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Boundary integral method for viscous potential flows: Three-dimensional dynamics of rising and oscillating bubbles. KUMAR BOBBA, CHENG WANG, University of Massachusetts-Amherst, DAN JOSEPH, University of Minnesota-Twin Cities, MORY GHARIB, California Institute of Technology — In this work a novel boundary integral method is developed for simulating viscous, potential flows (BEMVPF) containing evolving interfaces. The key idea is that, in potential flows the divergence of the shear stress tensor vanishes, but the shear stress tensor itself does not vanish. As a result of this, viscosity enters in the normal shear stress boundary condition, but not in the evolution equations. We show that this additional viscosity in the free boundary condition can be considered as a more general regularization procedure for the underlying equations. The boundary element method is implemented in the indirect form as a Fredholm integral equation of first kind with an immersed source boundary. This formulation circumvents the need for calculating the higher order derivatives of potential on the boundary, and allows for an optimal balance between the well-posedness of the operator and evaluating singular integrals. This new BEMVPF is applied to understand the three-dimensional and time dependent dynamics of a rising and oscillating bubble in a viscous ambient liquid in unbounded domain. The effect of an infinite rigid vertical boundary on the bubble motions is also studied numerically. The BEMVPF bubble computational results are excellent and are able to capture many new features that are not possible by traditional inviscid, potential flow bubble simulations.

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