Two and three dimensional numerical simulations of the single-mode Richtmyer-Meshkov instability

Tao Wang[1], Jin-song Bai[2], Yang Jiang[1], Ping Li[2], Min Zhong[1]

[1]*Institute of Fluid Physics, China Academy of Engineering Physics, Mianyang, Sichuan, P. R. China*
[2]*National Key Laboratory of Shock Wave and Detonation Physics (LSD), Institute of Fluid Physics, China Academy of Engineering Physics, Mianyang, Sichuan, P. R. China*

Abstract

Adopting the volume of fluid (VOF) methodology and piecewise parabolic method (PPM), a high precision numerical algorithm MVPPM (multi-viscous-fluid piecewise parabolic method) is proposed and applied to the multi-viscous-fluid dynamics problems. Several two and three dimensional single-mode Richtmyer-Meshkov instability (RMI) models with different amplitude and wavelength are numerically simulated by MVPPM. Comparisons show that the evolving of interface is highly sensitive to the initial conditions of perturbation. Both two dimensional and three dimensional calculated amplitude and growth rate of perturbed interface are consistent with the predictions of theory models, including linear model and nonlinear models, when the strength of initial perturbation is small. When the wavelength of initial perturbation preserves constant and the initial amplitude increases gradually, the calculated amplitude and growth rate of perturbed interface also increase. And when the amplitude of initial perturbation remains fixed and the initial wavelength increases gradually, the calculated amplitude and growth rate decrease at the early times, and then increase at the late times. The three dimensional numerical results are identical with the two dimensional ones at the linear stage and larger than the two dimensional ones at the nonlinear stage for the perturbation with the same wavelength and amplitude. So the effects of nonlinearity and three dimensions play an important role in the developing of Richtmyer-Meshkov instability.

The authors thank support from the Foundation of China Academy of Engineering Physics (Grant No. 2008B0202011) and the Fundamental Quality and Reliability of National Defence Science and Technology Industry of China (Grant No. Z112009B004).