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Electrohydrostatics of Capillary Switches KRISHNARAJ SAMBATH, OSMAN BASARAN, Purdue University — A pair of supported droplets that are coupled via a liquid filled cylindrical hole of radius R in a plate is referred to as a capillary switch (CS). A CS is known to exhibit two stable equilibrium states when the combined volume of the top and the bottom droplets is greater than $4/3\pi R^3$. This fact is exploited in various applications, including optical lenses and adhesion, where the main challenge is to come up with a method to"toggle" the CS between the two stable states that is reliable, is energy efficient, and has fast response. The use of an electric field to achieve this purpose is explored here through simulations in which the axisymmetric shapes and stability of a CS are determined as a function of applied field strength. In the simulations, the liquid is taken to be perfectly conducting and the ambient fluid on either side of the plate outside the CS to be a passive gas. An axial electric field is applied either on one or both sides of a grounded plate. The equilibrium shapes of the CS and the electric potential in the surrounding gas are governed by an augmented Young-Laplace equation and the Laplace equation, respectively. These equations are solved computationally using the Galerkin finite element method. Results are shown as plots of dimensionless volume difference between the two droplets against electrical Bond number (ratio of electric to surface tension force). These phase diagrams are used to infer whether an electric field represents an effective means for toggling a CS.

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