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Development of multi-component generalized sphere function based gas-kinetic flux solver for simulation of compressible viscous reacting flows. (English) Zbl 07149134

Comput. Fluids 197, Article ID 104382, 16 p. (2020).

Summary: In this paper, a multi-component generalized sphere function based gas-kinetic flux solver is developed for simulation of compressible viscous reacting flows. This work is inspired by the existing simplified gas-kinetic schemes, which use the circular or sphere function to develop single-component gas-kinetic flux solvers. The present solver applies the finite volume method to discretize the multi-component Navier-Stokes equations and evaluate the numerical flux at the cell interface by using the local solution of Boltzmann equation. In order to unify the existing circular and sphere functions, a generalized sphere function is derived from a reduced Maxwellian distribution function by assuming that all the particles are concentrated on an N-dimensional sphere. The present solver is then developed by integrating the generalized sphere function on the sphere surface. To obtain a multi-component solver, the mass fraction from both sides of the cell interface is used to compute the densities of different species. Considering the different physical properties of the species, the internal energy is computed by enthalpy, and the temperature at the cell interface is obtained by Newton iteration. In addition, to control the numerical dissipation, which is relevant to the grid aspect ratio and the chemical reaction, an improved switch function is introduced. Several benchmark problems are simulated to validate the present solver. It is shown that the developed flux solver has a satisfied performance for simulation of multi-component compressible viscous reacting flows.

MSC:

76 Fluid mechanics

Keywords:

gas-kinetic flux solver; multi-component generalized sphere function; compressible viscous reacting flows; finite volume method

Software:

CHEMKIN

Full Text: DOI

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