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Numerical Study of Single Air Bubble Formation in Viscous Liquid

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Synopsis

The dynamics of bubble formation in viscous liquids is a complex multiphase problem governed by the effects of buoyancy, surface tension, and viscous forces. This project numerically investigates the growth, necking, and detachment of a air bubble from a submerged nozzle. Using the `interFoam` solver in OpenFOAM v9, the study replicates the physics presented by Quan and Hua (2008). Detailed parametric studies were conducted to analyze the influence of liquid viscosity, surface tension, and gas density on the pinch-off mechanism. The simulation results, specifically, the bubble shape, neck thinning rates, pinch-off heights, and detached volumes—were validated against the reference numerical data. The findings confirm that, while gas density has a negligible effect, liquid viscosity and surface tension significantly alter the power-law scaling of the neck radius, pinch-off height and the final bubble volume.

Reference Paper:

Shaoping Quan and Jinsong Hua, "Numerical studies of bubble necking in viscous liquids," *Physical Review E*, **77**, 066303 (2008). DOI: 10.1103/PhysRevE.77.066303