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TESTING OF A SMALL HTP MONOPROPELLANT THRUSTER FOR SPACE APPLICATIONS

Abstract

HTP monopropellant thruster is designed for nominal 10[N] thrust. The design is optimized for minimal weight and volume, high efficiency and short response time to meet the requirements of space propulsion technology. The structure is light-weight, assembled of only two components, realized by additive manufacturing of Inconel 718 alloy. Catalyst bed is a pack of platinum coated pellets. Several configurations are designed and tested for parametric investigation. Two nozzles are realized with different throat diameter; fire tests are performed with the same HTP mass flow and different throat diameter, thus different chamber pressure. Two injectors are designed and manufactured, one of four parallel jets equally distributed along injection interface, and the other with impinging jets. Cold flow tests are conducted to characterize injection patterns in terms of pressure drop, jet shape and atomization. Then both injectors are examined in hot firing tests. Experimental campaign includes four thruster's configurations, each tested in a wide range of working points with different chamber pressure and mass flow, with thrust varied from 3[N] to 30[N]. Operating duration is also varied in wide range, from continuous mode up to 100[sec] to short pulses down to 45[msec]. Uniform test matrix is used with all configurations to allow comparison of thruster performance in terms of in terms of efficiency and response time. Finally, a repeatability test is performed. In total, over 500 thruster ignitions are successfully done. During fire tests, pressure and temperature measurements are conducted inside the chamber, catalyst bed and HTP feeding line. HTP mass flow in the feeding line is directly measured by a Coriolis mass flow meter. Outer wall temperature is also measured at different locations, and used to validate a simplified numerical model suggested to predict heat conduction from the thruster to inlet valve. Fire tests results showed high C* efficiency, with an Isp reaching 169[sec] (adapted to vacuum conditions and assuming ε=100). For the same HTP mass flow Isp increases with chamber pressure. Response time mainly depends on initial temperature; for cold-start response time is in the range of 300-800[msec] till 70% of steady-state chamber pressure is reached, while for hot start it gets bellow 20[msec]. Injector with parallel jets showed slightly better performance compared to impinging jets, with the drawback of intense mechanical abrasion, as catalyst mass loss after firing sequence was higher.