DEVELOPMENT OF A THERMO-CHEMICAL NON-EQUILIBRIUM SOLVER FOR WEAKLY IONIZED HYPERSONIC FLOWFIELDS

R. Balasubramanian and K. Anandhanarayanan
Defence Research and Development Laboratory (DRDL)
Kanchanbagh Post
Hyderabad-500 058, India
Email : bals.cfd@gmail.com / r_balasubramanian@drdl.drdo.in

Abstract

A three dimensional solver for numerical simulation of weakly ionized hypersonic reactive air flows past high speed flight vehicles had been indigenously developed. The two-temperature, seven species, eighteen reactions, thermo-chemical non equilibrium, ionizing, air-chemistry model of Park is implemented in a compressible viscous code CERANS and solved in the finite volume framework. The energy relaxation is addressed by a conservation equation for the vibrational-electron-electronic energy of the gas mixture resulting in the evaluation of its vibrational temperature. The contribution of vibrational-electron-electronic energy of the reactive mixture is accounted in total energy equation as well as in the source terms of the relaxation model. The AUSM-PW+ numerical flux function has been used for modeling the convective fluxes and a central differencing approximation is used for modeling the diffusive fluxes. The code has been characterized for standard test cases involving weakly ionized hypersonic reactive thermo-chemical non equilibrium flows and results obtained are in goodqualitative agreement with results available in open literature.

Keywords*: CERANS solver, Air-chemistry, Weakly ionized flow, Hypersonic, Park's model, Characterization*

Paper Code : V67 N1/851-2015.