Paper ID: 64290
student

IAF SPACE PROPULSION SYMPOSIUM (C4)
Liquid Propulsion (2) (2)

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CATALYTIC COMBUSTION IN A REACTOR WITH AN ALTERNATIVE HEHN MONOPROPELLANT

Abstract

In this research, a preliminary study of hydroxyethylhydrazinium nitrate (HEHN) was conducted. Hydrazine is widely used as a monopropellant. However, it is known to be toxic and carcinogenic with a high vapor pressure. Therefore, researchers need to be cautious in transferring and handling the propellant. For this reason, research on an ammonium dinitramide (ADN) based monopropellant, which is a high performance green propellant, has been conducted to replace the hydrazine. Advantages of ADN based monopropellants are that they have high specific impulse and low toxicity compared to hydrazine propellant. However, ADN has a high explosive property with a DOT hazard classification of class 1.1. Thereby, great amount of attention is required when synthesizing ADN and manufacturing propellants. In addition, the ADN based monopropellant is a premixed propellant in which an oxidizer and a fuel are mixed, and detonation may occur during a combustion test. In this study, HEHN was proposed as an alternative propellant to ADN based monopropellant. Unlike ADN based monopropellants, HEHN is a pure material which means there is a low possibility of detonation, and has the advantage of having a low vapor pressure of 0.01 kPa compared to LMP-103S (13.6 kPa). Furthermore, HEHN has a simple one-step synthesis compared to ADN. In this study, HENH was synthesized by mixing the 2-hydroxyethylhydrazine and nitric acid, and the theoretical specific impulse was calculated. The theoretical specific impulse of HEHN was approximately 247 seconds which is 7% higher than hydrazine. Thermogravimetric analysis and differential scanning calorimetry (TGA-DSC) analysis were performed to evaluate the thermal properties and storability of the propellant. As results of TGA-DSC analysis, HEHN had a high thermal stability, and decomposition of HEHN started at 253 ^{o}C. In addition, HEHN also had a high storability similar to ADN based monopropellant. A drop test was performed to find a reactivity with various active materials such as platinum, copper and manganese oxide by changing the preheating temperature (room temperature to 250 ^{o}C). The drop test revealed that platinum preheated over 200 ^{o}C had a high reactivity with HEHN. Finally, reactor combustion test with Pt/γ-Al_2O_3 was conducted for HEHN propellant. The catalyst was preheated over 300 ^{o}C. The test result confirmed that HEHN combusted stably in the reactor and can be used as a monopropellant without any detonation phenomenon. In the next study, the exact performance of the propellant will be evaluated by conducting the combustion test in a thruster.