Next-Generation Processes: Separation and Purification for Efficient Circular Economy

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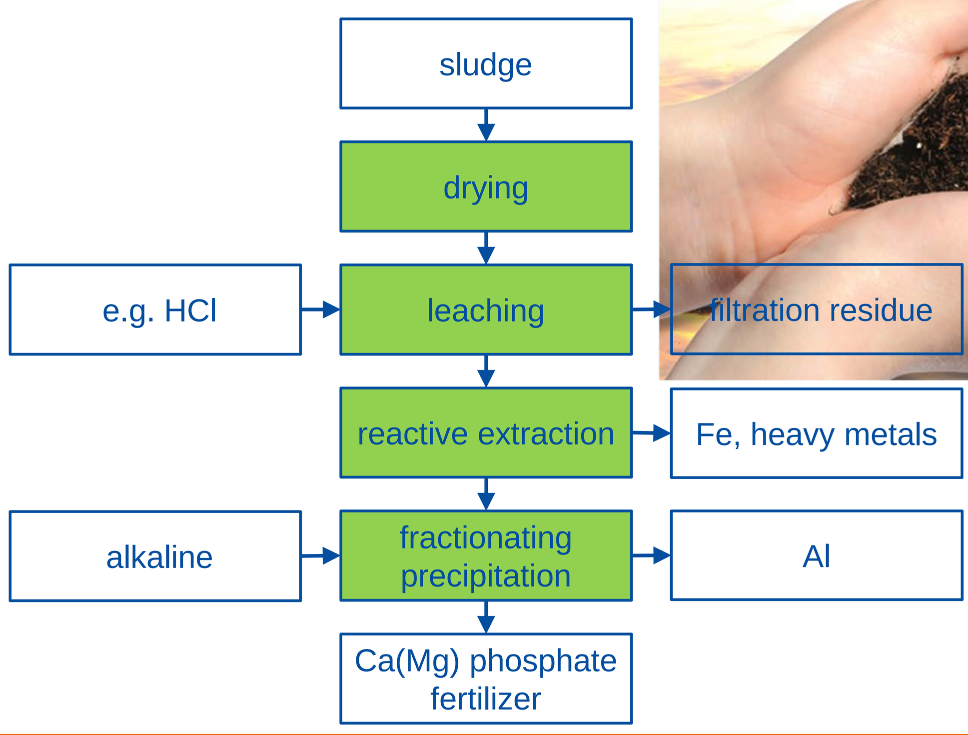
Motivation

Fossil resources need to be substituted by renewable, bio-based feedstock, also for production of products used in everyday life: plastics, detergents, pharmaceuticals, etc. Valuable components need to be recycled as far as possible without enriching detrimental or hazardous components. This calls for resource-efficient processes with optimal separation and purification steps with low energy demand and high purities to be reached.

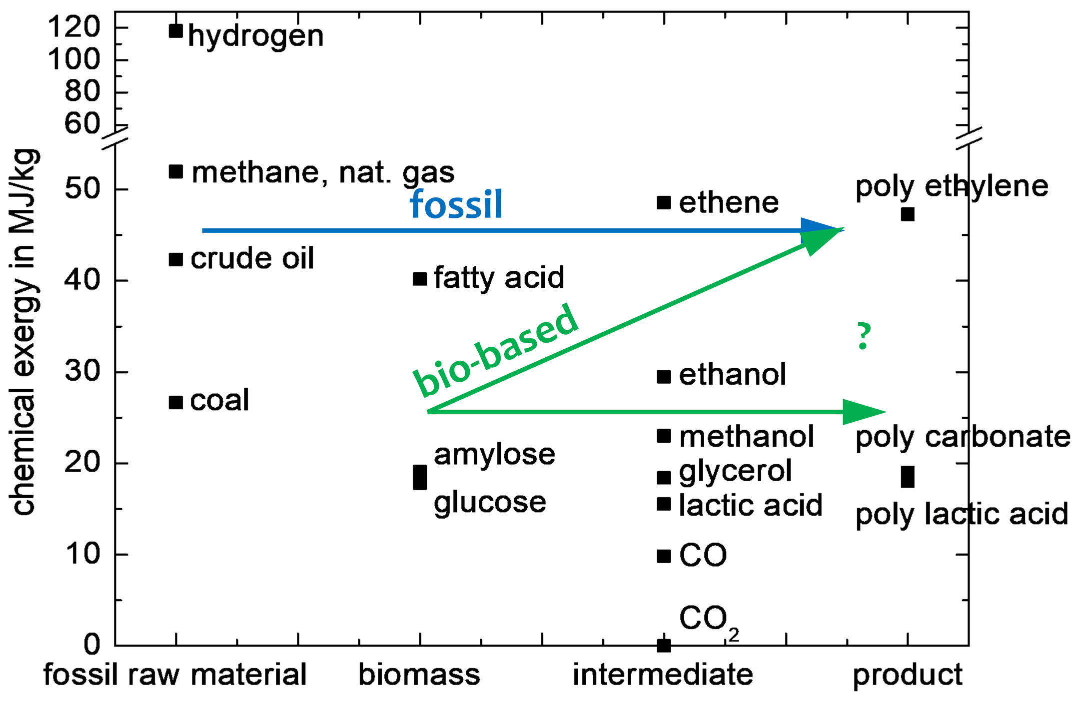
waste2value: Phosphorous from Sewage Sludge

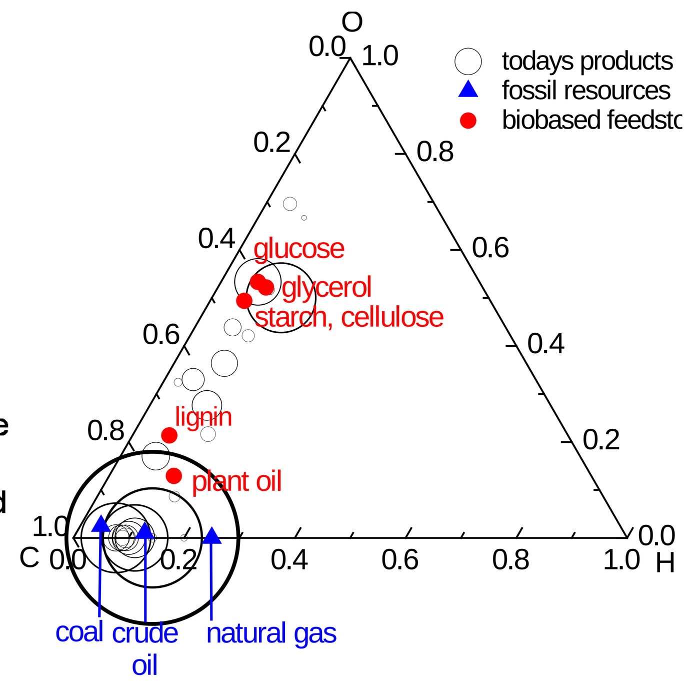
Phosphorous has been realized as **critical raw material** by the EU with a high supply risk. Phosphorous is one fertilizer component **essential for sustainable food production**, i.e. sufficient nutrition of a growing world population. Recycle rate of phosphorous in EU currently is only 17%. Thus phosphorous needs to be recovered from available sources, where it is enriched to a significant degree in sewage sludge. **Legislation** in some European countries already **requires efficient recovery** of the phosphorous from sludge to be implemented in roughly 10 years. Since in sewage sludge e.g. **heavy metals** are also enriched, these **need to be efficiently removed** before the product can be used as **fertilizer** to avoid accumulation of these components in the soil. In the **EU Interreg project PhosForYou** the **ULiège process** for phosphorous recovery is further developed including field tests of a pilot plant. ULiège total budget received from Interreg North-West Europe (2014-2020) is 834.765 € of ERDF jointly with the group of Angélique Léonard.



Sustainable Processes from Bio-Based Feedstock

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** and **lower vapor pressure** of process streams. We develop **separation processes** and tools for **equipment design** taking care of this foreseeable development which will e.g. favor **solvent extraction** vs. distillation, which needs to be operated with higher viscosities of the media.



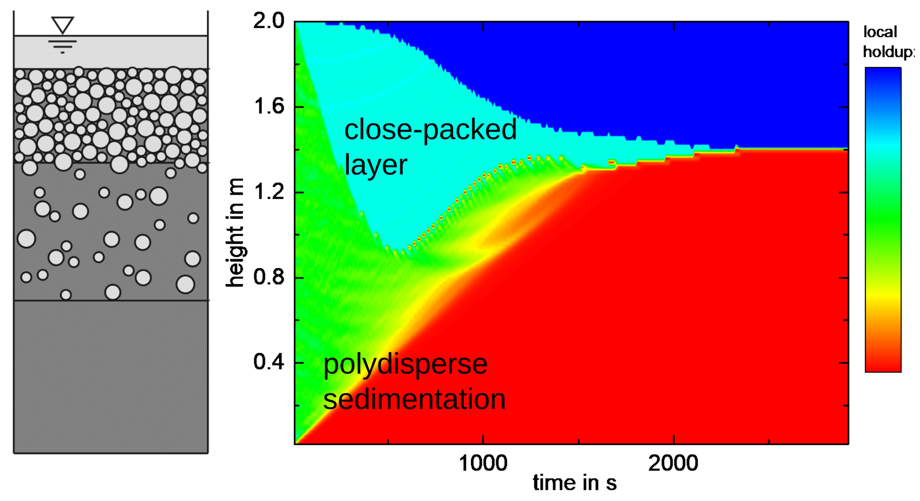


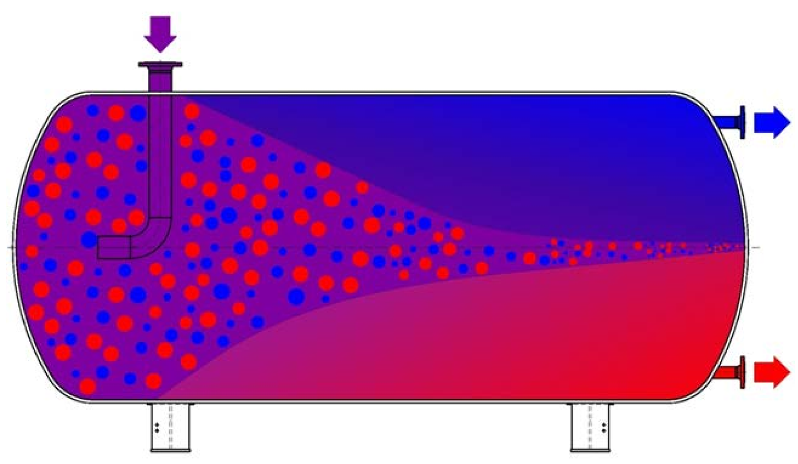
ERICAA: Phase Separation and Large-Scale Settler Design

Phase separation is a process step frequently encountered after a variety of unit operations in production processes. Especially the design of large settlers is demanding because of the overall flow. The challenge is to minimize settler volume for minimizing the hold-up.

In the **ERICAA consortium** we design and optimize the **standardized lab-scale settling cell** which will be used to characterize system behavior for phase separation. The evaluation of the experimental data and the following settler design will be based on **drop-based process modeling** which will resolve details accessible in experiment only with significant effort. The drop-based approach has been and is continually developed in close cooperation with industrial partners.

Simultaneously we develop **accurate models** to describe **sedimentation** and **drop coalescence**, especially for **demanding systems with high viscosity or solids** present in the system, which may stem from biomass feedstock. The approach links different size scales from interface to drops up to the entire settler.





Extraction-Column Design for Bio-Based Processes

Examples for extraction processes are **selective extraction** of monomers or pharmaceuticals from a fermentation broth, which is realized 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** for mass transfer and sedimentation to evaluate the behavior of real systems including all impurities present in technical systems.

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**.

ReDrop has been validated for many systems including technical applications and is now being **extended to highly viscous systems**. For these, the drop models are validated and implemented in the **simulation tool** allowing equipment design beyond stage-based modelling, which then allows **validation on pilot-plant scale**.

An open position is currently advertised: www.chemeng.uliege.be/jobs