Experimental study of single Taylor bubbles in closed vertical and slightly inclined tubes

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This work presents a study of single Taylor bubbles rising in vertical and slightly inclined tubes. The objective of the study is to develop and optimize the use of the visualization technique using high speed video camera and pulse-echo ultrasonic technique to measure the bubble velocities, the bubble lengths, the bubble profiles and the thickness of the liquid films falling around Taylor bubbles rising in vertical and slightly inclined tubes closed at the ends. The inclination angles studied were 0, 2.5, 5, 7.5, 10 and 15 degrees from the vertical position. By measuring the flow parameters, a better understanding of the structure and movement of Taylor bubbles, as well as of the slug flow structure, might be obtained. Water, glycerin and water-glycerin solutions were used as working fluids to evaluate the influence of the liquid properties, especially viscosity, in the measured parameters. Finally, the measured parameters may be compared with some appropriate correlations available in the literature to estimate them.
Figure 1 illustrates the vertical and slightly inclined column used in this work located at the Thermo-Hydraulic Laboratory of the Nuclear Engineering Institute (LTE/IEN/CNEN), [1].

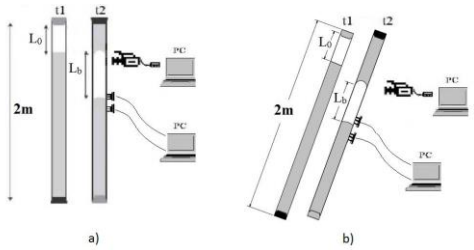

Figure 1. Schematic of the stagnant liquid column used in this work: a) vertical, and b) slightly inclined.

The high speed ultrasonic system used to measure the flow parameters consists of a generator/multiplexer board, transducers and a computer (PC) with software to control up to four transducers. The visualization system is formed by a high speed video camera zoom lenses, an acquisition and image analysis software, and a notebook.

Figure 2 shows the relationship Fr vs θ for distilled water according literature data [2], [3], and the results of this work, [1].

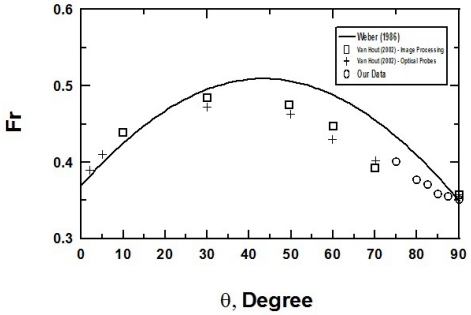

Figure 2. Relationship between Froude number and inclination angles for distilled water.

Figure 3 presents the experimental measured values of liquid film thickness (δ') plotted against inverse viscosity number (N_f), for the case of vertical tubes (90^o). In this figure, a model of literature, [4], has also been plotted.

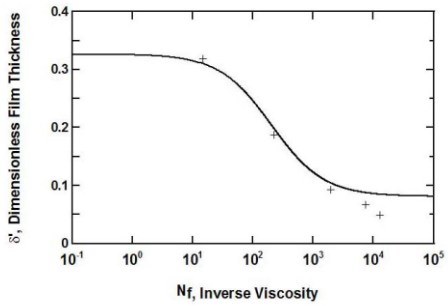

Figure 3. Experimental measured values of δ' plotted against N_f for the case when $\theta=90^o$:. + this work, solid line model, [4].

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