PO C 1

The Effect of Punch Velocity on the Initial Compression Stage of Caffeine and Microcrystalline Cellulose: Modelling by a Modified Heckel Equation

Carsten Burger and Hans Leuenberger Pharmacenter

Department of Pharmaceutical Technology, University of Basel

The initial compression stage of caffeine and microcrystalline cellulose was investigated by a model derived from Kuentz' and Leuenberger's[1] modified Heckel Equation.

Powder compression was performed with a Zwick® universal testing instrument measuring the pressure at the upper punch and the relative density in die.

Within the evaluated range from 0 to 1MPa, the model was able to accurately describe the increasing pressure against relative density for both substances.

Changing the compression speed from 0.5mm/min to 50mm/min had different influence on the densification process of caffeine and microcrystalline cellulose, respectively.

For microcrystalline cellulose, which mainly deforms plastically, higher compression speed was accompanied by stronger resistance against deformation; i.e., at same pressure the substance was less densified. This result was in line with the findings of previous research[2,3,4] and could be explained by the viscoelasticity of the material.

On the other hand, the brittle caffeine could easier be densified at 50mm/min than at 0.5mm/min, i.e., at same pressure higher relative density was determined.

The assumption that Caffeine undergoes more intensive comminution at higher punch velocity was confirmed by an evaluation of particle size distribution with a Malvern® Mastersizer. After compression at 50mm/min smaller caffeine particles were measured than at 0.5mm/min.

As smaller particles can better reduce porosity by filling small voids, the promoted densification of caffeine at higher punch velocity could thus be explained.

References:

1. Kuentz M., Leuenberger H. (1999): Pressure Susceptibility of Polymer Tablets as a Critical Property: A Modified Heckel Equation, J.Pharm. Sci. 88 (2), p. 174.
2. Rue P.J., Rees J.E. (1978): Limitations of the Heckel relation for predicting powder compaction mechanisms, J. Pharm. Pharmacol. 30, p.642.
3. Roberts R.J., Rowe R.C. (1986): The effect of the relationship between punch velocity and particle size on the compaction behaviour of materials with varying deformation mechanisms, J. Pharm. Pharmacol. 38, p.567.
4. Armstrong N.A., Palfrey L.P. (1989): The Effect of Machine Speed on the Consolidation of Four Directly Compressible Tablet Diluents, J. Pharm. Pharmacol. 41, p.149.