A coupled ISPH-FVM algorithm for surface tension dominant two-phase flows

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Abstract

In this study, a coupled method based on incompressible smoothed particle hydrodynamics (ISPH) method and finite volume method (FVM) is established to simulate the surface tension-dominated two-phase flows. In the ISPH-FVM coupling algorithm, one phase is represented by SPH particles, while the other phase is defined on the FVM grids. The coupling of ISPH and FVM is achieved through the transfer and interaction of physical parameters at the overlapping area of the SPH particles and FVM grids. The continuum surface force (CSF) model is introduced into the ISPH-FVM coupling method to evaluate the effect of surface tension on two-phase flow. Meanwhile, three different discrete methods of surface tension are tested in the context of the ISPH-FVM coupling method, namely: (1) Discrete calculation inspired by SPH method (CSF-S); (2) Discrete calculation inspired by VOF method (CSF-V); (3) Discrete calculation inspired by Level-set method (CSF-L). Several benchmark tests are performed to verify the validity of the present ISPH-FVM coupled method and the accuracy of three surface tension discrete models. The simulation results demonstrate the coupled method has good precision and convergence in solving surface tension-dominated two-phase flow problems, and it is in good agreement with the data reported in the literature.

Keywords: ISPH method, FVM method, ISPH-FVM method, surface tension, two-phase flow