DEVELOPMENT AND EXPERIMENTAL TESTING OF THE NEW RETARDING POTENTIAL ANALYZER FOR THE ELECTRIC PROPULSION PLUME DIAGNOSIS PACKAGE [[1]](#footnote-1)\*)

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The paper presents the results of the development and experimental testing of a new retarding potential analyzer (RPA) capable of measuring the energy spectrum of ions in the plasma plume of the electric propulsion rocket engines in an extended operating range of plasma parameters. The paper also considers the possibility of using the new probe as a part of the electric propulsion plasma diagnostics system both for measuring the ion energy distribution and the ion current density. The study of the plume makes it possible not only to diagnose the operation of spacecraft engines, but also to predict the plasma influence on the onboard devices of satellites located in the vicinity of the engine.

Existing probes for measuring the energy spectrum of ions in plasma use three or four grids and a current collector. The first grid is grounded and does not allow the internal grids to disturb the plasma outside the probe, preventing distortion of the results. A negative potential is applied to the second grid to repel electrons. The third grid, called the analyzing grid, is kept under a positive potential and forms a potential barrier for ions. This grid passes only ions with sufficient energy to overcome the potential barrier, which then reach the collector. The dependence of the collector current on the potential of the third grid allows to obtain the ion energy distribution function.

The effective transparency of the probe for ions, defined as the ratio of the collector current, at zero potential of the analyzing grid, to the ion current at the entrance to the probe, varies depending on the plasma density, which makes it difficult to interpret the results and can lead to an uncontrolled change in the systematic measurement error. Therefore, to diagnose the plume at all angles to the axis of the engine, it is either needed to use a probe with a variable geometry, or to use several probes, which is quite difficult and inconvenient.

The probe presented in this report solves this problem and, according to the simulation, allows measuring the ion energy spectrum with an error of less than 1%, both on the axis of the plasma plume with the highest current density, and on the periphery, where the current density is several orders of magnitude lower. The new probe uses an ion-optical system to focus the ion beam and to repel electrons. Ion filtration occurs directly on the collector, which is supplied with a changeable positive potential. Ions with insufficient energy do not reach the current collector.

The report presents the results of numerical simulation of the probe operation. The influence of the deviation of the aperture location from the coaxial and non-zero inclination of the ion incidence relative to the probe axis on the measurement error is investigated. The features of the probe design and the method of measuring currents on a collector under a high positive potential are presented. The report also shows the results of experimental testing of the new probe and compares the operation of the new probe and the probe of a standard, multigrid design. The conclusion is made about the possibility of using a new probe instead of a multigrid probe and a Faraday probe as a part of the electric propulsion plume diagnostic system.

References

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