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# SPACECRAFT WITH AIR-BREATHING ELECTRIC PROPULSION AS THE FUTURE ULTRA-SPEED AIRCRAFT

**Abstract**

Recently, there has been a tendency of lowering the orbits of spacecraft designed to solve problems of remote sensing and communication (for example, Starlink, OneWeb, etc.), which allows to reduce requirements for the size and power of equipment, and, therefore, the spacecraft mass. At the same time, with a decrease in orbit height, there is a need for a propulsion system to compensate the aerodynamic drag, and unconventional additional requirements are imposed on the spacecraft layout. For example, the GOCE, which performed a long-time flight at altitudes of 230-280 km, had an elongated shape with solar panels "stretched" along the spacecraft body.

Compared with engines that use the propellant supply aboard, for the long-term maintenance of spacecraft in ultra-low orbits with a perigee of about 200 km, air-breathing electric propulsion (ABEP) using outboard atmospheric gases as a propellant can be more effective.

For spacecraft with ABEP, the atmosphere, in addition to the source of drag, is also a condition for creating the thrust. In this sense, the motion laws of spacecraft with ABEP are closer to those typical to aircraft. The development of such spacecraft concept requires taking into account the mutual influence of the characteristics of the propulsion system, aerodynamic layout and flight trajectory, the spacecraft's motion around the mass center under the action of large torques, etc. The minimization of the consumed electric power takes on significant importance, since an increase in the area of solar arrays leads to a rise of the aerodynamic drag, which is comparable to the thrust.

In this work, the results of a system analysis of the requirements for the parameters of spacecraft layout and ABEP characteristics are presented taking into account the significant variations in the density and composition of atmosphere and orbit parameters. The conditions of the spacecraft's long-term existence in ultra-low orbits in space of generalized parameters are found, integrating such characteristics as the specific power of solar arrays, total thruster efficiency, etc.

It is shown that the optimal spacecraft layout is close to aircraft one with a large elongation body and a small transverse size of solar arrays. The key characteristics of the ABEP, which determine the possibility of the future spacecraft missions using ABEP, are noted.