World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:13, No:01, 2019

Aerodynamic Heating Analysis of Hypersonic Flow over Blunt-Nosed Bodies Using Computational Fluid Dynamics

Authors : Aakash Chhunchha, Assma Begum

Abstract : The qualitative aspects of hypersonic flow over a range of blunt bodies have been extensively analyzed in the past. It is well known that the curvature of a body's geometry in the sonic region predominantly dictates the bow shock shape and its standoff distance from the body, while the surface pressure distribution depends on both the sonic region and on the local body shape. The present study is an extension to analyze the hypersonic flow characteristics over several blunt-nosed bodies using modern Computational Fluid Dynamics (CFD) tools to determine the shock shape and its effect on the heat flux around the body. 4 blunt-nosed models with cylindrical afterbodies were analyzed for a flow at a Mach number of 10 corresponding to the standard atmospheric conditions at an altitude of 50 km. The nose radii of curvature of the models range from a hemispherical nose to a flat nose. Appropriate numerical models and the supplementary convergence techniques that were implemented for the CFD analysis are thoroughly described. The flow contours are presented highlighting the key characteristics of shock wave shape, shock standoff distance and the sonic point shift on the shock. The variation of heat flux, due to different shock detachments for various models is comprehensively discussed. It is observed that the more the bluntness of the nose radii, the farther the shock stands from the body; and consequently, the less the surface heating at the nose. The results obtained from the CFD analyses are compared with approximated theoretical engineering correlations. Overall, a satisfactory agreement is observed between the two.

Keywords : aero-thermodynamics, blunt-nosed bodies, computational fluid dynamics (CFD), hypersonic flow
Conference Title : ICSPHST 2019 : International Conference on Space Planes and Hypersonic Systems and Technologies
Conference Location : Zurich, Switzerland
Conference Dates : January 14-15, 2019

Open Science Index, Aerospace and Mechanical Engineering Vol:13, No:01, 2019 publications.waset.org/abstracts/95070.pdf