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Multiscale modeling in the numerical computation of isothermal nonwetting MARC K. SMITH, G. PAUL NEITZEL, Georgia Institute of Technology — A state of permanent, isothermal nonwetting of a solid surface by a normally wetting liquid may be achieved by having the surface move tangential to a liquid drop being pressed against it. Surrounding gas is swept into the space between the liquid and solid, creating a lubricating film that prevents wetting. The length scales of the drop and the film are typically three or more orders of magnitude different, making numerical simulation difficult from a resolution standpoint. A hybrid computational approach employing lubrication theory for the thinnest portions of the gas film and a finite element simulation for the liquid and outer gas phases is presented. The model problem is a steady, two-dimensional flow between parallel solid surfaces with the drop attached to the upper surface. Results are presented for a silicone oil drop with air as the surrounding gas. The drop shape, flow field, and forces on the drop are determined as functions of the Reynolds number, the flow rate through the system, and the solid surface separation distance. As the drop approaches the lower surface, both leftward-leaning and rightward-leaning drop shapes are possible, but there is a range of flow rates where steady solutions are not found. When the separation distance is less than the radius of the undisturbed hemispherical drop, only left-leaning drop shapes are found. The reasons for this behavior are explained in terms of the lubrication pressure field beneath the drop.

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