Hydrodynamics of Cocurrent Downward Liquid-Liquid Extraction Column

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Abstract

Liquid-liquid extraction (LLE), can be carried out using mixer-settlers, spray columns, pulsed columns, rotary disc contactors, fluidized beds etc. Fluidized bed extractors have been proved to have higher efficiency compared to other systems [1]. The operation in conventional fluidized bed extractors, generally, is through cocurrent upward flow of the phases in the presence of a batch of inert solids. In the present work, a three phase liquid-liquid-solid inverse fluidized bed (LLSIFB) extractor, with countercurrent flow of the liquid phases, is proposed based on our experience [2,3] with countercurrent gas-liquid-solid inverse fluidized bed which has high mass transfer characteristics [4]. Similar to the breakage of bubbles due to collision with particles in three phase IFB, particles are expected to break the drops in LLSIFB extractor leading to higher mass transfer rates.

Information on the contacting pattern proposed in the present study viz. liquid-liquid-solid inverse fluidization is not available in the literature to the best of our knowledge. Since this system is first to be studied, it is proposed that experiments can be conducted in cocurrent and countercurrent modes of operation. In the present work, attention is focused on cocurrent downward LLSIFB. As a first step in understanding the hydrodynamics of this system, it is proposed to collect experimental data on the hydrodynamics of two phase cocurrent downward liquid-liquid system (without the presence of solid particles) on flow regimes, pressure drop and phase holdups.

Cocurrent liquid-liquid downflow hydrodynamic experiments were conducted by keeping kerosene flowrate constant and varying water flowrate. Measurements were taken on pressure drop and holdup for various water and kerosene flowrates moving from kerosene continuous to kerosene dispersed regime. Flow regime map is obtained by determining the transition velocities

at which phase inversion takes place. The variation of the dispersed phase holdup along the regime boundary is also obtained. Effect of water and kerosene flowrates on pressure drop and kerosene holdup is studied.

References:

1. Roszak, J., and R., Gawronski, "Cocurrent Liquid-liquid Extraction in Fluidized Bed," *Chem. Eng. J*. **17**,101-109 (1979).

2. Krishnaiah, K., S. Guru and V. Sekar, "Hydrodynamic Studies on Inverse Gas-liquid-solid Fluidization", *Chem. Eng. J.* **51**, 109-112 (1993).

3. Renganathan, T., and Krishnaiah, "Prediction of Minimum Fluidization Velocity in 2- and 3-phase Inverse Fluidized Beds", *Can. J. Chem. Eng.* **81**, 853-860 (2003).

4. Nikolov.V., Farag.I., and Nikov.I, "Gas-liquid Mass Transfer in Bioreactor with Three-phase Inverse Fluidized Bed," *Bioprocess Eng.* **23**, 427-429 (2000).