Fluids and Space Engineering Seminar

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Phase separation in spacecraft

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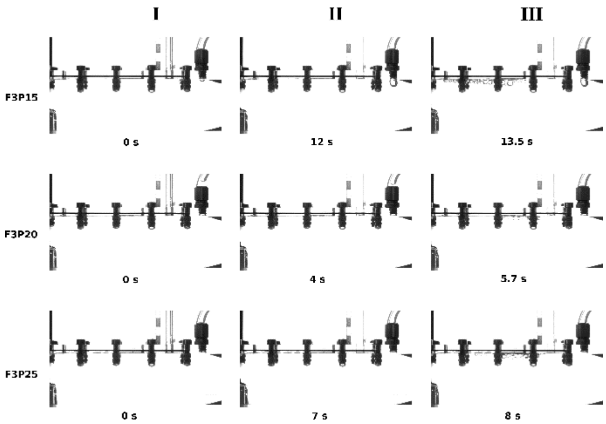

Fig. 1: Video images from experiments F3P15, F3P20, and F3P25 during the compensated gravity phase at different time intervals. In the first two columns (set I and II), the differential pressure across the screen remains lower than the bubble point pressure, and the saturated screen section S_1 blocks gas ingestion. The gas breakthrough occurs when the differential pressure exceeds the bubble point pressure, as shown in the third column (set III).

Phase separation in spacecraft is critical for gas-free propellant supply, life support systems, refueling in low earth orbit (LEO), and for deep space exploration missions. If accelerations or angular velocities act on the vehicle, the resulting hydrostatic pressure can be used to separate liquid from gas. During launch and accelerated phases, thrust induced body forces deposits the liquid over the outlet, and a continuous propellant supply is maintained. However, in a low gravity environment, hydrostatic forces are diminished, and capillary forces dominate the orientation of a liquid in a spacecraft tank. The transport of liquid to the tank outlet in a compensated gravity environment is accomplished by employing propellant management devices (PMDs), also known as liquid acquisition devices (LADs). LADs incorporate metallic screens to separate liquid and gas phases. The motivation of this work arises from the lack of experimental data on screen channel liquid acquisition devices (SCLADs) in a compensated gravity environment. SCLADs have been mostly tested in ground based experiments, using cryogenic and storable liquid. The majority of available information is on single phase flow, where experiments were performed with fully submerged scaled models. This report describes the results of phase separation in porous media integrated capillary channels under compensated gravity conditions.