Experimental and numerical investigation of the behaviour of complex shaped particles in a model scale fluidized bed

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ABSTRACT

Fluidized beds are widely used in process and energy engineering as they possess favourable characteristics such as fast mixing, uniform temperature distribution and high gas-solid contact. The pressure drop is a key parameter for the characterization of a fluidized bed and is subject to fluctuations. Besides experiments and correlations simulations can be used for the prediction of the pressure drop. With growing computational power numerical simulations with a coupled discrete element method (DEM) and computational fluid dynamics (CFD) approach recently became feasible for the simulation of fluidized systems. Previously most simulations were conducted with spherical particles only, which cannot precisely predict the behavior of real, complex shaped particles like encountered in biomass. With the introduction of new submodels [1, 2] to the DEM-CFD which consider the particle shape and orientation it has become possible to simulate fluidized beds with complex shaped particles [3–5]. As there is an ongoing discussion about the validity of certain submodels, experimental validation is necessary. In this study differently shaped Geldart D particles, including spheres, cylinders and cuboids were experimentally and numerically examined. The minimum fluidization velocity as well as the pressure drop were determined. An automated detection of particle orientations for image footage of the fluidized bed was developed and used to analyse the orientation of particles in the bed. Results were compared with numerically gained data. The simulations were able to predict the behaviour of the fluidized bed for most particles with reasonable accuracy. It was found that DEM-CFD simulations are a useful tool for the analysis of fluidized beds as they are cheaper and more flexible than experimental studies.

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