

A robust and efficient CFD model for interfacial multiphase flows on arbitrary unstructured grids

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Abstract

A numerical model has been newly developed for interfacial multiphase fluid dynamics on unstructured grids of arbitrary element shapes.

The fluid solver is based on a multi-moment finite volume formulation, where both the volume integrated average (VIA) and the point value (PV) are treated as the computational variables and updated simultaneously at each time step. The VIA is computed from a finite volume scheme of flux form, and is thus rigorously conserved. The PV is updated very efficiently from the differential form of the governing equations. The resulting fluid solver is of much improved accuracy and robustness in comparison with the existing formulations of conventional finite volume method. Without significant increase in algorithmic complexity and computational cost, this method is well-balanced between solution quality and computational cost.

In order to capture free interfaces for multiphase flows, we extend the THINC (tangent of hyperbola interface capturing) method, an algebraic type of volume of fluid (VOF) scheme, to arbitrary unstructured grids. Free of explicit geometrical representation of the interface, the THINC algorithm is very computationally efficient and easily implemented to unstructured grids. The results of benchmark tests show that the THINC method is a very practical approach to compute moving interfaces on unstructured grids.

Numerical verifications demonstrate the applicability of the present model as a promising tool for practical use in real-case applications.

Keywords: Computational Fluid Dynamics, Moving interfaces, Multiphase flows, Unstructured Grids