AAE Special Seminar

Sounding Rocket Experiment on Capillary Channel Flow*

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Friday, February 3, 2006
3:00 P.M.
GRIS 274

ABSTRACT

We will report on the experimental procedure and the results of a sounding rocketexperiment (TEXUS EML) on open capillary channel flows which was launched end of December 2005 from ESRANGE in North Sweden. The rocket provides 6 minutes of compensated gravity with the ability to communicate with the payload including the downlink of 2 S-VHS video channels.

The capillary channel consists of two parallel plates (25 mm breadth) mounted at a gap distance of 10 mm. The length of the open flow path, along which the test liquid (FC-72) is exposed to the ambient gas phase, is variable in-between 12 mm and 19 mm. Depending on the applied volumetric flow rate, the liquid pressure decreases in the flow direction due to flow losses. To achieve steady flow conditions the difference between the liquid pressure and the ambient pressure has to be balanced by the capillary pressure of the free liquid surfaces. A steady flow is only obtained for a flow rate below a critical value. If this value is exceeded, the liquid surfaces collapse at the channel outlet and the flow changes from steady single-phase flow to unsteady two-phase flow. The aim of the experiment is to determine the profiles of the free surfaces and to find the critical flow rate.

For this purpose the critical flow state was approached on one hand by increasing the flow rate and on the other hand by increasing the flow length. Additionally measurements of the flow velocity profiles were performed with a miniaturized Laser Doppler Veliciometer. The typical observation for a steady flow is shown in figure1(a), while an unsteady flow due to overcritical flow rate is shown in figure 1(b). Due to total reflection of the back illumination the liquid surfaces appear dark. In order to predict the flow, a one-dimensional theoretical model was developed[1], and the critical flow rate and the surface profile data are in good agreement with the theoretical predictions.

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[1] Rosendahl et al., J. Fluid Mech. 518, 187-214 (2004)

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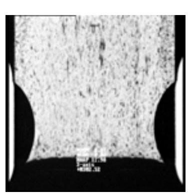
(a) 

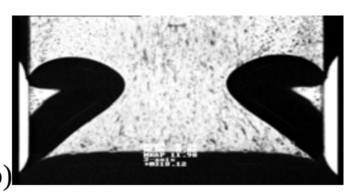
(b) 

Figure 1: Front view of the capillary channel. (a) Stable flow. (b) Unstable flow.

BIO

1989-1993: Pd. D. student at ZARM: capillary rise of liquid, combustion on free surfaces, capillary effects for surface tension tanks, bubble migration in heat pipes. **1993-2003:** Head of Interface Phenomena Working Group at ZARM: free surface reorientation, development of surface tension tanks, capillary transport in porous media, propellant settling tests, capillary channels flows, numerical simulation of transient capillary flows, deformation of emulsion droplets, two-phase flows in non-circular channels, liquid behavior in spacecraft tanks, topical team liquid management in space.

Since 2003: Department Head, Multiphase Flow and Fluid Metrology: capillary channel flows (DLR-NASA cooperation for microgravity science glovebox on ISS), surface reorientation, propellant management in spacecraft tanks (DLR-CNES cooperation COMPERE), laser-doppler anemometer for space application.

An informal coffee & cookie reception will be held prior to the lecture at 2:30 p.m. in GRIS 390