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PERFORMANCE ANALYSIS OF N2O/CO2 OXIDIZER MIXTURE WITH PARAFFIN BASED MICRO-ALUMINUM FUEL FOR MARS ASCENT VEHICLES

Abstract

The objective of this research is to perform experimental test of a hybrid rocket engine by using CO2/N2O mixture as oxidizer and paraffin as fuel with the addition of metallic powders such as micron size Aluminum and Magnesium. The impact of 3-micron size aluminum on key performance parameters such as specific impulse Isp, regression rate (r), nozzle erosion rate and combustion efficiency are being studied with a hybrid engine with 40mm combustion port. Thermochemical analysis is evaluated by NASA's Chemical Equilibrium Analysis (CEA) software for both 20 and 40% Aluminum addition by mass to paraffin wax. Meanwhile, liquid CO2 is added to liquid N2O between 10 to 60% by mass in order to observe Isp and oxidizer to fuel (OF) ratio change. Experiments performed as blow-down with self-pressurizing capability of N2O around 45-50 bar. The aluminum addition improves of heat of combustion and the adiabatic flame temperature thus increase the regression rate. In addition, the effect of aluminum addition to the paraffin-based fuel shift the combustion to a lower OF ratio. The OF ratio is shown as 8 in 20% Aluminum 80% Paraffin with 70% N2O 30% CO2 oxidizer mixture. If μAl increases to 40% the OF ratio reduces to 5. This is the indicator aluminum addition can foster more efficient propulsion systems. On the other hand, effects of micro aluminum powder are being studied on nozzle erosion and combustion instability such as slagging and chugging. The hybrid engine design as well as experimental results will be presented in this research. Finally, theoretical and practical studies will be adapted as Mars Ascent Vehicle propulsion system.