Influence of Liquid Viscosity and Column Diameter on Single Taylor Bubble Movement in a Stagnant Liquid Column

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The present paper reports an experimental study of single Taylor bubbles rising in vertical and slightly inclined tubes 2.0 m long, with inner diameters D of 0.019, 0.024 and 0.034 m containing different stagnant mixtures of water and glycerin, [1]. A Taylor bubble with length L_b was formed by the inversion ($t_1 - t_2$) of the pipe partially filled with liquid to leave an air pocket of length L_0 (Fig.1). The bubble velocities were measured by using a visualization technique with high speed video camera. Correlations available in the literature to estimate the bubble velocity and the influence of the Morton (M) and Eotvos (Eo) numbers on this parameter were evaluated for the range $1.17x10^{-11} \leq M \leq 29.86$ and $50 \leq Eo \leq 228$, [2], [3]. The results indicated that the bubble velocity tends to increase when the inclination angle increases and when M decreases. For all liquids studied, Eo has no influence on the bubble velocity, for $50 \leq Eo \leq 113$ (Fig.2-3). Increasing Eo ($Eo \geq 159$), the bubble velocity tends to increase, for lower viscosity liquids or $M \leq 6.04x10^{-8}$ (Fig.2), however no influence of Eo on the bubble velocity was observed for the higher viscosity liquids or $M > 1.86x10^{-4}$ (Fig.3). In general, all correlations evaluated can estimate the bubble velocities with relative errors smaller than 15%, for inclination angles between 0^o and 15^o (Fig.4).

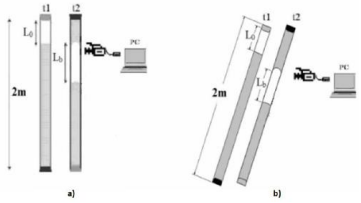

Figure 1. Schematic of the stagnant liquid column: a) Vertical and b) Slightly inclined.

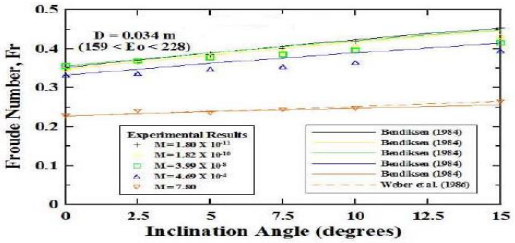

Figure 2. Fr vs θ for bubbles generated from L_0 = 0.10 and 0.20 m inside tubes with different internal diameters D containing distilled water.

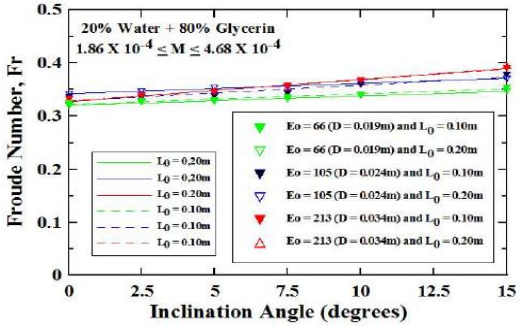

Figure 3. Fr vs θ for bubbles generated from L_0 = 0.10 and 0.20 m inside tubes with different internal diameters D and rising in 20% water + 80% glycerin mixture.

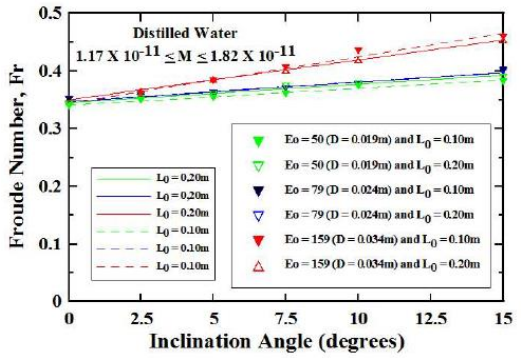

Figure 4. Comparison between the experimental values of Fr and those estimated by the models of Bendiksen (1984) and Weber et al. (1986).

References

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