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ANALYSIS OF INTEGRATED THERMAL SUBSYSTEMS FOR COMPOSITE PRIMARY SPACECRAFT STRUCTURES

Abstract

Composite materials have been used for spacecraft applications almost from the start of the space race in the late 1950s. The advantages of using advanced composites in primary spacecraft structures have been proven in innumerable missions. The structural weight of an aluminium spacecraft is normally about 23% of the total spacecraft weight. With the integration of composite primary structure and many composite secondary structures, structural weight is currently only about 7% of the total spacecraft weight.

Normally, a spacecraft's metal alloy based structure acts as an efficient passive thermal system and the heat generating payloads on-board are coupled to the structure to enhance effective thermal dissipation. In case of an all composite structure, due to the lower overall thermal conductivity compared to the aluminium alloys in the order of almost a decade, a dedicated active thermal subsystem has to be introduced to take care of the thermal control for the payloads on-board the spacecraft. This in turn adds to the weight once again, thus, negating the weight savings from using state of the art lightweight composite structures in the spacecraft bus in case of a small satellite.

Composite primary spacecraft structures are instrumental in ensuring weight savings but the weight advantage gained is minimized in case of a small satellite since there arises a need for a dedicated thermal system. So there is a need to understand the nature of heat conduction process in CFRP sandwich structures and being able to predict how well a particular composite will conduct heat are of critical interest to future spacecraft structural designers. This paper will identify the requirements, the challenges involved and the numerical methods that can be adopted in characterizing the thermal behaviour of composite space structures. This paper will also investigate the possibility of using such a structure as a passive thermal system or with active integrated thermal subsystems.