Paper ID: 45437
student

IAF SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations - IAF SPACE PROPULSION SYMPOSIUM (IP)

Author: Mr. Alec Yenawine
University of Miami, United States, alecyenawine@gmail.com

DESIGN AND EXPERIMENTAL ANALYSIS OF HYBRID ROCKET ENGINE ADDITIVELY MANUFACTURED COMPLEX PORT GEOMETRIES

Abstract

Recently the capability of hybrid rocket technology has been tested for use as a method of small satellite or CubeSAT propulsion. The aim of the proposed work is to build on existing research in effort to increase the performance of hybrid rocket engines for use in small satellite propulsion through combination of additive manufacturing and heterogenous fuel grain design.

Hybrid rocket engines provide several advantages over current solid and liquid rocket propellant systems. Hybrid rockets fuels elicit higher theoretical specific impulse than solid rocket motors, provide throttling capability, and are considered simpler and safer to operate over liquid propulsion systems. Despite the attractive advantages of hybrid systems, the combustion efficiency and regression rate of hybrid fuels are lower than desired to compete with performance of conventional solid or liquid systems.

Recently work has been conducted in effort to evaluate and improve the performance of hybrid rocket engines for use in small satellite or CubeSAT propulsion systems. AM presents attractive capabilities in designing hybrid fuel grains to better accommodate the volumetric constraints of CubeSATs, as well as allowing passive flow control of the oxidizer. AM has provided the capability of designing and printing complex fuel ports and geometries, printing multiple fuels at once, or printing a webbed fuel grain structure for future casting. In literature it is found that each of these methods have demonstrated increases in regression rates over conventional straight port or homogenous hybrid fuels.

Existing literature suggests that continued testing is required to fully understand the characteristics of flow and combustion through non-axisymmetric fuel grain and fuel port designs utilizing AM and its effect on regression rate and combustion efficiency. Initial work has been conducted in gaining a fundamental understanding of recent developments in hybrid propulsion technology and novel uses of AM in fuel grain design. Future work is proposed to design, hot fire test, and analyzing regression rates of additional novel grain fuel geometries with AM materials such as PLA, PE, ABS, PMMA Paraffin. Modification of existing designs such as helical and tangential injection ports is also proposed. The study will focus on fuel port geometry, although energetic additives and heterogenous fuel grain printing in combination with complex geometry is also an area of interest. Desired measurements from testing include regression rates, thrust, and chamber pressure. Heterogenous fuel grain samples may be analyzed prior to testing through ICP mass spectrometry or qualitatively through EDAX X-ray mapping.