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CATALYST ACTIVE MATERIAL DERIVATION FOR ETHANOL-BLENDED HYDROGEN PEROXIDE MONOPROPELLANT THRUSTER

Abstract

Hydrazine has been widely used for propellant in liquid monopropellant thrusters. However, due to the toxicity of hydrazine, high performance green monopropellant researches are progressed worldwide. Ionic propellants are representative high performance green monopropellants. However, these propellants are difficult to handle due to their complicated manufacturing processes and high handling cost. In this research, high performance green monopropellant with hydrogen peroxide and ethanol was proposed that has lower handling cost. Through firing tests, catalyst active material was derived to develop ethanol-blended hydrogen peroxide thruster. Theoretical performance evaluation of ethanol-blended hydrogen peroxide was performed with NASA CEA codes; by varying the mixture ratio, it was confirmed that high specific impulse can be achieved compared to those of other representative monopropellants. Propellant mixture ratio was selected according to blasting cap test results to minimize detonability. 10 N scale monopropellant thruster was fabricated and 5 seconds preliminary firing test was carried out using fabricated propellant and platinum catalyst on γ-Al2O3 support. As a result, firing test was found to progress successfully; characteristic velocity efficiency was 87.7%, and thermal efficiency was 84.6%. Platinum, palladium, iridium, silver, silver oxide and potassium permanganate were considered as catalyst active materials; these materials are known to induce catalytic combustion of hydrogen peroxide and ethanol. Platinum and palladium were chosen due to their high melting point and the poisoning with aqueous reactants and byproducts. Platinum and palladium catalysts with γ-Al2O3 support were fabricated and firing tests were undertaken for performance evaluation. Firing tests were conducted for 3 seconds, 4 times, for each catalyst active material. As a result, combustion chamber pressure and temperature were uniformly constructed during firing tests with Pt/γ-Al2O3. Average characteristic velocity efficiency was 95.1% and thermal efficiency was 94.4%. For Pd/γ-Al2O3, average characteristic velocity efficiency was 63.6% and the thermal efficiency was 81.0%; non-uniform combustion chamber pressure and temperature were obtained. This research presents about low-cost, high performance green monopropellant with hydrogen peroxide and ethanol. Theoretical performance evaluation of the propellant was progressed and propellant mixture ratio was selected in consideration of detonability. The possibility of ethanol-blended hydrogen peroxide thruster was verified through preliminary firing test. It was determined that platinum, because of its high melting point, non-poisoning with aqueous materials, high combustion efficiency and uniform combustion chamber pressure and temperature throughout firing tests, is suitable catalyst active material for development of ethanol-blended hydrogen peroxide thruster.