High-order numerical simulations of compressible two-phase flows with the complex equation of states

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ABSTRACT

In this paper, we investigate the applicability of high-order numerical resolution of compressible homogeneous two-phase flows governed by a quasi-conservative five-equation model of Allaire et al. [1], in which the flow regime of interests is assumed to be homogeneous with no jumps in the pressure and velocity (the normal component of it) across the interfaces that separate two regions of different fluid components. In contrast to many algorithms where in different regions different algorithms are used (for example: in regions away from the interfaces where the flow is a single phase, a standard reconstruction scheme such as MUSCL is used while a special method is used in regions near the interfaces where two different fluid components are present within a cell), our practical algorithm is the same in all regions. To be more specific, the Rusanov approximate Riemann solver is used to obtain the flux at cell edges/faces and the fifth-order upwind scheme with the modified monotonicity-preserving limiter [2] in the standard reconstruction process. Furthermore, based on Surel [3] and Johnsen [4]'s work, for the consistency with the Rusanov approximate Riemann solver, the algorithm is also used to solve the advection equation of the volume fraction and the primitive variables are used in the reconstruction process. Temporal integration of the algorithm is done by employing a third-order strong stability-preserving Runge-Kutta method.

Several one- and two-dimensional problems with different equations of states (such as the ideal-gas EOS, stiffened gas EOS, van der Waals EOS and Mie-Grneisen EOS for characterizing the materials) are used to demonstrate the feasibility of the proposed method.

References

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