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 the reduction of 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 has been identified as a promising technology to push the boundaries of 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 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 will be optimized using computational fluid dynamics which will be validated for the atomization of highly viscous liquids in experiments on a spraying rig. 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:

Aqueous solutions of maltodextrin have been identified as a suitable model system for the project. A computational model, implemented in STAR-CCM+, has been developed and was successfully used to evaluate the effect of increasing liquid viscosities up to 140 mPa·s on the atomization process. A modular drying tunnel for single droplet drying has been designed and constructed, which currently allows for direct observation of the morphology development during the drying process.

Next Steps:

The simulation will be extended with a non-Newtonian rheological model to evaluate flow stability and operation requirements with higher viscosities. The highest viscosities that can be feasibly atomized will be experimentally validated. The droplet generation for the single droplet drying setup will be optimized and an improved tracking of the drying kinetics will be implemented.