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PREPARATION AND ELECTROLYTIC COMBUSTION PERFORMANCE EVALUATION OF HIGH - DENSITY HAN BASED PROPELLANT

Abstract

Hydroxylammonium nitrate (HAN) is a monopropellant in which the oxidizer and fuel are mixed together, making it a promising eco-friendly alternative to conventional hydrazine-based monopropellants. Additionally, due to its ionic nature, it is electrically conductive and can be decomposed via electrolytic reaction. In this study, SHP-163 which is a developed HAN based monopropellant with methanol as a fuel is selected as a base formulation of high - density HAN based propellant. Then, polyvinyl alcohol, lithium nitrate, and multi-walled carbon nanotubes were mixed simultaneously as a thickening agent, secondary oxidizer, and conductivity modifier, respectively. The prepared propellant, named as HDP-44, provides higher electrical conductivity than SHP-163 which makes the electrical ignition be easier. The theoretical performance predictions of the HDP-44 are conducted by NASA CEA calculation. The adiabatic flame temperature was 2285 K for HDP-44, lower than 130 K than SHP-163. The specific impulse is calculated when the chamber pressure and expansion ratio are 10 bar and 100, respectively. The results were 274 sec and 283 sec for HDP-44 and SHP-163, respectively. In addition, The density specific impulse showed that the 4110 and 4046 sec·kg/m3 for HDP-44 and SHP-163, respectively. According to the results, HDP-44 has a potential to be used as a novel monopropellant system considering its comparable performances with SHP-163. Electrical ignition and combustion performance experiment is conducted in Ø 50 quartz tube with stainless steel-304 electrodes as an anode and cathode. The results showed that as least voltage of 100 V is required to initiate the combustion, while the current at minimum voltage showed lower than 50 mA. The thruster test is also conducted to evaluate the C* efficiency through designed 1 N lab-scale model. The parameters are evaluated through the thrust, chamber pressure, and combustion temperature. The maximum efficiency showed 88 In this study, the high - density HAN based monopropellant is prepared and evaluated the C* efficiency. The maximum efficiency is achieved at 400 V for designed thruster and found that the efficiency is highly affected by the voltage. It is expected that the higher performance and efficiency can be achieved by optimizing the electrode configuration considering the electrical effects on electrolytic decomposition of HAN based propellants.