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DEVELOPMENT OF A CHARGE EXCHANGE THRUSTER FOR NANOSATELLITE MISSIONS

Abstract

We will describe the development of a new type of electric propulsion device for nanosatellite missions, the Charge Exchange Thruster (CXT). Specifically, an electric propulsion system was presented, whereby an asymmetric hollow cathode is used to create a plasma discharge within the thruster, causing the ejection of a collimated plume of high velocity neutral atoms, thus producing thrust. The CXT has high promise for extreme fuel and power efficiency even at this early developmental stage, opening doors to many applications. The experimentations revealed that in general, the thrust produced varied linearly with the applied cathode voltage and the applied flow rate of the propellant through the thruster. It was found that for the direct-thrust experiments involving Hydrogen as the propellant, the CXT system was measured to produce a maximum thrust value of 18.51 μN at an applied power input of 2.65W. For the range of applied cathode voltages considered, the Argon experimentations revealed that a maximum thrust value of 93.89 μN at an applied power input of 2.61W. A comparison between thrust magnitudes estimated by optical spectroscopy and the direct thrust measurements were made for a range of applied cathode voltages at the same flow rate. It was concluded both methods of thrust determination were in agreement to within an order of magnitude (nearest power of 10) to each other. This consistency between the methods demonstrates the viability of the CXT system as new class of electric propulsion system. Comparisons between the CXT and current-generation electric propulsion systems were also undertaken. It was found that for generating a 100 μN of thrust, the CXT operates substantially at lower power levels between 0.5-7 W compared to both the Ionic and Hall-effect thruster which operate at 100 W-30 kW. The overall efficiency of the system was found to be between 70-85