DEM Simulations of Particle Dynamics in a Spheronization Process to describe the Pelletization Mechanisms

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ABSTRACT

Spherical granules produced by a combined extrusion and spheronization process are highly interesting for pharmaceutical applications. The rounding of the cylindrical extrudates in the spheronization process is influenced by a variety of overlapping mechanisms. An important factor affecting those mechanisms is the particle dynamics in the spheronizer, which consist of a rotating disk having a structured surface, so-called friction plate, and a steady cylindrical wall.

In this contribution, the particle dynamics in the spheronizer was studied with DEM. To approximate the behaviour of the pellets, the parameters of the contact model were calibrated by experiments. Force-displacement curves were obtained by compression tests of pellets produced from microcrystalline cellulose and lactose in the combined extrusion and spheronization process. From these force-displacement curves material parameters like stiffness and coefficients of restitution were derived.

In addition to the particle residence probability in the poloidal cut, the poloidal and toroidal velocity fields are evaluated by time averaging the velocities in steady state. Koester et al. [1] described five different zones of the particle movement in the poloidal cut. It was found an opposing rotational motion of the particles in the upper zone V at the top of the torus.

Besides the particle kinematic, the collision characteristic was in the focus. Therefore, distributions of the collision rate and the average collision forces were created for interparticle collisions and collisions with the wall and the friction plate.

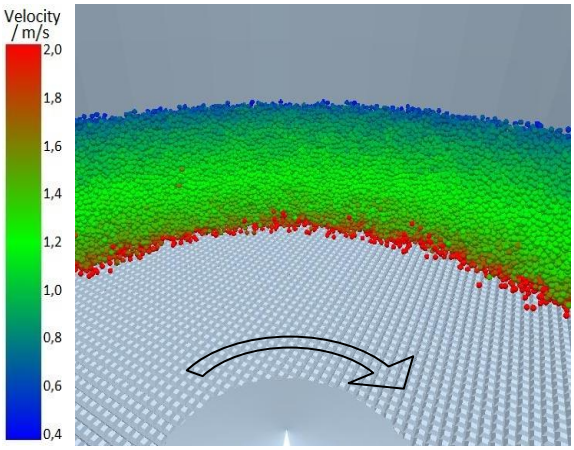

Fig. 1: Snapshot of the particle motion from DEM-simulation of the spheronization process

Effects of process conditions like filling degree and rotational speed of the friction plate were investigated. Moreover, the impact of material properties like stiffness, coefficient of restitution, coefficient of friction and particle diameter was analysed.

REFERENCES

[1] Martin Koester, R. Edwin García, Markus Thommes, "Spheronization process particle kinematics determined by discrete element simulations and particle image velocimetry measurements", *International Journal of Pharmaceutics, 477, 81–87 (2014)*