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ONE-DIMENSIONAL FINITE ELEMENT SIMULATIONS FOR CHEMICALLY REACTIVE HYPERSONIC FLOWS

Süleyman Cengizci [1]

Abstract. Hypersonic vehicles are utilized in recent years massively for both military and civilian purposes. As the vehicles fly through an atmosphere at hypersonic speeds (generally considered as $Mach > 5$), they experience critical physical and chemical interactions due to extremely high (several thousands of Kelvin) temperatures generated around the vehicles. This high-temperature effects may cause vibrational excitation, dissociation and ionization of atoms and molecules. Therefore, the perfect gas hypothesis is no longer valid for air and high temperature effects also should be included in the mathematical model.

In this study, one-dimensional compressible multi-species Navier-Stokes Equations for thermo-chemical non-equilibrium are simulated utilizing a Galerkin Finite Element Method. Air mixture is considered as a combination of atoms Oxygen (O), Nitrogen (N) and molecules Nitric oxide (NO), Dioxygen (O_2), Dinitrogen (N_2).

Keyword: Hypersonic, non-equilibrium flow, chemically reactive, finite element, Vibration-dissociation coupling
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[1]Antalya Bilim University, Antalya, Turkey, suleyman.cengizci@antalya.edu.tr