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GENERATION OF THE REFERENCE MAP IN DESIGN PARAMETERS FOR EFFICIENT THERMAL CONTROL OF SATELLITE COMPONENTS USING PCM

Abstract

The purpose of satellite thermal control is to ensure that satellites and its components are always within the operating temperature range on a mission orbit thermal environment. It is a typical design that dissipated heat from the working components is released into the space through radiator. A part of the satellite components in low earth orbit operate in a very short period of time and generate a large amount of heat, resulting in a drastic temperature variation in the components, which shortens their lifespan. Therefore, an excessive radiator area to compensate the abrupt heat dissipation is required, and a heater design in preparation for undercooling of the components rest of the period is essential. The solid-liquid phase change material (PCM) is a good candidate to handle periodic or intermittent working components because it can passively relieve drastic temperature change through the latent heat, however, it is not easy to design efficiently. In order to applying the PCM, not only the conditions of heat dissipating component and radiator size but also thermo-physical properties of PCM must be reflected in the design. Because thermal resistances among components, PCM, and radiator play roles in using PCM, it adds more complexities in design optimization. In this study, configuration of PCM is standardized in cylindrical geometry and the thermal resistances were also standardized through heat pipes. We produced a reference map to optimize thermal design using PCM through numerical analysis. Design conditions in parameters such as component heating conditions, thermal mass of PCM, radiator size, etc., were referenced under the maximum liquid volume fraction in PCM melting phase during heating. The map presented in this study can be used to optimize the thermal design using PCM under various thermal conditions.