Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Mathematical modeling of two phase stratified flow in a microchannel with curved interface RAJAT DANDEKAR, Indian Inst of Tech-Madras, JASON R. PICARDO, International Center for Theoretical Sciences, TIFR, Bengaluru 560089, India, S PUSHPAVANAM, Indian Inst of Tech-Madras — Stratified or layered two-phase flows are encountered in several applications of microchannels, such as solvent extraction. Assuming steady, unidirectional creeping flow, it is possible to solve the Stokes equations by the method of eigenfunctions, provided the interface is flat and meets the wall with a 90 degree contact angle. However, in reality the contact angle depends on the pair of liquids and the material of the channel, and differs significantly from 90 degrees in many practical cases. For unidirectional flow, this implies that the interface is a circular arc (of constant curvature). We solve this problem within the framework of eigenfunctions, using the procedure developed by Shankar [Proc.R.Soc.A, 2005, 461, 2121-2133]. We consider two distinct cases: (a) the interface meets the wall with the equilibrium contact angle; (b) the interface is pinned by surface treatment of the walls, so that the flow rates determine the apparent contact angle. We show that the contact angle appreciably affects the velocity profile and the volume fractions of the liquids, while limiting the range of flow rates that can be sustained without the interface touching the top/bottom walls. Non-intuitively, we find that the pressure drop is reduced when the more viscous liquid wets the wall.

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Date submitted: 25 Jul 2017 Electronic form version 1.4