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DEVELOPMENT OF POLYMER MATRIX COMPOSITE FOR SPACECRAFT FUEL TANKS IN MICRO-GRAVITY

Abstract

With the advancement in space technology, long duration human space flights are aspired which require reliable propulsion systems. In spite of the advancement, fuel handling remains one of the most critical aspects in space missions. Most of the fuels used in space missions are non-renewable, limited and expensive while liquid fuel remains the most widely used energy source. Efficient utilization of fuel turns out to be crucial in micro-gravity as it has adverse effects on fluid behavior due to domination of surface tension forces over gravitational force. The fuel adheres to the walls of fuel tanks, forming an ullage at the center of the tank which leads to in-utility of a significant part of fuel. Few of the existing techniques implemented to tackle this issue include the use of baffles and vanes. This paper involves the development of a Polymer Matrix Composite(PMC) material as a potential candidate among all other existing techniques, whose surface properties reduce the affinity of fuel towards the walls. Vanes are employed as well to guide the fuel to the exit. The proposed material has high thermal stability, resistance to creep and deformation; is lightweight, non corrosive and chemically inert in nature. Experiments were conducted on PMC using Force Tensiometer and Drop Shape analyzer to determine the required physical properties. Analysis of fluid in tanks having vanes of various geometry and dimensions was performed using COMSOL® Multiphysics and ANSYS® Fluent softwares simulating micro-gravity conditions to develop the most effective material. The aforementioned material can decrease the wastage of fuels in space missions.Thus, this material is proposed to be used in interplanetary missions to avoid insufficient consumption of fuel.