Modelling of Gas-Solid Flows with Cohesive Powders

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ABSTRACT

Fluidized beds are widely used in the chemical and process industries for a large variety of processes. Good understanding of the transport phenomena in these systems is of great importance to improve design and scale-up procedures [1]. The focus of the work is on the investigation of interaction between cohesive particles and interstitial gas by means of non-resolved CFD-DEM simulation and the experimental investigation of the spout bed, where such interaction can be observed.

Gas-solid flow heterogeneity, such as particle clustering, can have significant impact on interphase transport properties. It is of interest to establish which parameters have influence on the channel properties and distribution, and to what extent, so a correlation can be derived as a function of the properties (such as fluid velocity and viscosity, solid volume fraction etc.).

Experimental measurements are conducted in a lab-scale 2D fluidized bed test facility. The main purpose of the experiment is to obtain the information on the overall dynamics of the spout bed with dry and moisturized particles. With wet particles, it is expected to observe the effects related to the particle cohesion, such as channeling and formation of particle clusters. Beside images captured by high speed camera, data will be obtained from pressure sensors to get pressure drop through the bed. Inlet velocity is controlled by controlling the fan power and measured with the pitot tube.

The recorded images were processed in MATLAB using a script for digital image processing. For each experimental run, an initial snapshot of the bed is captured and initial bed height is calculated. Mean images and pixel variance images are calculated and such images provide a reproducible result that can be compared with previous measurements. Image processing also allows the identification of different zones inside the bed. In the mean images, it is possible to observe central spout, blurred moving annulus region and sharp dead zones.

The problem will also be addressed by non-resolved CFD-DEM simulation. Particles are modeled with the Discrete Element Method (DEM), where one integrates Newton's law of motion for each particle under the forces due to the surrounding particles. This method is based on the use of an explicit numerical scheme in which the interaction of the particles is monitored contact by contact [2, 3]. CFD-DEM simulations allow the incorporation of single-particle properties and modifications of their interaction, and are as such suitable for this study. Numerical simulation can be validated by the experimental measurement.

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