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Capillary Driven Flows along Rounded Interior Corners
YONGKANG CHEN, MARK WEISLOGEL, CORY NARDIN, Portland State University — The problem of capillary flow along interior corners that are rounded is re-visited analytically in this work. By careful selection of geometric length scales and with the introduction of a corner roundedness parameter λ, the Navier-Stokes equation is reduced to a convenient $\sim$O(1) form for both analytic and numeric solutions for all values of corner half-angle α and λ for perfectly wetting fluids. Local and global scaling analysis of the problem captures much of the intricate geometric dependence of the viscous resistance, significantly reduces the reliance on numerical data compared to several previous solution methods, and leads to an intricate second order nonlinear evolution equation for the free surface. In general, three asymptotic flow regimes may be clearly identified: the 'sharp corner' regime, the narrow 'rectangular section' regime, and the 'thin film' regime. Flows may be observed to transition between regimes, or may exist essentially in a single regime depending on the system. Perhaps surprisingly, for the case of imbibition in tubes or pores with rounded interior corners, similarity solutions are possible and are obtained numerically for all conditions with analytic solutions obtained under the constraints of the three regimes.

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