Contribution ID: **120** Type: **Oral Presentation**

Modelling pharmaceutical tablet swelling using discrete element modelling and a single particle swelling model

Wednesday, 1 June 2022 16:00 (15 minutes)

PURPOSE
Typical pharmaceutical tablets are porous media made through the compaction of a powder blend that consists of a drug substance and excipients. Most tablets have to break up into smaller fragments when they come in contact with a physiological fluid to accelerate the release of the drug –a critical quality attribute of solid oral dosage forms. This break up is caused by the swelling of individual particles in a tablet that leads to the interruption of the interparticulate bonds. The swelling is initiated by the wetting of the particles in the porous tablet and therefore the liquid uptake process is a prerequisite to initiate the swelling and eventually the break up. Since these critical processes, i.e. liquid uptake, swelling and break-up, directly impact the performance of tablets, it is crucial to have a deep understanding about these mechanisms and how they are linked to the raw material attributes and manufacturing conditions. This study focused on modelling the swelling of a tablet using discrete element modelling (DEM) paired with a single particle swelling model [1,2] and experimental liquid penetration depth data.

METHODS
The modelling consists of three different steps: 1) simulation of compaction to generate a particle configuration in DEM to represent the tablet, 2) modelling swelling of a single particle [2] and 3) modelling tablet swelling by integrating the single particle swelling model in the DEM tablet model. The particle-particle interaction in the DEM compaction model was described by the Luding elasto-plastic contact model [3] using YADE-DEM [4]. The parameters of the Luding contact model were calibrated using experimental compaction data of the materials. The analysis was conducted for microcrystalline cellulose (MCC) (Avicel PH101, Roquette, Lestrem, France) and croscarmellose sodium (CCS, FMC International, Philadelphia, USA). Experimental data to test the model for tablet liquid penetration and swelling was measured by a flow through cell [5] coupled with a commercial terahertz system (TeraPulse 4000, Teraview Ltd., Cambridge, UK).

RESULTS
The DEM modelling parameters were calibrated for MCC PH101 and CCS with an RMSE of 0.022 (-) for a porosity of 15%. The calibrated parameters were tested for tablets with porosities of 10% and 20% giving an RMSE of 0.025 (-). The tablet swelling was experimentally measured as a change in height at a single point on the tablet surface which was replicated in DEM. Experimental results showed that tablets with higher porosity swelled faster than tablets with lower porosity, also liquid penetration rate was faster in high porosity tablets. The results from tablets consisting of a mixture of MCC PH101 and CCS showed that an increase of CCS content resulted in a lower tablet swelling, even though the swelling capacity of single particles of CCS is higher than of MCC PH101 [2].

ACKNOWLEDGEMENTS
The author would like to thank the National Manufacturing Institute for Scotland for funding this work.

Acceptance of the Terms & Conditions

Click here to agree

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

United Kingdom

References

1. Sweijen, T. et al.,2017, Powder Technol., 318, 411-422
2. Soundaranathan, M et al, 2020, Int. J. Pharm.,590, 119903.
3. Luding, S et al.,2008, Granul. Matter, 10, 235-246.
4. V. Šmilauer et al. 2015, Yade Documentation 2nd ed. The Yade Project.
5. Al-Sharabi, M et al, 2021, Chem. Eng. Res. Des., 165, 386-397.

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

Online

Primary author: SOUNDARANATHAN, Mithushan (University of Strathclyde)

Co-authors: AL-SHARABI, Mohammed (University of Cambridge); Dr SWEIJEN, Thomas (Utrecht University); Dr PITT, Kendal (GlaxoSmithKline); Prof. ZEITLER, Axel J. (University of Cambridge); Prof. HASSANIZADEH, S. Majid (Utrecht University); Prof. JOHNSTON, Blair (University of Strathclyde); Dr MARKL, Daniel (University of Strathclyde)

Presenter: SOUNDARANATHAN, Mithushan (University of Strathclyde)

Session Classification: MS04

Track Classification: (MS04) Swelling and shrinking porous media