Advanced computational modeling of milling with applications

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Modeling of milling has advanced dramatically these last 30 years or so, primarily as the result of development and popularization of the discrete element method (DEM), besides proper understanding of particle breakage. The empirical and phenomenological models of the past can now, finally, be replaced by advanced computational models that allow connecting the response of individual particles and machine design and operating variables to macroscopic performance indices such as mill throughput, product size distribution and specific energy consumption. The presentation reviews the UFRJ mechanistic mill model, a microscale population balance model which has been successfully used to model and simulate media mills, including different tumbling mills, stirred mills and planetary mills. The status on the application of techniques to describe the fluid phase, namely CFD and SPH, is analyzed. The presentation also reviews applications to non-media mills, such as hammer mills, in this case using the Tavares Breakage Model in DEM. Challenges that include breakage characterization and application to non-brittle materials, and future trends, including model implementation in plant flowsheet simulators and the role of AI, are analyzed.