

Unsteady Similarity Solution for a Slender Dry Patch in a Thin Newtonian Fluid Film

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Abstract : In this paper the unsteady, slender, symmetric dry patch in an infinitely wide and thin liquid film of Newtonian fluid draining under gravity down an inclined plane in the presence of strong surface-tension effect is considered. A similarity transformation, named a travelling-wave similarity solution is used to reduce the governing partial differential equation into the ordinary differential equation which is then solved numerically using a shooting method. The introduction of surface-tension effect on the flow leads to a fourth-order ordinary differential equation. The solution obtained predicts that the dry patch has a quartic shape and the free surface has a capillary ridge near the contact line which decays in an oscillatory manner far from it.

Keywords : dry patch, Newtonian fluid, similarity solution, surface-tension effect, travelling-wave, unsteady thin-film flow

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