Numeric simulation of internal ballistics processes in rocket propulsion systems on cryogenic solid propellant

© A.V. Voronetsky, S.A. Suchkov, L.A. Filimonov

Bauman Moscow State Technical University, Moscow, 105005, Russia

The article presents the results of numeric simulation of operating process in rocket engine of new type on cryogenic solid propellant (CSP) which contains both oxidizer and fuel at temperature lower than its melting temperature. Mathematical at model of operating process is based on non-stationary axisymmetric Navier — Stokes complete equation system for gas (including k-ε turbulence model) and heat and mass transfer equations for CSP. Calculations are made for CSP oxygen + hydrogen and oxygen + methane. Disk-stack and sponge arrangements of CSP structure for channel propellant grain are considered and influence of propellant structure dimensions on operating process is analyzed. , The article conclusdes that stable combustion of CSP oxygen + hydrogen is impossible under given condition, but CSP oxygen + methane allows to ensure stable operating process in combustion chamber and to control regression rate of the GSP components by specifying the propellant internal structure. Additionally, the article presents main features of operating process in a novel kind of hybrid rocket engine on cryogenic propellant, where component in liquid phase state and the other component are solid.

Keywords: *numeric simulation, operating process, rocket propulsion systems, cryogenic solid propellant.*

Voronetsky A.V. (b. 1946) graduated from Bauman Moscow Higher Technical School in 1970. Dr. Sci. (Eng.), Professor, Honored Scientist of the Russian Federation, Head of the Department of the Scientific Research Institute for Power Engineering at Bauman Moscow State Technical University. Author of more than 100 scientific papers in the field of heat and mass transfer in two-phase flow and conversion applications of rocket thrusters. e-mail: voron@mx.bmstu.ru

Suchkov S.A. (b. 1967) graduated from Bauman Moscow State Technical University in 1990. Senior Researcher of the Scientific Research Institute for Power Engineering at Bauman Moscow State Technical University. Author of more than 20 scientific publications in the field of mathematical modeling of heat and mass transfer in multi-phase flows. e-mail: ss@el.bmstu.ru

Filimonov L.A. (b. 1962) graduated from Bauman Moscow Higher Technical School in 1987. Researcher of the Scientific Research Institute for Power Engineering at Bauman Moscow State Technical University. Author of more than 20 scientific publications in the field of mathematical modeling of heat and mass transfer in multi-phase flows. e-mail: voron@mx.bmstu.ru