Water: A threat in the air

Few people realise the impact of condensation on the longevity and efficienty of an aircraft. Nor is there much awareness of how much water vapour is generated in a 60 minute flight.

This major issue has again come to the fore and is now literally on centerstage. More and more people are probing the issue. Captain Ingemar Torloff of SAS leads the awardness programme and calls it a risk to all pilots.

The removal of condensation has been a major war zone in aircraft maintenance and only now is it being given the consideration it deserves. Research has shown that the passenger is a major cause of corrosion in the aircraft but also contributes to short circuits, fuses and electrical malfunctions.

Speedy and efficient removal of condensation is now becoming an important activity and the industry is creating a far more scientific front in the issue. One of the major breakthroughs is the Zonal Drying™ System from CTT that has upped the control leavels a whole new notch.

A special report

Flight 208 is carrying 275 people from New York to San Francisco. In those six hours the passengers will be generating 2.75 liters of water an hour in a narrow tube made of aluminium with much of its additional materials susceptible to the damp effect.

What can be done to dry it up before it has an adverse impact? Let's look at the physiology behind the condition.

People consist mainly of water. Every passenger on an aircraft exhales and perspires on about a decilitre of water an hour. In a modern aircraft operating on long hauls and with high passenger densities, large amounts of water vapour condense on the cold aluminium skin of the fusalage. This water causes not only corrsion in the aircraft structure but also malfunktions or short circuits in the electrical system.

Some of the water collects in the insulation, wich thereby becomes soggy and ineffective. Every flight generates more water and the aircraft becomes steadily heavier. Many aircraft are today flying with an unknown load in the form of hundreds of kilograms of water. The industy's carriers often ignore this factor but now there is an increased awareness that hidden water could be a contributor agent in aircraft trimming and even in the compromise of air saftey parameters. What if crashes in the past can be traced to a failure in recognition of this phenomenom.

The Zonal Drying™ System is the only known method of reducing / eliminating condensation in aircaft. Those behind it are pushing for a higher acknowledgement of the problem and are hoping to educate maintenance and engineering crews in handling the vapour.

It is just that it seems difficult to accept that people breathing in and out can be a weight hazard over a period of time. Health and safety engineers have found that the continuous moisture in the aircraft insulation is an excellent breeding ground for fungus, bacteria and mildew. This may be extremely irritating, since many people experience problems with throat irritation and allergies. Similar problems occur in well-sealed, incorrectley insulated buildings.

According to the System's manufactrers, Boeing has made an extensive study of moisture-related problems and developed recomendations for minimising them in its commercial aircraft. All passenger aircraft experience moisture-related problems since humid air inevitably come into contact with cold structures. The rate of condensation will depend on the rate of buoyancy-driven air movement over the structure, as well as the cabin humidity level. In-flight cabin humidity levels are low from the standpoint of human comfort (usually less than 20 per cent relative humidity). However, the air is not completely dry, and any moisture it contains will condense as the sir flows over the cold structure. Condensation on structures and resulting moisture problems are heavily influenced by seating density and aircraft operations, especially load factors and utilisation rates.

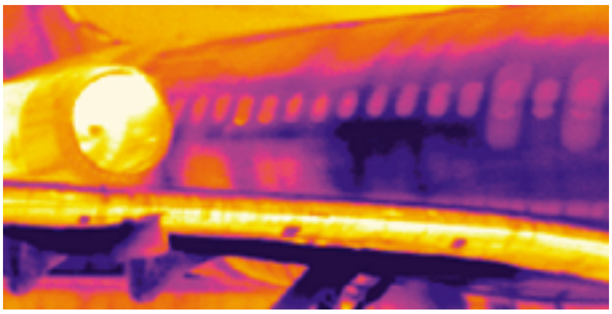
High passenger loads result in higher cabin humidities and condensation rates. As part of its study, Boeing reviewed operator reports to learn where moisture problems were occuring and wich operators were affected. Many operators have reported waterdripping into the passanger cabin and problems with saturated insulation blankets. Inspections for water stains on the upper surfaces of ceiling panels and stowage bins have indicated water dripping through penetrations and gaps in the insulation blankets.

Inspections have also shown that water accumulating on the upper surface of the ceiling panels and stowage bins migrates through joints into the passenger cabin. Other service experience has shown that water dripping into electrical equipment has been the cause of number of failures.

Operators can take various steps to reduce moisture related problems. Such actions are directed at:
- Insulation blankets
- Moisture control methods
- Bilge trays
- Ground-based dehumidification systems
- Reducing excessive gaps between insulation blankets.

Maintenance personnel remove wet insulation blankets during maintenance checks, often wiring them to expel water. Although this helps drying the blankets, it also damages the insulation material, reducing the blankets thermal and acoustic capabilities prematurely. Applying Nomex felt to these areas reduces the amount of water that can drip into the passenger cabin. Bilge trays have been found to provide better protection than the strings and nets currentley used. Ground-based dehumidification systems can maintain very low humidity levels in an aircraft. However, a considerable amount of time is required to dry out an aircraft using these systems, and the aircraft doors have to be kept closed for the duration of the process.

Thermal photographic experiments conducted on an aircraft show the affect in literal black and white.



This is an MD80 photographed with just such a thermal camera. The dark patches indicate cool areas and the light patches warm areas. For example, it can be seen that the fuel tanks in the wing are cold, while the area around the engine is hot.

The black patches on the side of the aircraft indicate moisture and frost problems. By studying a large number of thermal photographs of aircrafts, it has been found that water collects mainly in the insulation and in the pockets in supporting beams and structual reinforcements.

This is serious since moisture always leads to problems. The thermal camera is used in many industries for identifying moistures and cold zones, as in buildings, aircraft, bridges and cars. The technique is well-documented and the analysis is very reliable.

Warm air has the capacity to transport more water vapour than cold air. When the cabin air meets the cold outer skin of an aircraft, it is cooled below its dew point and the water vapour condenses to water.

Methods are now avalible for reducing the damage from condensation using drainage to lead the water to the underbody, special plastics to protect the installation, etc. However, this only moves the problem to another area. Condensation continues to form, which is unacceptable. Although it is theoretically possible to dry out the aircraft on the ground, it is too expensive and impractical to take out of service since turnaround times in commercial operation are too short.

There is only one effective way of eliminating this process. The moisture content of the air must be reduced by drying it out and thereby lowering the dew point. The Zonal Drying™ System takes air from the cabin and feeds it through a rotor impregnated with silica gel, witch removes the moisture. The dry air is then blown between the cabin liner and the aircraft skin, on the inside of the insulation blankets. The barrier of dry air lowers the dew point and eliminates condensation.

An internal stream of warm air across the unit absorbs the moisture in the silica gel and returns it to the cabin. The unit is presently avalible in two sizes: the smaller version weighs 4.9 kg (10.8 lbs), and the larger 8.0 kg (17.6 lbs). The complete installation in a Boeing 767 30 kg (69 lbs).

The Zonal Drying™ System has no effect on other systems and require no personnel training. The system is in permanent operation and dries out the aircraft continuously as long as the aircraft is powered up. Installation takes 80 - 130 man hours and is normally carried out during the C-check.

In the final analysis, the safety factor gains precedence over all other considerations. Water accumulation in aircraft may present a saftey problem since it is almost impossible to judge. It is the captain's responsability to check the aircraft weight, the flying distance and fuel burn. Aircraft with high passenger densities on long hauls are most exposed to this weight problem. Over 500 kg (1100 lbs) extra weight has been measured in the form of condensation. The captain's responsability is also to distribute the load and trim the aircraft, but since he does not know where the unaccounted load is located and how much it weighs it is difficult to achive an optimal trim.

The less the extra weight carried, the more accuratley he can calculate fuel quantities and fly safely and efficiently. Crews working for long periods on board are well aware of the condensation problem. Unfortunatley, they have had to accept this since there has so far been no reliable way of dealing with the problem.

This is expected every day in a variety of ways. Sometimes, water drips from the cabin ceiling or condensation forms in instruments and on the windscreen. In fact, there may even be icicles along the ceiling strips.