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C2Po2B-01 [16]: Development of a cryogenic loop heat pipe for space applications

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To improve measuring sensitivity of an IR detector in spacecrafts, it should be cooled down to cryogenic temperature in a limited space and zero gravity environment, connected to a cryocooler. For the heat transfer from the sensor to the cryocooler, a cryogenic loop heat pipe (CLHP) can be used due to its efficient heat transfer performance and reliability without using mechanically moving elements.
In this study, thermo-hydraulic design of CLHP is presented to transport heat load of 10 W over 0.5 m distance at the cryogenic temperature less than 150 K from a cryocooler as a heat sink. Nitrogen gas and liquid was used as a working fluid of the CLHP and sintered wicks made by porous nickel were applied for primary and secondary evaporators to generate capillary pressure. Initial start-up was achieved using a secondary evaporator to be used in zero gravity environment. A pressure reduction reservoir (PRR) was also applied considering supercritical start-up from room temperature. After the fabrication of CLHP, it was horizontally installed in a lab-scale space simulation chamber that have a GM-cryocooler to cool the condenser of CLHP in vacuum. Transient thermal behavior was investigated including the supercritical start-up and the operation of secondary loop. The secondary loop moves liquid nitrogen in the condenser to the primary evaporator using the secondary evaporator, which was thermally attached to the condenser. Then, heat transfer performance was evaluated to verify the heat transportation limit using heat load to the primary evaporator.

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