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COMBUSTION PERFORMANCE ENHANCEMENT OF A HYDROGEN PEROXIDE BI-PROPELLANT THRUSTER USING THE FLUIDIC OSCILLATOR KEROSENE INJECTOR

Abstract

High Test Hydrogen Peroxide is one of the green propellant candidates for replacing high toxic propellants such as hydrazine and its derivatives. Due to its easy handling, many small-scale hydrogen peroxide thruster systems are being developed. Most hydrogen peroxide bi-propellant thruster is dump combustor configuration with the catalyst bed. Since the utilization of the catalyst bed, the L* is longer than other thrusters and causes the increasing system volume and weight. For this reason, combustion performance enhancement is needed to reduce the L*. To improve the combustion performance of the dump combustor configuration bi-propellant thruster, a study was conducted on the application of the fluidic oscillator to the transversal fuel injector. The fluidic oscillator can make spatially oscillating jet ejected through the nozzle using a specially designed flow path, and through this, the combustion performance can be enhanced by improving the fuel atomization and mixing performance with the oxidant inside the combustor. For the combustion test, a feedback-free type fluidic oscillator injector with a hydraulic diameter of 400 microns at the nozzle outlet was designed and manufactured. Before the combustion test, characteristics such as the frequency and spray angle of the manufactured fluidic oscillator were predicted through ANSYS FLUENT, and this was measured and validated using a laser and high-speed camera. To understand the effect of the fluidic oscillator injector on combustion performance, a small-scale uni-element bi-propellant thruster was designed and manufactured. The thruster uses 90 wt% hydrogen peroxide as an oxidizer and kerosene as a fuel. To compare the effect of the oscillating jet to the combustion performance, the non-oscillating round orifice injector with the same nozzle outlet area was manufactured. As a result of combustion tests, combustion successfully occurred with the fluidic oscillator injector. There was no influence on pressure oscillations in the combustor due to the oscillation of the jet. The C* efficiency with the fluidic oscillator injector was ∼3 % higher than another injector when the same Q(crossflow/jet momentum ratio). While the jet penetration height influences the C* efficiency, it was assumed that the jet penetration height was the same when the Q is identical. In the future, the study of the jet in crossflow characteristics using the fluidic oscillator injector will be conducted. The correlation between fluidic oscillator jet penetration height and Q will be acquired.