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LIMITATION OF CAPILLARY FLOW RATE IN ASYMMETRY OPEN CHANNELS

Abstract

This investigation mainly focuses on the forced, isothermal, and impressible capillary flow in an asymmetric interior corner. In the microgravity environment, surface tension forces are significant in dominating the location and orientation of liquid. The curvature of the interface at the open side of the channel is determined by the pressure difference between the surrounding gas pressure and liquid pressure along the flow path. As the flow rate increases to a critical value, surface tension can no longer balance the pressure difference, leading to the interface collapses. This unsteady flow will cause the failure in propellant management.

So far, large amount of work has been done to study the stability and collapse of capillary flow in interior corner, such as parallel plate channels and wedge-shaped channels. The critical flow rate has already been studied by Rosendahl for the parallel plate geometry[1] and Haake[2] for the groove geometry. Klatte [3] investigates the collapse phenomenon as a function of the wedge-shaped channel geometry. But yet, all these mentioned above are cornered with the symmetric interior corner. Flow in asymmetric interior corner has not been considered in literature.

In this paper, we focus on the asymmetry channels consisting of outer vanes and tank wall. Outer vanes are amounted perpendicularly alongside the tank wall and form the asymmetry interior corner consisting of one straight side and one arc. As the symmetry of tank and vanes, surface may be determined by analyzing the smallest symmetrical element. The laminar isothermal flow through an asymmetrical open channel of vane width d, tank radius r, and channel length l is investigated. Coordinate system is located at the bottom of the inlet. The liquid flows along the x-axis from the inlet to the outlet and is maintained by an external pump with flow rate Q at the outlet. Channel is surrounded by passive atmosphere of pressure P. We aim to determine the critical flow rate that leads to the surface collapse.