Stationary plasma thruster for small space satellites.

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Creation of reliable and effective little power (160 W) plasma thrusters recently become a vital problem [1]. Such thrusters can be used for maneuvering and correction of the orbit of small space satellites that weigh is not more than 200 kg.

It is known [2] that the less the overall dimensions of the SPT are, the less consumed power is, but its efficiency also goes down. This paper is devoted to the creation of the small power SPT and the experimental studying of its integral parameters. A special attention was paid to the long-term work of the thruster, with lifetime more than 2000 hours.

The calculations showed that if the consumed power of the SPT is equals 150 V, the necessary mass flow of Xenon through anode is approximately 0.8 mg/s, and discharge voltage is in range (170– 200)V. Determination of radial dimensions of the model is based on the Melikov-Morozov criterion which is described in [3]. On the base on the calculation and modeling of the magnetic field SPT α-37 was constructed, it belongs to the new SPT generation of class α [3]. Dimensions of the thruster are diameter d=66 mm, length l=76mm. The distance between the magnetic circuit poles was chosen in such a way that the magnetic field lines in the channel were symmetrical. Optimal channel gap was determined experimentally. The inner diameter of the outer model channel is 37 mm.

The experiments on the measuring of the integral parameters were held on the vacuum chamber, equipped with the diffusion pumps with total pumping speed of 28000 l/s for the air. The static pressure was $6*10^{-6}$ Torr, the dynamic pressure was $1*10^{-4}$ Torr. The integral parameters of the designed model of the thruster were measured for three mass flow rates $\dot{m}_a$ = 0,8mg/s ; 0,9 mg/s and 1,0 mg/s in the range of the discharge voltage U=(130-200)V. The model thrust was in the interval of F=(7-12) mN, and the specific impulse P=(800-1200) s. Anode efficiency of the SPT α-37 was (34-36)%.

Dependences of discharge current, thrust, specific impulse, efficiency on discharge voltage and input power one can see on pictures. Also there are dependences of efficiency on channel gap. Due to experiment results the best operation mode is U= 170 V, $\dot{m}_a$ = 1.0 mg/s, F= 11 mN, P= 1125 s with efficiency 36.17%.

To ensure thermal stability temperature of magnetic coils was measured. Stable temperature of internal coil was 266°C, and temperature of external coil was 400 °C.

To estimate thruster lifetime radial erosion rate of dielectric channel walls was measured after 50 hours work on the best operation mode. Average radial erosion rate for internal wall was 3 mkm/h, and for external wall was 2.25 mkm/h. Using this data it is possible to calculate lifetime of SPT α-37. It appears to be not less than 2500 hours.

References.

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