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THERMAL DESIGN FOR THE CYCLIC WORKING COMPONENT IN SPACECRAFT USING THE SOLID THERMAL BUFFER MASS AS A THERMAL CAPACITOR

Abstract

Some electrical components in spacecraft operate in cyclic manner. The duty phase of the components is generally short compared to the whole period of the cycle. The component heats up with operation and its temperature hits the highest peak at the end of the duty phase due to the heat dissipation. During the off-duty phase the component temperature continues to fall until the next sortie. There are the required temperature limits in the component thermal design. Because the highest temperature should not exceed the maximum limit the radiator is designed its size to emit enough heat into the space. When the cooling down temperature reaches the minimum limit the extra heater power is required to compensate the energy loss from the radiator. Although the high heat dissipating component working in short duty the radiator should be designed for the peak temperature and then it leads the over-sized area. It affects not only the system size, mass and cost by itself but also the spacecraft power system due to the heater power increment. To reduce the impact on the system design the solid thermal buffer mass (TBM) as a thermal capacitance installed between the component and the radiator is a good recommendation. The TBM accumulates the instantly generated heat and releases the thermal energy moderately, and it makes the time varying temperature profile damped down. In this study the mass or thermal capacity of the TBM is optimized to meet the design temperature limits of the component based on the mathematical analysis. The linear approximation method is suggested to solve the nonlinear unsteady energy equations caused by 4th order radiation term. As a result the compensation heater duty cycle lessens compared to original design without TBM.