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Confined Air-Liquid Drainage: Local Analysis and Invasion Percolation Model

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This paper studies drainage of a wetting liquid by non wetting air between two confined rough solid surfaces. We focus on the limit of small Reynolds and capillary numbers. In this limit the viscous pressure drop is negligible and the pressure inside the liquid and the air is uniform. In this case the invasion process is controlled by the liquid-gas interface curvature, in keeping with Laplace law. The invasion of air in complicated geometries, is controlled by bottom-neck constrictions that the uniform pressure inside the air finger has to overcome. From convergence of asymptotic, numerical and experimental analyses, we found simple expressions for the air finger width and total curvature invading a single saddle-point as a function of its aspect ratio. The result of this local analysis is applied to a new invasion percolation numerical model which is compared to experiments involving drainage between complicated rough surfaces.

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