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ANALYSIS OF THE DESIGN AND MEASUREMENT PARAMETERS OF THE HALL THRUSTER

Abstract. This paper analyzes the design of the Hall thruster and determines the main measurable parameters affecting its efficiency. Key parameters such as thrust, power consumption, specific impulse, plasma distribution, thermal regimes, and operational stability of the thruster are considered. The obtained results can be used for further optimization of the thruster design and improvement of the energy efficiency of Hall thrusters.

Keywords: Hall thruster, thrust, specific impulse, magnetic field, measurable parameters, efficiency.

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АНАЛІЗ КОНСТРУКЦІЇ ТА ВИМІРЮВАННЯ ПАРАМЕТРІВ ХОЛЛОВСЬКОГО ДВИГУНА

Анотація. У цій роботі проведено аналіз конструкції холловського двигуна та визначено основні вимірювальні величини, що впливають на його ефективність. Розглянуто ключові параметри, такі як тяга, споживана потужність, питомий імпульс, розподіл плазми, температурні режими та стабільність роботи двигуна. Отримані результати можуть бути використані для подальшої оптимізації конструкції та підвищення енергетичної ефективності холловських двигунів.

Ключові слова: Холловський двигун, тяга, питомий імпульс, магнітне поле, вимірювальні величини, ефективність.

Hall thrusters are a promising type of electric propulsion system for spacecraft. They provide high efficiency in propellant utilization, long operational lifetime, and stable performance in extended space missions. A key advantage of these thrusters is the ability to precisely control the thrust vector, making them ideal for satellite orbit correction [1]. This study

presents a detailed analysis of the thruster's design and identifies the key measurement parameters required for performance evaluation in various operating modes.

1. Hall Thruster Design

— Main structural components anode, cathode, magnetic system, ionization chamber, power supply system, and support systems.
— Operating principle the interaction of ionized gas with a magnetic field generates thrust, ensuring ionization stability and reducing electrode erosion.
— Construction materials and their effect on efficiency the use of heat-resistant materials, minimizing erosion impact on working components, and selecting the optimal composition of the propellant.
— Interaction between the magnetic field and plasma analysis of magnetic field lines, identification of the zone of maximum ionization, and optimization strategies for the magnetic system [2].

2. Measurement Parameters

— Thrust (mN) measured using thrust stands to improve accuracy.
— Power consumption (W) determined by measuring the voltage and current at the anode and analyzing energy efficiency.
— Specific impulse (s) calculated as the ratio of thrust to propellant flow rate, which is a key parameter for evaluating thruster efficiency in long-duration missions.
— Plasma distribution analyzed using probe measurements, spectroscopy, and numerical modeling.
— Thermal regimes studied using thermocouples and heat flow simulations.
— Thruster operational stability assessed by analyzing changes in thrust characteristics and plasma parameter fluctuations during long-term testing [3].

3. Analysis of Experimental Data

— Analysis of thrust dependence on power supply parameters impact of voltage, current, and propellant type on thruster characteristics [2].
— Study of the influence of the magnetic field on thruster stability evaluation of magnetic field uniformity and its role in maintaining optimal plasma conditions [3].
— Comparison of experimental results with theoretical calculations validation of mathematical models against experimental data.
— Assessment of thruster lifespan impact on operational characteristics under different load conditions [1].

The conducted analysis provides deeper insight into the structural features of the thruster and identifies the key parameters affecting its efficiency. The obtained results can be used for further design optimization, improving energy efficiency, and enhancing the longevity of Hall thrusters. The research also confirms the importance of precise control over the magnetic field parameters and propellant properties to ensure stable thruster operation in extended space missions.

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