Thermal Performance Evaluation of a Small Loop Heat Pipe for Space Applications

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Abstract

A small Loop Heat Pipe (LHP) featuring a wick of only 1.25 cm (0.5 inches) in diameter has been designed for use in spacecraft thermal control. It has several features to accommodate a wide range of environmental conditions in both operating and non-operating states. These include flexible transport lines to facilitate hardware integration, a radiator capable of sustaining over 300 freeze-thaw cycles using ammonia as a working fluid and a structural integrity to sustain acceleration loads up to 30 g. The small LHP has a maximum heat transport capacity of 140 Watts with a thermal conductance ranging from 17 to 43 W/°C. The design incorporates heaters on the compensation chamber to modulate the heat transport from full-on to full-stop conditions. A set of start up heaters are attached to the evaporator body using a specially designed fin to assist the LHP in starting up when it is connected to a large thermal mass. The total mass of the small Loop Heat Pipe, including the evaporator body and the radiator, was only 1.4 kg.

This paper describes the steady state and transient performance of the small LHP in four different orientations: vertical, horizontal, adverse and reflux. The tests include start up and shut off results for the four orientations at hot and cold case conditions. The results of the test program indicate that the small LHP can successfully transport moderate heat loads for many space related applications.