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SPACE EXPLORATION SYMPOSIUM (A3)
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EFFECT OF NOSE CAVITY ON THE HEAT FLUXES TO REENTRY VEHICLE IN TITAN'S ATMOSPHERE

Abstract

The effective exploration of the outer reaches of our solar system is one of the most important objectives in the various space programs of the world. One of the more interesting objectives of such an exploration is a robotic space probe mission to Titan. There are various observational data to suggest that Titan may hold the key to various key raw elements and this can be verified with a mission that has an objective of a successful reentry to Titan's atmosphere. A typical probe for Titan's entry with forward facing axisymmetric cavity is investigated numerically for peak heat fluxes using commercially available Computational Fluid Dynamics code Ansys Fluent 13.0. The cavities investigated are of circular and hyperbolic in shapes with rounded lips while the lip radius is varied from 20 cm to 80 cm. The Martian entry vehicle chosen for the simulation is 60-deg sphere cone probe with a projected diameter of 2.7m and nose radius of 1.25 m. The flow conditions simulated in the investigation are that of ballistic descent through the Titan's atmosphere with freestream Mach No., pressure and density of 18.86, 15.62 Pa and 0.000296 kg/m3 respectively. A two dimensional axisymmetric computational fluid dynamic analysis is done for both perfect gas and non equilibrium chemically reacting gas assumptions with non catalytic wall. The non equilibrium chemistry is simulated using thirteen species with 24 step reaction of Gokcen. The presence of large cavity at the nose is likely to reduce the maximum heating rates at the stagnation region which is extremely desirable for safe delivery of payloads. It is the objective of this paper to ensure to suggest relevant design parameters for a successful reentry mission to Titan so that it can set the trend for similar missions in the future.