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The experimental study of the spraying ability of porous rings

The results of an experimental study of the spraying ability of porous rings as part of a centrifugal pump are presented. The influence of the characteristics of a porous body on the dispersity of the liquid sprayed by it is shown.

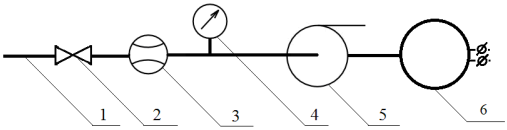
Introduction

The use and research conducted in the field of advanced fuels are an important scientific and technical problem in the field of aviation and rocket and space technology. In this regard, the systems for supplying and mixing fuel components in the combustion chamber are also being improved. One of the promising areas of engine building is the improvement of the design and workflow in hybrid rocket engines, in particular, direct hybrid engines. Experience in the development of propulsion systems based on hybrid engines of direct and reverse circuits shows the possibility of using a system for supplying a liquid fuel component to the combustion chamber, which is directly located in its internal cavity. This circumstance provides the possibility of smooth throttling of the engine chamber with the possibility of changing its depth. The layout of the combustion chamber with an internal location in the combustion chamber of the supply units makes it possible to abandon the mechanical regulation of the injectors, to ensure a reduction in the mass of the engine due to the rejection of the injector head, and also makes it possible to rationally use fuel to increase the range of use of the device. The use of porous ring structures in the design of liquid-supplying units makes it possible to qualitatively improve the processes of mixture formation and liquid spraying, as well as to improve the processes of fuel combustion. The limited number of publications and studies on this topic, as well as the prospects and expansion of the field of application of hybrid rocket engines determine the relevance of research in this area of engine design.

The purpose of the study was to experimentally determine the spraying capacity of rotating porous rings.

The experimental equipment, and practical value

Experimental studies were carried out on the created installation, the hydraulic scheme of which is shown in fig. 1.



1 - hydraulic line, 2 - valve,
3 - flow meter, 4 - pressure gauge,
5 - porous atomizer, 6 - electric motor
Fig. 1. Hydraulic scheme of the experimental equipment

The impeller was used of a closed type and had a wire mesh winding in the internal cavity in accordance with the data presented in table 1.

Table 1.

Parameters of porous rings

inlet diameter of porous rings, m	peripheral diameter, m	rotation frequency, 1/s	peripheral height of porous ring, m	dimensions of the grid of mesh rings, mm
0,068	0,104	710	0,007	0,75 x 0,75
0,068	0,104		0,007	0,5 x 0,5
0,068	0,104		0,007	0,3 x 0,3

The liquid was supplied through the hydraulic line 1, in which the valve 2, the flow meter 3, and the pressure gauge 4 were installed. The pump 5 housing had cylindrical shape with a tangential liquid outlet pipe. In addition, a window was made in the stern of the pump for sampling the sprayed liquid, which had dimensions of 0,02 x 0,07 m. Samples of the atomized liquid were obtained after reaching the required rotor speed, which was controlled by a sensor connected to a frequency meter. In the experiment, the diameters of the sprayed liquid droplets and their distribution per unit area were determined.

To achieve this purpose, a device was used, the principle of which corresponded to the operation of the camera shutter. The receiving platform had dimensions of 0,04 x 0,02 m, covered with white paint, after which a layer of soot was applied to its surface. The shutter frame window is 0,03 x 0,04 m. The exposure time was 0,33 s. The actual droplet diameter distribution was determined using a vertical metallographic microscope. After the experiment, the impeller with a porous body was replaced in accordance with the data in table 1, and the experiment was repeated. The results of the experimental studies carried out are shown in Figs. 3.

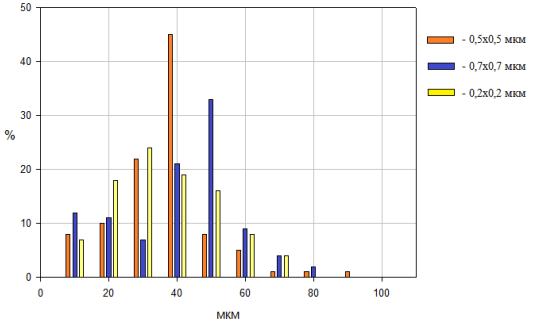


Fig. 3. Dispersion of water particles for a rotational speed of 314 1/s at different cell sizes of the porous body

Conclusions

In accordance with the purpose and the results obtained, the following conclusions can be drawn:

- the spraying ability of the porous body makes it possible to use mixture formation systems based on rotating porous bodies;
- the dispersion of drops at the level of 20 - 50 microns, which was obtained in the experiment, is commensurate with the atomization of liquid by centrifugal orifice;
- the advantage of mixture formation with the help of rotating porous structures is the possibility of throttling the engine.

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