Thermal and Reliability Testing of Advanced Loop Hot Reservoir Variable Conductance Heat Pipe for Lunar Night Survival

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Abstract: NASA's vision to deploy more landers and rovers on the moon surface poses a significant thermal design challenge. There is a need to extend the duration of the missions in both cold and hot environments, including cis-lunar and planetary surface excursions. The heat rejection turn–down ratio of the increased thermal loads in the above-mentioned conditions is crucial for minimizing vehicle resources (e.g. power). Therefore, future exploration activities will need advanced thermal management systems that can provide higher reliability and turn-down ratio, and, at the same time, with reduced power and mass. To meet these requirements a passive thermal link that offers a large turn-down ratio is highly encouraged, which can be a Hot Reservoir Variable Conductance Heat Pipe (VCHP).

Advanced Cooling Technologies, Inc. (ACT) has developed multiple versions of hot reservoir VCHP and successfully demonstrated its thermal control capability through a series of ground testing [1][2]. A reliable operation of hot reservoir VCHP requires a good working fluid management strategy, which includes the feature to avoid working fluid entering the warm reservoir and efficiently remove moisture from the reservoir (i.e. purging) using minimal energy resources. A novel compact VCHP loop design was developed under an STTR program. Figure 1 shows the fabricated hot reservoir loop VCHP investigated. VCHP was made of aluminum. Acetone and toluene were investigated as the working fluid with helium as the NCG. This design has both reservoir and an external NCG tube integrated with the heat pipe body, thus a very compact device. Two fill tubes were used in this design: one on the condenser is a regular fill tube for fluid charging, and another fill tube attached to the reservoir is design for reliability testing. Thermal control performance and reliability of hot reservoir VCHP were experimentally characterized. Test results will be presented in the conference.

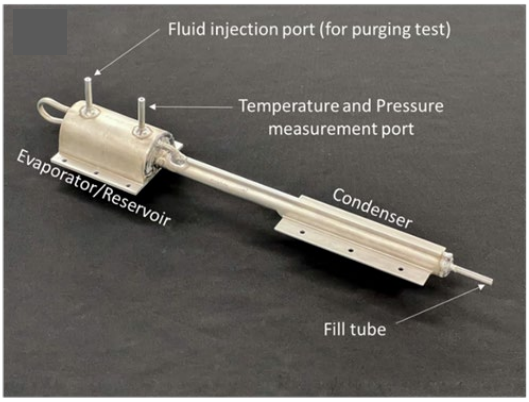

Figure 1. Integrated hot reservoir VCHP

References

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