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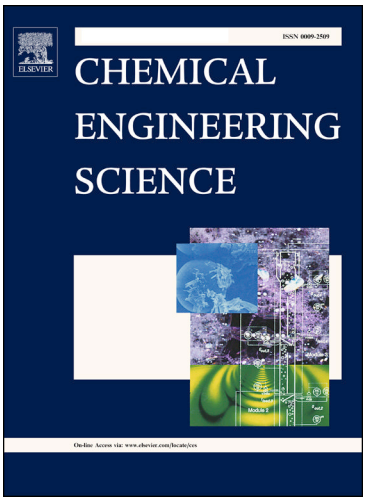

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Residence time distribution of particles in circulating fluidized bed risers

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Abstract: Solids Residence Time Distribution (RTD) in Circulating Fluidized Bed (CFB) risers has received increasing attention due to its vital role in determining the operating condition, particle properties, and reactor geometry in industrial CFB applications. In recent years, various solids RTD experimental techniques and theoretical models have been utilized and proposed to study CFB risers. Some controversial issues, however, also arose in the open publications. By means of exploring the advantages and disadvantages of each available RTD experimental technique and model when they are applied to particles in CFB risers, this study discussed the primary causes leading to the huge discrepancy in magnitude of solids dispersion coefficient and Peclet number, which can achieve 4 orders or span from 1 to 100. On the basis of the massive experiment data collected from the literature, the variations of average residence time, Peclet number and dispersion coefficient of solids with superficial gas velocity, solids mass flux and solids concentration were presented. By applying the transition of flow regime in CFB mode, we provided a helpful way to explain some existing contradictions in the reported effects of operating conditions on solids RTD. The possible reasons were also summarized to clarify why some researchers measured a double- or multi-peak solids RTD curve and the others could not in a similar situation.

Keywords : Solids residence time distribution, Circulating fluidized bed, Peclet number, Solids dispersion coefficient, Bimodal residence time distribution curve

1. Introduction

The prediction and control of particle mixing process in the riser is crucial for the design and operation of gas-solids circulating fluidized bed (CFB) reactors, due to its vital role in maximizing the profitability of target products. Solids residence time distribution (RTD), reflecting the degree of internal recirculation of particles in the riser, therefore becomes a primary indicator of particle mixing process on a macroscopic scale. In CFB reactors, different solids RTD curves are required by different kinds of reaction processes in order to achieve the highest product yield. On the one hand, for catalytic gas-phase reactions (e.g., fluid catalytic cracking) where particles serve as both a heat transfer medium and a catalyst, a short contact time between gas and solids is often desirable because of the high reaction rates, and backmixing should be avoided as far as possible. Then solids RTD configuration towards plug flow should be promoted. On the other hand, for gas-solids reactions

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