THREE-DIMENSIONAL NUMERICAL SIMULATION OF OPERATION PROCESS AND THRUST PERFORMANCE OF BENCH ROCKET ENGINE WITH CONTINUOUS DETONATION COMBUSTION OF NATURAL GAS – OXYGEN MIXTURE

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Abstract: Prediction opportunities of the computing technology developed at N. N. Semenov Institute of Chemical Physics and designed for full-scale simulation of the operation process in continuous-detonation combustors have been verified based on the results of firing tests with a sample continuous-detonation liquid rocket engine (LRE) burning a mixture of natural gas with oxygen. Comparison of calculation results with measurements showed that the calculation accurately predicts the number of detonation waves circulating in the tangential direction of the annular LRE combustor of a given design (four, three, or one wave), and accurately predicts the chaotic near-limit mode resembling the mode with a detonation pulsating in the longitudinal direction. Calculations predicted the detonation frequency with reasonable accuracy, i. e., the values of predicted detonation velocities were close to the measured values. In addition, calculations correctly predicted trends in variation of flow parameters with decreasing the mass flow rate of fuel mixture in the LRE of a given design: as in the experiment, the number of detonation waves, detonation speed, and thrust decreased. As in the experiment, installation of the external nozzle to the LRE increased the thrust. As for the thrust values, they are systematically overestimated by at least 27% compared with measurements, even for the conditions of LRE cold purging.

Keywords: continuous-detonation combustor; liquid rocket engine; natural gas; oxygen; three-dimensional calculation; thrust

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