Experimental and numerical investigation of stratified gas–liquid flow in downward-inclined pipes

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This paper reports an experimental and numerical investigation of stratified gas–liquid two-phase flow in downward inclined circular pipes. Reynolds averaged Navier–Stokes equations with the κ–ω turbulence model were solved by using the least-square finite-element method to simulate the stratified gas–liquid flow. Experiments were carried out in an air–water two-phase flow loop with a test section of 7.8 m long circular pipe with 1 inch inner diameter for 3 downward-inclined angles, −2.5◦, −5.0◦, and −10.0◦. The height of the liquid layer was measured by using a pulse–echo ultrasonic technique with a single fast transducer and a visualization technique with a high-speed digital camera.
Numerical results for the liquid height and hold-up as a function of inclination angles were compared favorably with experimental results of the present study [1], and literature [2] data as shown in Figure 1.

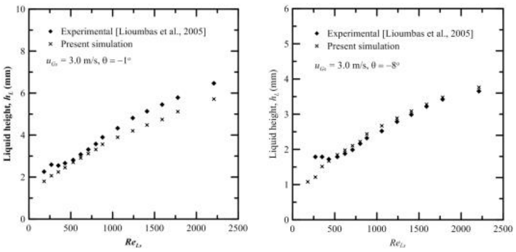

Figure 1. Comparison of numerical liquid height with experimental data of Lioumbas et al. (2005), as a function of Reynolds number, Re_{LS}, for u_{Gs} = 3.0 m/s and θ = –1◦/–8◦.

Figure 2 shows the normalized h_L/d as a function of the gas volumetric fraction β for the inclination angle of –2.5◦.

In Figure 3 the time-averaged void fraction was determined by averaging the liquid height showed in Figure 2.

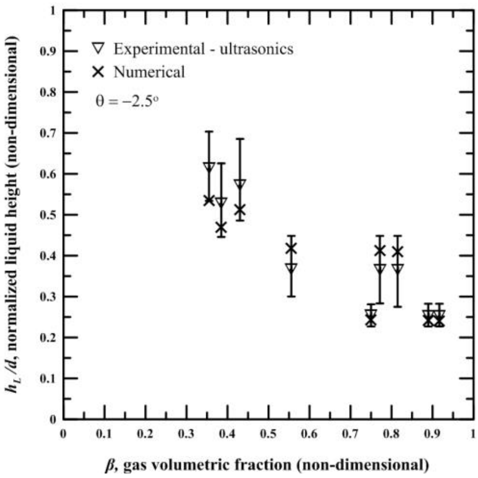

Figure 2. Normalized liquid height as a function of gas volumetric fraction for θ = –2.5◦.

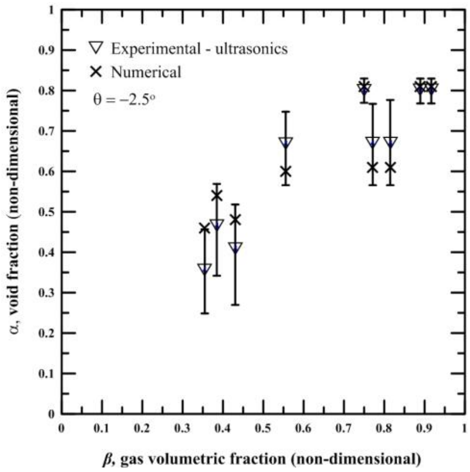

Figure 3. Averaged void fraction as a function of gas volumetric fraction β.

The experimental results were compared with the numerical results, in terms of a normalized liquid height and void fraction as a function of gas volumetric fraction. The numerical model can be considered suitable to simulate the present experiments.

References

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