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Inertially collapsing bubbles: a boundary layer approach to mass transfer modelling[1] STEPHEN SHAW, Xi'an Jiaotong-Liverpool University (XJTLU), DAVIDE MASIELLO, IGNACIO TUDELA, PRASHANT VALLURI, The University of Edinburgh, RAMA GOVINDARAJAN, International Centre for Theoretical Sciences (ICTS) — Gas-mixture segregation in rapidly collapsing bubbles must be correctly described in order to predict the bubble dynamics around its minimum size, where the excess vapour accumulated in the bubble centre cushions the collapse. Reduced-order models have accounted for segregation of only vapour by approximating the thickness of the diffusion boundary layer to a penetration length, with a somewhat arbitrary upper cut-off for slow oscillations. In this work, a more accurate approach applicable to all the components of the gas mixture is devised. By assuming a concentration radial profile satisfying the boundary conditions, the diffusion-convection equation is employed to derive an expression for the rate of change of the boundary layer thickness. This new equation has been tested for a variety of cases of increasing complexity, from simple diffusion to diffusion-convection with interfacial non-equilibrium phase change. The formulation shows remarkable agreement with results obtained from the numerical solution of the full PDE and provides interesting insights into the mass transfer process in non-linearly oscillating bubbles.

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