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NANOFLUID BASED ACTIVE THERMAL CONTROL SYSTEM FOR SPACECRAFTS

Abstract

Conventional heat management systems in past missions like the Apollo-IV were observed to be less efficient and bulkier. Recent advancements on Nanofluids show that the fluid suspensions of Nano-sized particles or metals suggested to have benefits in active thermal control systems of spacecrafts. This research sheds light on the analysis and selection of nanoparticles with the base fluid such that nanoparticles remain stable throughout their operating temperature range. A comparative study of the properties of nanoparticles and their carrier fluids is performed to assess the best suited nanofluid for the thermal conditions on a spacecraft. The properties of nanofluids such as: concentration, mass flow rate, type of flow, and operating temperatures on the performance of the thermal control system is analyzed between various combinations of nanoparticles and base fluids. The study focuses on nanofluids that are used in an Active Thermal Control System (ATCS) of a spacecraft, which use input power to operate and maintain all the spacecraft systems within an acceptable temperature range. ATCS is used in conjunction with a Phase Change Material (PCM) heat exchanger in the two-loop control system, during re-entry which experiences harsh conditions. The results obtained with the nanofluid thermal control system are compared with the existing ones, and improvement in the efficiency has been studied.

Keywords: Nanofluid, Active Thermal Control System, Phase Change Materials, Re-entry, two-loop control system, spacecraft