DOI: 10.34854/ICPAF.51.2024.1.1.149

REALIZATION OF A HELICON PLASMA SOURCE AND ION HEATING SYSTEM AS PART OF A POWERFUL ELECTRODE-LESS PLASMA ROCKET ENGINE ON THE E-1 DEVICE *)

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Currently, the National Research Center "Kurchatov Institute" is conducting plasma experiments on a prototype of an electrodeless plasma rocket engine (EPRE) [1, 2], which is the E-1 device.

The aim of this work is to consider the main blocks implemented on the E-1 device, as well as to obtain parametric dependencies of the outflowing plasma parameters, with subsequent optimization of these parameters.

The EPRE concept involves a combination of a high-power helicon plasma source (HPS) with subsequent ion cyclotron resonance heating (ICRH). Both of these systems imply the use of a magnetic field, which serves both to magnetic confinement of plasma and to create a directed plasma flow. At stand E-1, to create a magnetic field of the required configuration and amplitude, it is planned to use coils made of high-temperature superconductor (HTSC) of the second generation in combination with a dry cryostat.

The HPS consists of a high-frequency (HF) generator with a power of 50 kW, operating at a frequency of 13.56 MHz, a matching L-circuit and a half-wave left-handed antenna. This makes it possible to obtain cold superdense plasma in a source with an electron density $n_e > 10^{19}\ m^3$ [3].

The use of the ICRH system is the main mechanism for transmitting RF power to the propellant. This system is a 150 kW HF generator operating at a frequency of 0.5 MHz, a matching T-circuit and a half-wave right-handed antenna. To convert the energy of an electromagnetic wave into the gyromotion of a particle, the following condition needs to be satisfied: $\omega_{ci} \approx \omega_0$, where ω_{ci} is the cyclotron gyro-frequency of the ions, and ω_0 is the operating frequency of the generator.

To explore the output parameters of the EPRE, a diagnostic complex is used, which includes corpuscular diagnostics and microwave interferometry.

The work presents a description of the main blocks of E-1 device, and the results of processing and analysis of data obtained using the diagnostic complex. As a result of this work, a search was carried out for optimal parameters for the creation and subsequent heating of plasma.

References

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*) abstracts of this report in Russian