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Study on Turbulent Mixing Induced by Rayleigh-Taylor Instability Using the RANS Model

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The classic $k-\varepsilon$ model is used to study the turbulent mixing induced by Rayleigh-Taylor instability (RTI). In the model the transport equations of turbulent kinetic energy and its dissipation are used to describe turbulence. In the flow induced by RTI turbulence is driven by pressure and density gradients instead of velocity gradient, which is different from the traditional shear flow. The expression of the turbulence production term reasonably describing the characteristics of RTI is given.

Third-order Runge-Kutta method is used to carry out time integration. Advection terms use high order WENO method to reconstruct fluxes on grid boundaries. Alternate direction implicit (ADI) method is used to solve diffusion terms.

On the basis of these, experiments of Youngs et al and Kucherenko et al under constant and variable accelerations (see Refs. [1-2]) are simulated by this model. The results are compared with detailed experiment data to prove the validation of the model closure, model constants, numerical algorithm and the implementation of the model used in the paper. In addition, the influences of density ratio of two materials, value of acceleration and deceleration time on turbulent mixing are further investigated.

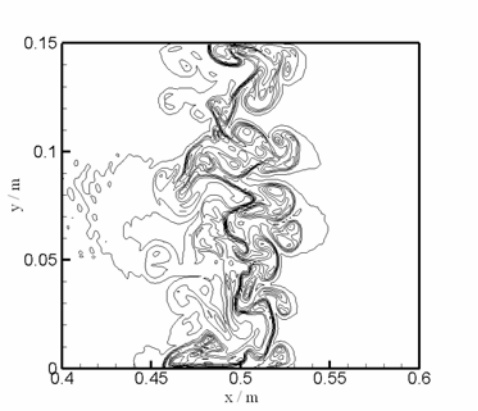

Fig.1 Contours of density(t=50ms)

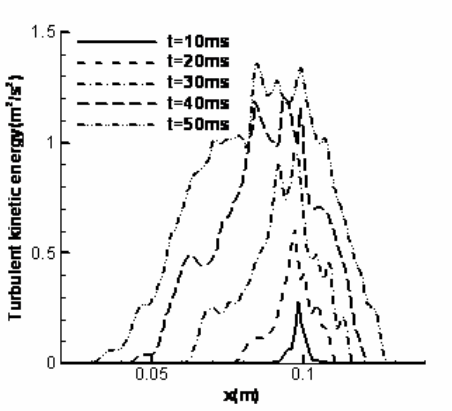

Fig.2 Distribution of turbulent kinetic energy

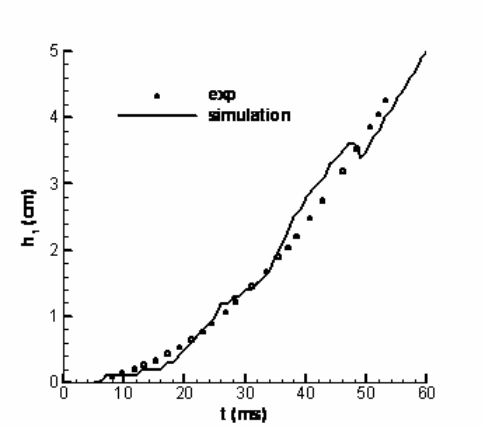

Fig.3 Numerical calibration of the penetration of light fluid into dense fluid

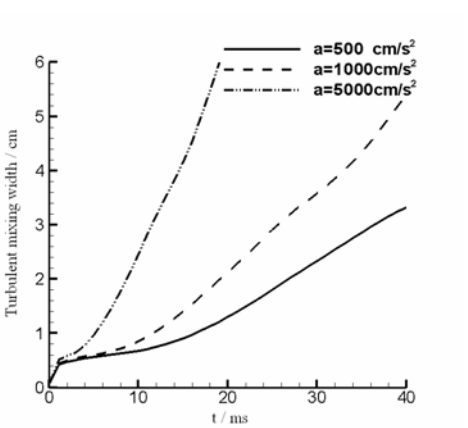

Fig.4 Evolution of turbulent mixing width with different accelerations

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