NUMERICAL SIMULATION OF THE DESIGN AND PERFORMANCE OF A RAMJET WITH CONTINUOUS-DETONATION COMBUSTOR

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Abstract: The possibility of organizing a continuous-detonation operation process in a scramjet propulsion system with annular combustor in flight conditions with Mach 5.0 at an altitude of 20 km using hydrogen as fuel and air as the oxidant has been proved based on multiparametric three-dimensional numerical calculations. The conceptual scheme of the power plant with an axisymmetric supersonic inlet, expanding annular combustor, and an outlet nozzle with a truncated conical central body has been suggested. Calculations of internal and external flows taking into account finite rates of turbulent and molecular mixing of the components with each other and with the combustion products, as well as the finite rates of chemical reactions and viscous interaction of the flow with the bounding surfaces have shown that in these flight conditions, the power plant could exhibit the following characteristics: 16.7 kN thrust, specific thrust of 0.75 kN·s/kg, specific impulse of 2660 s, and specific fuel consumption of $\sim$ 0.14 kg/(N/h). In the combustion chamber, the operation process with one or two detonation waves traveling in the annular space at an average velocity of 1400 m/s can be realized. It is shown that the flow in the combustor can be locally subsonic but at its downstream end, it is essentially supersonic everywhere.

Keywords: scramjet engine; continuous-detonation combustion chamber; hydrogen; air; three-dimensional calculation; thrust; specific impulse

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