World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:15, No:08, 2021

Sizing and Thermal Analysis of Mechanically Pumped Fluid Loop Thermal Control Technique for Small Satellite Scientific Applications

Authors : Shanmugasundaram Selvadurai, Amal Chandran

Abstract : Small satellites have become an alternative low-cost solution for several missions to accomplish specific missions such as Earth imaging, Technology demonstration, Education, and other commercial purposes. Small satellite missions focusing on Infrared imaging applications require lower temperature for scientific instruments and such low temperature can be achieved only using external cryocoolers but the disadvantage is that they generate a large amount of waste heat. Existing passive thermal control techniques are not capable to handle such large thermal loads and hence one of the traditional active Thermal Control System (TCS) is studied for a small satellite configuration. This work aims to downscale the existing Mechanically Pumped Fluid Loop (MPFL) TCS to a 27U CubeSat platform for an imaginary scientific instrument. The temperature-sensitive detector in the instrument considered to be maintained between 130K and 150K to reduce dark current noise and increase the data quality. A Single-Phase fluid based MPFL is chosen for this system-level study and this TCS consists of a microfluid pump, a micro-cryocooler, a fluid accumulator, external heaters, flow regulators, and sensors. This work also explains the thermal control system architecture with a conceptual design, arrangement of all the components, and thermal analysis for different low orbit conditions. Sizing and extensive trade studies for the components are conducted and the results have shown that the Single-phase MPFL system is able to handle the given thermal loads and maintain the satellite's interface temperature within the desired limit.

Keywords : active thermal control system, satellite thermal, mechanically pumped fluid loop system, cryogenics, cryocooler
Conference Title : ICSTCTA 2021 : International Conference on Spacecraft Thermal Control and Thermal Analysis
Conference Location : London, United Kingdom
Conference Dates : August 19-20, 2021