The Effect of Collision Parameters and Particle Diameter on Dynamics and Mixing Process of Granular Material by using Discrete Element Method.

Kozakovič, M.

2018

The effect of collision parameters and particle diameter on dynamics and mixing process of granular material by using Discrete Element Method

[1]M. Kozakovic, [1]A. Parikova, [2]T. Travnickova, [3]M. Kohout, [1,2]J. Havlica
[1] University of Jan Evangelista Purkinje, Ceske mladeze 8, 400 96 Usti nad Labem, Czech Republic, email: martin.kozakovic@gmail.com
[2] Institute of Chemical Process Fundamentals of the CAS, v. v. i., Department of Multiphase Reactors, Prague, Czech Republic
[3] University of Chemistry and Technology Prague, Technicka 5, 166 28 Prague, Czech Republic

Mixing of granular material as a field of technology is widely used in the pharmaceutical, chemical, food, cosmetic and civil engineering industry. Many challenges persist in the analysis of various granular flow problems. Nowadays, we are able to face these challenges and computer simulations seem to be a very useful tool in the process of understanding [1].

This contribution is focused on mixing dynamics and homogenization process of the granular material via Discrete Element Method. The simulation is conducted by using open-source code LIGGGHTS. The mixing process of approximately forty-two thousand monodisperse spherical particles is simulated in a vertical cylindrical mixer with two opposed flat blades. The rake angle of blades is 45°. The mixing process was studied with varying blade rotational speed (from 15 rpm to 540 rpm), coefficient of friction (from 0.05 to 0.9), coefficient of restitution (0.1 to 1.0), Poisson's ratio (0.1 to 0.45) and particle diameter (2 mm, 4 mm). Each of simulated processes was performed for 80 stirrer revolutions.

Based on knowledge of position, velocity and force interactions among the particles, the integral characteristics, 1D, 2D and 3D velocity and concentration fields were investigated. The dynamics of the system is also analyzed by surface level deformation, movement of the particles in specific regions and force-chain visualizations. The Lacey mixing index was used to measure the quality of mixing process (level of homogeneity) for two initial loading configurations (radial "side by side", axial "bottom up"). Due to the complexity of studied system, new integral characteristic for qualitative evaluation of the homogenization level was suggested.

Obtained results show that coefficient of friction significantly affects the dynamics of the system as well as the homogenization process. With increasing coefficient of friction the tangential motion is slower, radial and axial movement grow. Increasing coefficient of friction also supports the formation of secondary flow (recirculations) and reduces the rotation period of these dynamical structures. These features support the homogenization [2], see Fig. 1. The magnitude of normal forces of mutual particle interactions are also enlarged by higher values of coefficient of friction. On the other hand, the effect of coefficient of restitution and Poisson's ratio on the granular dynamics and homogenization is negligible.

Acknowledgements:
This research was supported by the grant UJEP-SGS-2018-53-002-2.

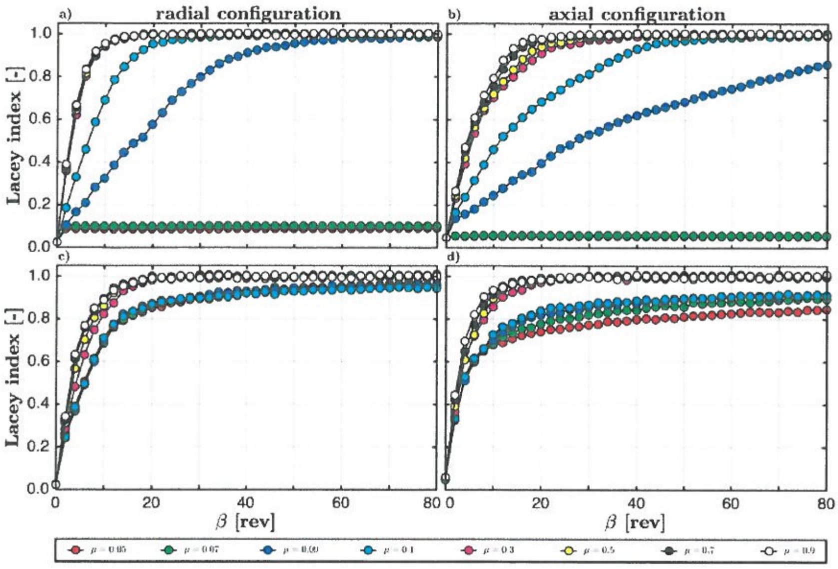

Figure 1: Lacey's indexes depending on the number of revolutions: a) initial radial loading for 15 rpm, b) initial axial loading for 15 rpm, c) initial radial loading for 540 rpm, d) initial axial loading for 540 rpm.

References:

[1] BARCZI, Tomas, Tereza TRAVNICKOVA, Jaromir HAVLICA and Martin KOHOUT. Effect of Bed Depth on Granular Flow and Homogenization in a Vertical Bladed Mixer via Discrete Element Method. *Chemical Engineering & Technology* [online]. 2015, 38(7), 1195-1202 [cit. 2018-05-28]. DOI: 10.1002/ceat.201400686. ISSN 09307516.

[2] HAVLICA, J., K. JIROUNKOVA, T. TRAVNICKOVA and M. KOHOUT. The effect of rotational speed on granular flow in a vertical bladed mixer. *Powder Technology* [online]. 2015, 280, 180-190 [cit. 2018-05-28]. DOI: 10.1016/j.powtec.2015.04.035. ISSN 00325910.