IFPRI Project Abstract

[Project Title]

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Project Objective:

The key objective of the research project is to reduce the environmental impact of the spray drying process by reducing the water content of the feed liquid to be dried. For this purpose, the Air-Core-Liquid-Ring (ACLR) nozzle was identified as a promising technology to increase the liquid viscosities that can be feasibly atomized with a low air demand. To understand the impact of highly concentrated feeds on the spray drying process, a single droplet drying (SDD) setup will be designed to measure drying kinetics and track morphology development of paste like droplets under controlled conditions.

Approach:

After identifying and characterizing a suitable model system, the ACLR nozzle was modelled through computational fluid dynamics, using experimental atomization data with highly viscous liquids. This model can then be used to optimize the nozzle design. At the same time, a single droplet drying setup will be used to mimic the spray drying process and determine process-structure-functions to elucidate the impact of feed composition, concentration and morphology development on the drying kinetics.

Recent Results:

The data analysis of the established single droplet drying setup was improved. The impact of dry matter concentration and drying temperature was investigated for viscosities of up to 1.2 Pa·s. Even though higher viscosities lead to lower drying rates during drying, the lower water content leads to overall similar drying times. The results also indicate a much earlier locking point, which leads to the assumption, that powder stickiness should not be an issue during industrial drying. WP 2 is now finished. The CFD Model from WP 1 was used as base for a geometrical optimization of the ACLR-nozzle. The simulation plan was carried out and it was found that the optimized design favors the formation of thinner liquid films and reduces the ALR requirements. The nozzle was constructed and showed that 33 % smaller droplet sizes and narrower droplet size distributions were achieved at same pressure conditions.

Next Steps:

Spray experiments with other liquids with the optimized nozzle are planned.
A renewal of the project for 2 years is proposed. The ACLR nozzle's applicability will be extended to additional systems, by defining and characterizing suitable systems and evaluating their drying behaviors.