NUMERICAL EXPLORATION OF TRANSVERSE SONIC JET IN HYPERSONIC CROSS-FLOW

Vivek Kishanlal Bhati
Post Graduate
Department of Aerospace Engineering
Indian Institute of Technology Bombay
Powai, Mumbai-400 076, India

Debasis Chakraborty
Department of Aerospace Engineering
Indian Institute of Technology Bombay
Powai, Mumbai-400 076, India
Currently Professor Mahindra Universiy, Hyderabad
Email :
debasis.chakraborty@mahindrauniversity.edu.in

Abstract

At high altitudes, due to low air density, the control response of highly agile and manoeuvrable aerospace vehicles through conventional aerodynamic surfaces is rather slow and inadequate. The control demand of such vehicles can be met very effectively with high-pressure side jets positioned at different locations of the vehicle. Additionally, as none of the components of passive jet control intrudes in the flow path in a passive state, no additional drag is incurred. CFD methods are increasingly being used to characterize jet-controlled aerospace vehicles. Before using in the design exercise, CFD methods need to be validated against reliable experimental results to find its range of applications and error band. In this work, a recent experimental study of transverse sonic injection into Mach 5 hypersonic stream is numerically explored by solving three-dimensional Reynolds Averaged Navier Stokes (RANS) equations using a commercial CFD solver. The computed surface pressures show a reasonable match with experimental results for different momentum ratios of jet and free stream flows. The predictive capabilities of different turbulence models were assessed. The spreading and penetration characteristics of the injectant are analysed from the computed data. The computed penetration and spreading of the injectant depicts nearly linear dependence with the momentum ratio.

Keywords: CFD, Jet, Sonic Injection, Momentum Ratio