Capillary Flows along Open Channel Conduits: the Open-Star Section

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Abstract

Capillary rise in tubes, channels, and grooves has received significant attention in the literature for over 100 years. In yet another incremental extension of such work, a transient capillary rise problem is solved for spontaneous flow along an interconnected array of open channels forming what is referred to as an 'open-star' section. This geometry possesses several attractive characteristics including passive phase separations and high diffusive gas transport. Despite the complex geometry, novel and convenient approximations for capillary pressure and viscous resistance enable closed form predictions of the flow. As part of the solution, a combined scaling approach is applied that identifies unsteady-inertial-capillary, convective-inertial-capillary, and visco-capillary transient regimes in a single parameter. Drop tower experiments are performed employing 3-D printed conduits to corroborate all findings.

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