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PULSATING HEAT PIPE FOR THERMAL CONTROL OF SPACECRAFT ELECTRONICS COOLING: THEORETICAL AND EXPERIMENTAL INVESTIGATIONS

Abstract

The electronic device and flight control system is one of the most critical systems devised for spacecraft on orbit during the whole mission. However, it always is beard to the high heat fluxes due to its continuously increasing power and serious dangerous surroundings which will worsen the performance of the electrical components. As a result, it is becoming more and more meaningful and challengeable for us to satisfy the need of high heat flux thermal control for electronics cooling. The heat pipe cooling technology as an advanced thermal control method plays an important role in spacecraft thermal management. And pulsating heat pipe (PHP), with simple structure without wick, compact size and low weight, is considered as one of the promising technologies for a high heat transfer device on small space.

This paper presents a novel study on performance of pulsating heat pipe using ammonia as working fluid. The tested PHP, consisting of 6 or 12 turns, is made of aluminum tubes with 6 mm outer diameter and 2 mm inner diameter. The filling ratio in PHP are varied from 50 to 80 percent. Firstly, in order to obtain a basic understanding of the main parametric effects of an ammonia PHP at a steady state, an experimental study is conducted. The startup performance and thermal resistance and critical heat flux of the aluminum-ammonia PHP will be highlighted. Then, a theoretical discussion on the parametric effects involved in the mathematical modeling is developed. At last, the comparison of the experimental and theoretical results for the ammonia PHP is presented. Overall, we conclude that the ammonia PHP has very low thermal resistance and rapid startup performance, indicated that the heat can be transferred from heating section (electronic components) to cooling section (radiator) very quickly in space application.