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Three-dimensional simulation of droplet migration in a Hele-Shaw microchannel[1] YUE LING, JOSE-MARIA FULLANA, STEPHANE POPINET, CHRISTOPHE JOSSERAND, Institut d'Alembert, UPMC-Paris 6 — Droplet-based microfluidics is a promising tool for performing biomehcanical and chemical assays. Three-dimensional simulations are performed in this work to investigate the migration of a droplet in a confined microchannel (a Hele-Shaw cell). As the droplet moves in the channel, a thin film is formed between the droplet and the wall. The thickness of the film can be two orders of magnitude smaller than the channel height. Furthermore, the time step which is mainly controlled by the surface tension effect becomes very small for low Capillary number. Therefore, numerical simulation of droplet migration in microchannel is challenging. The present simulations are conducted with a two-phase flow solver (GERRIS) on an adaptive mesh. The interface between the two phases is captured by the Volume-of-fluid method. The droplet dynamics are very different as the aspect ratio (the ratio between the droplet diameter and the channel height) varies from smaller to larger than unity. For droplets of large aspect ratio, the droplet velocity is mainly dictated by the dynamics of the thin film. The simulations also show that the flow around the droplet is three dimensional and has a significant impact on the droplet shape.

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