DNS of Turbulent Reacting Flow Using a Reduced Hydrogen-Oxygen Mechanism

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ABSTRACT

The research of this investigation is to develop a 2D numerical code and compute flow field properties generated by supersonic mixing of two co-flowing fluid streams (H2/O2) with shock-induced combustion. Direct numerical simulations (DNS) of this kind of turbulent, chemically reacting flow will calculate the detailed evolution of the turbulent velocities, temperature, chemical concentration of each component of species, pressure distribution and location of shock wave. The fully coupled, 2D Navier-Stokes equations with finite rate chemistry are solved in conservation law form. There is no subgrid turbulence modeling introduced. The mixture of gases is considered thermally perfect. Since the time scale of the chemistry tend to be much smaller than the time scale of fluid motion, the set of equations describing chemically reacting flow is mathematically stiff. The conservation compact WENO scheme is proved to be one of the most efficient methods available and which is adopted in this work. Initial research, numerical simulation conditions used J. K. Ahuja and S. N. Tiwari the same boundary conditions to simulate. The key parameters for the onset of periodic unsteadiness have been identified as (1) induction time, (2) reaction rate constant, (3) activation energy, (4) heat release and (5) projectile nose radius. In the initial research, we adjust the different nose radius and flow speed of the reaction front while keeping the first four parameters constant by choosing a particular reaction model and by fixing the free-stream Mach number. The premixed fuel oxidizer mixture is taken as 2H2 + O2 + 3.76N2, and the stoichiometric chemical reaction for the system can be written as 2H2 + O2 + 3.76N2 2H2O + 3.76N2.

Keywords: Navier-Stokes equations; Supersonic combustion; WENO scheme; Finite rate chemistry.

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