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The Impact of Slurry loading on Bubble Properties in Pilot Scale Bubble Column with Industrial Heat Exchanger Internals Structure for Fischer-Tropsch (FT) Synthesis

Hayder Al-Naseri, Joshua P. Schlegel[2], Muthanna Al-Dahhan[1]
[1]Multiphase Flow Reactors Engineering and Applications Laboratory (mFReal)
Department of Chemical and Biochemical Engineering, Missouri University of Science and Technology, Rolla, MO 65409-1230. USA

[2]Mining and Nuclear Engineering, Missouri University of Science and Technology, Rolla, MO,65409-1230. USA
Email: h.alnaseri@mst.edu

Highlights

- **The solid loading effects significantly on the local gas holdup.**
- **Bubble size increases with increasing the solid loading.**
- **Solid loading enhances the liquid circulation.**

1. Introduction

The bubble columns (BC) and slurry bubble columns (SBC) are kinds of the multiphase reactors which have wide range of using in the industry, biochemical, and petroleum including the production of alternative clean fuel via Fischer-Tropsch (F-T) synthesis. Most of the application of bubble/slurry bubble columns involve high catalytic and exothermic reaction. Therefore, the internals (heat exchanging tubes) are used to keep the reaction at desired temperature, but it also effects on the bubble dynamic properties. As well, in industry, the actual bubble column height to diameter (H/D) is usually at or lower than five due to large diameter of the column. The previous studies on bubble column are made at hydrodynamic level (H/D) more than five. Hence there is knowledge gap about bubble properties in region H/D equal or less than five. Therefore, the aim of this work is to study the effects of different slurry concentrations which is mimicking to the catalyst on the axial and radial profile of bubble properties (local gas holdup, chord and interfacial area) in presence heat exchanging tubes that occupying 23.25% of column cross sectional area. The experimental work was carried out in a 0.6 m inside diameter and 3.65 m height of bubble column for an air-water-solid system. The slurry with an average size of 150 µm and density 2500 kg/m^3 was used as the solid/fines phase with 9.1 and 25 % by volume. The superficial gas velocity applied based on the free cross section area available for flow varied from 0.2 to 0.45 m/s which can cover the churn turbulent flow regime. The uniqueness of this work is the bubble dynamic properties are studied in industrial scale and bubble column height to diameter H/D = 5.

2. Methods

The bubble properties have been measured by using the four-point optical fiber probe technique which manufactured in (mFReal) and as shown in Figure 1. The signal was annualized by using [1] algorithm.

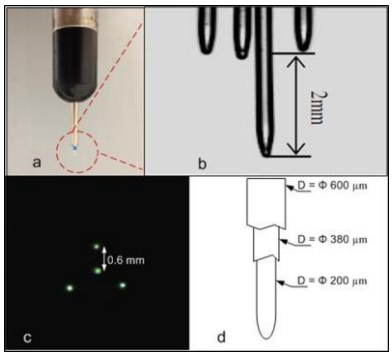

Figure 1. Four-point optical fiber probe

3. Results and discussion

Figure 2 depicts the impact of solid loading on the radial profile of the local gas holdup when operating in the dynamic liquid level H/D = 5. The result shows a good agreement with open literatures results [2]–[4]. that could be attributed by that solid loading will increases the viscosity of liquid (water), and that in role will enhance to greats big bubble size which has high rise velocity. Thereby, reduce the local gas holdup. Other properties will be displayed in the conference time.

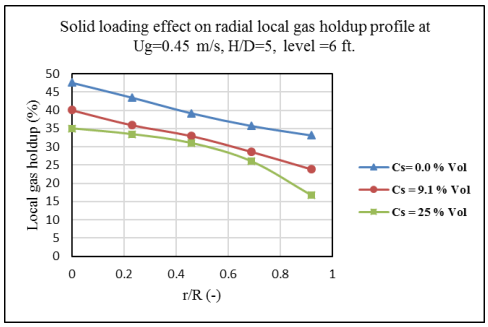

Figure 2. Solid loading effect on the local gas holdup

4. Conclusions

The solid loading effect on the bubble properties at low aspect ratio (low dynamic liquid levels) was investigated by utilized the industrial size bubble column with internal. The results show the following.

- The internals existence shows big influence on bubble properties in both regions (center and wall)
- Internals with hexagonal arrangement affects the bubble properties in both center and wall region
- Significant effect for the solids loading and the dynamic liquid level in bubble column with internals on bubble dynamics in bulk region
- Insignificant effect for the solid loading and dynamic liquid level in bubble column with internals on the bubble dynamics in sparger region
- Expected the low dynamic liquid level and the solid loading enhances the liquid circulation, as result for increase the different in local gas holdup between center and wall region.

5. References

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Keywords

"Slurry concentration; slurry bubble column; Internals; Churn turbulent flow".