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THE COMPARISON OF COMBUSTION CHARACTERISTICS BETWEEN OXYGEN/METHANE AND OXYGEN/PROPANE FOR BIPROPELLANT THRUSTER

Abstract

The green propellants have been being considered as next generation propellants. The advantages of green propellants are following; non-toxic, reusability, low cost propellant, easier and safer to handle. The representative green propellants combinations are LOX/LH2 and LOX/Hydrocarbon. Although LOX/LH2 propellants combination has the best performance among them, but it is difficult to handle and store. The methane has been being considered as representative fuel to replace hydrogen and kerosene. Oxygen/methane propellants combination has been developed for middle or large engine, and there are some cases for small thrusters including OMR (orbit maneuvering system) and RCS (reaction control system). Although oxygen/methane has the better performances than the other hydrocarbon, but the methane has a physical- and thermal property to more difficult to handle than the other hydrocarbon, because the methane is also a cryogenic material. In this study, the propane was chosen for replacing hydrogen and kerosene. It confirmed that although oxygen/propane propellants combination had lower performances than oxygen/methane, but it was better than oxygen/kerosene. In case of the propellant storage density, the gaseous propane was 2.2 times higher than the gaseous methane. The liquefied propane (-42.2 degrees Celsius) was 1.4 times higher than the liquefied methane (-161.5 degrees Celsius).

Through these data, it confirmed that the propane was better than methane in terms of handling and storage. It meant that the weight of system would be decreased. The weight of system is critical factor when launch vehicle is launched. Oxygen/propane propellant combination has been not actively researched yet. Therefore, the research was conducted to analyze the combustion characteristics between oxygen/methane and oxygen/propane. 2500 N thruster shape was used for numerical analysis. This thruster shape was developed for H2O2/kerosene bi-propellant in this lab. The chamber pressure was 30 bar.

First, it was calculated by CEA (chemical equilibrium with applications) program. It confirmed optimal mixture ratio and data for numerical analysis. And then, in adiabatic condition, the combustion characteristics were analyzed by fluent program. it used standard K-epsilon model, standard wall functions. Through this process, the stable model was constructed for heat transfer and film cooling analysis. Finally, the analysis of heat transfer and film cooling model was conducted.

As a result, it confirmed the following: pressure distribution, temperature distribution, turbulence shape, shock shape and so on. It confirmed that propane was available propellant for replacing hydrogen and kerosene.