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Numerical simulation of film formation in tablet coating

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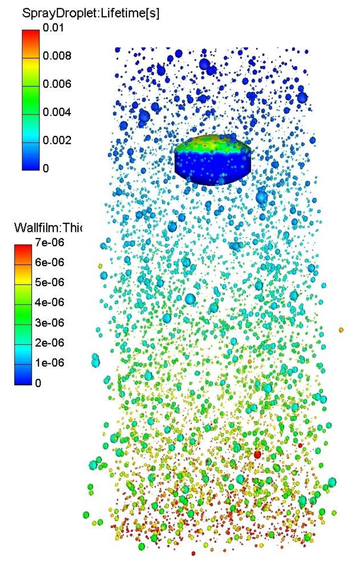
Introduction

The application of a coating layer on a tablet is a commonly used technique to selectively control tablet characteristics. Among the most important functions of the coating is the regulation of the release of active ingredient.

In the course of a typical coating process, the tablet passes a spray zone multiple times. Each time, a partial coating layer is applied. For each tablet, this is repeated numerous times until a film of desired thickness is achieved. The number of repetitions needed as well as the quality of the final coating depends strongly on the quality of the partial coating.



A horizontal tablet inside the spray generated according to measurements

Goals

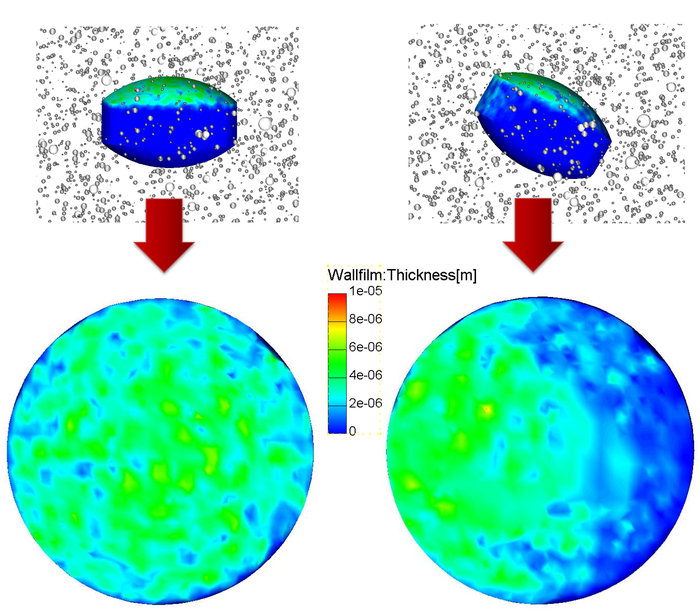
- Numerical simulation (CFD-Solver „AVL FIRE“) of the film formation on a single tablet for a coating event made up of a spraying and a drying phase.
- External parameters entering the simulation are **based on measurements** of industrial-scale coating equipment.
- Study the influence of central process characteristics:
  - **Tablet rotation**
  - **Spray pressure (i.e., droplet diameter distribution)**
  - **Temperature**

  on the quality of the resulting coating.

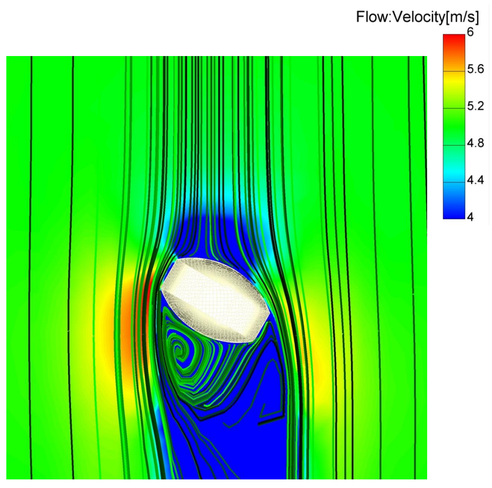
Numerical Method

- Simulation of the spray droplets in the air flow using an Euler-Lagrange approach.
- Splashing model for the interaction between droplets and tablet bed (Mundo-Sommerfeld).
- Multi-component evaporation of the spray droplets (modified Abramzon-Sirignano approach).
- Solution of the two-dimensional transport of the wall film.
- A series of spraying events is simulated by using the data from a single event and applying statistical considerations.

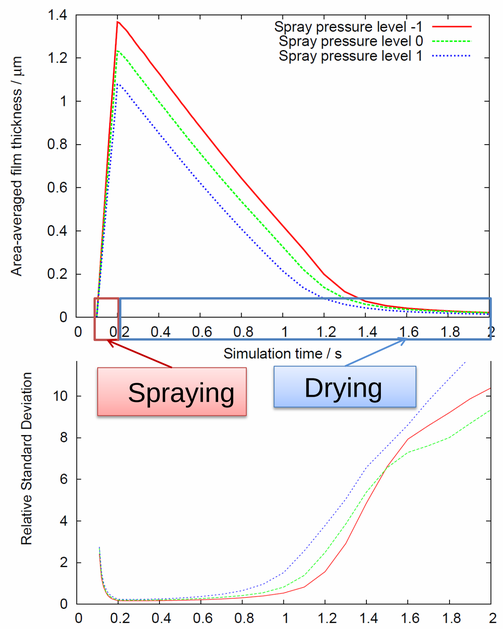
Results



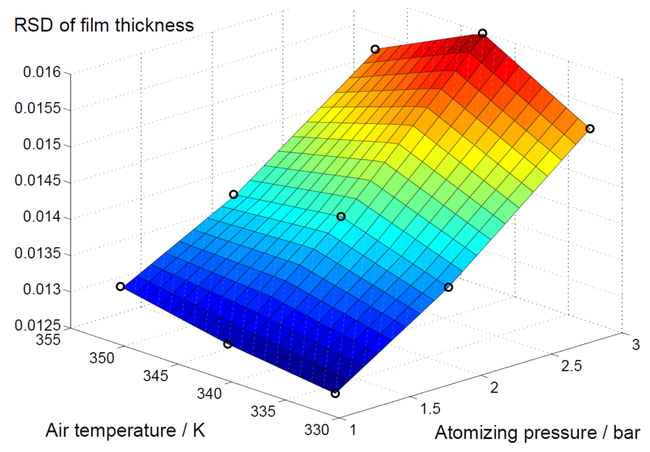
Pattern of the coating layer after one spray event, for horizontal (left) and 30 rotated tablet (right)



Air flow around the tablet, note the velocity variation at the tablet top



Evolution with time of the coating thickness mean (top) and relative standard deviation (bottom)



Relative standard deviation (RSD) of the coating thickness after 1000 coating events as a function of Air temperature and Atomizing pressure

Conclusions

- In this work, we show the application of numerical simulations to the investigation of the film formation on a tablet in a coating process.
- Adapted computational fluid dynamics (CFD) models are applied to determine the influence of central process characteristics (e.g. temperature, tablet rotation or droplet diameter distribution) on the quality of the coating layer.
- Quantitative (e.g., air stream and coating pattern) as well as qualitative (e.g., RSD of coating thickness) results help to develop a deeper understanding of the mechanisms behind tablet coating.

References

Suzzi D., Radl S. and Khinast J.G., 2010, Local analysis of the tablet coating process: Impact of operation conditions on film quality, Chem. Eng. Science.

Toschkoff G., Suzzi D., Tritthart W., Reiter F., Schlingmann M., Khinast J.G., A Detailed Analysis of Air Flow and Spray Loss in a Pharmaceutical Coating Process, in preparation

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