IFPRI Project Abstract

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

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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. The applicability of the insights gained will be tested in pilot scale spray-drying trials.

Recent Results:

A computational model was developed in STAR-CCM+. After validating with experimental data, we confirmed that it can recreate the behavior of non-Newtonian highly viscous feeds inside the ACLR nozzle, completing the objectives of WP1. From the experimental side, maltodextrin solutions of up to 3 Pa·s and a dry-matter concentration of 57% were atomized in a spray rig. The correlation between the internal and external flow instabilities of the nozzles means that geometrical optimization can focus on the internal flow of the ACLR. The SDD setup was optimized for measurements of the drying kinetics of droplets. The setup allows the determination of the surface-weighted evaporation rate and the first and second drying step.

Next Steps:

The numerical model developed will be used to evaluate and optimize the geometrical design of the nozzle. For the SDD setup, the droplet generation of highly viscous droplets will be optimized and a parameter study will be conducted. The industrial applicability of the optimized nozzle design will be investigated in atomization trials using different model systems.