Ph.D. Opportunities in the PEPs Group: Products, Environment, and Processes

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Research Focus in the PEPs group

In the PEPs group we are active in the fields of:

- **Valorization of waste and by-products** for circular economy
- **Biotechnology** and bio(chemical) reactor design
- **Thermal and mechanical** process steps
- **Process simulation**, among others for bio-based materials
- Energy processes including **low-carbon energy systems**
- **Environmental technology** and sustainable development

This includes the corresponding fundamentals, especially mass and energy transfers and multi-phase fluid dynamics.

A strength of our approach is to link the different scales in time and space:

- starting from microscopic and even molecular level
- having a strong focus on the equipment level in experiment as well as modelling
- reaching up to the simulation of entire processes
- and evaluating the favored large-scale deployment pathway

One of our assets are the many close and fruitful collaborations within our group and with external partners. In PEPs we integrate fundamental research and application-oriented studies. We thus also have many active projects with local and international industrial partners.

Research Perspectives

The future perspective of our research – besides further development of our fundamental methods – is to get chemical-engineering design tools prepared for the future. Thus our current research topics aim to **allow safe design of sustainable chemical and bio-based processes**, where process-specific material and energy transformations imply properties changes in the systems like e.g. increased viscosity, posing challenges to the chemical engineer.

Our research approach allows us to reliably **describe and optimize equipment performance** based on physically sound modelling, which even includes extrapolation beyond the region of experiments.

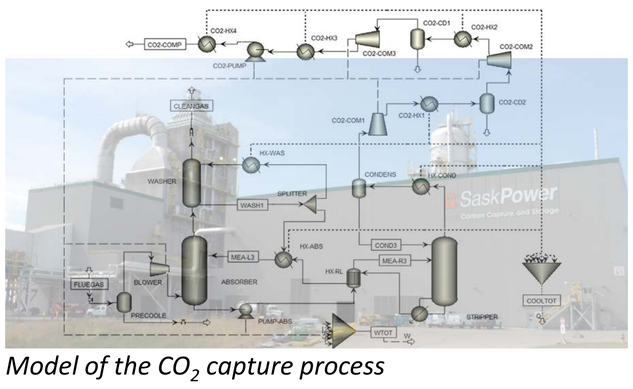
The majority of our methods and applications is developed in **cooperation or at least close contact with industry**, including essentially all major chemical companies and a variety of local and European SMEs.

Experimental infrastructures are available for model development and validation, covering a wide range of applications. In addition, adequate chemical analysis is used to determine gas and liquid-phase compositions. These tools permit a knowledge-based optimization of equipment design and operation parameters, as a basis for safe, **sustainable and profitable scale-up of processes**.

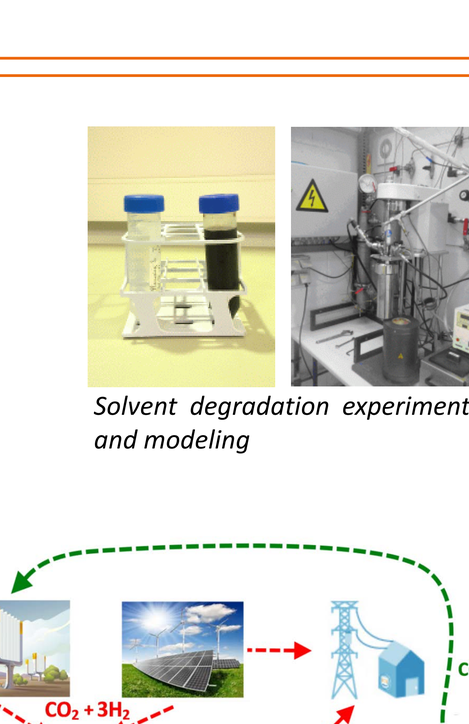
Indeed, the simulation of entire processes together with **Life Cycle Assessment** as eco-design support guide the optimization on the process level, where **economic as well as environmental parameters are included in the evaluation**.

X-rays macro-tomography

Experimental bench for drying



Model of the CO_2 capture process

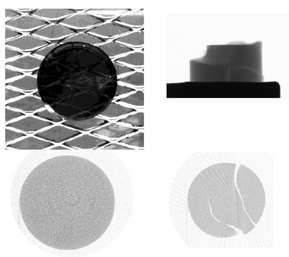


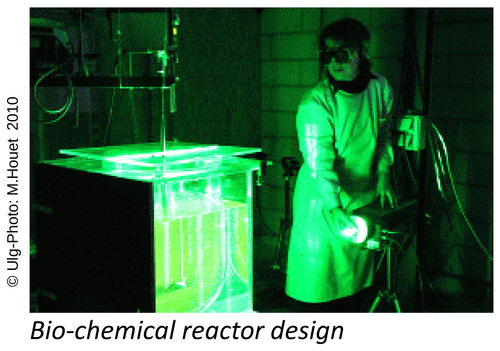
Chemical exergy of a variety of components from different component classes (diagram by Philipp Frenzel)

Research Themes

In the PEPs group, our main research themes are:

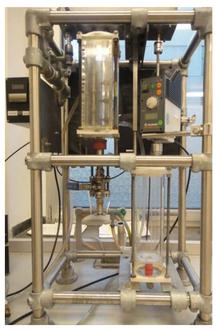
- Life cycle assessment (LCA)
- Sludge management
- Drying of materials
- Solvents and reactive extraction
- Coalescence, liquid-liquid phase separation and settlers
- Exergetic evaluation
- Reactor design
- Advanced experimental visualization techniques
- Product-oriented engineering
- CO_2 capture and re-use
- Power-to-gas, Power-to-fuel
- Process simulation, optimization and economic evaluation

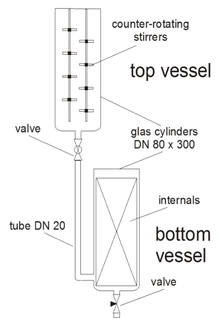

Picture, radiography and cross sections of resorcinol-formaldehyde gels



Bio-chemical reactor design

Solvent degradation experiments and modeling


Standardized settling experiment



Long-term energy storage with power-to-fuel

Conclusions

As doctoral student in the PEPs group you will be integrated in our research in one of the above-mentioned areas. The details of your research can be chosen accounting for individual preferences. Personal support and input will be mainly given by a senior scientist or in c²ase of a cooperation project by the supporting scientists.
At the same time all senior and junior group members are available for discussion and input.

In most of your research options also close interaction with our industrial partners will occur, because they support the development of our tools and methods.

If you are interested in one of our research topics or themes as well as in case of remaining questions: Please contact us!