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EXPERIMENTAL INVESTIGATION OF FUEL TRANSVERSE INJECTION DURING THROTTLING IN A BIPROPELLANT THRUSTER.

Abstract

Space exploration has always been given a peculiar interest by nations and recently by private entities. To perform these missions, soft-landing is required to safely ground on the celestial body's surface. Several studies on hybrid propulsion system with hydrogen peroxide have been issued. However, the investigation on the throttling of bipropellant thrusters using hydrogen peroxide and fuel is still scarce. Some experiments suggested using a system of valves regulated in a pulsed mode. However, the difficulty to obtain high-frequency valves was shed into light. Therefore, a new design focused on a single throttling engine using a cavitating venturi valve to control the oxidizer mass flow rate and a pressure-compensated valve to control the fuel line has been qualified on a horizontal test bed. The thruster is defined as a bipropellant thruster using hydrogen peroxide and fuel injected in a transverse injector. In these categories of thrusters, the jet penetration and its breakup represents a key component to understanding the mixing characteristics and efficiency of the engine. Previous research has visualized the mixing using glass and blue UV light while operating the thruster with a constant mass flow rate. Therefore, the behaviour of the injected jet is yet unknown during the throttling campaign. The following paper suggests an experimental procedure to visualize and understand the attitude of the penetration jet during throttling. The operation was achieved in a range of pressure from 10 to 50 bar. Throttling was accomplished in two distinct configurations. In the first segment, only the oxidizer mass flow rate was controlled from 120 to 12 g/s. In the second section, the fuel mass flow rate was automatically modified to keep the desired O/F ratio of 7.1. A glass using blue light allowed us to see clearly the jet's behaviour and the consequences of throttling on its structure. The results from this study have allowed to enhance the design simulation of throttling bi-propellant thruster.