Boundary Integral Simulations of Liquid Emptying from Model Gravure Cells

Nazish Hoda and Satish Kumar

Department of Chemical Engineering and Materials Science
University of Minnesota, Minneapolis, MN 55455

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We perform boundary integral simulations to understand the removal of Newtonian liquids from model gravure cells. Two different configurations are considered. In the first configuration, there is a free-surface and an outlet boundary, and liquid is driven out of a cavity by a combination of horizontal substrate motion and an imposed pressure gradient; a similar model was used by Powell et al. [Trans. IChemeE 78 (2000) 61]. The fraction of liquid remaining in the cell, V_r, is influenced by the capillary number, Ca, cell depth, D, and contact angle. We find that V_r decreases with a decrease in Ca or D, consistent with prior studies. Also, for a shallow enough cell, almost all of the liquid can be removed from the cell. Additionally, V_r decreases with an increase in contact angle. In the second configuration, there are two free surfaces, and liquid is driven out of a cavity by moving the substrate both horizontally and vertically. Our simulations show that V_r decreases with an increase in the vertical velocity, V, and in some cases the entire cell can be emptied when V is greater than a critical value. The above results suggest that removal of liquid from a cell can be drastically increased either by reducing the depth of the cell or by increasing V.

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