Accurate Modeling of Moving Contact Line in Two-Phase Immiscible Flows

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ABSTRACT

In simulations of moving contact line problems (i.e. flow problems involving two immiscible fluids that are in contact with a solid) it is necessary to introduce slip to avoid a singularity in the stresses. However, when the dynamics of the moving contact line is driving the flow, in for example capillary-driven flows, introducing slip in an accurate way is not straight-forward. Common problems are inaccuracies in the model and grid effects.

We present a second order accurate method to impose a slip velocity at the contact line. The method presented here is based on the so-called hydrodynamic model for steady movement of a contact line. The hydrodynamic model consists of an analytical expression for the fluid velocity field close to a moving contact line. This expression is derived from the creeping flow approximation of the Navier-Stokes equations and by imposing appropriate boundary and interface conditions. In this work, the velocity field from the hydrodynamic model is used to impose a slip boundary condition at the solid and to advect the contact line. Numerical results will be presented. Further, appropriate level set reinitializations for moving contact line problems will be discussed.