Simulation of charge-slurry interactions in tumbling and stirred mills

Tumbling mills have been used for the last 100 years with very little change in their basic design. While tumbling mills are relatively simple to operate and maintain they are one of the most energy intensive and least energy efficient steps in minerals processing. This has led to concerted effort to both improve the efficiency of tumbling mills, as well as to develop novel milling technologies, such as the stirred mills that have become popular for fine grinding in recent years.

To be able to develop better mills it is important to be able to model and simulate their behaviour. A simulation technology that has been applied to this problem by many researchers is DEM (Discrete Element Method). While this method has led to better understanding of milling, it is restricted to the simulation of the charge only. In real mills there is typically a significant difference between the behaviour of dry and wet mills and thus it is important to incorporate the effect of the slurry on the milling behaviour.

In the past attempts have been made to couple DEM and CFD in order to simulate mills, but this has typically involved simulating the fluid at a similar resolution as the particles, with the interactions being via drag and buoyancy relationships. The validity of these relationships in mills is questionable as they are typically derived from the behaviour of individual particles falling through a fluid, which is far from the beds of sheared highly interacting particles encountered in a mill.

In this project a new massively parallel SPH-DEM simulator will be used. This simulator scales well enough that it is feasible to have the fluid resolution an order of magnitude or more greater than that of the DEM particles and thus directly simulated the fluid motion between the particles, with the drag and buoyancy being emergent properties rather than imposed relationships. This simulator will be used to investigate the impact of slurry properties on the milling behaviour and how this is influenced by both the charge properties and the mill design in both tumbling mills and stirred mill geometries.

These results will be compared to the measured behaviour obtained by tracking both the charge and slurry motion using PEPT (Positron Emission Particle Tracking) imaging.

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