Abstract

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Numerical study of an individual Taylor bubble drifting through stagnant liquid in an inclined pipe

The objective of this paper is to investigate the motion of a single Taylor bubble through stagnant Newtonian liquid in an inclined pipe by performing a complete dimensionless treatment followed by an order of magnitude analysis of the terms of equations of motion. The main contribution of this analysis is that Froude, Eötvös and Reynolds numbers are the main physical parameters prompting the dimensionless governing equations for inclination angle up to . The bubble drift velocity diminishes in inclination angles near the horizontal orientation, and thus the reduced Galilei number is suggested to govern the bubble dynamics. To support the developed logical approach of the problem, the present study employs a CFD study so as to investigate the hydrodynamics of single Taylor bubble drifting through stagnant liquid in an inclined pipe through using the volume-of-fluid (VOF) methodology implemented in the computational fluid dynamics software package, ANSYS Fluent (Release 16.0). The simulation results show good correspondence with the developed dimensionless treatment of the problem. No bubble propagates in a zero axial pressure gradient horizontal pipe, hence, a simplified model is suggested to solve the challenging problem of the three-dimensional Taylor bubble in near horizontal and horizontal pipes, and thus saving computational resources.