2013

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IDENTIFICATION OF BED ZONES AND FLOW REGIMES IN SINGLE AND MULTIPLE SPOUT-OPERATED BEDS BY DIGITAL IMAGE PROCESSINGAND PRESSURE PROBES

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Fluidized beds have a huge variety of applications in process industry. As the desired properties of the fluidized bed can strongly vary according to the process it is crucial to have proper knowledge of the flow regimes within the fluidized bed.In typical large scale applications in industry, fluidized beds are operated with one or more spout sections without background fluidization. In such cases it is necessary to minimize dead zonesbetween the spouts to avoid sticking of material in these areas. Spout operated beds also show some mixed regimes (like e.g. spoutswithin a bubbling bed). These mixed regimes might appear only within close borders of superficial velocity or bed height. Therefore, it is helpful to have regime maps (like presented by Link et al. (1)) or correlations to predict the bed behaviour for certain boundary conditions correctly.

Theaim of this experimental study is to identify the different flow regimes and bed zones via digital image processing of high-speed video data and pressure measurements on the bed. Experiments were conducted in a lab-scale 2D bed with a cross-section of 0.15 x 0.02m and different particle diameters of 0.5, 2 and 4mm.

After a general visual classification of the flow regime (Fig. 1), the recorded image sequences were processed in Matlab to identify the different bed zones. Calculating the mean images and pixel variance images allows identification of the dead zones and annular regions for the spout bed regimes (Fig. 3). In the bubbling zones a Lagrangian object tracking (cf. Busciglio et al. (2)) calculates equivalent bubble diameters and bubble rise velocities. In addition, a PIV (particle image velocimetry) cross correlation can calculate particle velocities. The basic idea for all processing steps is that they work equally on experimental images and post-processing images from CFD and CFD-DEM coupled simulations. This provides a good basis for data comparison and evaluation of simulation models.

From the pressure drop information the frequencies of spout collapsing or slugging can be extracted via FFT (Fast Fourier Transform). In the case of an internal jet with bubbling bed the bubble eruption frequency can be detected (Fig.2).

The observed values for minimum spout velocities and jet penetration length match quite well with correlations from literature (e.g. Bi (3)).

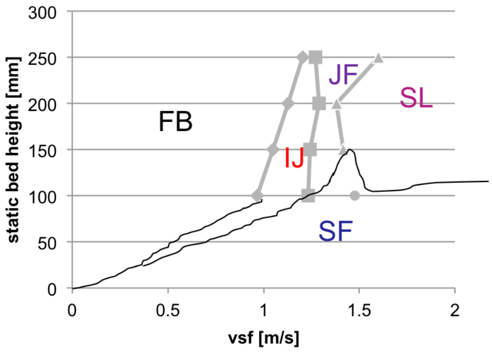


Figure 1: Regime map for 2mm particles.

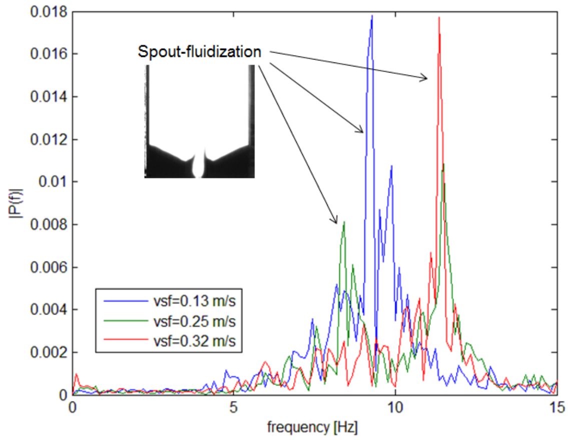
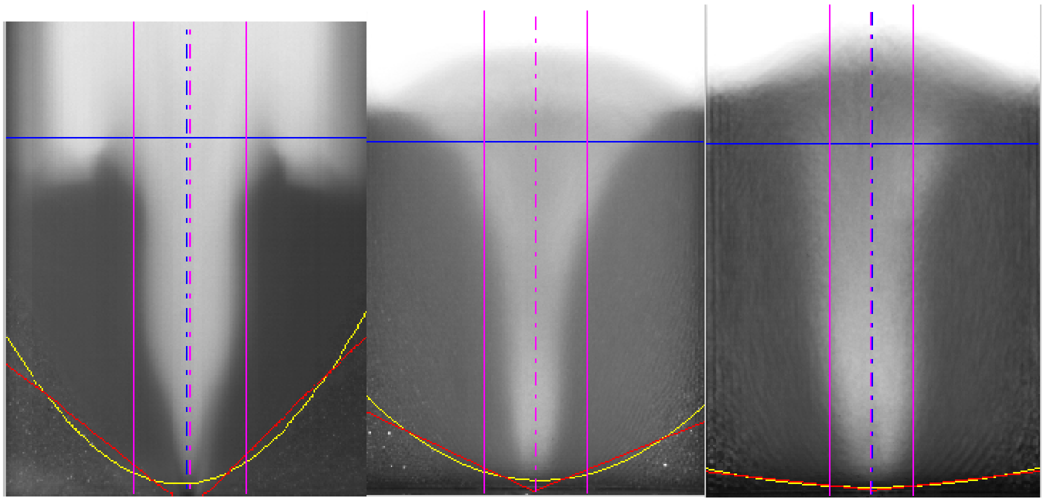


Figure 2: Fouriertransform of pressuresignals.



a) b) c)

Figure 2: Bed zones in spout-bed regime for a) 0.5mm, b) 2mm and c) 4mm particles. The blue line marks the static bed height, the magenta linesidentify the spoutregionsand the yellowand red lines mark the dead zones via square andlinearinterpolation.

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