Drying of Frozen Aircraft Structural Shapes

One of the principal aircraft components is the fuselage, the central part of the airframe to which all other parts are attached. It houses the cockpit, the passenger compartment and the cargo compartment. The fuselage has a round or oval cross-section both to absorb the loads acting upon it and to meet aerodynamic requirements. The fuselage is made of multiple parts, among them so-called stringers formed from structural shapes such that the exact shape of the fuselage is achieved. Forming these stringers is a particular challenge to the manufacturer because it may not be made other than at specific temperatures and within a highly restricted time window. A northern German company met this challenge by combining freezing, partial thawing and drying.

Claudius Peters of Buxtehude is a company with an aerospace division to produce components for the European Airbus. This includes the manufacture of aluminium stringers to become part of aircraft bodies. Much know-how goes into achieving the exact geometry of the stringers and, particularly, into preventing fatigue and resulting cracking of these components. The in-service loads acting upon the material are enormously high. Much so are the international rules and regulations imposed on aircraft manufacture which the components must of course fulfil.

The globally operating company, part of a privately owned engineering group in the UK, freezes the shapes to retain the structure of the material. Once thawed, the aluminium shapes may undergo further processing. The applicable procedures provide for only a short period of time within which such processing may be accomplished. This period may not be fully used, however, because during the first thawing stage a condensate builds up. For processing, however, the shapes must be completely dry. Moreover, the shapes must have a uniform temperature across their full cross-section to prevent repeated cooling and resulting condensate build-up after drying, explains Mona Lemke, head of Claudius Peters aircraft component manufacture. Also, 60 °C drying temperature and 25 °C product temperature must not be exceeded.

Otherwise, components may deteriorate and may not undergo immediate further processing, she continues. Yet, Claudius Peters' drying requirements are even more demanding. The component manufacturer sets the bar high in terms of drying time, energy efficiency and noise impact. To meet all these challenges, Claudius Peters looked out for a partner to provide an adequate drying solution and finally found the drying system manufacturer HARTER GmbH of Stiefenhofen, southern Germany.

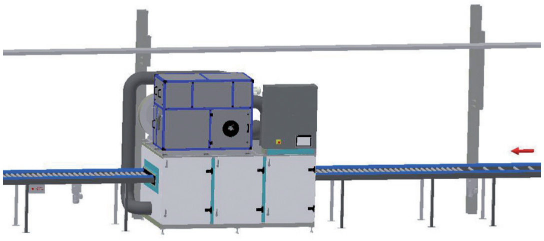
Low Temperature Makes the Difference

HARTER offers a heat pump based condensation drying technology ideally suited to meet such complex requirements. The drying method used features short drying times, uniform drying, constant parameters, and, above all, low temperatures. Claudius Peters' project was still very special under various aspects and required much creativity and engineering spirit on the part of HARTER. As usual, HARTER set out by running drying tests, initially in HARTER's own pilot plant station and later on in a mobile test station at the customer's premises. These tests paved the way to successful project implementation.

The drying system installed allows for a significant reduction in thawing time and resulting increase in processing time. Today, the shapes are dried fully, uniformly and gently at temperatures between 50 °C and 60 °C for a constant time. After drying, the shapes have a temperature of about 20 °C, which is within the limits required (between 15 °C and 25 °C). Despite their complex geometries, the shapes are fully dry all over so that the risk of repeated cooling is safely prevented. But what exactly are the physical prerequisites that make it possible to meet all these requirements, and how were they turned into an engineering solution?

Air Dehumidification and Routeing

To understand this, let us first explain the workings of heat pump based condensation drying. The process uses an alternative physical approach. It was launched on the market 25 years ago and has undergone continued further development ever since. The air used for drying is essentially stripped of any moisture while being heated in a dehumidification module. Once unsaturated, the air is passed into the dryer and over the items to be dried to quickly absorb humidity. Subsequently, the now saturated air is returned to the dehumidification module where it is cooled. Water condenses and is drained off the system. The dry air is reheated in the closed circuit and becomes available again for drying.



Overall System Layout

The use of extremely dry air makes low temperature drying possible. The drying temperature may be varied between 20 °C and 90 °C, as required for the specific application and/or desired by the customer. Normally, the drying temperature ranges between 45 °C and 75 °C. Due to its nature, this drying method features several favourable and desirable characteristics. Dry air alone, however, wins no more than half the battle, says Michael Richter of HARTER technical sales, the second essential factor that governs successful drying is air routeing. HARTER integrates a specifically designed air routeing system in every dryer. This ensures that unsaturated air, rather than flowing indiscriminately, is forced exactly onto, over or through the items to be dried. This is why the interior design of each HARTER dryer reflects much know-how plus the experience gained from building drying systems for more than a quarter of a century.

Continuous Operation

The Claudius Peters drying system is a continuous type. The shapes to be dried have various thicknesses, and lengths ranging between 30 cm and 10 m. This is why continuous operation was the best choice. The deep-frozen shapes (-25 °C initial temperature) are placed on a roller track which carries them to the drying tunnel. The tunnel houses

Mona Lemke, Head of Claudius Peters' Aircraft Component Manufacture in Front of the New Drying System

a stainless steel roller track purpose designed for optimum air routeing. Attached to the continuous dryer is a so-called Airgenex® module conditioning the air for drying. This dehumidification module was placed atop the continuous dryer for space restrictions.

First, the shapes are thawed using a recirculation fan until their surface is ice-free. Then, the water drops are removed from the surface using blow-off nozzles. HARTER installed a customised blowing-off provision to meet the requirements of the large variety of shapes – for larger and heavier shapes and for smaller and lighter ones. All these shapes have water perfectly removed by blowing while remaining in their position on the roller track – the latter being achieved by an ingenious engineering trick. Two air recirculation fans and special air deflector plates ensure uniform distribution of the dry air inside the dryer.

Following drying, the shapes are conveyed by another roller track from the dryer to the place where they are picked for further processing. The individual rollers of all tracks have a plastic coating to prevent scratching of the aluminium shapes. The drying tunnel is 1600 mm long, 3200 mm wide and 1600 mm high. The roller track is equally long, 800 mm wide and its clearance is 1000 mm high. The track speed may be varied. The longest shapes (10 m), for example, are thawed and dried within two minutes.

Energy-saving and Low Noise

Airgenex® condensation drying is also interesting under energy aspects. The entrance and exit openings of the drying tunnel are designed to minimise heat loss. The tubing between the module and the dryer is insulated to keep precious heat inside the system. The integrated heat pump technology ensures efficient air conditioning. The dehumidification module has a connected load of but 4.3 kW. Together with the six blowing-off and recirculation fans, Claudius Peters' connected load limit of 20 kW is met.

Also, workers shall not be exposed to excessive noise. Therefore, the sound pressure level requirement was not to exceed 72 Decibels. HARTER was able to meet this requirement, too. For us, this system is a perfect engineering solution that provides constant process parameters, ease of operation, and fulfils our numerous and demanding requirements, Lemke says in conclusion.

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