A 3D Numerical Method for Simulating Gas Bubbles Rising in Viscous Liquids

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The rise and deformation of a single air bubble in water has been investigated extensively by experiment in the past. Consequently various empirical relations have been proposed to characterize for use in industrial process design. However, the existence of dramatically different flow regimes makes the formulations of empirical relations characterizing the terminal bubble shape and bubble velocity complicated. Hence, it would be essential to develop a numerical simulation method capable of accurately predicting the rise of a single or multiple bubbles in water across a wide range of flow regimes.

We present an improved numerical model for the solution of three-dimensional multiphase and interfacial flows based on a finite volume / front tracking method[1,3]. The model is integrated with the software package PARAMESH – a block-based adaptive mesh refinement (AMR) tool developed for parallel computing. Some applications involve moving fronts, e.g. a gas bubble rising in a liquid, and for computational efficiency the simulations are therefore carried out in a reference frame that moves with the front[2]. The new algorithm is applied to simulate the buoyancy-driven rise and deformation of a single bubble in a quiescent liquid in a three-dimensional domain. We validate the simulation algorithm by comparing experimental and numerical results – see Table 1.

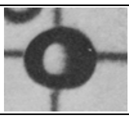
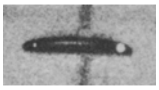
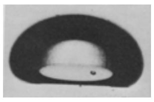
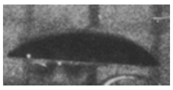
Observed terminal bubble shape					
Predicted terminal bubble shape					

Table 1: Comparison of observed and predicted terminal bubble shape for a bubble rising in a viscous liquid.

References:

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