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Laser Induced Fluorescence measurement of liquid film thickness and variation in Taylor flow

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ABSTRACT

In the present work, experiments are done to understand the distribution of liquid film in Taylor flows occurring in small circular mini channels using laser-induced fluorescence. Gas-liquid Taylor flow is generated in 3 different channels of inner diameter 1.5, 2.1 and 3.1 mm to understand the effect of flow parameters and nature of forces on the liquid film thickness. Rhodamine-B, a fluorescent dye is mixed with water, the primary phase in the two-phase mixture and is excited by a pointed laser beam of wavelength 531nm. The liquid film thickness with the excited fluorescent dye emits light at 610nm which is captured using a CMOS high-speed camera. A long pass filter is used to filter the reflected laser light before being captured by the CMOS sensor camera. Subsequently, the image obtained is processed with a set of image processing techniques to determine the liquid film thickness. Different slug shapes are obtained for various combinations of flow velocities and are found to depend on the Bond number. Further, it is also found from the experiments that asymmetry in the flow regime is found to depend on the capillary forces acting on the flow and it increases with the capillary number. The film thickness is also found to vary across the air slug length and its distribution along the flow length is also presented.

Keywords: Laser induced fluorescence, liquid film thickness, Taylor flow, slug length