International Space Station Common Cabin Air Assembly Condensing Heat Exchanger Hydrophilic Coating Operation, Recovery, and Lessons Learned

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Abstract

The ability to control the temperature and humidity of an environment or habitat is critical for human survival. These factors are important to maintaining human health and comfort, as well as maintaining mechanical and electrical equipment in good working order to support the human and to accomplish mission objectives. The temperature and humidity of the International Space Station (ISS) United States On-orbit Segment (USOS) cabin air is controlled by the Common Cabin Air Assembly (CCAA). The CCAA consists of a fan, a condensing heat exchanger (CHX), an air/water separator, temperature and liquid sensors, and electrical controlling hardware and software. The CHX is the primary component responsible for control of temperature and humidity.

The CCAA CHX contains a chemical coating that was developed to be hydrophilic and thus attract water from the humid influent air. This attraction forms the basis for water removal and therefore cabin humidity control. However, there have been several instances of CHX coatings becoming hydrophobic and repelling water. When this behavior is observed in an operational CHX in the ISS segments, the unit's ability to remove moisture from the air is compromised and the result is liquid water carryover into downstream ducting and systems. This water carryover can have detrimental effects on the ISS cabin atmosphere quality and on the health of downstream hardware. If the water carryover is severe and widespread, this behavior can result in an inability to maintain humidity levels in the USOS.

This paper will describe the operation of the five CCAAs within the USOS, the potential causes of the hydrophobic condition, and the impacts of the resulting water carryover to downstream systems. It will describe the history of this behavior and the actual observed impacts to the ISS USOS. Information on mitigation steps to protect the health of future CHX hydrophilic coatings as well as remediation and recovery of the full heat exchanger will be discussed.