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Paul W. Cleary

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Particulate Mixing in a Plough Share Mixer using DEM with Realistic Shaped Particles

Paul W. Cleary

CSIRO Mathematics, Informatics and Statistics, Private Bag 33, Clayton South, 3168, Australia

E-mail: Paul.Cleary@csiro.au

Abstract

Mixing of granular materials is important in a broad range of industrial processes ranging from blending in pharmaceuticals, plastics, household products and food processing through to mineral processing. A plough share mixer is one machine used for such particulate mixing. The Discrete Element Method (DEM) is used to understand the performance of a laboratory mixer when mixing elongated particles (rice grains). Previously, such modelling approximated the particles as spherical which led to too shallow an angle of repose for the bed surface. Using a much more realistic representation of the particle shape leads to better representation of the bed strength due to increased numbers of contacts with neighbouring particles and the inability to fail by in-situ rolling. This leads to strong differences in process performance including a reduction in the fraction of the bed influenced by the blade, large increases in the size of the dead zones at each end of the mixer, steeper angles for the interfaces between the dead zones and the active flowing region, higher surface angles of repose, reduced axial transport and strong reductions in the mixing rate. Comparison to a PEPT experiment for this mixer is revisited, and the level of agreement is improved when using a more realistic particle shape. The material flow and the mixing rates are shown to be insensitive to the coefficient of restitution but mildly sensitive to the friction coefficient of the granular material being mixed. Lower friction means that the bed has lower mechanical strength and the volume of material influenced by the blade increases slightly leading to modestly faster mixing. Together these findings demonstrate the critical importance of particle shape to mixing process performance and the importance of including this in DEM modelling.

Keywords

DEM, super-quadric, non-round shape, plough share mixer, mixing, PEPT.

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