SPACE PROPULSION SYMPOSIUM (C4)
Electric Propulsion (4)

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AN EXPERIMENTAL INVESTIGATION OF A 100-KW CLASS APPLIED FIELD MPD THRUSTER

Abstract

This paper presents experimental data from a recent research carried out at Alta addressing several issues of the performance and lifetime of a pulsed, quasi-steady, 100-kW class applied-field magnetoplasmadynamic (MPD) thruster. The thruster design is based on a central multi-channel hollow cathode (McHc) and a coaxial flared anode. Measurements were obtained with argon propellant for a variety of currents, mass flow rates and magnetic field strengths in a power range between 20 and 250 kW. Tests were carried out in Alta's IV10 vacuum facility. With a volume of about 200 m3, IV-10 allowed for a current-pulse duration up to 1s maintaining a back-pressure in the order of 10-4 mbar as well as for the minimization of the plume-wall interactions and the entrainment of back-pressure gases. Although the shot duration was still too short to achieve steady-state thermal conditions, it allowed for direct, time-resolved thruster measurements. To this purpose an advanced single-axis thrust stand was designed to improve the full scale and the frequency response of the existing thrust stands commonly employed for high power devices. A maximum thrust efficiency of about 30% was obtained at 200 kW for an applied magnetic field of 120 mT and a mass flow rate of 60 mg/s. At 100 kW, for the same mass flow rate and magnetic field, the thruster reached a thrust efficiency slightly higher than 20% and a specific impulse of about 2500s. From the technological point of view, the test campaign proved the reliability of the set-up in performing long quasi-steady firings. Moreover, the test highlighted the need for refractory-metal cathodes since thermal loads turned out to be the main critical issue within the operative envelope tested. Although the anode power deposition has been long identified as the main power dissipation mechanism in applied-field MPD thrusters, neither signs of anode erosion nor localized arc attachment were found. Finally, the results of a simple phenomenological model were compared with a wide number of experimental data. The theoretical predictions are in good agreement with the observations even though further experiments are needed in order to confirm the usefulness of the suggested model as a tool for the design of MPD thrusters.