# A Systems Engineering Approach to Dry-Milling with Grinding Aid Additives

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## Project summary

**Second phase (3 years period):**

- Determine a proper powder macroscopic property to represent the combination of material and GA type and dosage
- Relate measurable microscopic particle properties with powder bulk behavior
- Design a characterization procedure to obtain the model parameters required for axial transport simulation
- Model powder internal axial transport during milling
- Validate all developed models and flowsheet simulation with industrial data
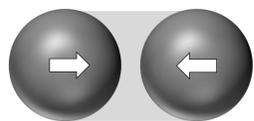
## From micro to macro
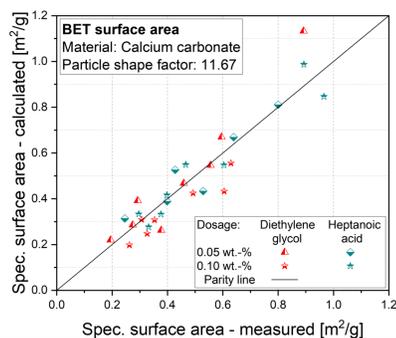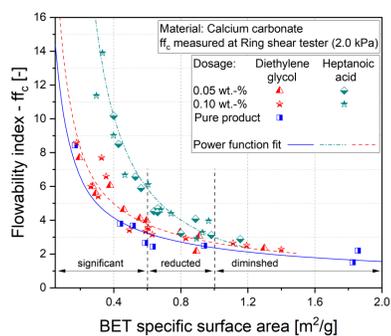


## Powder internal transport
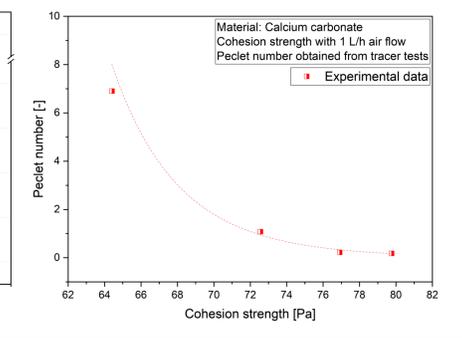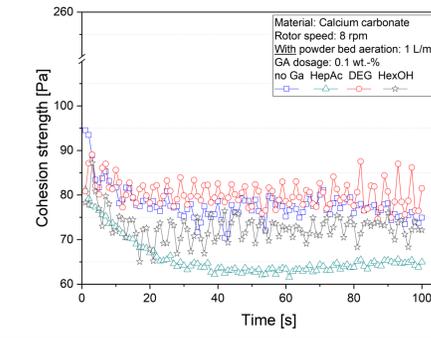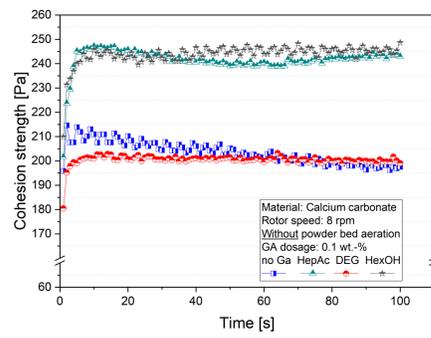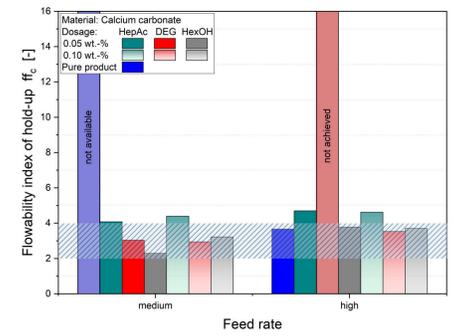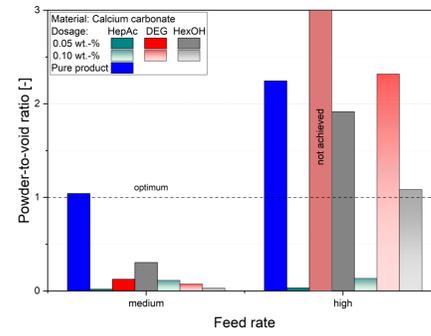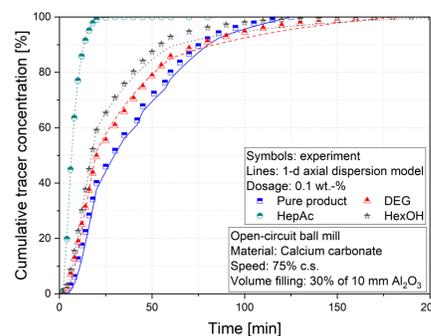


## Simulation with mechanistic PBM

- Accounting for change in powder flowaility by size reduction through the correlation between flowability index and specific surface area.



- Modeling axial material transport with the one-dimensional dispersion model (one parameter model).

$$\frac{\partial Q}{\partial t} = D_x \frac{\partial^2 Q}{\partial x^2} - u_x \frac{\partial Q}{\partial x} \qquad Pe = L \frac{u_x}{D_x}$$

$$Q(t) = \frac{1/\theta}{2\sqrt{\pi \cdot Pe \cdot \left(t/\theta\right)^3}} \, exp\left[-\frac{\left(1 - t/\theta\right)^2}{4 \cdot Pe \cdot \left(t/\theta\right)}\right]$$

- Estimating transport model parameter from powder properties obtained from dynamically characterization techniques, like the powder rheometer.



## Acknowledgment