Fluid-Particle Energy Transfer in Spiral Jet Milling

Selasi Dogbe*, Mojtaba Ghadiri*, Ali Hassanpour*, Colin Hare*, David Wilson[†], Richard Storey[†] and Iain Crosley[¥]

[*] School of Chemical and Process Engineering
University of Leeds
Leeds LS2 9JT, UK
e-mail: pm08smcd@leeds.ac.uk, web page: http://ghadiri-group.leeds.ac.uk

[†] AstraZeneca,
Macclesfield, UK
e-mail: david.wilson4@astrazeneca.com, web page: http://www.astrazeneca.co.uk

[¥] Hosokawa Micron
Runcorn, UK
e-mail: icrosley@hmluk.hosokawa.com, web page: http://www.hosokawa.co.uk

ABSTRACT

Spiral jet milling is a size reduction process used to reduce particulate solids to micron sizes with narrow size distributions. The process is driven by the fluid energy of high velocity gas jets, which promote inter-particle and particle-wall interactions which are responsible for size reduction. The process is energy intensive, but inefficient. The underlying mechanisms for size reduction in the mill are also not very well understood. The optimum grinding conditions are still currently found by trial and error experimentation.

In this work, the Discrete Element Method (using EDEM software) coupled with Computational Fluid Dynamics (using FLUENT software) is used to investigate the dynamics of fluid and particle motions within the mill, in particular the effects of different parameters on the particle collisional behaviour in a spiral jet mill. These include the particle concentration in the grinding chamber, the particle size, and the fluid power input. The normal and shear stresses present in the system are also analysed to investigate their relative contributions to particle breakage. Results showed a dominance of interparticle energy transfer compared to particle-wall, an inverse relationship between particle concentration and the particles' relative collisional velocity, and a direct relationship between fluid power and particles' relative collisional velocity. Normal stress was also found to be a greater contributor to breakage than shear stress.