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EXPERIMENTAL EVALUATION OF THE EFFECT OF SWIRL OXIDIZER INJECTION AND ALUMINUM PARTICLE ADDITION IN N2O-PARAFFIN WAX BASED LABORATORY HYBRID ROCKET PROPULSION SYSTEM

Abstract

Despite the advantages of hybrid rockets like relative design simplicity, restart capability, safe shut-down, higher Isp than solid rocket motors for a few particular fuel-oxidizer combinations and higher density Isp than liquid bi-propellant rocket engines, its applications are limited because of its lower regression rate, limited control of fuel flow rate and combustion instability in large scale motors. To overcome some of these disadvantages, numerous methods have been experimented with. Some of them include use of liquefying fuels like Paraffin wax, swirling/vortex injection of oxidizer, addition of metal additives etc. Previous research has shown that swirl injection of oxidizer can increase regression rate by several factors in HTPB-GOX based hybrids. Significant research has been done with HTPB and other polymeric fuels with swirl injection, but very less literature is available on similar study with liquefying paraffin wax fuel-N2O based hybrids. Addition of Aluminum particles to fuel increases the density specific impulse and shifts the optimum O/F ratio. Also, prior research has shown up to 50% increase in regression rate in aluminized HTPB-GOX based hybrids. While, the results with lab scale wax-GOX hybrids are mixed. In liquefying fuels, addition of metal powders affects the melt layer viscosity and which in turn can affect the regression rate. The current study aims to further investigate the effects of direct swirl oxidizer injection and addition of micron sized atomized aluminum powder to paraffin wax fuel and add to the literature. In order to achieve the same, a lab scale and a 5000N thrust class paraffin wax-N2O hybrid rocket propulsion system with Nitrogen gas supercharge is being developed at BMS College of Engineering, Bengaluru. An experimental setup including thrust chamber, oxidizer tank, feed system and test stand was designed. Currently the full scale feed system is being integrated and Cold flow tests are being carried out to determine the injector discharge coefficients and feed line pressure losses. Paraffin wax fuel samples are being prepared and tested to check the mechanical strength of fuel grain to be loaded as cartridge in combustion chamber. Over the course of next few months, a series of hot fire tests will be performed to validate the hybrid motor performance and obtain the data required to assess the fuel regression rates and other combustion parameters.