S. S. VASYLIV[1], S. G. BONDARENKO[2], L. V. MUZYKA[1]

STUDY OF A PASTE-PROPELLANT ENGINE ROCKET ENGINE START-UP

[1]*Institute of Technical Mechanics*
of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine
15 Leshko-Popel St., Dnipro 49005, Ukraine; e-mail: gl_konstruktor@ukr.net
[2]*Oles Honchar Dnipro National University*
72 Nauky Ave., Dnipro, Ukraine

Paste-propellant rocket engines combine the advantages of liquid and solid propellants, so their use may improve the engine performance characteristics and expand the application fields of rocket hardware. However, they are still at the stage of experimental prototype development. Many technical and technological problems arise on the way of prototyping an engine of this type. Designing a paste-propellant engine involves determining the paste flow rate that provides a given design pressure in the chamber during combustion. Experiments are not always a success. Nevertheless, they give information on the behavior of the system in extreme conditions, thus increasing the value of the data. The goal of this work is to study the start-up of a paste-propellant engine and identify an additional condition for its operability.

The paper analyzes the results of firing tests of a model paste-propellant rocket engine and puts forward two hypotheses on the possible behavior of its start-up. It is shown that when the paste flows through the branched area of the feed duct, the density of its components may vary in an unwanted manner. This may decrease the critical diameter of the detonating charge down to values provided in the model engine, which might be responsible for the observed failure. Besides, there are other reasons for a similar behavior of the propulsion system. To draw general conclusions from the observed failure of the engine, the engine start-up process was simulated for the two hypothetical cases to get the time dependence of the pressure during start-up. The results confirm the hypothesis that a detonation process occurred in the above-described experiment. Based on the results of this study, one more condition is formulated for the design of a paste-propellant rocket engine to be correct. The presented technique allows one to supplement the calculation so as to design a paste-propellant engine with account for its features.

Keywords: rocket engine, paste fuel, die hole, detonation, engine start-up process.

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