Analysis of particle breakage under impact milling using a bonded discrete element method

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ABSTRACT

Milling to achieve a desired particle size reduction is widely recognised to be an energy-intensive and highly inefficient process. Despite many attempts to interpret particle breakage during a milling process, the grindability of a material in a milling operation remains aloof and the mechanism of particle breakage is still poorly understood. Milling by means of impact such as a centrifugal pin mill comprising alternate rotating and static pin rings is commonly used in some industries. To predict milling performance in an impact pin mill it is necessary to study the breakage behaviour of particle subject to the impact regimes in the milling process which can be very complex. As a precursor to provide a better understanding, a DEM simulation of single particle breakage subject to the velocity regimes pertaining to an impact mill is conducted to evaluate the breakage propensity which is then compared to experimental results. A recently developed new bonded contact model by Brown et al (2014) that was based on the Timoshenko beam theory considering axial, shear and bending behaviour of the bond is utilised. The breakage behaviour of particle from chipping to fragmentation was investigated under low, medium and high impact velocities. The result provides an improved understanding of particle breakage characteristics which helps to shed light on material grindability in the context of prevailing stressing modes during an impact milling operation.

Keywords: Particle breakage, Impact pin mill, DEM simulation, Bonded model.

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