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PROGRESS IN 30KN LOX/METHANE EXPANDER CYCLE ENGINE

Abstract

An experimental program was conducted to demonstrate the feasibility of using the liquid oxygen/liquid methane expander cycle rocket engine. Torch igniter has been developed utilizing gaseous oxygen/ gaseous methane. Injectors have been experimented to screen the highest performance injector. Regenerative cooled thrust chambers have been designed, fabricated, and tested. Turbo-pumps performance data have been obtained using liquid nitrogen as a working fluid. Expander cycle engine for demonstration firings have been integrated and assembled. Engine system start transient characteristics using existing components have been established. Cold flow filling tests and starting firings will be conducted as planned. The demonstrator delivers 30kN thrust operating at chamber pressure of approximately 3.5MPa. The performance level at a mixture ratio of 3.5 would achieve the target goal of 95Gaseous oxygen/gaseous methane torch igniter ignited using the spark plug. The methane flow is split with a calculated flow of 0.5g/s entering the combustion chamber and 5.5g/s flowing down along the outside of the torch injection tube to provide cooling. The oxygen flow is calculated 15g/s which made the combustion chamber mixture ratio equal to 25. This was chosen to create a combustion temperature of approximately 1640K. At the exit of the torch injection tube, the cooling methane mixes with the products of combustion and the resulting mixture ratio is 2.5 and burns at a temperature of approximately 3140K which is sufficient to vaporize and ignite the LOX/LCH4 propellant combination. Several injector trade studies were performed to determine which concept would yield the best chance of meeting the design requirements. Coaxial shear, coaxial swirl and fixed pintle gas/liquid injector were experimented. Because of the performance the coaxial swirl offers and the history in our institutes, the coaxial swirl was chosen as the injector which characteristic velocity efficiency reached 98.5The regenerative cooling thrust chamber was composed of an inner copper liner with milled cooling channels and an electroformed nickel outer wall. The coolant flowed in the opposite direction against the combustion gas in the chamber. The thrust chamber pressure-fed tests were conducted at ground. The temperature rise and differential pressure in the cooling channels were approximately 350K and 2.5MPa respectively. Next month, integrated expander cycle engine will be experimented as planned. Transient starting characteristic and steady-state performance will be obtained through several tests.