

Thrust Stand Measurements of a Conical Inductive Pulsed Plasma Thruster

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Inductive Pulsed Plasma Thrusters are spacecraft propulsion devices in which electrical energy is capacitively stored and then discharged through an inductive coil. The thruster is electrodeless, with a time-varying current in the coil interacting with a plasma covering the face of the coil to induce a plasma current. Propellant is accelerated and expelled at a high exhaust velocity by the Lorentz body force arising from the interaction of the magnetic field and the induced plasma current.

While this class of thruster mitigates the life-limiting issues associated with electrode erosion, inductive pulsed plasma thrusters can suffer from both high pulse energy requirements imposed by the voltage demands of inductive propellant ionization, and low propellant utilization efficiencies.

A conical coil geometry may offer higher propellant utilization efficiency over that of a flat inductive coil, however an increase in propellant utilization may be met with a decrease in axial electromagnetic acceleration, and in turn, a decrease in the total axially-directed kinetic energy imparted to the propellant.

Impulse bits were calculated from thrust stand measurements of three preionized conical inductive pulsed plasma thrusters to determine how the initial charging voltage of the capacitor bank, propellant mass flow rate, and coil geometry affect thrust. A maximum in impulse bit was found with respect to coil geometry, and the mass flow rate for which the impulse bit is maximized was found to decrease with decreasing initial capacitor bank charging voltage.

Dependencies on these experimental parameters are discussed in the context of previous semi-empirical modeling of the effect of inductive coil geometry on thrust efficiency.

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