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Bulk oscillation and velocity wave propagation in a vibrated fluidized bed at minimum fluidization conditions

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Abstract

The present work experimentally characterizes the behavior of the bed bulk and the solids velocity in a vertically vibrated pseudo-2D fluidized bed operated at minimum fluidization conditions. Measurements are undertaken combining Digital Image Analysis (DIA) and Particle Image Velocimetry (PIV). Vibration at different amplitudes and frequencies is applied to the bed by the use of two vibro-motors symmetrically disposed at both sides of the bed vessel. The results show that both the center of mass of the bed and the bed surface oscillate with a frequency equal to that of the bed vessel. The bed surface oscillates in opposition of phase with the bed vessel, which reflects a cyclic compression and expansion of the bed bulk. The average solids velocity at each oscillation phase clearly shows that there exist a compression wave, produced by the impact of the bed bulk with the gas distributor, and an expansion wave, produced by the expansion of the bed bulk. Both waves travel upwards the bed bulk perturbing the velocity of particles along the bed height. The waves span all the bed width and separate the bed bulk into two clearly distinguishable regions with different relative velocities. When the particles belonging to the region under the wave move upwards, the particles in the region above the wave move downwards and vice versa. The results also reveal that the compression wave generated at the bottom of the bed propagates at a velocity similar to the reported velocity of sound inside a fluidized bed. Far from the distributor, this wave velocity resulted to be nearly independent of the vibration amplitude and frequency for the range of conditions tested. These results can be useful for the understanding of the behavior of particles and bubbles in vibrated fluidized beds.

Keywords: Fluidized bed, Vibration, Bulk, Pseudo-2D, PIV, Wave

1. Introduction

Many key operations in the chemical, energy and process industries rely on gas-solid fluidized beds because of their high contact area, homogeneity, heat and mass transfer rates and solids handling capabilities [1]. Among these operations are fluid catalytic cracking (FCC), gasification, combustion of solid fuels,

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