INSTITUT VERFAHRENSTECHNIK
Lehrstuhl Systemverfahrenstechnik

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Master's Thesis Topic
Determination of Residence Time Distributions in a Counter-current Screw Reactor for PET Glycolysis

Background and Motivation

In recent years, plastic waste and its recycling has become a topic of great interest for academia and industry alike. Currently, significant portions of plastic waste streams are deposited in landfills or incinerated for thermal energy utilization. Especially plastics contained in textiles, such as polyethylene terephthalate (PET) or polyamides (PA), pose a significant challenge for an efficient recycling. Shredded textile waste typically exhibits a low density, due to which a high solvent amount is required to sufficiently wet such particles. Additionally, floatation and strings, which might wrap around stirrers, further complicates processing in traditional reactor setups.
In this project, a counter-current screw reactor is utilized to overcome these challenges. For this, PET, contained in textiles, is continuously depolymerized via glycolysis. Within this tubular reactor, textile shreds are transported via a motorized screw while the solvent, ethylene glycol (EG), and the therein dissolved catalyst are pumped into the other side of the reactor resulting in a counter-current flow scheme. This not only allows for an inherent solid-liquid separation but also leads to optimal solid-liquid contacting within the reactor and increased mass transfer rates resulting in increased reaction yields. Additionally, the solid phase is compacted by the screw further decreasing the solvent demand of the process.
This process is currently being realized as a pilot plant at the Max Planck Institute for Dynamics of Complex Technical Systems in Magdeburg. Apart from the technical realization, a theoretical process simulation is being developed to guide and eventually optimize pilot plant experiments.

Thesis Objectives

During this thesis, the student will develop strategies and carry out experiments to measure phase specific residence time distributions (RTD) for the pilot plant reactor setup. For this, several parameters should be varied to obtain insight into their influence on the residence times. Such factors include but are not limited to screw rotation speed, liquid flow rate, solid loading, and temperature. Experimental results will be analyzed using moments to obtain mean residence times and their variances. Finally, an approximation for the number of phase specific theoretical reaction stages is to be calculated.

Work Plan

- Literature review: Surveying commonly applied methods for determination of RTDs, especially in screw reactors.

- Identification of key process parameters affecting the RTD and planning on proper experiments.
- Validate analytical techniques used and perform RTD experiments on the pilot plant setup.
- Analysis of experimental data and calculation of final RTDs and theoretical stage numbers.
- Writing and finalizing thesis: documentation of methodologies, findings and discussions thereof. Preparation of results for academic publications and thesis presentation.

Requirements

- Completed B.Sc. in Chemical Engineering or related field.
- Basic understanding of chemical reaction engineering and conceptual plant design.
- First experiences in laboratory work.
- Programming knowledge, e.g. in Python or Matlab, is a plus.
- Strong analytical and critical thinking skills.
- Ability to work independently and systematically.

Duration: 20 Weeks
Start: September/October 2026
Supervisor: Dr.-Ing. Vico Tenberg
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Application:
Please send your application including your CV and transcript of records via email to Dr.-Ing. Vico Tenberg.