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A NEW CONCEPT VARIABLE RESISTANCE RADIATOR

Abstract

Since its beginning, space exploration has always thrown difficult challenges to engineers; one of these was to maintain the temperatures of spacecraft critical components within their operational range. Radiators represent one of the key elements of thermal control systems. However, because of the extremely variable conditions that satellites can face, such devices must be controlled to achieve an adequate flexibility in the heat rejection. Nowadays most radiators exploit ad-hoc, highly optimized solutions, often based on a passive plate coupled with devices that allow a sort of control of the system (heaters, heat pipes or complex emissivity control systems). The use of these devices has many inherent issues that, depending on the type, have a strong impact on other system drivers, as well as on the architecture and on the complexity of the entire spacecraft. Moreover, they cannot deal easily with sudden or unforeseen variation of the environment thermal loads. In this framework, this paper presents a new concept of heat radiator, which is able to vary its equivalent thermal resistance; through this skill the proposed concept allows to obtain a flexible active thermal control, just slightly changing the radiator geometry but avoiding complex mechanisms that could affect the radiator reliability. In detail, the variable resistance radiator is composed by three overlapped plates, parallel and constrained so that it is possible to separate them or put them in good thermal contact. Taking advantage of this possibility, the radiator changes the way the heat passes through it, from a conductive path to a radiative one. The switching operation, obtained by mean of a linear actuation, is controlled in order to vary the system equivalent thermal resistance and so to control the heat flux dissipated to the environment. Thus, the radiator adaptability is achieved with a simple but very effective solution. This paper presents a detailed 3D prototype design and a thermal numerical simulation of its behavior. These have been internally developed and the simulation has been verified by a commercial FEM software. In addition the results will be analyzed and discussed in order to highlight its potentialities for future space and planetary missions.