COMPARATIVE CHARACTERISTICS OF A HIGH-FREQUENCY ION SOURCE OPERATING ON INERT GASES AND IN AIR [[1]](#footnote-1)\*)

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High-frequency ion sources (RF IS) are widely used in ground-based and space technologies [1]. On the ground, RF IS are used in cleaning and surface modification of materials, in processes of ion stimulation in the deposition of thin films. In space, RF IS are used to create thrust, which makes it possible to control the orientation of spacecraft (SC), to compensate for the loss of their speed due to friction, and to change the height of the orbit. Until recently, xenon was the main working gas of IS or, more precisely, electric propulsion (EJE) engines.

In recent years, the organization of spacecraft flights in low Earth orbits (LEO) (180–200 km) has become relevant, opening up prospects for the development of telecommunications, transport operations and a wide range of scientific research [2]. The main problem of flights to LEO is the high resistance of the residual atmosphere, leading to a rapid loss of spacecraft altitude. A way out of the situation is to equip the spacecraft with an EJE capable of compensating for the speed loss. However, calculations show that the fuel reserves required for long-term operation of the spacecraft at altitudes of 180–200 km are unjustifiably large. In this regard, the world is intensively working on the creation of devices for the intake of atmospheric gases (UZAG), coupled with an electric propulsion engine. The flow of gases entering the EJE from the UZAG must ensure the creation of the thrust necessary to compensate for the resistance of the residual atmosphere. In this regard, there is a need to develop efficient RF IS operating on molecular nitrogen and oxygen, as well as on atomic oxygen, which prevail in the Earth's atmosphere at a distance of 180–200 km from the Earth, or their mixture with inert gases.

In this work, the task was set to study the possibilities of optimizing RF IS when operating on xenon, argon, air, and their mixtures. An inductive source of ions with a diameter of 5 cm is used as a model of RF IS. The source consists of a quartz gas-discharge chamber (GDC) and an ion-optical system (IOS) formed by three perforated electrodes. In the upper part of the GDC there is a gas inlet through which the working gas enters the GDC. A solenoidal antenna is located on the outer side surface of the GDK. The antenna was connected to the RF generator through a matching system. The power of the RF generator could be varied in the range 0 – 1000 W, the frequency of the generator was 13.56 MHz. An external magnetic field was applied to the inductive RF discharge, the value of which was selected from the condition of the maximum ion current.

Preliminary measurements showed that replacing xenon with argon and air significantly decreases the fraction of the RF generator power absorbed by the plasma (from 0.8 to 0.47). This is accompanied by a decrease in the value of the ion current obtained at a given power of the RF generator and an increase in the "energy price" of the ion. Nevertheless, the results show that atmospheric gases can be used as a working medium for a spacecraft engine. The experimental results are compared with the calculations. The first calculations of the motion of molecules inside the UZAG have been carried out.

References

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