INVESTIGATION OF TRANSIENT TEMPERATURE OSCILLATIONS OF A PROPYLENE LOOP HEAT PIPE

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Abstract

A technology demonstration propylene Loop Heat Pipe (LHP) has been tested extensively at the Jet Propulsion Laboratory in support of the implementation of this two-phase technology on NASA's Earth Observing System Tropospheric Emission Spectrometer (TES) instrument. This cryogenic instrument is being developed at the Jet Propulsion Laboratory for NASA. In this paper, we report on the transient testing results showing low frequency temperature oscillations.

In space applications, when LHPs are used for thermal control, the power dissipation components are typically of large mass and may operate over a wide range of power dissipations, there is a concern that the LHP evaporator may see temperature oscillations at low powers and over some temperature range. In addition, the LHP may not start when power is applied to the component until a significant temperature overshoot from the equilibrium temperature is developed. In some space applications, this may be a problem because the maximum allowable flight temperatures (AFTs) may be exceeded. When equipment temperature stability is important, this becomes a serious issue. Its important to understand the LHP behavior in such a situation in order to make reliable on-orbit component temperature predictions and to prevent component temperatures from exceeding their AFT limits.

A test program was developed to characterize the transient behavior of a propylene LHP with a large mass attached to the evaporator and at low powers. The LHP was tested in a horizontal orientation with heat loads of 15 to 75 watts and condenser temperature ranging from -30°C to 0°C. In addition, a small heater and temperature sensor were placed on the LHP compensation chamber to provide close loop temperature control and was tested under similar conditions. Transient results show repeatable low frequency temperature oscillations for a range of conditions. When temperature control is applied to the compensation chamber the evaporator temperature oscillations disappear. Recommendations are made for future applications and additional research on this topic.

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