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Phase separation in capillary channel flow using porous media

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Kamal S. Bisht, Michael E. Dreyer, University of Bremen, Faculty of Production Engineering, Department of Fluid Mechanics, ZARM, University of Bremen, Germany

In propellant management devices (PMD), porous media are widely used for the phase separation process and delivery of vapor free propellant. However, instability of the free surface flows in open capillary channels limits the flow rate capacity and affects the effectiveness of the porous media. In low-gravity conditions, capillary pressure only balances the pressure difference across the liquid-gas interface. At the critical flow rate, the maximum capillary pressure is exceeded; the free surface collapses and gas bubbles are ingested into the liquid. The presence of gas degrades the quality of the propellant and severely affects the engine efficiency. In this project, a setup with a metallic porous screen covering a rectangular groove channel is investigated to obtain a higher flow rate in capillary channels without collapse of the free surface. The saturated porous screen permits liquid to pass through but acts as a barrier to the gas breakthrough until the differential pressure across the screen exceeds to the bubble point pressure.

This feature is governed by porous media properties such as permeability, porosity, wettability and pore diameter. A theoretical study has been done and is currently under investigation using numerical tools and ground tests. The computations are performed with Matlab and the computational fluid dynamics program Ansys Fluent. The setup for the experimental test facility is defined which shall be tested next year in summer during drop tower test. The theoretical, experimental and numerical results will be presented in the talk.

References

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Primary author: Mr BISHT, Kamal Singh

Co-author: Prof. DREYER, Michael

Presenter: Mr BISHT, Kamal Singh

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