A pre-conditioned solver for sharp resolution of multiphase flows at all Mach numbers

A pre-conditioned five-equation two-phase model coupled with an interface sharpening technique is introduced for simulation of a wide range of multiphase flows with both high and low Mach regimes. Harten-Lax-van Leer-Contact (HLLC) Riemann solver is implemented for solving the discretized equations while tangent of hyperbola for interface capturing (THINC) interface sharpening method is applied to reduce the excessive diffusion of the method at the interface. In this work, pre-conditioning technique is used in a system of equations including viscous and capillary effects. Several one- and two-dimensional test cases are used to evaluate the performance and accuracy of this method. Numerical results demonstrate the efficiency of pre-conditioning in low Mach number flows. Comparisons between results of pre-conditioned and conventional system highlight the necessity of using pre-conditioning technique to reproduce main characteristics of low-speed flow regimes. Additionally, pre-conditioned systems transform to the conventional systems at high Mach number flows thus exhibiting the same level of accuracy as the standard flow solver. Therefore, the pre-conditioned compressible two-phase method can be used as an all-speed two-phase flow solver accounting for capillary and viscous stresses.

Keywords: Interface capturing, Multi-phase flows, Preconditioning, Five-equation model, Interface sharpening

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