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CATALYTIC REACTOR TEST WITH AN ALTERNATIVE ADN-H2O2 MONOPROPELLANT

Abstract

In this research, a blend of ammonium dinitramide (ADN) and hydrogen peroxide monopropellant was developed and preliminary study of ADN-H_2O_2 monopropellant 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 transporting and handling the propellant. For this reason, research on an ADN based monopropellant and 90 wt% hydrogen peroxide, which are green propellants, has been conducted to replace hydrazine. Advantages of ADN based monopropellants are that they have high specific impulse and low toxicity compared to hydrazine. However, to use the ADN based monopropellant, preheating a catalyst over 350 ^{o}C is needed. For 90 wt% hydrogen peroxide, it can be decomposed by a catalyst at room temperature. However, it has a low specific impulse of 172 seconds compared to hydrazine. For this reason, in this study, ADN was mixed with 90 wt% hydrogen peroxide to compensate the preheating temperature. The theoretical specific impulse of ADN-H_2O_2 monopropellant was calculated. The theoretical specific impulse of the propellant was 206 seconds. Thermogravimetric analysis and differential scanning calorimetry (TGA-DSC) analysis were performed to evaluate the thermal properties of the propellant. As a result of TGA-DSC analysis, the propellant had two exothermic reaction at 122 ^{o}C and 247 ^{o}C. The storability test was conducted by measuring the molecular change of the samples which were stored at room temperature (23 ^{o}C) and refrigerator temperature (2 ^{o}C) for one year. As a result of the storability test, it was confirmed that the propellant can be stored at refrigerator for 5 months. In addition, safety evaluation test was conducted to measure the explosive power of the produced propellant. The blasting cap test was selected for the safety assessment test. By using pressure sensors, the explosive power of the fabricated propellant was measured. From the safety evaluation test, it was confirmed that the ADN-H_2O_2 monopropellant has a similar explosive power to LMP-103S which is widely used as the ADN based monopropellant. Finally, catalytic reactor test with La/Pt/-Al_2O_3 was conducted for ADN-H_2O_2 monopropellant. The monopropellant was injected into the reactor for 10 seconds without preheating. The temperature and pressure of the reactor were measured by using three temperature sensors and one pressure sensor. The test result confirmed that ADN-H_2O_2 monopropellant can be decomposed in the reactor without preheating and can be used as a monopropellant without any detonation phenomenon.