

IMPROVEMENT OF XENON HEATING METHODS TO PREVENT THE LIQUID PHASE OF THE WORKING SUBSTANCE FROM ENTERING THE FEED SYSTEM

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Among the various types of electric propulsion, the Hall thruster type is becoming the most common. This is due to the fact that the use of a Hall thruster makes it possible to obtain high values of the thruster characteristics with a simple design compared to other types of space propulsion systems. For Hall electric propulsion thrusters, the main working substance is xenon because of its fairly high atomic weight, low ionization energy, and unreactiveness, which makes it possible to obtain high thruster characteristics with ease of operation. The use of xenon as a working substance features a peculiarity involving its critical temperature (289.74 K), which gives rise to the liquid phase in the tank and, accordingly, pressure jumps, thus making it impossible to use the xenon feed system. To exclude the ingress of the liquid phase of xenon into the accumulator tank in electric propulsion systems, heaters are placed on the xenon tank to maintain its temperature within a given range. However, this approach has the following disadvantages: the low thermal conductivity of composite tanks impairs heater-to-xenon heat transfer; warming up the whole of the tank before starting the thruster increases the thruster start-up preparation time; the continuous maintenance of the tank temperature increases energy consumption by the propulsion system; and it is impractical to maintain the temperature of the whole of the xenon, while only a few grams of it are consumed for one thruster start-up. The problem that was solved in this work consists in changing the approach to heating the working substance that enters the feed system. The analysis of literary sources showed that this problem is relevant and offers ways to improve existing methods. To solve this problem, theoretical calculations were carried out and verified by experiment. As a result, a method was proposed to calculate the gasifier so that it may maintain the temperature of the working substance entering the accumulator tank within the range from 293 K to 298 K, thus eliminating the possible ingress of the liquid phase of xenon into the accumulator tank of the feed system. This study allows one to use the proposed structural element (gasifier) instead of tank heaters, which significantly reduces power consumption and maintains the stable operation of the working substance feed system. The conclusions drawn from the study may be useful to most developers of storage and feed systems for electric propulsion systems.

Keywords: working substance storage system, electric propulsion system, xenon, gasifier calculation method.

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