SECO/WARWICK

INVENTION MEETS RELIABILITY

# Aluminum Annealing Furnaces

Mass flow heat treatment

# Aluminum Annealing Furnaces

**VARIOUS LOADS NEED VARIOUS SOLUTIONS. THEREFORE SECO/WARWICK IMPLEMENTED**

- Mass Flow design, especially for foil annealing where the surface of the load is vurnerable for damages during high atmosphere flow.
- Vortex Flow jet heating system, for coil annealing when the advantage of high heat transfer can be used.

SECO/WARWICK provides custom engineered aliminium coil and foil annealing furnaces with capacities ranging from single coil modular furnaces to multizone furnaces having tight zone control. We have the experience, knowledge and talent to manufacture efficient furnaces. With exceptional temperature uniformity and unique charging techniques to fit the most demanding application.

## FURNACE EFFICIENCY

Further efficiencies are realized with SECO/WARWICK's thermal head, air-to-work ratio control system, which uses separate load and air thermocouples in each control zone. Because the load temperature is constantly monitored, a thermal head is maintained without risk of overheating the load. When the load approaches metal set point, the air temperature is reduced in direct proportion to the rate of rise in load temperature.

Therefore, the maximum amount of thermal head is maintained for the maximum amount of time, resulting in the shortest possible heating time. To further enhance the control system, an adjustable ratio system is also available and is most applicable when varying coil sizes are being annealed.

To maximize efficiency, as well as protect coils from dusting or ceramic fiber contamination, SECO/WARWICK developed and uses a proprietary mesh and mortar insulation system which not only increases insulation efficiency by 15-20%, but also simplifies maintenance.

Our insulation system starts with several millimeters of board-type insulation covered by a ceramic fiber blanket. A stainless steel wire mesh covers the entire insulating surface and is coated with a high- temperature mortar, which provides a rigid surface. If insulation damage occurs, it is much easier to repair than stainless steel liner sheets. To further enhance furnace efficiency, SECO/WARWICK designs radiant tubes to achieve maximum tube life.

## TEMPERATURE UNIFORMITY

SECO/WARWICK's annealing furnaces exploit several different designs to ensure temperature uniformity. SECO/WARWICK holds patents for innovations on controlling airflow recirculation over various size loads, increasing heat transfer and uniformity. Our furnaces incorporate both vertical airflow with specifically designed vertical baffles on each side of the load, or the high-velocity directed mass flow system. In either case, the vertical baffles improve air stream uniformity and separate the load from direct heat radiation. Radiant tubes for either gas-fired burners or electric heating elements provide indirect heating, protect the load from direct heat radiation, and maximize temperature uniformity. With large coils, the temperature uniformity is governed by load configuration. In very large coil applications and where tight temperature tolerance is required, SECO/WARWICK designates two temperature-control zones for each recirculation fan. This field-proven design compensates for differing coil characteristics, combustion performance, and loading practices.

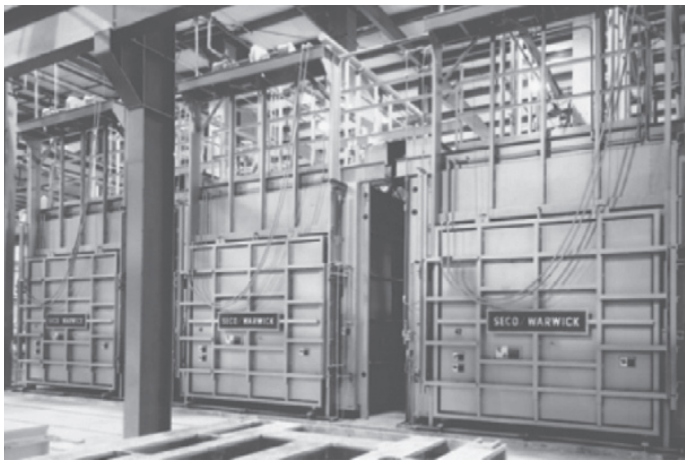
## BYPASS COOLERS

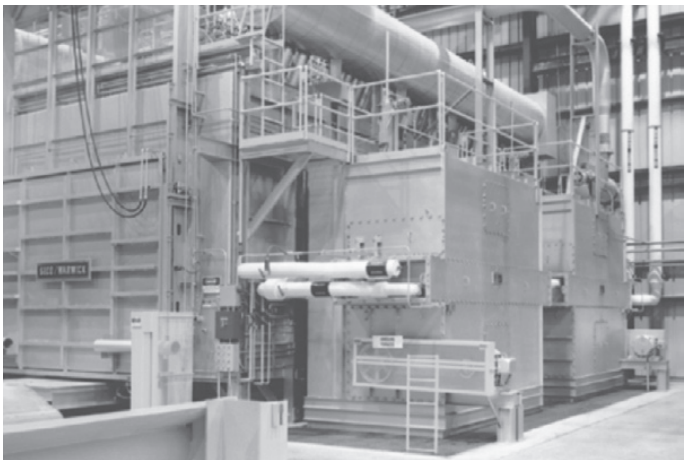
SECO/WARWICK provides a proprietary bypass cooler design for annealing furnaces. Cooling under a protective atmosphere for either metallurgical or handling considerations is very important in this application.

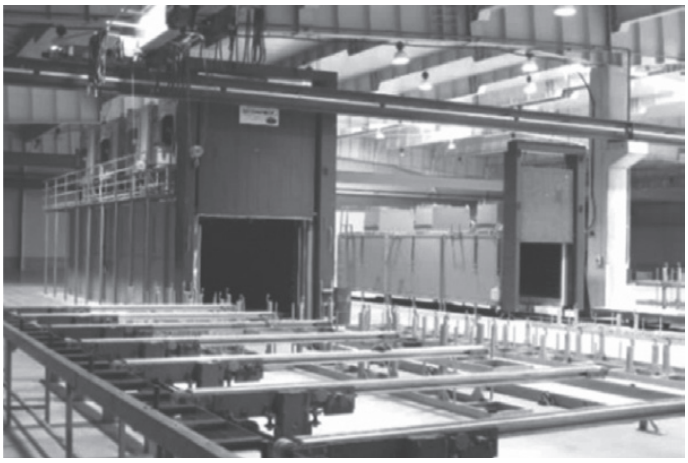
The coolers use an internal bypass arrangement which limits the temperature of the atmosphere going through the heat exchangers to 1750°C. This prevents baking of the volatized rolling oil on the fins of the heat exchanger. The coolers are designed to provide plunge, programmed, or auxiliary cooling and are available in standard or custom sizes. The coolers can be rear or side mounted according to space availability. Additionally, multiple coolers can also add a bypass cooler to an existing annealing furnace. SECO/WARWICK currently has over 100 of these coolers in operation in coil and foil annealing applications.

## FURNACE IDEA

Annealing of Al-coils requires an advanced convective heating system to obtain heat up times as short as possible without degradation of quality. Degradations of quality typically appear at the strip edges and are represented by non-uniform material properties like hardness, discolorations of the strip surface in case of 5xxx and 7xxx alloys caused by Mg- or Mn-bleedings, cracking residuals of milling oil while degreasing





of the coil or even fatal degradations by local melting of the coil surface. The reason for these degradations is local overheating at the coil head surface caused by non uniform heat flow of the convective heat transfer system used.

The governing parameter describing the temperature uniformity of a convective heating system is the ratio of maximum to minimum heat transfer coefficient max/min. This parameter limits also the heat up time since the smaller the max/min ratio the higher is the average () which can be obtained without exceeding the maximum tolerable local heat transfer. Annealing of Al-coils requires an advanced convective heating system to obtain heat up times as short as possible without degradation of quality. Degradations of quality typically appear at the strip edges and are represented by non-uniform material properties like hardness, discolorations of the strip surface in case of 5xxx and 7xxx alloys caused by Mg- or Mn-bleedings, cracking residuals of milling oil while degreasing of the coil or even fatal degradations by local melting of the coil surface.

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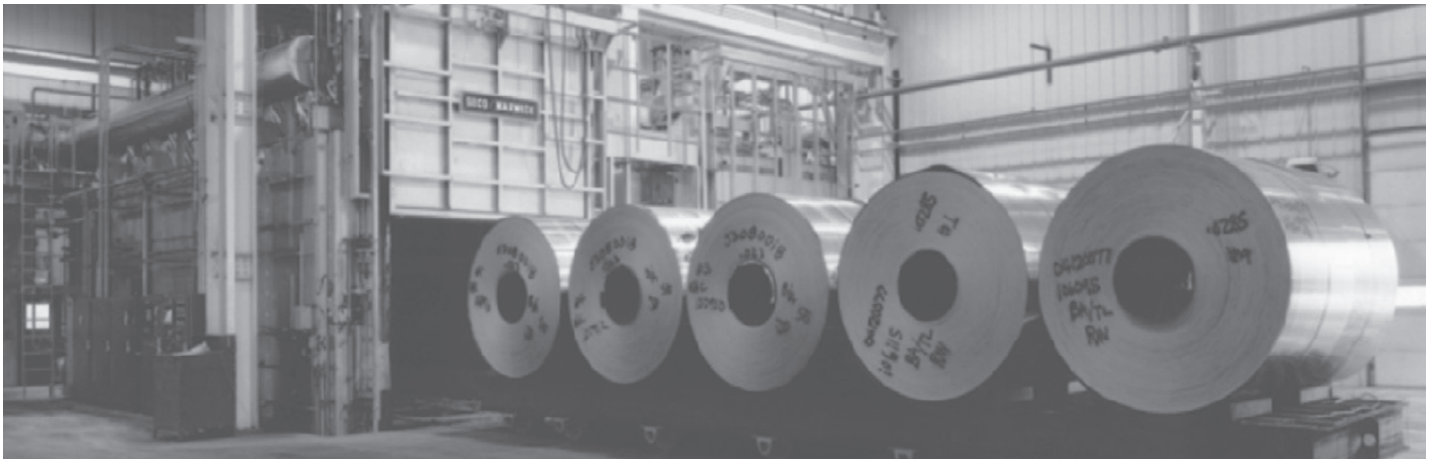
These requirements are fulfilled at its best with the Vortex Flow jet heating system, where arrays of 4 inclined round nozzle jets each induce big swirls which care for high heat transfer without hot spots. The volume flow of this nozzle system is high, thus 1 kg of Al is heated more uniformly by more kg's of atmosphere, which is driven by the specially developed semiaxial fan. Because the effective thermal conductivity in a strip coil is much lower in the radial direction than in the axial direction, the most effective way of heating the coil is through the edges of the coil wraps. The difference between the thermal conductivity for the two directions is caused by the heat insulating effect of the gas and milling oil layers in the coil between the strip layers.



# ADVANTAGES

The analysis of the pictures from the thermovision camera, equally scaled, indicated that a more uniform surface temperature was achieved by using the new High Convection Vortex Flow Jet Heating system.

The coil surface temperature uniformity profiles present the overview of temperature uniformity for the entire heat up cycles. This confirms that better surface uniformity was achieved by the vortex nozzle system.

The a min/a max ratio calculated based on the above data is 1,25 for vortex nozzle system. For aluminum alloys of lower thermal conductivity, the results in this parameter is expected to be even higher.

- The heat up time without local overheating can be reduced.
- Uniformity of material properties is improved.
- Local cracking of milling oil is avoided.
- Lower electrical fan power because of lower speed in spite of higher volume flow.

# SECO/WARWICK
## Invention Meets Reliability

SECO/WARWICK is the 1st choice supplier
of solutions for heat treatment and metallurgy.

We create innovative products that provide our customers with reliable, safe and environmentally friendly solutions for heat treatment and metallurgy and ensure the economic efficiency of their businesses. Expertise includes end-to-end solutions in 5 categories: vacuum heat treatment, atmosphere, and aluminum thermal processing, controlled atmosphere brazing of aluminum heat exchangers and vacuum metallurgy.

SECO/WARWICK Group, with 8 companies located on 3 continents, has customers in nearly 70 countries with more than 4000 deployed solutions. The company provides standard or customized state-of-the-art heat processing and metallurgy equipment and technologies to leading companies in the following industries: automotive, aerospace, electronics, tooling, medical, recycling, energy including nuclear, wind, oil, gas, solar and production of steel, titanium, and aluminum.

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