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EFFECT OF ECCENTRICITY ON THE HEAT TRANSFER RATES OF A RE ENTRY VEHICLE WITH CONCAVE WINDWARD SURFACE

Abstract

One of the most important criteria in a successful space program is the concept of having a reusable spacecraft that can successfully survive numerous reentry conditions. The reentry of most of reusable space shuttles resembles a flat plate at high angles of attack because of its flat windward surface. The feasibility of a concave ventral surface in space shuttles is investigated computationally with a commercially available computational fluid dynamics solver Ansys fluent 13.0. A full three dimensional Navier stokes equations are solved over a thin concave plate at different angles of attack to a hypersonic flow and the total heat transfer rates, stagnation heat fluxes and drag coefficients are compared with that of a thin flat plate normal to the flow. The length, breadth and thickness of the flat plate are 1m, 1m and 10 cm respectively. The flat plate is bent along its longitudinal axis to obtain concave surface with different eccentricities varying from 1 to 10. The free stream conditions used in the simulation are that of earth's atmosphere at an altitude of 60 km and Mach number 20. The air is assumed to be composed of real gases in chemical non equilibrium and the laminar finite rate chemistry is simulated using 5 species 17 reaction model. The flow is assumed to be continuum. The angle of attack is varied from 75 degrees to 90 degrees while sideslip angle and roll angles are fixed at zero degree. The peak heat fluxes and total heat transfer rates for concave plate is compared with that of flat plate with no concavity. This paper discusses the results of these simulations and how these results can be utilized for a more successful shuttle type spacecraft in the future.