Paper ID: 86631
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations - IAF SPACE PROPULSION SYMPOSIUM (IPB)

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EXPERIMENTAL INVESTIGATIONS INTO THE LOW TOXICITY HYPERGOLIC IONIC LIQUID-ETHANOL FUEL AND HYDROGEN PEROXIDE OXIDIZER

Abstract

Hydrazine-based hypergolic fuels have been utilized in various rocket engines for several years due to their good performance. However, they are toxic, carcinogenic, and require expensive handling procedures, posing risks to the various space missions. Therefore, the development of low-toxicity and high-performance hypergolic propellants is an emerging research area in the space propulsion domain. One of the potential alternative for hydrazine propellants is the low-toxicity hypergolic ionic liquid fuel and hydrogen peroxide oxidizer. Hence, the present research was focused on investigating the performance of ionic liquid (ethyl methyl imidazolium thiocyanate)-ethanol fuel blend with hydrogen peroxide oxidizer. The use of biofuel (ethanol) helps to lower the viscosity and costs of fuel for the sustainable development. Further, a Cu-P3 additive (3 to 13 wt%) was dissolved in fuel and ignition delay time (IDT) measured with 95 wt% oxidizer by using drop test method. For example, a 13 wt% Cu-P3 in ionic liquid-ethanol blend showed an average IDT of 6.3 ms with a 95 wt% H2O2. Additionally, the thermal properties, viscosity, and density of fuels were also measured. Theoretical performance parameters such as characteristic velocity, specific impulse, and density-specific impulse of the propellant were calculated using the NASA-CEA code. Considering the optimum performance of 9 wt% Cu-P3-ionic liquid-ethanol fuel blend with 95 wt% H2O2, it was further tested in a 50 N hypergolic rocket engine having chamber pressure of 10 bar. Performance, including combustion efficiency, combustion instability, and rise time, was measured. These findings demonstrate the potential of ionic liquid-biofuel blend and hydrogen peroxide oxidizer as a promising hypergolic propellant for affordable and sustainable space exploration.