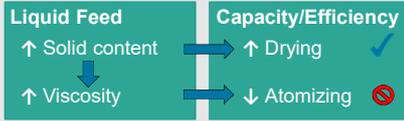


Spray-Drying of Pastes with ACLR-Nozzle for Process Intensification

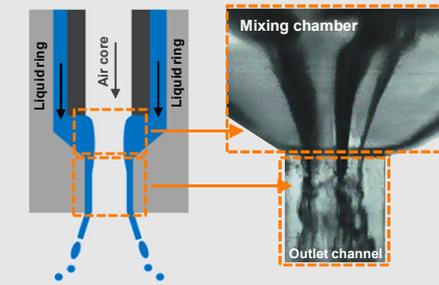
M. Ballesteros, S. Höhne and V. Gaukel

Spray drying

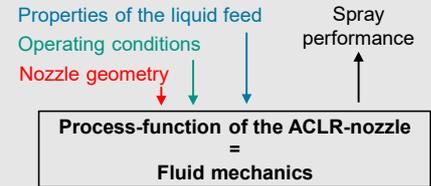


Air-Core-Liquid-Ring (ACLR) atomizer:

- ✓ can handle highly viscous feeds
- ✓ requires minimum air flow and pressure
- ⊗ can suffer from unstable internal flow conditions



Schematic and photo of the annular flow inside of the ACLR nozzle



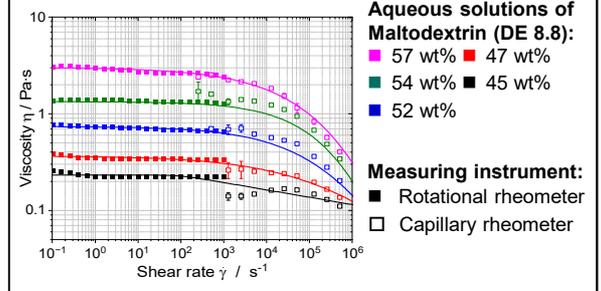
- Droplet composition → high impact on drying kinetics and particle morphology, and therefore on final powder properties
- Single droplet drying setups can be used to mimic the convective spray-drying process

Project schedule

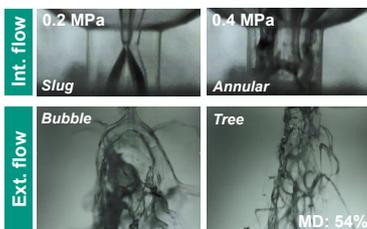
Project year	1				2				3			
Quarter	I	II	III	IV	I	II	III	IV	I	II	III	IV
WP 1: Atomization with the ACLR nozzle (CFD and validation)												
WP 2: Impact of composition and morphology on drying kinetics												
WP 3: Industrial applicability of the ACLR nozzle for spray-drying												

Current stage

Model system

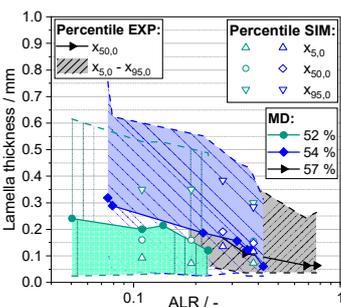
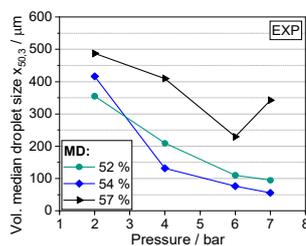


WP 1: Characterizing the ACLR atomizer



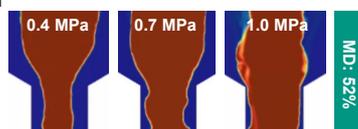
- The flow pattern inside the nozzle relates to the spray cone formation
- The int. and ext. instability frequencies are correlated
- SIM can focus exclusively on int. flow → Efficiency

- Droplet size can be controlled with pressures, even at higher η
- Larger pressures might be needed than what can be reached in EXP



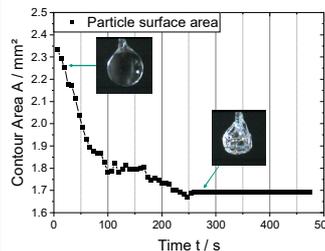
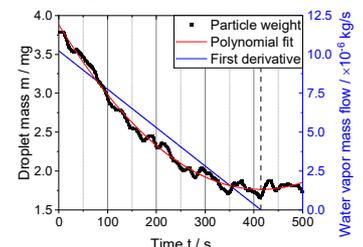
- SIMs predict expected behavior: Lower internal flow variations with increasing ALRs, even at high η
- ALRs below 1 are still sufficient
- Lamella thickness: similar values at similar ALRs, regardless of η

- Non-Newtonian modelling was validated and can be used for extrapolation and optimization



WP 2: Drying kinetics in a single droplet setup

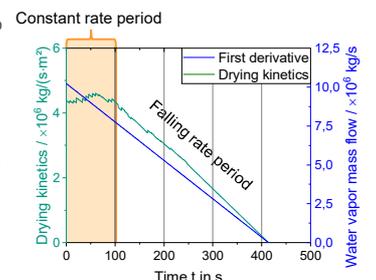
- A polynomial fit is used to fit the data
- Water evaporation rate is obtained by determining the first derivative
- Drying end point is determined by intersection with the x-axis



- The contour area is tracked, allowing for calculation of the particle's surface area

- Drying kinetics are normalized by particle surface area
- Results give insight into constant and falling rate period

Challenge: initial droplet mass is varying significantly



Outlook

- Refine MATLAB code for faster and easier contour area analysis
- Improve droplet generation method for highly viscous liquids to obtain a more consistent initial droplet weight
- Investigate larger range of viscosities and drying rates