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The motion of free surface in a narrow gap between parallel plates

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When two parallel plates confining with viscous fluid between the narrow gap are separated at a constant velocity, air penetrates into the gap, and free surface moves to the center of plates. When viscosity of fluid is high or the separation rate of the plates is large, the free surface forms complicated finger pattern caused by pressure instability. Such phenomenon is referred to as the meniscus instability, a similar pattern is also observed in fracture surface of amorphous materials. The meniscus instability may be controlled by a capillary number which is a dimensionless number and the ratio of surface tension to the viscous stress. In the present study, multiphase flow analysis program based on VSIAM3 is developed, and meniscus instability taken into account of elastic deformation of plate surface is simulated. The fluid-structure interaction is calculated using immersed boundary method, and STAA is applied for interface capturing.

Keywords: Meniscus instability, Multiphase flow, Immersed boundary method, Free surface