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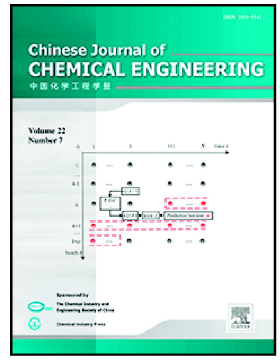

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Fluid Dynamics and Transport Phenomena

Hydrodynamics and bubble behaviour in a three-phase two-stage internal loop airlift reactor☆

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Abstract: Local hydrodynamics of a gas-liquid-solid system, such as bubble circulation regime, gas holdup, liquid velocity and axial profile of solids concentration, are studied in a two-stage internal loop airlift reactor. Empirical correlations for gas holdup and liquid velocity are proposed to ease the reactor design and scale-up. Different bubble circulation regimes were displayed in the first (lower) and second (upper) stages. Increasing superficial gas velocity and solid loading can promote regime transition of the second stage, and the gas holdup of the second stage is higher than that of the lower stage. In addition, the effects of solid loading on bubble behaviour are experimentally investigated for each stage. It is found that bubble size in the downcomer decreases with the presence of solid particles, and bubble size distribution widens under higher superficial gas velocity and lower solid loading.

Keywords: two-stage internal loop airlift reactor, hydrodynamics, bubble, multiphase flow

1. Introduction

Internal loop airlift reactor (ILALR) is an important class of multiphase reactors, and has been widely applied in chemical / biochemical processes, and wastewater treatment.[1-5] Compared with conventional stirred tanks and bubble columns, ILALRs have many advantages, such as simple structure, low energy consumption, low shear rate and excellent interphase contacts. [6-9]

Hydrodynamic parameters including phase holdup, liquid velocity, and mixing time are very important for the industrial design and scale-up of ILALR. Researchers have studied the hydrodynamics of ILALR by experimental and numerical simulating methods[10-13]. In a novel airlift loop photobioreactor, Guo *et al*.[14] investigated effects of the top clearance on hydrodynamics and mass transfer coefficient, and empirical models of these paramters are proposed to control the reactor rationally. Using computational fluid dynamics, Ghasemi and Hosseini [15] simulated the gas holdup in riser and downcomer under different bubble circulation regimes, and found that both the gas holdup differences and ratios between the riser and downcomer change significantly as the regime changes. Bubble circulation regimes can be identified according to changes in the gas holdup or gas holdup ratios. Mendes and Badino [16]

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