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UNDERSTANDING REGRESSION RATE CHARACTERISTICS OF CO2 AS AN OXIDIZER COMPOUND IN PARAFFIN BASED HYBRID ROCKET MOTORS

Abstract

The objective of this research is to understand the ignition characteristics of CO2 as an oxidizer in hybrid rockets. Experimental tests are performed by using N2O/CO2 mixture as the oxidizer and paraffin wax as fuel with the addition of metallic powders. Larger scale hybrid motor tests are performed in order to understand the maximum combustion limit of carbon dioxide-based oxidizers. Spherical shaped 3 microns Aluminum is added to the paraffin wax up to 60% in mass fraction to observe regression rate with up to 50% CO2 by mass within the nitrous oxide. In addition, flake shape aluminum powder is also used since higher surface area creates more efficient combustion. The Mars Hybrid Rocket Motor (MHRM) is be used for upcoming experiments. The fuel grain length is 180 mm with 20 mm port diameter. The outer grain diameter is 48 mm with phenolic tube as a protective layer. Injector hole diameter is 0.8 mm produces up to 200 grams/second oxidizer flow rates with 8 seconds burn time. Motor nozzle is made out from graphite has 8 to 10 mm throat diameter with aspect ratios of 1 and 3. Experiments are performed in blowdown mode that an electrical resistance is used to heat up the tank in cold weathers to achieve the intended tank pressure around 50 bars. The overall thrust will be 200 Newtons during 8 second motor test. Thus, preliminary calculations showed that there is a potential increase in regression rate by adding CO2 up to 40% by mass compared to traditional Paraffin/Nitrous Oxide hybrid motors. Mixing CO2 with N2O also reduces the OF ratio of the system for high combustion efficiencies that can be considered in-situ rocket system for Mars Ascent Vehicles.