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TOWARDS SUSTAINABLE PROPULSION: EXPERIMENTAL EVALUATION OF A 'GREEN' NON-TOXIC, HIGH PERFORMANCE AMMONIUM DINITRAMIDE (ADN) MONOPROPELLANT IN 10N THRUSTER

Abstract

The use of non-toxic monopropellants for small satellites and spacecraft's have gained immense attention in recent years with many new 'green' low-hazardous monopropellants are being investigated as potential alternatives to toxic hydrazine derivatives. The transition to environmentally sustainable propulsion technologies is essential in the face of increasing environmental regulation and the growing push for greener space operations. One promising solution is the use of Ammonium Dinitramide (ADN) based monopropellants which offer high specific impulse (>6%) and density impulse (>30%) than hydrazine while eliminating the toxic and environmentally harmful characteristics of hydrazine monopropellants. With its high oxidizing properties and lower toxicity, ADN offers advantages in both operational safety and propulsion efficiency, substantially reduces the environmental hazards associated with handling, storage, and disposal making it suitable for a range of satellite and space mission applications. This study investigates the performance of an in-house developed ADN-based monopropellant (a ternary mixture of ADN, methanol and water) in a 10N class thruster designed for an operating pressure of 24 bar. The thrust chamber, injector and the nozzle were made of Haynes25 alloy to withstand high temperature of exhaust gases with an area ratio of 7. An injector head with a diffuser mesh inside the chamber distributes the propellant on a preheated high temperature resistant catalyst. Granulated catalyst supports with active metals viz., Iridium (Ir) and Platinum (Pt) with varying loading (20-30%) were synthesized, characterized and successfully used for the catalytic combustion of ADN monopropellant. Tests were conducted at varied injection pressures from 2 to 24 bar at a pre-heating temperature of 250 to 300 deg.C. The dissociation temperature upon combustion and the rise in chamber pressure was monitored during the steady state firings each with a duration of 5s. Post test results indicate that both active

metal supported catalysts show nominal performance, with the Pt-based catalyst demonstrating superior endurance compared to the Ir-based catalyst. A comprehensive account on the experimental details, instrumentation, results and discussion are presented in the paper. This study provides critical insights into the use of ADN-based monopropellants as an alternative to traditional toxic hydrazine fuels. The data from the experimental evaluation in 10N thruster paves way for further development and optimization of high thrust ADN thrusters for future space missions aiming at a technology readiness level (TRL) of 6.