Experimental Evaluation of a Krypton Propellant Arrangement in a T-100-3 Hall-Effect Thruster

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ABSTRACT

Stationary Hall thrusters are electric, moderate-specific impulse propulsion systems developed in Russia. These devices manipulate electric and magnetic fields to expel ionized gas (plasma) components, resulting in thrust. The success of Hall-effect engines in USSR satellite-transfer missions quickly sparked western interest in the design. Extensive government and academic study commenced shortly after the dissolution of the Soviet Union, when the technology was made available to the United States. The common SPT-100 model was the primary subject of such studies. Unfortunately, limited literature exists for rare and uncommon Hall thruster models. The T-100-3 stationary plasma thruster suffers from this gap; few xenon-propellant datasets are readily available. No exhaustive studies have been published with inexpensive and alternative krypton propellant. Our evaluation seeks to comprehensively record and analyze the performance parameters of a krypton-fed T-100-3 stationary plasma thruster. In particular, the discharge voltage, discharge current, erosion, temperature, thrust, efficiency, and specific impulse were investigated with thermocouples and force-calibrated inverse pendulums. Plume distributions and ion flux were additionally measured, using Langmuir probes and Faraday cups. These variables were analyzed over 2.5 approximate hours of run-time with a large range of flow, magnetic, and power operating conditions. Based on a -47% nominal flow state (25.0 sccm anode flow, 10.0 sccm cathode flow, 8.5 W magnetic field, 1.39 kW discharge supply), the T-100-3 achieved thrust values of 28.1 mN with a corresponding specific impulse of 1313.4 s. Our study suggests the feasibility of krypton in moderate-specific impulse satellite keeping missions.

KEYWORDS

Hall Thruster, Electric Propulsion, T-100-3, Plasma, Krypton, Xenon, Ion Flux, Plume, Thrust