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PROBE CALORIMETER FOR ESTIMATING THE PARAMETERS OF THE OUTFLOWING PLASMA FLOW IN AN ELECTRODELESS PLASMA ROCKET ENGINE *)

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An electrodeless plasma rocket engine (EPRE) is a type of electric rocket engine, one of the distinctive features of which is its high power density, which in the future will allow its use for interplanetary flights. Fundamentally, the EPRE consists of three blocks. In the first (helikon plasma source), a cold plasma flow is created by means of absorption of the input RF power by the working body. In the second block, the created plasma flow enters the heating zone at ion-cyclotron resonance, where additional RF energy is invested in the cyclotron movement of ions. The third block is a magnetic nozzle, which is formed naturally at the end of the magnetic system. It is in it, under conditions of a decreasing magnetic field, that the rotational energy of the ions is converted into the energy of their longitudinal motion, which gives us the main contribution to the speed of the outflowing flow and the thrust of the engine. The task is to study the plasma flow flowing out of the BPRD. In this work, it is proposed to use a calorimeter/probe to estimate its parameters.

A calorimeter to "capture" the entire plasma flow, and therefore all its energy, must be an ideal black body, into which particles of the plasma flow, undergoing multiple collisions with the walls, transfer to it all their thermal energy, by measuring which we obtain the power transferred by the plasma flow. By applying a large negative potential relative to ground to the calorimeter body and measuring the current flowing through it, we obtain the total ion current of the plasma flow. Dividing one by the other, we get the average ion energy.

A calorimeter of the following design was designed and manufactured: it is a copper cylinder, the radius of which is slightly larger than the radius of the plasma cord at the measurement site, the bottom of the calorimeter is made in the form of a cone, with its apex facing inward. This shape serves to ensure that a particle entering the calorimeter hits its walls at least twice and gives up most of its energy to it. Thus, the energy of the heat flow is converted into thermal energy of the calorimeter, the change of which we record. This design also ensures sufficient pumping of the flow "dead" on the walls from the calorimeter.

By connecting the calorimeter according to the single Langmuir probe circuit, it can be used to measure the total ion current of the plasma. Given the high values of the measured currents, the use of a powerful power source and a special measuring circuit is required. In our case, the measuring circuit was implemented based on the ACS715 sensor.

The calorimeter/probe can also be used to calibrate other plasma diagnostics. In this work, we used it to calibrate a moving double Langmuir probe.

*) abstracts of this report in Russian