Paper ID: 20028
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SPACE PROPULSION SYMPOSIUM (C4)
Hypersonic and Combined Cycle Propulsion (9)

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CALCULATION OF AERODYNAMIC CHARACTERISTICS OF SAME MODEL SWIVEL NOZZLES WITH MATHEMATICAL MODELING OF REAL GAS EFFECTS

Abstract

At present the development testing of mathematical models enabling to consider the real flight effects is an urgent problem for future aviation and rocket and space technology items development while their physical modeling at the ground test rigs to the full extent is infeasible. The given paper focuses on the of high-level model maturation enabling to determine the swivel nozzle aerodynamic characteristics of rocket and space technology items with due consideration of the physical/chemical transformations in the neighborhood of the engine nozzle. The problem of mathematical reproduction of single-swivel nozzle rocket launcher model flow was numerically solved on a computer in the context of the full Navier-Stokes equations system complemented with vector equations for eleven-component air and four-component flow in the engine jet. To obtain the desired closing conditions at the engine nozzle exit section the four-component flow through the nozzle passage was calculated in the dimensional formulation according to with nonequilibrium chemical kinetics modeling. The swivel nozzle aerodynamic characteristics, first of all its hinge moment were determined numerically for hot and cold jet discharge cases with/without consideration of chemical kinetics. The acquired quantitative estimates are shown as increments and may be used for extending the tunnel test results to the full-scale conditions. The obtained data authenticity has been proved by comparison of the tunnel test results versus theoretical study data.