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OPTIMIZATION OF THE ACCUMULATOR TANK FILLING MODES OF THE XENON FEED SYSTEM FOR ELECTRIC PROPULSION SYSTEM

The xenon feed system (XFS) is crucial part of the electric propulsion system. It ensures accurate supply of the required amount of working substance to the anode and cathode units of the thruster. The accuracy, stability, and reliability of the XFS are essential for maintaining optimal thruster operating modes and overall electric propulsion system.

A key aspect of the XFS is its ability to maintain the mass flow rate of the working substance with high precision, typically within ±5% [1; 5; 10]. The accuracy of maintaining the mass flow rate depends on the accuracy of upholding the pressure in the XFS. For this purpose, an accumulator tank is usually used to reduce the pressure from a high level (12.5 MPa) to the operating level (0.1-0.2 MPa) and stabilise it.

The analysis of literature sources showed that the problem of accurate maintenance of the mass flow rate of the working substance when using small-volume accumulator tanks is typical and has not been solved yet. The methods of ensuring the necessary mass flow rate of the working substance specified in the particular works (such as increasing the volume of the accumulator tank, implementing two-stage pressure regulation, installing of a flow regulators or a thermothrottle after the accumulator tank, and using of the "bang-bang" mode as a method of filling the accumulator tank)do not solve all the requirements put forward by the spacecraft to the XFS mass, dimensions, power consumption, service life, reliability, and price. All this makes it possible to assert that it is ongoing research to improvement of the accumulator tank filling method in order to upgrade the performance of XFS while reducing the volume of the accumulator tank.

The aim of this research is to refine the filling modes for accumulator tanks while minimizing the size of the XFS and reducing the frequency of solenoid valve activations. To achieve this objective, the following tasks were achieved:

1. Following theoretical and experimental investigations of the XFS of the electric propulsion system SPS-25, it was established that decreasing the volume of the accumulator tank results in pressure spikes that exceeding the acceptable range of ±3% of the nominal value. Research spanning inlet pressure from 2 to 7 MPa

facilitated the correlation identification between pressure spikes in the accumulator tank and the inlet pressure. Utilizing this data, enhancements were implemented to the accumulator tank filling method to maintain the required pressure within the system, despite a reduced accumulator tank volume, ensuring stable operation of the electric propulsion system.

2. The precision of maintaining pressure in the accumulator tank of XFS SPS-25 was validated through laboratory experiments and telemetry data obtained during spacecraft operation in orbit, confirming the effectiveness of the enhanced accumulator tank filling method. According to the study results, the pressure maintenance accuracy of the compact accumulator tank (0.45 L) remained within ±3% over the entire inlet pressure range from 2 to 12.5 MPa. At maximum inlet pressure, the improved filling method resulted in a fourfold increase in pressure maintenance accuracy within the accumulator tank compared to the method based on feedback from the pressure sensors.

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BIOPOLYMER NANOCOMPOSITES FOR THERMAL SHIELDS OF METEOROLOGICAL ROCKETS

As the density of the atmospheric layers increases consistently during entry, the nosecone is exposed to ever-increasing drag forces. The effect of these drag forces during supersonic entry leads to shock wave formation. These shock waves further lead to a phenomenon called aerodynamic heating and hence, the development of an elevated temperature profile over the surface of the nosecone stage. Whilst the exact temperature that can potentially develop is dependent on the tumbling motion of the nosecone, if no change in orientation is achieved for timescales below a hundred seconds, temperatures between 100 and 500 °C are to be expected. Whilst these temperatures can be sustained by the aramid lines of the drogue parachute, they cannot be sustained by the nylon lines of the main parachutes and hence, the heat shield that protects the outer surface of the recovery module before drogue deployment becomes a requirement [1].

Biopolymers are polymers obtained from certain living organisms, making them biocompatible and having various functional groups that allow controlling the interface with nanofillers. They are used in many fields due to their flexibility in processing conditions and competitive cost of final products. This work proposes the use of composites based on biopolymers with inorganic nanofillers such as metal, metal oxides, semiconductor nanoparticles, and carbon-based nanoparticles for application in creating thermal shields for meteorological rockets [1].

Unlike conventional polymer composites, the thermal and mechanical properties of nanoscale fillers, combined with other characteristics, have led to the development of macro-scale materials with highly desirable properties. By using the technique of affine deformation to obtain nanocomposite films from suspension, a composite can be obtained that will have resistance to transport phenomena, such as diffusion. This,