Long Term Coating Predictions in a Large Scale Wurster Coater Based on CFD DEM Simulations

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Industrial fluid-bed coating operations involve the flow of over 100 million beads in a large-scale Wurster-coating device. Experimental measurements available from such large scale operations are limited as only few beads (10-100) can be analyzed. Coupled Computational Fluid Dynamics (CFD) - Discrete Element Method (DEM) simulation can help to create a better understanding of the process and identify key parameters that influence coating-thickness uniformity. Earlier simulation were limited to simulate laboratory cases with limited amount of particles (< 1 million particles). With recent advances in computational hardware and software, including graphics card (GPU) based processing, simulations of larger industrial-scale systems can be attempted.

With our GPU-enabled code, "eXtended Particle System", simulation of ~20 million beads is realistically possible. In the presently-simulated Wurster-coater process the number of beads is over 216 million for a work load of 40 kg. Thus the number of particles is an order of magnitude higher than can realistically be simulated. Therefore, we exploit the azimuthal symmetry of the geometry to simulate a smaller 3-D sector (pie-slice) of the full unit. Single-phase CFD simulations are performed to determine the air flow distribution through the distributor plate, which is subsequently used as the inlet boundary conditions for the CFD-DEM models. Comparison of a 30° and a 90° slice showed good agreement regarding the particle flow and process parameters (e.g. Residence time distribution, particle velocity).

The influence of controllable process parameters, such as air-flow rates and material properties (particle size distribution, density etc.) are virtually investigated using these CFD-DEM simulations. The residence time distributions of the beads in various zones (e.g., inside and outside the Wurster column) for different conditions are explored in this work. These residence time distributions, especially inside the Wurster column, provide qualitative and quantitative measures of the inter-bead coating uniformity. Residence time distribution and cycle time information for various regions in the Wurster coater are used to create long term coating prediction models. Results of these long term coating models will be validated using experimental data of the coating thickness. These models can then be used to provide recommendations of favorable process settings.