulated to assist in faster heat up rates and achieving the required temperature uniformity. Often this requires two or more specialist fans to be installed appropriately in adjacent positions to the main charge.

Usually, T4 and T6 heat treatment solution standards are required. A variety of options are available with the furnaces, which may include:

- Temperature uniformity +/-5C
- Temperature uniformity +/-3C
- Quench speeds 5, 7, 10 or 15 seconds
- Quench tank cooling systems
- Glycol management system
- Gas burner recuperation
- Additional quench tanks

Normal features include:

- Fastest ramp-up and lowest consumption
- Dual speed electro-mechanical or pneumatic winch system simple and reliable

- Electric or gas heating
- Ceramic fibre block module insulation
- Stainless steel air baffle
- Sliding or swinging door
- High volume recirculating stainless steel fans
- Pneumatically operated doors
- Tank mounted on mobile cart with rails
- Heating elements and belt driven circulating fan mounted in protected chambers beside and above working area

Recently, Thermserve Ltd of Telford, UK has built a medium sized drop quench furnace. Thermserve's drop quench furnaces are designed for an intensive and continuous use up to 650°C. The loading and quenching systems are fully automated by PLC. The dual speed pneumatic winch system permits a controlled acceleration/deceleration of the load descent and has proven to be very reliable and sturdy when compared with more commonly used systems. The insulation of drop bottom ovens consists of 150mm of ceramic fibre modules. This high efficiency material assures minimum heat loss and heat storage for rapid heat

cyclling and energy economy. Contrary to layered blanket arrangement, ceramic blocks have a great resistance to high air velocity abrasion. This configuration is extra durable and requires very little if no maintenance.

A complementary Precipitation Hardening is the heat treatment process generally undertaken between 100 and 200°C and causes dissolved alloying elements to finely precipitate within the aluminium. This results in the alloy becoming harder and stronger. This process is time dependant, hence, the term "age hardening" is often used.

Types of products heat treated for the general engineering sector include fastenings, manifolds for diesel engines in the marine sector, medical parts such as wheel chair frames, various tubular fabrications etc. In the automotive sector from major integral parts such as turbo housings, cylinder heads, cylinder blocks through to bumper brackets and aerospace high integrity components for military and civil applications.

With the advancing growth in aluminium use, the demand for more drop quench furnaces is increasing. ■