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Trapping and release of bubbles from a linear pore ANNE JUEL, GEOFFREY DAWSON, University of Manchester, UK, SUNGYON LEE, UCLA — Multiphase flows of practical interest are characterized by complex vessel geometries ranging from natural porous media to man-made lab-on-a-chip devices. Models based on the over-simplification of the pore geometry often suppress fundamental physical behavior. We study the effect on bubble motion of a sudden streamwise expansion of a square tube. The extent to which a bubble driven by constant flux flow broadens to partially fill the expansion depends on the balance between viscous and surface tension stresses, measured by the capillary number Ca. This broadening is accompanied by the slowing and momentary arrest of the bubble as Ca is reduced towards its critical value for trapping. For $Ca < Ca_c$ the pressure drag forces on the quasi-arrested bubble are insufficient to force the bubble out of the expansion so it remains trapped. We examine the conditions for trapping by varying bubble volume, flow rate of the carrier fluid, and length of expanded region, and find that Ca_c depends non-monotonically on the size of the bubble. We verify with experiments and a capillary static model that a bubble is released if the work of the pressure forces over the length of the expansion exceeds the surface energy required for the trapped bubble to reenter the constricted square tube.

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