Thermal Control of Surveillance Systems Using Pulsating Heat Pipe and Heat Pipes

Conference Paper · July 2013

DOI: 10.2514/6.2013-3664

1 author:

Roger R. Riehl
National Institute for Space Research, Brazil
93 PUBLICATIONS **530** CITATIONS

SEE PROFILE

AIAA-2013-3664
49th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit
11th International Energy Conversion Engineering Conference
14-17 July 2013, San Jose, CA USA
Chapter DOI: 10.2514/6.2013-3664

Thermal Control of Surveillance Systems Using Pulsating Heat Pipe and Heat Pipes

Roger R. Riehl[1]
National Institute for Space Research, São José dos Campos, SP Brazil, 12227-010

Liomar de O. Cachuté[2]
National Institute for Space Research, São José dos Campos, SP Brazil, 12227-010

Important applications can be found on surveillance systems using high performance thermal control devices, especially passive ones using heat pipe technology. With the growing need for heat dissipation presented by this type of system, usually hybrid solutions are designed. This is usually applied when the heat source is located far from the heat sink and the use of liquid cooling or any other active thermal control system is not possible. Since most of the surveillance systems being designed today require thermal control devices that operate under adverse orientation, some restrictions apply. Therefore, the technology that is currently used and disseminated for aerospace can find many other applications in surveillance systems for defense purposes. With severe restrictions regarding available space for integration of common thermal control devices, the design and application of pulsating heat pipes (PHPs) becomes the most indicated solution for the present investigation, together with the use of heat pipes for proper heat rejection. Based on this fact, this investigation is focused on presenting the thermal control management of electronic components of a surveillance system being done by PHPs configured as open loops with conventional heat pipes. Despite the relatively high temperature difference observed between the heat source and the sink (up to 25 ^{o}C), the open loop PHP was able to transport the rejected heat (up to 40 W) from the electronic components to a remote heat dissipation area, while keeping their temperatures within the required range established by the project (below 80 ^{o}C) and relatively high thermal conductances (up to 1.6 W/^{o}C), as demonstrated by experimental results. The heat pipe has demonstrated the capability of spreading the heat evenly, positively affecting the operation of the PHP. The operation of this combined solution has shown to be stable and reliable.

I. Introduction

As a reliable two-phase thermal control device, pulsating heat pipes (PHPs) consist of a simple meandering tube bended with several curves forming several parallel channels, without the presence of a wick structure. The channels are formed from capillary tubing and a working fluid is responsible for acquiring the heat from a source and dissipating it in a sink. This kind of device can be considered a special type of heat pipe and was introduced by Akachi[1]. PHPs can be applied in several thermal control problems, such as microelectronics, but recently has gained interest in applications such as those for aerospace and surveillance systems used on the ground.

Since PHPs operate by means of slug/plug dynamics[2], several investigations have been performed in order to improve their efficiency, also focusing on working fluids with the presence of solid nanoparticles, which can act on the improvement of this dynamics as well as on the thermal conductivity of the fluid[3]. PHPs have been under investigation in the last years with great development regarding the phenomenon involved in their operation, but further investigations are still required. Delil[4] has presented a survey on pulsating/oscillating devices suitable to be used in space and microgravity environments where important contributions to understand such devices are given. Lin et al.[5] presents an experimental investigation on an open loop PHP, where the maximum heat transport capability was investigated, showing the great perspective of using PHP as a thermal control device. The first investigations regarding the operation of PHPs were important to guide the future studies and applications, focusing

[1] Senior Research Engineer and Faculty, Space Mechanics and Control Division, Av dos Astronautas 1758.
[2] Senior Mechanical Engineer, Space Mechanics and Control Division, Av dos Astronautas 1758.