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AEROTHERMODYNAMICS OF ROUND LEADING EDGE AIRFOIL WITH A FLOW-THROUGH DUCT AT HYPERSONIC SPEED

Abstract

The human dream of commercial hypersonic flight remains unfulfilled as of now. The problems of aerodynamics heating must be resolved to ensure safety of passengers with reduced drag for commercial feasibility of such flights. The aerothermodynamics of a conceptual blunt symmetric airfoil with a circular flow through duct is investigated numerically with a commercially available Navier-Stokes Solver. The constant area circular duct is so designed that the flow enters into the airfoil on the lower surface near the leading edge and comes out of the airfoil at a point on the lower surface near the trailing, following a circular path. The travelling of air in a circular path increases the circulation about the airfoil and escape of high pressure air through the airfoil also decreases the pressure drag of the body resulting in high lift-to-drag ratio for the airfoil. The diameter of the flow-through duct housed inside an airfoil of 10 cm chord is varied from 1 mm to 20 mm. Transient two dimensional solutions are obtained at a velocity of 3 km/s and freestream conditions prevailing at an altitude of 50 km representing a moderately lifting trajectory point. In this work, air has been treated as weakly ionized chemically reacting mixture of seven species viz. O, N, NO, O2, N2, NO+ and e- with 24 elementary reactions. This paper presents the effect of duct diameter on the total heat transfer rates, peak heat fluxes, aerodynamic drag and moment at various angles of attack from 0o to 75o. The results of this research, if implemented practically, can provide a fruitful solution to commercial hypersonic transport problem.