Spontaneous Rise of Rivulets in Square Capillaries

Vignesh Thammanna Gurumurthy[1], Daniel Rettenmaier[1], Ilia V. Roisman[1], Cameron Tropea[1] and Stephen Garoff[2]

[1] *Institute of Fluid Mechanics and Aerodynamics, Technische Universität Darmstadt, Alarich Weiss Str. 10, 64287 Darmstadt, Germany.*
[2] *Department of Physics and Center for Complex Fluids Engineering, Carnegie Melon University, Pittsburgh PA15213, USA.*

Capillary driven flows in non-circular channels/capillaries with corners are relevant in the field of microfluidics, porous media, etc. While the bulk capillary flows in the cornered capillaries are very much similar to the cylindrical capillaries, the presence of corners enhances the capillary effects resulting in the formation of rivulets rising in the corners. These rivulets are known to impact the performance of the microfluidic devices which necessitates the understanding of capillary flow in corners.

In this computational study, we investigate the capillary rise in square capillaries under gravity. The flow is modelled using Volume-of-Fluid method and the free surface is accurately tracked using adaptive mesh refinement. The influence of the parameters such as liquid viscosity, gravity, contact angle and the capillary size are investigated.

Results show that the rivulets are formed in the capillaries only when the contact angle is less than 45 degrees [1]. At long times, the rivulet grows as one-third power of time ($h \sim t^{1/3}$) as shown in the Figure. This one-third rise behaviour agrees with the existing experiments on capillary rise in corners between different geometries [2]. Finally, the growth rate of the rivulets is presented using a scaling relation which is valid for different liquids and contact angles.

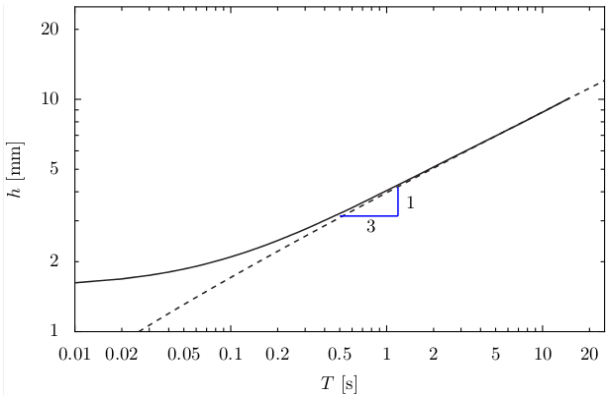

Figure 1: Temporal evolution of rivulet height for 3mm capillary at a contact angle of 30°. The dashed line is the one-third asymptotic least squares fit.

References

[1] P Concus, R Finn, *Appl.Math.Sci* (1969).
[2] A Ponomarenko et.al, *J.Fluid Mech* (2011).

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