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Entitled

THE EFFECT OF VORTEX COOLING AND INJECTION PARAMETERS ON A BIPROPELLANT 3D PRINTED THERMOPLASTIC THRUSTER

by

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Abstract

This research reports an experimental investigation of the efficiency and cooling performance of a 10N-vortex cooled Propane/Gox bi-propellent thruster designed and tested with different fabrication materials including a thermoplastic combustion chamber, and metal faceplate and nozzle. The study proposes vortex as a possible solution for cooling thrusters made from partially 3D-printed thermoplastic. This enables the vortex injection method to be 3D printed in a single solid piece thruster to minimize the design complexity and reduce weight, production time, and cost compared to conventional cooling methods. Vortex cooling is simply made by changing the direction of propellant injection rather than using conventional rocket propulsion cooling systems, such as regenerative cooling, film cooling, ablative cooling, and radiative cooling, which are potentially more complex and may require more system components to cool combustion thruster walls. The literature emphasizes the basis for designing an ideal vortex thruster. The study investigates injection-related parameters and their impacts on engine wall temperature and characteristic velocity efficiency. Operational parameters include O/F ratio, propellant mass flow rate, injection position, and combination of various fuel and oxidizer injection configurations including 5 different injection cases to support the comparison analysis to utilize the appropriate injection combination for achieving the mission of partially made thermoplastic thruster and gives an insight on a fully 3D printed thermoplastic thruster. Based on the experimental test results, it has been found that the vortex-cooled thruster can maintain an acrylic chamber wall temperature and nozzle below 100°C which is below the acrylic melting point. Therefore, the swirl can result in the oxidiser's circulation following the chamber's inner surface, thereby isolating the wall from the combustion reaction. The surface is thus protected from the high-temperature flame at a relatively low level of difficulty in the manufacturing process and operation. The study proves that thermoplastics can be safely cooled when swirl cooling is adopted.

Keywords: Regenerative cooling, film cooling, ablative cooling, radiative cooling, combustion chamber, nozzle, swirl injection, bi-propellent, vortex-cooled thruster.