EVALUATION OF DEM MIXING MODELS USING THE MAXIMUM ENTROPY CONCEPT

S. Zigan[1], A. Adekunle[1], A.Ghaderi[2] and T.A.H. Simons[3]

[1] University of Greenwich, School of Engineering Central Avenue, Chatham Maritime, Kent, ME4 4TB, s.zigan@gre.ac.uk and http://www2.gre.ac.uk/
[2] Telemark University College, Kjølnes Ring 56, 3918 Porsgrunn, Norway, s.ali.ghaderi@gmail.com and http://www.hit.no/eng
[3] University of Braunschweig, Volkmaroder Str.5
38104 Braunschweig, t.simons@tu-braunschweig.de and https://www.tu-braunschweig.de/

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Scientist and practitioners alike are looking for ways to predict and optimise the performance in granular mixers for industrial applications. The performance of mixers determines the quality of granular based products. The quality of the granulated products is fluctuating because of the occurrence of segregation during the mixing process. Segregation is driven by different mechanisms such as kinetic sieving, percolation and diffusion effects.

Segregation effects in mixers are studied experimentally and using simulation approaches such as discrete element modelling (DEM). Experiments and simulation approaches are very powerful tools investigating the extent, the rate and the propensity of segregation. Researchers studying mixing processes in experiments are mainly looking at the macro state of the powder bed after it reaches steady state in the mixer. Researchers applying simulation approaches such as DEM are trying to reproduce the physics of the powder bed on a micro scale looking at forces between particles and the mixer at very short time scales. Now, comparing results from experiments and simulations to provide a quantitative conclusion about the state of mixing or segregation is challenging because of the different length/ time scales of the experiment.

On the micro scale the particles follow a random path which can create many different microstates of mixing in the powder. Different microstates can lead to the same macro state of powder mixing observed in the experiment. Consequently, an evaluation tool needs to be

applied which evaluates the number of possible microstates in the mixer and then provides a number which gives in indication of how well the bed is mixed. A large number of micro stages is indicating a high degree of freedom for particles to move around in the powder bed. A low number of micro stages is indicating that segregation occurs in the powder bed. The number of micro stages can be expressed by introducing the concept of maximum entropy.
Maximum entropy is an expression to form conclusions based on inductive interference satisfying constrains of the mixing function which shows a finite discrete distribution with identical maxima.

This research is providing a framework using the maximum entropy concept to e.g. evaluate a DEM simulation model with experimental data obtained in a 10 l agitated mixer. One finding was that there was a good agreement between the DEM simulation model and the experiments. Maximum entropy was successfully used to evaluate the simulation model. This could be a fruitful way of introducing an evaluation procedure for simulations using the maximum entropy concept.