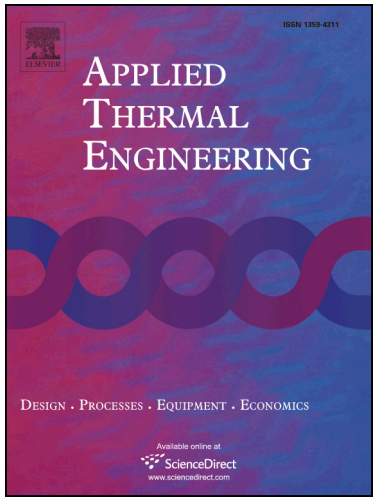

Analytical investigation of anode heat flux in a magnetoplasmadynamic thruster

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Analytical investigation of anode heat flux in a magnetoplasmadynamic thruster

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Abstract

An analytical approach has been developed to analyze the anode thermal process in a self-field MPD thruster. Effects of both non-neutral and quasi-neutral plasma regions near the anode surface have been included. The heat flux calculation, which requires the contributions of current density and voltage drop, has been determined by deriving the analytical correlations between these parameters. The solution process has been formulated based on an iterative method to satisfy the condition of current density continuity at the mentioned regions interface. The anode of Princeton benchmark thruster has been investigated for ratios of the squared discharge current to mass flow rate of 16, 36, and 64 $(\mathrm{kA})^2 \cdot \mathrm{s}/\mathrm{g}$. Generally, the calculated heat flux, current density, and voltage drop have shown a good agreement with the corresponding experimental data. Furthermore, the modeling has corroborated that the heat flux becomes maximum at the anode mid-plane where the total voltage drop is lowest. Also, it has been discussed that the second law of thermodynamics has obliged the current density to have a peak-shaped profile.

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