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Helicopter gearboxes are subject to extremely high in-service stress. They are designed for both low-loss transmission of the propelling forces and for optimum transfer to the airframe of any dynamic loads occurring in flight.

DRYING PROCESS FOR HELICOPTER GEARBOXES

The challenge: very large components and much water entrapped after rinsing

Complete drying of large helicopter gearbox component surfaces posed an entirely new challenge to a drying system manufacturer. The challenge was successfully met using a modified combined water blowoff / drying chamber.

The Calden, Germany, based ZF Luftfahrttechnik GmbH (ZFL) develops and manufactures dynamic components for helicopters. They also maintain, overhaul and repair gearboxes of many renowned helicopter manufacturers. ZFL with their comprehensive portfolio has also been a partner of the Bundeswehr (German Armed Forces) for many years. In order to continue to meet the extremely stringent requirements of their customers ZFL had to bring their drying process up to date. Gearboxes or components thereof, whether manufactured or maintained, invariably undergo surface finishing and require subsequent reliable and uniform drying. In search for a suitable partner ZFL found drying system manufacturer HARTER of Stiefenhofen, Germany, on the internet. HARTER had a 25 year business record bristled with engineering challenges and had resolved many drying problems using their closed heat pump based condensation drying system. HARTER was requested to develop a suitable solution for ZF Luftfahrttechnik GmbH, too.

Large-scale Testing

Upon an initial visit to the customer's premises to inspect both the items to be dried and the environment in which drying was to be accomplished, HARTER became aware that the task ahead would surpass anything done so far. The gearbox components have very large surface areas - some of them are more than one metre long - and extremely large volumes. Their highly complex geometries did not resemble any item dried in HARTER's classic rack or other type dryers before. Being innovation-minded drying specialists, HARTER's engineers knew that large-scale drying tests were inevitably required. The standard dryers available in their pilot plant station were much too small for the large components to be dried. HARTER therefore prepared a special test setup to simulate the actual conditions as best as possible. HARTER always uses the most challenging component for drying tests. If a viable solution is found for this component then this solution should also be good for the less challenging ones. Using a crane, the gearboxes provided for test purposes were inserted in a rinse tank and tilted upon removal such that some water was drained off. Yet, the amount of water still entrapped was large enough to prevent immediate drying. To cope with such situations, HARTER had developed a non-compressed air blow-off technique some time previously. The latter is used before drying proper for items with particularly complex geometries. The results of the test were promising so that the system layout could proceed.

Time is not a Priority

HARTER designed a separate, walk-in drying-blow-off booth. Using a crane, an operator first places each gearbox component into this booth. Then, they enter the booth for setting up the blow-off equipment. Normally, air knives are used in dryers. For ZFL's application, where each component to be dried is unlike all others,

HARTER chose to use individual nozzles which may be directed as required to blow off water from the specific item. Having completed the blow-off equipment setup the operator leaves the booth closing the door and lid by pushing a button and starting the combined blow-off/drying process. Other than in conventional applications where cycle times are tight, the drying time is not a big factor for ZFL. The components, some of which are really very large, remain in the booth for 30 minutes or more to be dried at a temperature of 60 °C. The drying booth is made from polypropylene and is connected to a so-called Airgenex dehumidification module to provide the process air required for drying. "Non-compressed air blow-off and drying take place in a closed system" states ZFL to emphasize this important aspect.

For best results, the geometrically complex helicopter gearbox components are subjected to non-compressed air blowing off and subsequent finish drying at a temperature of 60 °C.

Extremely Dry Process Air

Condensation drying in a closed system is a technique developed by HARTER. Two factors govern its success - first, efficient air dehumidification using a heat pump, and, second, adequate air routeing. HARTER uses an alternative physical approach for dehumidification. Extremely dry and thus unsaturated air is passed over or through the item(s) to be dried absorbing moisture in this process. Subsequently, the air is stripped of its moisture load in the so-called Airgenex dehumidification module. The moisture condenses, and the condensate is drained off the system. Then, the cooled air is reheated using the energy recuperated and returned to the drying chamber. The circuit is thus closed. Drying is accomplished at temperatures variable between 40 °C and 90 °C, as required for the specific application. It is important that dehumidification be combined with exact air routeing. For even the driest air is of no avail unless directed exactly to the place where it is supposed to absorb humidity. HARTER has a wealth of experience of how to engineer adequate air routeing.

Low Space and Power Requirements

Both the dehumidification pack and the fan for air blow-off where installed on the first floor for space restrictions. The piping of the whole system is insulated to minimize heat loss. The connected load of the high pressure fan for the blow-off nozzles is 5.5 kW, that of the Airgenex pack is 9.5 kW. The drying booth has six recirculation fans with a rated power of 0.7 kW each installed. Also included is an electrical heater battery with a 10 kW rating. The latter is only in operation at the beginning of the drying process to faster raise the temperature in the booth to the required level. The rating of the whole system in productive operation is 15 kW. "With this system we are well placed for our highly diverse applications. All engineering, quality and power requirements were fully met" summarizes ZFL this project.

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