HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Interactive Presentations (IP)

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INNOVATIVE PASSIVE THERMAL CONTROL SYSTEMS FOR MANNED SPACE MODULES AND VALIDATION ON-BOARD THE INTERNATIONAL SPACE STATION

Abstract

This paper deals with the on-orbit validation of low-toxicity heat pipes designed for thermal control in human spaceflight. Heat pipes are currently used outside the International Space Station for the thermal control of electronic devices. Since they contain a toxic fluid like ammonia, they cannot be used inside the module; thus thermal control is mainly performed by means of air circulation systems or liquid cooling loops that require electrical power for their activation. The use of passive thermal devices like heat pipes to support or replace active thermal control systems will not require electrical power consumption and maintenance, ensuring low complexity and high reliability.

An extended research activity was started by Argotec 4 years ago and it is still ongoing. The goal is the identification of working fluids with low toxicity to be used in manned space modules, and the design of the internal geometry of the heat pipe grooves in order to guarantee good thermal performance, safety, and reliability.

The technology demonstrator Thermal Exchange has been developed to be operated on-board the International Space Station with the purpose of demonstrating the on-orbit performance of the heat pipes. Thermal Exchange is a sub-rack payload planned to be launched on OA-6 and operated inside the Microgravity Science Glovebox (MSG). The goal of the experiment is to test in microgravity conditions four axial heat pipes with different internal structures and filled with low toxicity working fluids. Once installed and power is provided, the experiment is automatically run by the electronics, which provides variable thermal loads to the heat pipe heaters; while the MSG cold-plate is exploited as a heat sink. After a brief description of the Thermal Exchange payload, the paper provides the results of the on-orbit tests compared with the baseline data collection obtained from the ground test campaign. In particular the baseline data collection derives from tests performed with the Thermal Exchange Flight Unit using

a simulated MSG cold-plate in the Argotec laboratory and the Microgravity Science Glovebox (MSG) Ground model at the Marshall Spaceflight Center. The ground test campaign is carried out applying the same thermal power profile and cooling conditions of the on-orbit testing session, and varying the heat pipe orientation with respect to the gravity field. Furthermore a possible architecture for the integration of the axial heat pipes in the thermal control system of future space modules is drawn and potential terrestrial applications are also identified.