Interfacial shape of liquid films

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Liquid film flow occurs in many application such as dip coating. Interfacial profile is important to determine film thickness, especially for flow with low capillary number. In this low capillary number regime, the balance among viscous drag, surface tension, and gravity determines interfacial shape and film thickness.

For liquid film on substrate in upward motion, commonly referred as the Landau-Levich problem, Kheshgi (1992) extended classical theory for infinite pool to consider confined geometry by integrating the simplified basic integrodifferential equation with arc length coordinate (Higgins 1979), but did not include two dimensional characteristics, i.e., normal viscous stress. This two dimensional characteristics was considered by Esmail and Hummel (1975). However, curvature of interface is greatly approximated, and the dynamic region, where film is entrained, cannot be matched static region properly in their study.

Unfortunately, it fails to add directly two dimensional characteristics to Kheshgi's model due to arc length coordinate. In this study, the problem is resolved, and is compared with computational results.