Contact line motion of a volatile liquid in an inert gas

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For a liquid wedge on a moving substrate, specific approaches are required to model the contact line vicinity in order to relieve the dynamical singularity due to the divergence of the shear stress at the contact line [1, 2]. Among the different mechanisms that are proposed in this context, the present study focuses on the evaporation/condensation phenomena induced by the deformation of the profile close to the contact line (Kelvin effect). Previous studies have been performed for pure vapor and partial wetting [3, 4], or diffusion in an inert gas and total wetting [5, 6]. In a partial wetting configuration (liquid wedge), we develop a model in the framework of lubrication approximation that takes into account diffusion of the vapor in the gas phase and kinetic resistance at the interface. We perform a perturbation analysis assuming a small substrate velocity. The evaporation flux is solution of an integro-differential equation that is solved numerically. This provides quantitative estimations for the local curvature and evaporation flux induced by the substrate motion. This model is valid if the characteristic length of the problem is consistent with hydrodynamic approach. We thus determine the Voinov length for different fluids and wetting properties and analyze the validity domain of the regularization approach based on evaporation/condensation.

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