MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Environmental Effects and Spacecraft Protection (6)

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AEROTHERMODYNAMICS OF A REENTRY VEHICLE NOSE WITH A FORWARD FACING CONICAL CAVITY

Abstract

Aerodynamic heating is one the major design criteria for most trans-atmospheric hypersonic vehicles. With objective aerodynamic heat reduction, the paper investigates the effect introducing a forward facing conical cavity with rounded apex at the nose of a generic reentry vehicle on the total heat transfer rates and the peak surface heat fluxes of the vehicle. The reentry module chosen for the investigation is a blunt sphere cone with a total length of 0.4 m, semi aperture cone angle of 4.6 degree and nose radius of 0.035 m while the depth of cavity to base radius of the conical cavities is either 3 or 4. Transient numerical solutions of the two-dimensional axisymmetric Navier-Stokes equations are obtained using a commercially available CFD code for different cavity configurations at a freestream Mach number, pressure and temperature of 20.2, 32.78 N/m2 and 255.27 K respectively. In this work, air is regarded a chemically reacting mixture of O, N, NO, O2, N2, NO+ and e— in thermo-chemical nonequilibrium. The paper presents the reductions in total heat transfer rates and peak surface heat fluxes obtained for various configurations as compared with base model without cavity. Results suggest that the total heat transfer rates and peak heating can be favorably reduced by the use of deep conical cavities