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A Two-Phase Flow Interface Tracking Algorithm Using a Fully Coupled Pressure-Based Finite Volume Method

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Abstract : Two-phase and multi-phase flows are common flow types in fluid mechanics engineering. Among the basic and applied problems of these flow types, two-phase parallel flow is the one that two immiscible fluids flow in the vicinity of each other. In this type of flow, fluid properties (e.g. density, viscosity, and temperature) are different at the two sides of the interface of the two fluids. The most challenging part of the numerical simulation of two-phase flow is to determine the location of interface accurately. In the present work, a coupled interface tracking algorithm is developed based on Arbitrary Lagrangian-Eulerian (ALE) approach using a cell-centered, pressure-based, coupled solver. To validate this algorithm, an analytical solution for fully developed two-phase flow in presence of gravity is derived, and then, the results of the numerical simulation of this flow are compared with analytical solution at various flow conditions. The results of the simulations show good accuracy of the algorithm despite using a nearly coarse and uniform grid. Temporal variations of interface profile toward the steady-state solution show that a greater difference between fluids properties (especially dynamic viscosity) will result in larger traveling waves. Gravity effect studies also show that favorable gravity will result in a reduction of heavier fluid thickness and adverse gravity leads to increasing it with respect to the zero gravity condition. However, the magnitude of variation in favorable gravity is much more than adverse gravity.

Keywords : coupled solver, gravitational force, interface tracking, Reynolds number to Froude number, two-phase flow
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