Equipment and Process Design for Bio-Based Processes: Extraction, Phase Separation, Exergetic Evaluation

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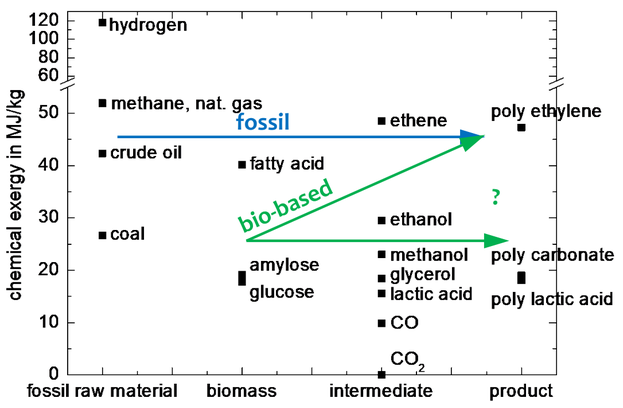
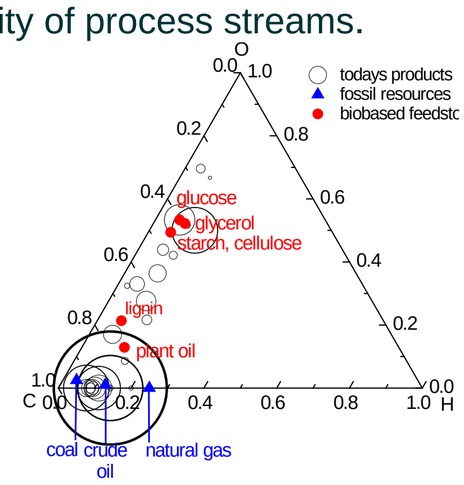
PEPs PRODUCT ENVIRONMENT PROCESSES

CHEMICAL ENGINEERING

Background, Exergetic Evaluation

The increased demand for **sustainable processes** will lead to a shift from fossil to **bio-based feedstock** for production of chemicals and materials. Thus research is focused on **separation steps** suitable for corresponding processes. Also overall bio-based process-routes are evaluated based on exergy, i.e. accounting for the value of energy. This leads to foresee that the oxygen-content of intermediates and products will increase leading e.g. to higher viscosity of process streams.

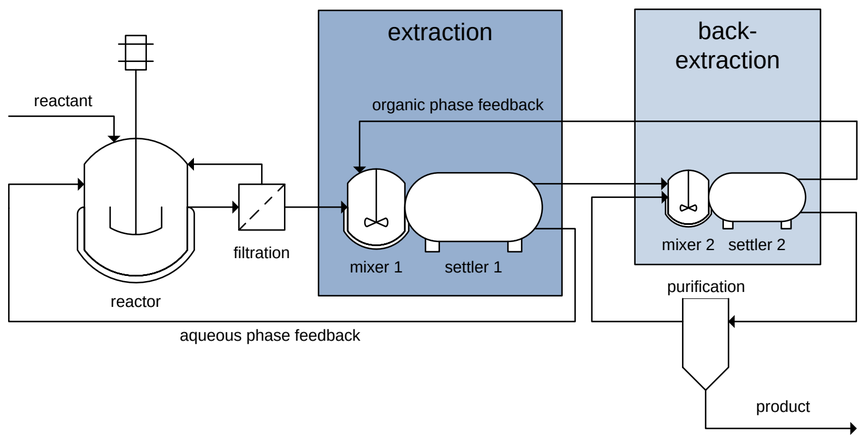




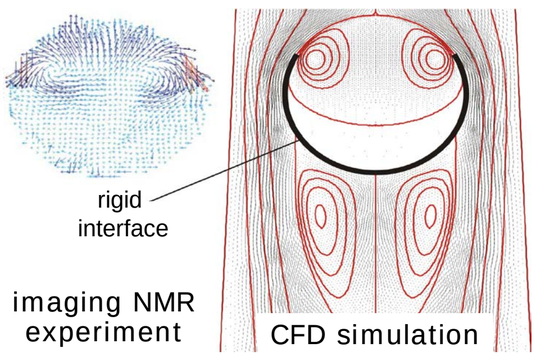
see e.g. https://www.youtube.com/user/Groschen42/playlists
http://www.sustainicum.at/de/modules/view/191.Bilanzen-als-Wegweiser-fr-eine-nachhaltige-Zukunft

From Drops to Processes

Examples are **selective extraction** of pharmaceuticals or monomers from a fermentation broth, in-situ in the optimal case.

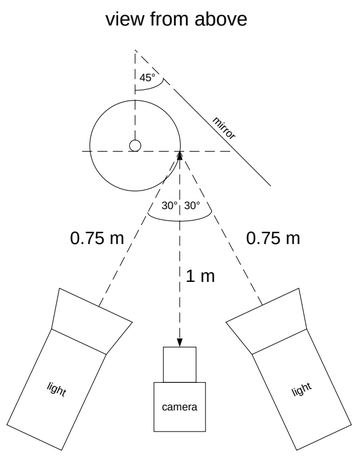


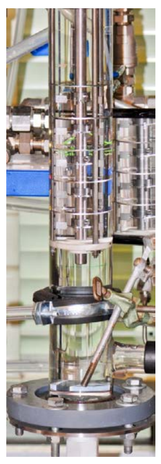
For the equipment design **individual-drop behavior** is studied, which allows the drop-based modelling and detailed simulation of equipment performance. This is realized in **standardized drop equipment** e.g. for mass transfer and sedimentation to evaluate the behavior of real systems including all impurities present in **technical systems**.

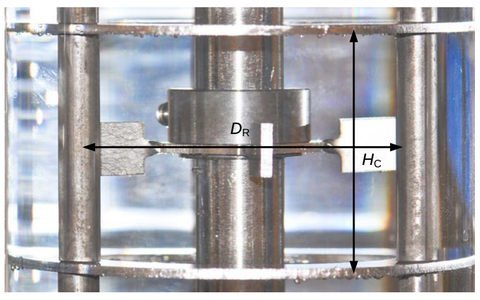


Extraction-Column Simulation and Optimization

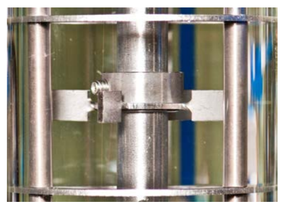
In an **extraction column** with rotating internals the drops inside the stacked compartments are investigated with a camera allowing full 3D tracking. The results allow e.g. optimization of equipment-size without loss in performance.



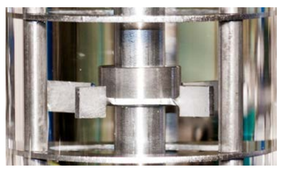




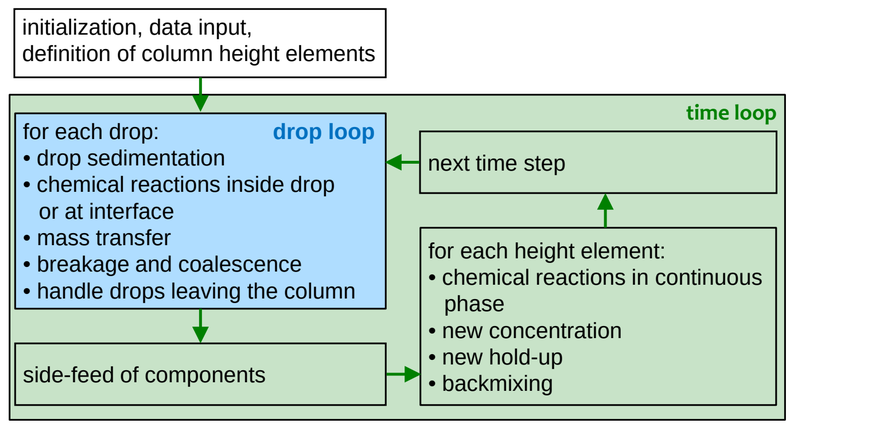
H_C = 43.5 mm
centric stirrer



H_C = 35 mm
acentric stirrer

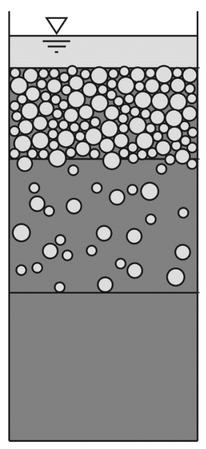


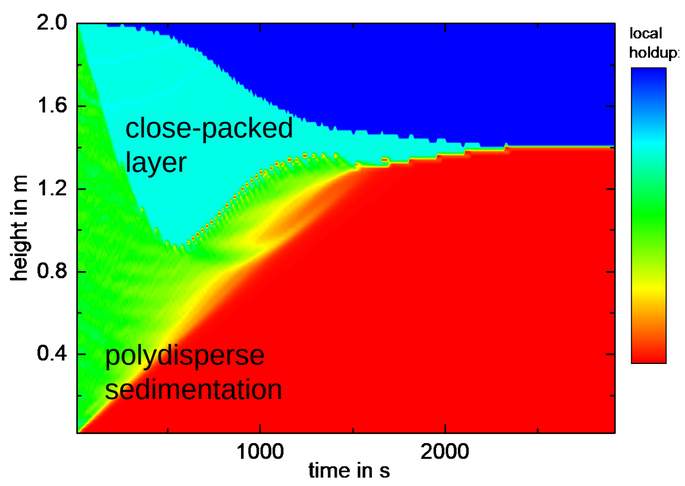
The advantage of **drop-based modelling** is the ability to extrapolate beyond the region of data acquisition, e.g. for **all types of column** internals without any additional experiments. Our **ReDrop** program (representative drops) depicts extraction-column performance including reactions in either phase as well as reactive extraction, where the reaction occurs at the interface, with **better than 10% accuracy**.



Phase Separation, Settler Design

Also for liquid-liquid **phase separation** drop-based process modeling can be achieved with similar accuracy, resolving details accessible in experiment only with significant effort.





This approach is the basis also for tackling increasingly complex real-world **technical challenges** like crud formation, almost regularly observed in technical extraction processes.

Crud:
Chalk River Undefined Deposit
corrosion residual unidentified deposit

The drop-based approach has been and is continually developed in close cooperation with industrial partners.

Dissertation Perspectives

Dissertation projects include a wide **variety of facets** in extraction, phase separation, as well as fundamentals like mass transfer, fluid dynamics and interfacial behavior. **Scales of interest** range from molecular level, e.g. for molecular simulation of interfaces, via lab-scale measuring cells to characterize drop behavior to pilot-plant scale for validation of the simulation tools. Depending on the individual project the **individual preferences** for experimental or theoretical work can be taken into account. Almost all projects include interaction with the partners local or international companies.

Lonza
EVONIK INDUSTRIES
BAYER Science For A Better Life
LANXESS Energizing Chemistry
PRAYON
BASF We create chemistry