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The motion of long drops in rectangular capillaries at low capillary numbers HARRIS WONG, SAI RAO, Louisiana State University — The immiscible liquid-liquid drop flow in rectangular capillaries has found extensive industrial applications. However, the flow patterns and pressure-flow rate relations are not well understood. We study the steady motion of a long drop of length LW (L>>1) in a rectangular microchannel of width W and height BW (B≥1). The drop is moving at a velocity U such that the capillary number Ca=mU/s <<1, where m is the viscosity of the carrier liquid and s is the interfacial tension. The drop is non-wetting so that a carrier liquid film separates the drop from the channel wall. We find that the carrier liquid either pushes the drop (plug flow) or bypasses the drop through corner channels (corner flow). When $LCa^{1/3}$ >>1, the plug flow dominates, whereas the corner flow dominate when $LCa^{1/3}$ <<1. The plug flow and the corner flow are coupled through the corner interface. Hence, when the corner flow dominates, the carrier liquid bypasses the drop and drags the drop fluid forward faster than the drop velocity. To conserve mass, the drop fluid circulates from the front to the back of the drop along the center region. The pressure-flow rate relation is linear when $LCa^{1/3}$ <<1 or >>1, and is nonlinear when $LCa^{1/3} \sim 1$. The coupled flow is studied for B = 1, 1.2, 1.5, and 2, and for viscosity ratio R = 0.001 to 100, where R is the ratio of drop viscosity to carrier liquid viscosity.

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