Extensional Deformation of Liquid Bridges near Gravure Cells

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Gravure printing involves the transfer of liquid from tiny cells (~ 100 microns deep) to a web that can move at speeds of up to 15 m/s. The high print resolution and speeds achieved in gravure make it a prime candidate for manufacture of flexible electronics, but the mechanisms that control liquid removal are poorly understood. To address this issue, we study the extensional deformation of liquid bridges near model gravure cells. Newtonian fluids in axisymmetric geometries are considered, and the Navier-Stokes equations are solved using the Galerkin/Finite-element method over a range of Reynolds numbers, capillary numbers, and contact angles at the gravure roll. The results suggest that liquid transfer improves when the contact angle is increased at a fixed capillary number. When the contact angle is fixed and the capillary number is increased, the liquid transfer improves when the roll is wetting and worsens when the roll is non-wetting. A non-zero Reynolds number is found to promote the formation of satellite drops. The mechanisms underlying these observations are discussed with reference to the shapes of the free-surface profiles.

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