Assessment of the effect of microcrystalline cellulose (MCC) spheres size on the flow via powder rheology

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Introduction

- The main objective of this study was to investigate the effect of MCC spheres (Cellets) size effect on the powder properties to assess the possible impact of the Cellets' size on the powder behaviour.

Materials

Cellets 90, 100, 200 and 350 (D_{50}-size from **94 to 424µm**).

- The particle size distribution of Cellets was determined using **optical digital microscopy (Keyence VHX-600; 1)**.

Methods [Ref.]

For characterisation the following methods were employed:

- Standard pharmacopoeia methods as **bulk/tapped density** and flow rate measured with **gravitational funnel** method
- investigation of **dynamic angle of repose** and **dynamic cohesivity index** with a rotating drum tester (GranuDrum)
- **basic flowability energy**, **specific energy**, **aerated energy**, **permeability** and **compressibility** by powder rheometer (FT4 Powder Rheometer®)

Results & Discussion

- The increase in Cellets' size was accompanied with a decrease in the calculated apparent specific surface area (**SSA**; **2**) Thus, along with Cellets' size decrease, an increase in mechanical interlocking was expected.
- The **bulk and tapped density** of Cellets increased with the increase of the particle size but the **densification kinetics** was approx. the same (**3**). Even a few periodical vibrations (oscillations) significantly changed the density of Cellets.
- At the same applied force, as the Cellets' particle size increases
  - the **compressibility** decreases (**4**) - worsening packing efficiency
  - the **permeability** increases (**5**) – increase in voids between particles
- The **gravitational funnel** method suggests an absence of correlation between the **flow properties** and Cellets' size or SSA (**6**)
- Based on the **dynamic angle of repose** (to characterise the dynamic ability of powder flow), the difference between the different size of Cellets wasn't clear (**7**).
- As the Cellets' size increased
  - **Specific energy** decreased (**8**) – the level of interlocking and friction between powder particles decreased, the flowability - increased
  - **Basic flowability energy** decreased (**9**) – the flowability in a constrained environment increased
- The aerated energy
  - decreased as air velocity increased (**10**) - can be used to determine the minimum fluidization velocity; changing interparticle interactions with increasing air velocity
  - increased with Cellets' size increased (**11**) – dependent on particle mass and interparticle interactions (interlocking, friction)
- The **cohesive index** decreased with Cellets' size increase (**12**) – an indicator of the sum of interparticle interaction forces

Conclusion

Powder rheology methods were successfully used for the determination of

- bulk powder behavior,
- powder flow,
- and interparticle interaction

as a function of microcrystalline cellulose spheres size.

Ref.: Mohylyuk V, Styliari ID, Novykov D, Pikett R, Dattani R. Assessment of the effect of Cellets' particle size on the flow in a Wurster fluid-bed coater via powder rheology. J Drug Deliv Sci Tec. 2019;54:101320. doi: 10.1016/j.jddst.2019.101320.

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