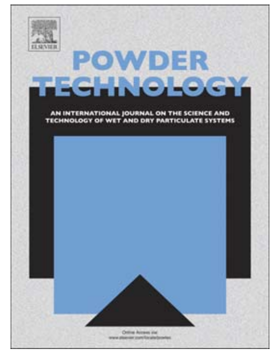
Accepted Manuscript



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PII: S0032-5910(17)30141-9
DOI: doi: 10.1016/j.powtec.2017.02.015
Reference: PTEC 12353

To appear in: *Powder Technology*

Received date: 8 August 2016
Revised date: 7 December 2016
Accepted date: 9 February 2017

Please cite this article as: Peter Ostermeier, Annelies Vandersickel, Stephan Gleis, Hartmut Spliethoff, Three dimensional multi fluid modeling of Geldart B bubbling fluidized bed with complex inlet geometries, *Powder Technology* (2017), doi: 10.1016/j.powtec.2017.02.015

Three dimensional multi fluid modeling of Geldart B bubbling fluidized bed with complex inlet geometries

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ABSTRACT

The hydrodynamics of dense solid-gas fluidized beds are strongly affected by the geometry of the bed and the properties of the bed material. The objective of this study is to numerically investigate the influence of the following aspects on these fluidization hydrodynamics: three dimensional versus two dimensional modeling, wall boundary conditions, particle size distribution, particle sphericity and inlet geometry of the nozzle floor. Simulations are carried out in a fully Eulerian framework to describe the gas (air) and solid phases (corundum, Geldart B, mean particle diameter 197 µm, sphericity 0.82). Analysis of particle-wall-interactions is performed by variation of the specularity coefficient φ, which characterizes the tangential momentum transfer from the particles to the wall. Different particle sizes can be accounted for by defining several granular solid phases, each representing one particle diameter respectively. The sphericity factor ψ is incorporated into the drag model to include the effect of the non-spherical shape of the particles on the fluid-solid-interactions. Comparison of simulation predictions and experimental data from a cylindrical lab-scale test rig (inner diameter 140 mm, nozzle floor) show good agreement with respect to externally accessible values (expansion, pressure drop, bubbling dynamics and solid circulation at the wall). Internal phenomena are validated by comparison with empirical correlations and data measured inside the fluidized bed. Additionally, the arrangement of the nozzles of the inlet geometry is modified to prove the predictive capability of the model. Results show that all of the aforementioned aspects strongly affect the hydrodynamics of the numerical simulation and therefore should be considered when modeling fluidized beds with non-spherical widely-distributed particles and complex inlet geometries.

Keywords: Fluidized bed; Computational Fluid Dynamics; Eulerian approach; Kinetic Theory of Granular Flow; Hydrodynamics