

Research Placement, Bachelor or Master Thesis (experimental / theoretical)

Process automation and AI based image recognition for dynamic phase separation in microemulsion systems

Research background:

We are investigating homogeneously catalysed processes in liquid multiphase systems. In particular we are looking at the hydroformulation of long chained olefins in microemulsion systems and are implementing the process in a mini-plant. The idea behind using a microemulsion system is to use the advantages of a very efficient homogeneous catalysis and combining them with a simple phase separation step for a reliable recovery of the catalyst. The advantage of a microemulsion system is that the phase state (2 or 3 phase) is temperature dependant and can be switched by changing the Temperature.

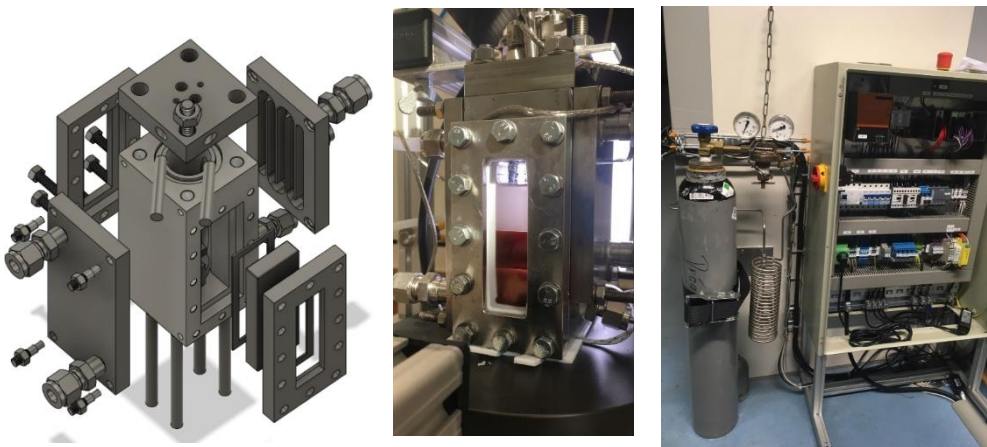


Fig 1: Experimental setup for the investigation of dynamic phase separation and liquid liquid equilibria

Task:

The modelling of thermodynamic modelling of microemulsions is currently still too complex and hence hybrid models based on experimental data are needed. To obtain this experimental data we have built a test stand in which the phase separation can be investigated and the results can be analysed with a webcam.

Your task will be to further advance the process automation in LabView to enable fully automatic experiments at different temperatures.

In addition to the automation of the experimental setup the analysis of the obtained images from the webcam also has to be automated with AI (convolutional neural network) based image recognition. For this a U-Net approach for semantic

segmentation is used [1] in python. Initial training data can be generated with an existing HSV-based image analysis script in python.

The following aspects will be investigated:

- Some Experiments for phase separation with synthetic reaction mixtures of the hydroformulation in microemulsions
- Automation of the experimental Setup in LabView
- Development of a CNN-base framework for image recognition of the phase separation

The thesis can be written in either German or English

Motivation:

After finishing this thesis, you will have a deeper understanding of process automation and AI-based image recognition software. In addition, you will gain insights into model development based on experimental data. You will also understand how microemulsion systems work and how they contribute towards green chemistry. You will have experience in solving industry related tasks; experience what it means to work with a real mini-plant, its Process Control System (PCS), OPC and OPC UA data exchange protocols.

Skills and Knowledge:

You can successfully complete this thesis if you have some experience in the lab; have an understanding of thermodynamics, basic python knowledge and enthusiasm to develop your skills in using neural networks,

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[1]: <https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/>