A NUMERICAL TECHNIQUE FOR 2D COMPRESSIBLE MULTIPHASE FLOW

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A turbulence model based on the equation of multiphase flow is used at AWE to model fluid mixing in compressible flows due to a combination of Rayleigh-Taylor, Richtmyer-Meshkov and Kelvin-Helmholtz instabilites [1]. The model has been applied to problems for which the mean flow is either 1D or 2D. This paper concentrates mainly on the implementation in a 2D multimaterial Eulerian hydrocode [2] for which the basic numerical method consists of a Lagrangian step followed by a rezone step. The numerical technique described is, however, also applicable to an ALE hydrocode with a regular mesh connectivity. If the multiphase flow model is activated, two extra steps are included before the Lagrangian step - a mixing step and a mass exchange step. The mixing step solves a multifluid advection-diffusion equation and the mass exchange step calculates exchange of mass between the phases. The Lagrangian step is extended to calculate multifluid acceleration.

A key issue is the accurate calculation of the growth of the relatively thin turbulent mixing zones , in other words avoidance of spurious mixing due to numerical diffusion. This is achieved by (a) use of the van Leer advection method in the mixing step and (b) use of a technique based on the solution of ordinary differential equations for the early stages of the turbulent mixing growth.

2D results are shown for shock tube mixing experiments performed at AWE. The effect of mesh size is illustrated. Also, to demonstrate the effectiveness of the turbulence model, results are compared with Large Eddy Simulation.

References

1. D.L.Youngs, “Time-dependant multi-material flow with large fluid distortion”. In Numerical Methods for Fluid Dynamics, eds K.W.Morton and M.J.Baines, Academic Press (1982)
2. D.L.Youngs, “Numerical simulation of mixing by Rayleigh-Taylor and Richtmyer-Meshkov instabilities”. Laser and Particle Beams, vol 12, p725 (1994)