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Effect of Solid Properties on Axial Liquid Dispersion in Bubble Column

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Abstract

Experiments were conducted to study axial liquid dispersion coefficient in slurry bubble column of 0.15 m inside diameter and 1.6 m height using perforated plate gas distributor of 54 holes of a size equal to 1 mm diameter and with a 0.24 free area of holes to the cross sectional area of the column. The three phase system consists of air, water and PVC used as the solid phase. The effect of solid loading (0, 30 and 60 kg/m^3) and solid diameter (0.7, 1.5 and 3 mm) on the axial liquid dispersion coefficient at different axial location (25, 50 and 75 cm) and superficial gas velocity covered homogeneous-heterogeneous flow regime (1-10 cm/s) were studied in the present work. The results show that the axial liquid dispersion coefficient increases with increasing superficial gas velocity, axial distance, solid concentration and an inverse relationship with particles diameter.

Keywords: *Axial liquid dispersion coefficient; Axial dispersion; Mixing; Liquid circulation; Backmixing; Slurry bubble column; Bubble column.*

1. Introduction

Slurry Bubble column are multiphase contactors widely used as absorbers, strippers and reactors in chemical, biochemical and petro chemical industrial processes, because of their advantages as simple construction and excellent heat and mass transfer, as mixing is induced only by gas aeration [1,2].

Holdup and axial dispersion of liquid are two important parameters affecting the performance of the gas – liquid contacting devices. Wrong estimations of liquid holdup and axial dispersion lead to an unexpected low performance [1]. Flow distribution in different axial locations is an important aspect of study in gas-liquid-solid three phase fluidized beds [3].

The main drawback is a severe degree back mixing in the liquid phase, which is due to the low liquid flow rate. Back mixing is known to increase drastically when local liquid circulation develops [4]. The dispersion coefficient is expressed in dimensionless form as Peclet number (P_e); its value denoting the degree of back mixing in the column. If Pe=0 back mixing is complete and if Pe=∞ plug flow prevails [1].

Axial and radial mixing of the liquid phase in bubble columns is characterized by using dispersion coefficients that are analogous to the diffusion coefficient of Fick's law diffusion [1]. The estimation of the axial dispersion coefficient of the liquid phase is important for the design and scale up of bubble column reactors [2]. Dispersion coefficients are generally calculated using the measured concentration – time response to input of a nonreactive, nonabsorptive inter tracer in the reactor. The methodology is well established for calculating the axial dispersion coefficient only, as the one dimensional dispersion model that is typically used for the fitting contains axial dispersion coefficient as the only fitting parameter [5]. It is usually assumed that the dispersion coefficient does not depend on the column height [6].

Unlike diffusion, dispersion arises from convective motion of fluid caused by the following main factors : relative movement of the gas and liquid phase; bubble coalescence and break up; the