MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Thermal/Fluidic Systems (7)

Author: Prof. Taig Young Kim
Korea Polytechnic University, Korea, Republic of, tagikim@kpu.ac.kr

RESEARCH ON THE THERMAL CONTROL HARDWARE COMBINED WITH HEAT PIPE AND PHASE CHANGE MATERIAL

Abstract

The HP (Heat Pipe) embedded radiator is the common H/W for thermal control of the satellite electronic components. If a high heat dissipating component works intermittently with short duty the radiator has to be sized to account for instant peak temperature occurrence. Such a design leads oversized radiator and needs heater to prevent the excess cooling of the component. The solid-liquid PCM (Phase Change Material) is a good candidate to accommodate oversizing with reliable and passive technique. With proper distribution of PCM around the dissipating component the thermal capacity of radiator is increased due to the heat of fusion of PCM and it makes the instant peak temperature moderate. During the cooling phase of off-duty component the accumulated heat on PCM allows saving heater power consumption. Unfortunately PCM with large heat of fusion tends to have low thermal conductivity, therefore, PCM placed relatively far from the dissipating component does not properly work. In present study the triple channel combined HP-PCM is suggested as a new thermal design H/W to make up for the low thermal conductivity of PCM. The middle channel is for working fluid of HP and PCM is encapsulated in the parallel channels both sides of HP. During the normal operation the component heat is well transferred through the working fluid with small temperature gradient along HP. The representative distance between HP and PCM is small and it helps heat spreading into the whole portion of PCM. The numerical analyses were performed for the triple channel combined HP-PCM embedded radiator where the component baseplate was also modeled to be loaded the intermittent heat. The aluminum channel wall with ammonia as a working fluid of HP was considered and the n-triacontane was selected for PCM. Resulting from the computational prediction about 10K for the baseplate temperature was decreased with PCM compared to without PCM. It clarifies that the triple channel combined HP-PCM not only is very effective to control the temperature of a short-duty-cycle component but also reduces the mass and size of the radiator.