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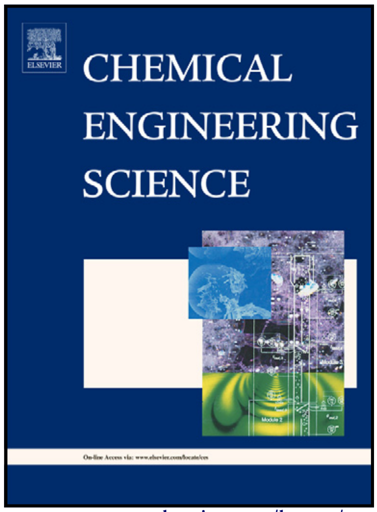

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Characterization of pressure fluctuations from a gas-solid fluidized bed by structure density function analysis

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Hydrodynamics in a gas-solid fluidized bed reactor were studied based on differential pressure signals measured over several height intervals at different temperatures. Structure density function analysis was utilized to study the dynamics of multi-scale structures. An amplitude division method based on the Gaussian distribution and the Kolmogorov-Smirnov test was developed to divide the structure density distribution of pressure signals into three characteristic regions linked to: I. fine-scale structures, II. small-scale structures, and III. large-scale structures. The frequency of large voids and the uniformity of multi-scale flow structures were quantitatively characterized by parameters $SDF_{b,II}$ and K_{SDF}, respectively. K_{SDF} reached a maximum when large bubbles or slugs dominated the flow, then decreased until it remained almost constant in the turbulent flow regime. Structure density function analysis showed that increasing the operating temperature enhanced the transition of flow regimes, while the transition direction was determined by the superficial gas velocity. Increased gas velocity and decreased minimum fluidization velocity at higher temperature were major factors promoting earlier flow regime transitions. The frequency of large-scale structures decreased at higher temperature for the same flow regime.

Fluidized bed, Pressure fluctuations, High temperature, Structure density function, Multi-scale.

1 Introduction

Fluidized bed reactors have been extensively used in industrial processes such as catalytic cracking, reforming of hydrocarbons, biomass and coal gasification (Grace et al., 2005; Rakib, 2010). With hydrogen separated in-situ by selectively-permeating membrane panels, high-purity hydrogen can be produced in a fluidized bed reformer at moderate temperatures (Rakib, 2010). Since the performance of a fluidized bed reactor depends greatly on the flow dynamics in the bed, fluidized bed hydrodynamics have been studied by various methodologies.

Pressure fluctuations are significant indicators of the hydrodynamics in gas-solid fluidized beds. Due to their ease of measurement and readily available analysis tools, pressure fluctuations can

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