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Experimental study of isothermal vertical slug flow

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Large gas bubbles separated by the liquid slugs are the main characteristic of the slug flow regime. We have analyzed the stagnant Taylor bubble in the vertical isothermal counter-current flow with high speed videos at 100 to 800 frames per second. A single Taylor bubble was captured in each experiment through dynamical balance of the bubble drag in the downward liquid flow. Bubbles of around two to six diameters length were observed in two pipes of 12.4 and 26 mm diameter. Liquid Reynolds numbers in front of the bubble were around 1000 (laminar flow) and 6000 (turbulent flow) in small and large diameter pipe, respectively. Video frequencies at around 400 Hz were found sufficient to capture all temporal fluctuations of the bubble interface. Algorithms for two-phase interface recognition have been developed and applied on the images of the cap and the body of the Taylor bubbles. We have shown stable axisymmetric Taylor bubble in laminar flow and asymmetric bubbles in turbulent liquid flow. Even the long time averaging of up to 10 minutes did not produced axisymmetric time-averaged shape of the bubble in turbulent liquid flow. In turbulent regime we have observed bubble of bullet-train shape with the thinnest liquid film on the belly of the bullet-train shape bubble. Azimuthal position of the bubble's belly is randomly determined during the injection of the bubble into the test section. In addition, dynamics of the tiny disturbance waves with tenth of mm amplitudes has been tracked along the interface of the Taylor bubbles in laminar and turbulent cases. Stable standing waves were observed in the laminar case and traveling waves in the turbulent liquid experiments. Cross-correlations of time-dependent interface fluctuations were measured at different spatial positions in turbulent flow to determine propagation speeds of the traveling interface waves.

Speaker Bio

Primary authors: Dr MIKUZ, Blaz (Jozef Stefan Institute, Slovenia); TISELJ, Iztok (Jozef Stefan Institute, Slovenia); Mr KREN, Jan (Jozef Stefan Institute, Slovenia)

Presenter: TISELJ, Iztok (Jozef Stefan Institute, Slovenia)

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