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EXPERIMENTAL INVESTIGATION OF SWIRL OXIDIZER INJECTOR EFFECT ON 3D PRINTED ABS HYBRID ROCKET FUEL REGRESSION RATE

Abstract

Additive manufacturing has revolutionized various industries, including aerospace. Regarding hybrid rocket motors, the utilization of specialized ABS (Acrylonitrile butadiene styrene) fuel produced through additive manufacturing can have significant advantages. These advantages include producing fuels with complex internal ports and optimizing fuel grain designs for enhanced combustion efficiency and performance in hybrid rocket systems. The present study investigates the influence of additive manufacturing of ABS fuel on the regression rates in hybrid rocket motors using swirl and shower head injectors. Geox is chosen to be the oxidizer thanks to its availability and induced safety to be used in a lab scale firing. ABS, valued for its strength and thermal stability, is evaluated for hybrid rocket use. Experimental setups replicate operational conditions, with swirl injection creating a vortex for better mixing, while shower head injectors ensure uniform oxidizer dispersion. Regression rates are measured under varying oxidizer mass fluxes by changing the oxidizer mass flow rate using a mass flow controller while the initial port area of the fuel grain is kept constant. The firing data are analysed using the mass difference technique where the grain mass is measured before and after the firing. A series of experiments has been conducted on both injectors under three different conditions. Eighteen firing tests are planned to be conducted on a standard 2-inch engine. The experimental setup and the engine detail drawing will be explained in detail in the full paper. The oxidizer mass flux is varying between 25 and 200 kg/m2s while the pressure inside the combustion chamber is from 1 to 2.5 MPa. Two pressure transducers are mounted in the precombustion chamber of the engine to retrieve the pressure traces during the firing. All experimental setup is being controlled and monitored using NI data acquisition system with LabView software. The software, built in house, is capable of sending all the signals to control the electro valves mounted on the fluidic lines of oxidizer and purge gas (N2). Nine tests have been conducted using a shower head injector and the test results show regression rates of 0.940.2, 0.450.04, 0.360.01 mm/s at oxidizer mass fluxes of 127.922.25, 54.652.45, 36.130.64 kg/m2s respectively.