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Flow of two immiscible fluids in a periodically constricted tube: Transitions to stratified, segmented, churn, spray or segregated flow[1]

JOHN TSAMOPOULOS, DIMITRIS FRAGGEDAKIS, YIANNIS DIMAKOPOULOS, Univ of Patras — We study the flow of two immiscible, Newtonian fluids in a periodically constricted tube driven by a constant pressure gradient. Our Volume-of-Fluid algorithm is used to solve the governing equations. First the code is validated by comparing its predictions to previously reported results for stratified and pulsing flow. Then it is used to capture accurately all the significant topological changes that take place. Initially, the fluids have a core-annular arrangement, which is found to either remain the same or change to a different arrangement depending on the fluid properties, the pressure driving the flow or the flow geometry. The flow-patterns that appear are the core-annular, segmented, churn, spray and segregated flow. The predicted scalings near pinching of the core fluid concur with similarity predictions and earlier numerical results (Cohen et al. (1999)). Flow-pattern maps are constructed in terms of the Reynolds and Weber numbers. Our results provide deeper insights in the mechanism of the pattern transitions and are in agreement with previous studies on core-annular flow (Kouris & Tsamopoulos (2001 & 2002)), segmented flow (Lac & Sherwood (2009)) and churn flow (Bai et al. (1992)).

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