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IFPRI Review Brief
Modeling Gas-Particle Transport in Mills and Classifiers

The International Fine Particle Research Institute wishes to commission a comprehensive critical literature review of strategies and capabilities for modeling fluidized particle flow in mills and classifiers, and by extension any fluidized particle processes with a complex geometry.

The breakage of particles in mills is conveniently deconstructed into a material function that describes how a particle breaks under specified stress and a machine function that describes the magnitude and frequency of stress events experienced by particles in the mill. The stress events can be interparticle and particle-surface (static walls or moving internals) collisions. In most mills, particles are transported pneumatically, and the complex turbulent two-phase transport of particles in the mill determines the magnitude and frequency of these interactions and the mill hold-up (and residence time). Crucially, these determine the overall energy efficiency of the milling process, which is simultaneously energy intensive and inefficient. Similar considerations apply to the efficiency of particle classifiers.

In this context, we are interested in a critical review of the state of the art in modeling turbulent gas-solid flows with specific application to simulating the flow dynamics in mills and classifiers. Particular emphasis should be made on the fidelity of models for calculating particle stress, as this is critical to application to simulation of mill performance (both particle breakage and mill wear). The review should consider mills and classifiers with fixed internals (e.g. jet mill, cyclone) and those with moving internals (e.g., pin mill, rotating basket classifier). It should discuss how the models incorporate particle morphology (size distribution and shape) how the models are calibrated and validated. Finally, models should be evaluated in terms of their industrial application, including their development status (commercially available, in development, open- or closed-source) and computational requirements.

The scope of the review is limited to dry systems in which transport is inertial, not Brownian. Particle shape should be considered, as industrially relevant particles are almost never spherical; shapes of interest include ellipsoids, polyhedral, fibers, platelets, and aggregates. Ball mills are out of scope, as the particle stress events are not solely controlled by the dynamics of gas-particle transport. While not strictly in scope, insight into the application of the transport models to predicting wear is also of interest.