Numerical Investigation of Agitated Beds Homogenization in Dependence on Bed Depth via DEM.

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Granular materials such as packed beds present a unique state of matter and are currently in the urgent need of developing the proper theoretical basis for its basic aspects. The particle mixing is therefore studied comprehensively and a lot of equipment with uncertain internal behaviour is used. In contrast to mixing of continuous liquid phase where behaviour is relatively well known, in case of description of discrete phase the present state of affairs is rather unsatisfactory. The process of homogenization is mainly studied at macroscopic (equipment) scale and, therefore, results can be used for describing and understanding only the mixer type of particular interest. The studying of homogenization from the first principles, which can be taken for general description, remains still poorly understood due to its complexity.

One of the possible ways for mathematical modelling of mechanical interactions between particles in granular systems is based on discrete element methods (DEM). In DEM models each particle is represented as a sphere with defined properties and is tracked individually. The motion of each sphere is calculated as a sum of external (gravitational force) and collision forces (caused by the collision of particles between each other or by the contact of the particle with the wall). Resulting translational and angular velocities than characterize the movement of the particles. In this contribution open source DEM particle simulation software LIGGGHTS was used. Collision forces are there modelled by the soft-sphere approach with the Hertzian collision model.

As an application we studied agitated particle beds (packed from glass spherical particles of two colours – packed vertically and horizontally) mixed in a vertical cylindrical mixer with two opposed flat blades. Dependence of spatiotemporal dynamics on geometrical aspects (blade rotational speed and packed-bed depth) was analysed at microscopic scale by the complex flow patterns with different nature. At macroscopic scale degree of homogenization was characterised by commonly used global mixing characteristics such as Lacey and Poole mixing indexes. These indexes represent overall degree of homogenization and therefore should be used for prediction of suitability of chosen geometrical aspects. In addition macroscopic and microscopic approaches were connected and from flow pattern observation optimal conditions for the best homogenization were predicted.