research center pharmaceutical engineering

Fluid Bed Granulation: Towards a Comprehensive gSOLIDS Model

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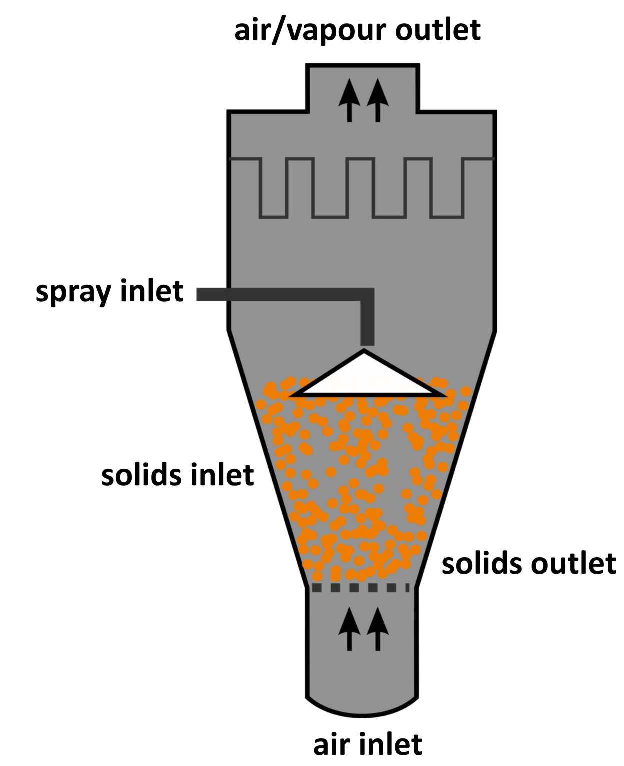


Introduction

Despite of being a widely-used unit operation, the application of fluidised bed granulation (FBG) is still very much guided by empirical methods rather than by scientifically-based strategies. The development of realistic mathematical models that are combined with suitable process measurements can yield powerful tools for knowledge-based control of process and product quality. The complex interplay of various phenomena that govern the process dynamics of FBG on different scales poses a significant challenge in developing such models. Most importantly, a realistic FBG model has to incorporate all phenomena associated with the three fundamental classes *wetting & nucleation*, *consolidation & growth*, and *breakage & attrition.* It also needs to treat all parameters that influence these phenomena as model input.

Ultimate Goal

A **realistic model for FBG** (developed within the gSOLIDS framework) that **captures all essential phenomena** influencing the process, i.e. its topology includes the following phenomena:

- **Wetting** (continuous addition of wet binder)
- **Drying** (continuous removal of wet binder)
- **Agglomeration** (nucleation, consolidation, coalescence)
- **Breakage** (breakage of granules, attrition)

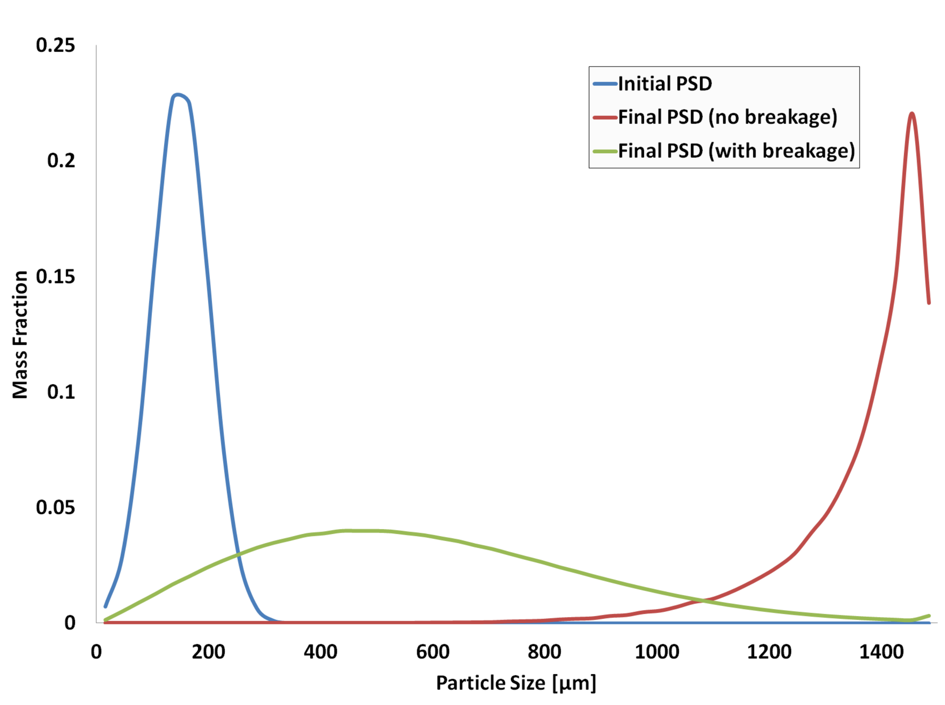
These phenomena **take into account all critical process parameters** in a physically correct manner and they are **interlinked appropriately.**

Extended gSOLIDS Model – Status Quo

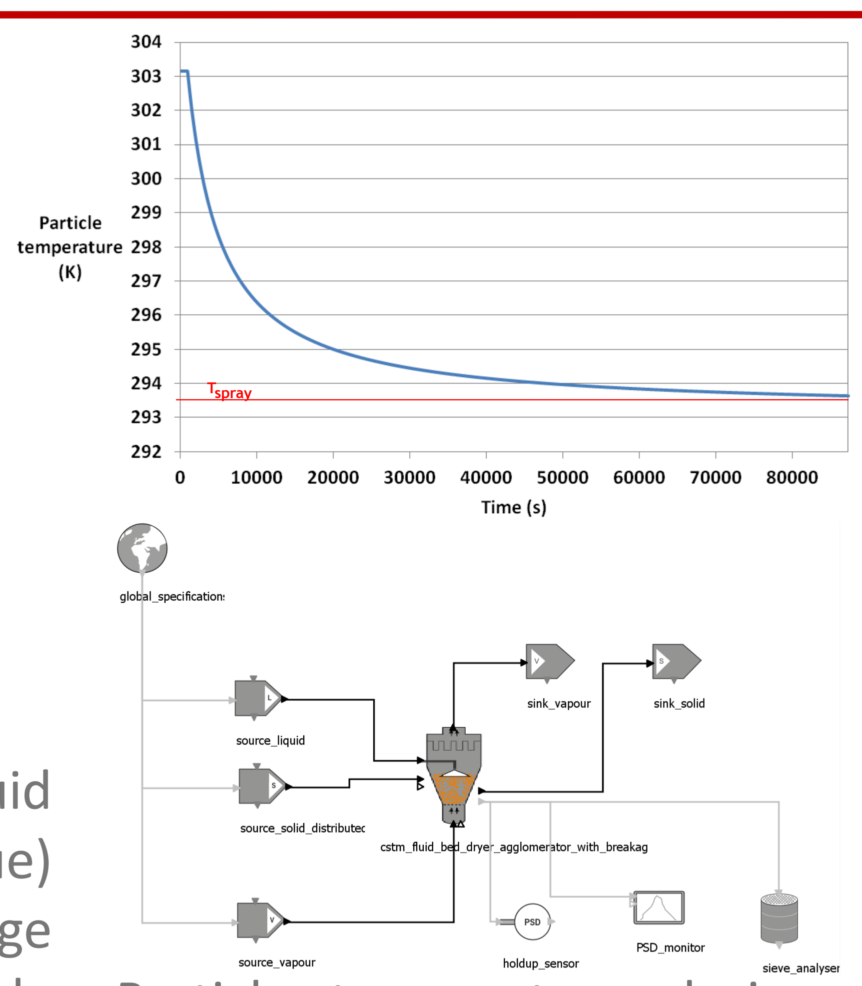
The existing model for the Fluid Bed Dryer Agglomerator has been supplemented with **two additional features**:

- **Wetting** via new user-defined phenomenon
  - liquid binder is introduced via **new external port** (spray inlet)
  - allows to set (time-varying) **liquid addition rate** directly
- **Breakage** via integration of existing gSOLIDS phenomenon
  - model **topology and structure extended** to allow for breakage
  - makes a total of **18 possible combinations** of available breakage (3) and agglomeration (6) kernels that can be employed

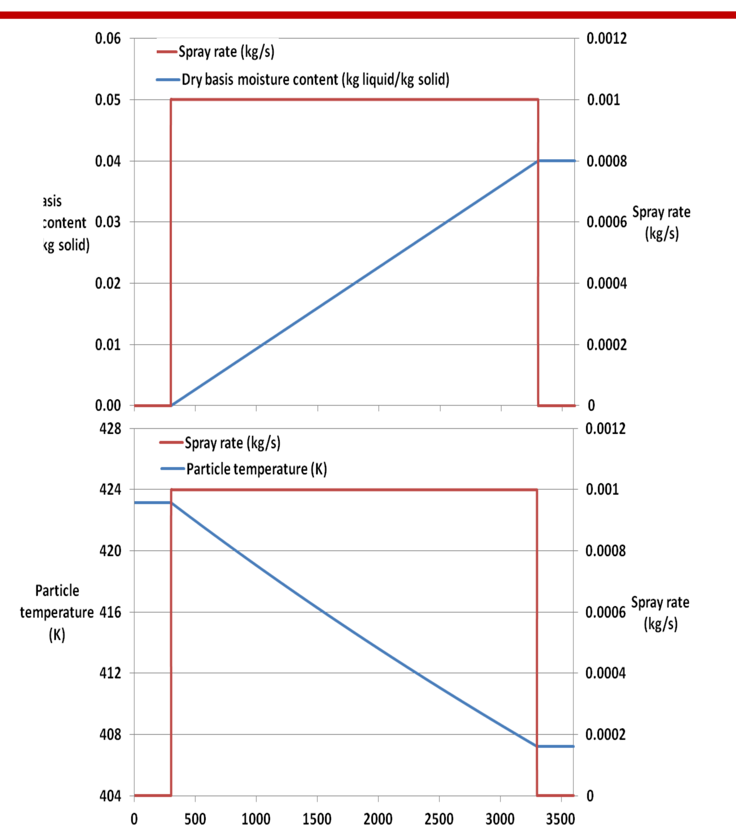
Results



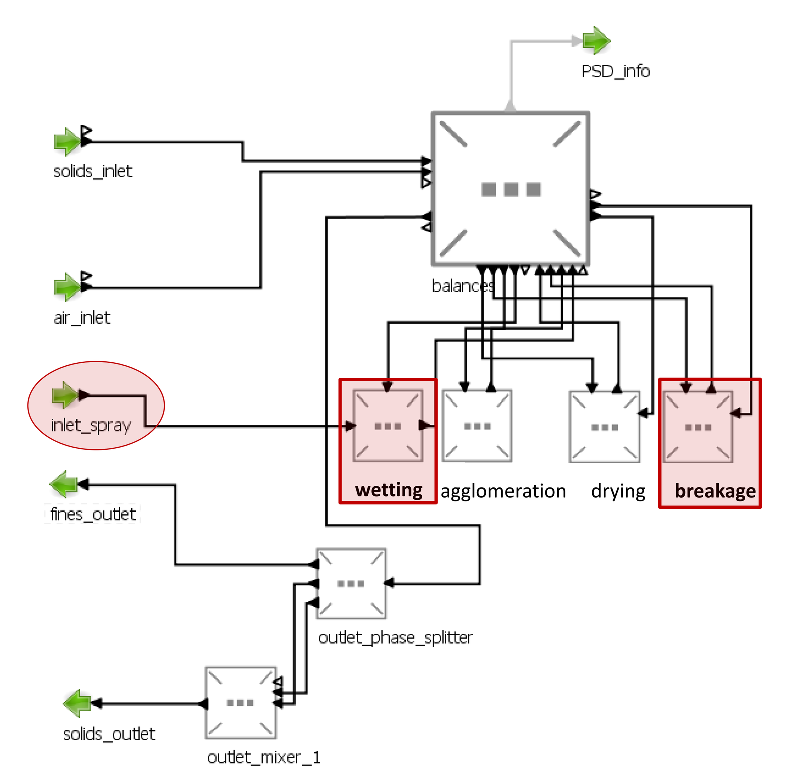
Particle size distributions (PSD) for a Fluid Bed Granulation process: initial PSD (blue) and final PSD for both cases, no breakage effects present (red) and with breakage á la *Austin* (green) as predicted by the extended model.



Particle temperature during spraying (top) and model flowsheet (bottom).



During spraying, moisture content of particles increases (top) while particle temperature decreases (bottom) for $T_{spray} < T_{particle}$ @ t = 0.



Topology of the extended Fluid Bed Dryer Agglomerator model with new features highlighted: spray inlet, wetting and breakage phenomena

Conclusions

- In this work, we extend the existing gSOLIDS model for the Fluid Bed Dryer Agglomerator. The phenomenon of **breakage** and the **continuous introduction of an additional liquid phase** are included into the existing framework.
- We show that the implementation of both effects results in an **anticipated model performance**. Upon the introduction of spray, **particle moisture content increases** while particle **temperature decreases** and asymptotically approaches the temperature of the sprayed liquid itself. Employing various combinations of agglomeration and breakage kernels, a substantial difference between final PSDs (with and without breakage) towards **enhanced fines sections** is observed.

References

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FFG   Das Land Steiermark   SFG Steirische Wirtschaftsförderung

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