Investigating the effect of heat exchange tubes size on phase distribution of bubble columns for Fischer Tropsch synthesis by using Gamma Ray Computed Tomography (CT) Technique

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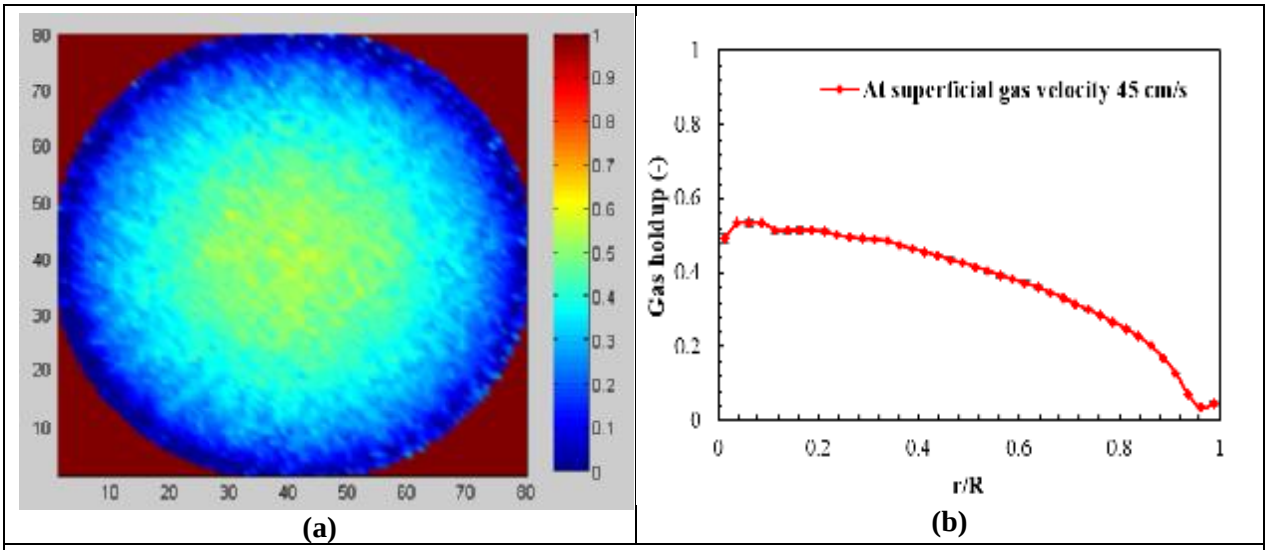
Abstract

Cross-sectional gas holdup distributions and their radial profiles are considered among the key parameters in the design, scale up, modeling, and performance calculation of bubble/slurry bubble column reactors. Gas phase structure drives the liquid circulation and turbulence. Thus, gas holdup distribution governs the rate of heat and mass transfer and consequently the conversion and selectivity of these reactors. Very few experimental studies have been done on a bubble column with internal, however, most of the local measurements of various hydrodynamic parameters are performed by invasive techniques and limited to one size of internals. Therefore, this study focuses on assessing for the first time the effect of internals size on the time averaged cross-sectional gas holdup distributions and their radial profiles via non-invasive Gamma Ray Computed Tomography (CT) technique. A 6 inch bubble column with two different size (0.5 and 1 inch in diameter) of internals covering 25% of the column cross-sectional area (CSA) that represent the internals coverage of the Fischer Tropsch synthesis was developed and used. In this work we used air -water system at 5,15,20,30 and 45 cm/s superficial gas velocity based on the free cross sectional area for the flow which covers bubbly, transition and churn-turbulent flow regimes, respectively. The CT scan images show that the cross-sectional gas holdup distribution for the bubble column without and with internals was symmetry for all ranges of superficial gas velocities. Higher gas holdup in the center of the column was observed in the column equipped with 0.5 inch diameter internals than that with 1 inch and than that without internals for all gas velocities. Moreover, higher gas holdup at wall region was obtained in bubble column with internals as compared to that without internals. The radial profiles of the gas holdup in the column without internals are parabolic shape while they are wavy for bubble column with internals due to the structure of the internals.

Keywords: *Bubble column, Gas holdup, Radial profile, Internals, γ-ray CT.*

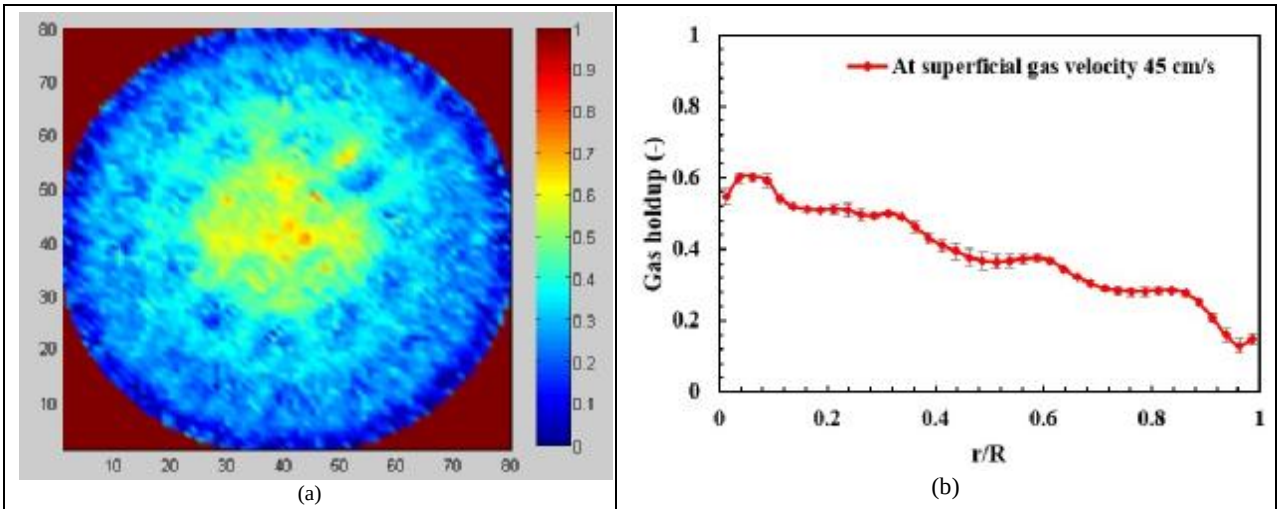
The cross-sectional time-averaged gas holdup distribution which obtained by computed tomography (CT) scan images for an air-water system without internals (tubes) at (L/D = 5.2) using different superficial gas velocities. As a sample of results the Figure 1 shows the gas velocity at 45cm/sec. The parabolic shape is clear for empty column for radial gas holdup profiles.



(a) **(b)**

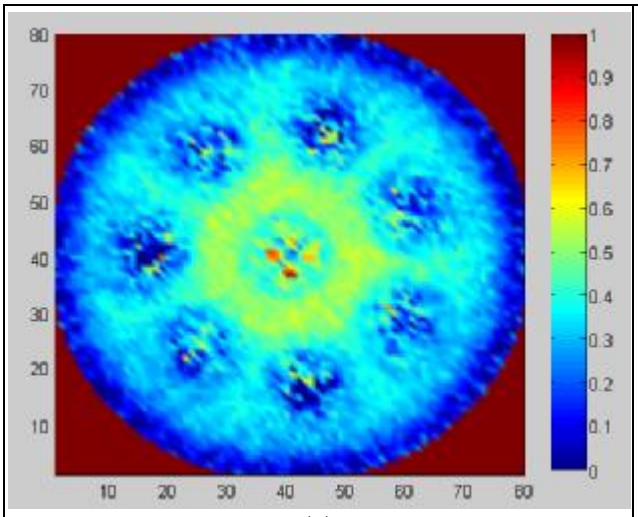
Figure 1: (a) Time average cross-section distribution & (b) Radial gas holdup profile (empty bubble column at 45 cm/s)

The variation in color that obtained the difference between the gas distributions and the water. So, the blue color shows the water and it has the lower value but the yellow (coming red at so high gas velocity) color indicates the gas distribution and it has high holdup values. As shown in figures2-3, there are a significant effect in a cross-sectional gas holdup and their radial profile for bubble column with internals (0.5 and 1 inch) and it has wavy behavior.

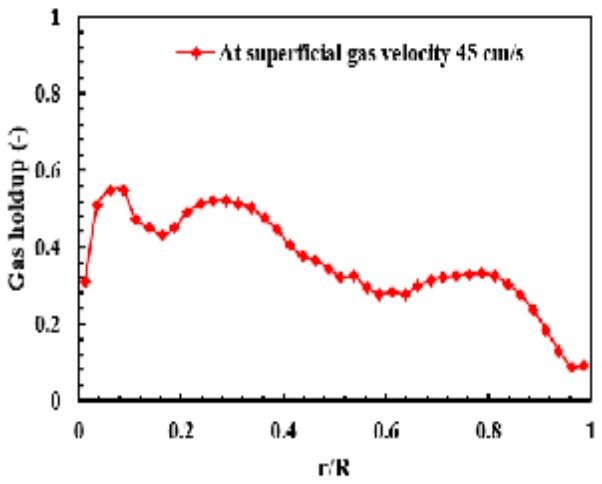


(a) (b)

Figure 2: (a) Time average cross-section distribution & (b) Radial gas holdup profile (bubble column with 0.5 inch internals at 45 cm/s)



(a)



(b)

Figure 3: (a)Time average cross-section distribution & (b) radial profile gas holdup (bubble column with 1-inch internals at 45 cm/s)

Acknowledgments

The authors would like to acknowledge the financial provided; Iraqi Ministry of Education & the Higher Committee for Education Development in Iraq (HCED) and fund provided by Missouri S&T and professor Al-Dahhan to develop the techniques, the experimental set-up and performing the experiments.