Universität Bremen

Chemical Process Engineering

Faculty 04
Production Engineering

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HiWi position for project:

Thermal effects on gas transport in catalytic membranes

Project description

The project is a cooperation between the University of Marseille and the University of Bremen (more precisely the Chemical Process Engineering working group), which is concerned with improving catalytic processes. Approximately 90% of all products in the chemical industry are produced in catalytic processes and most of them with heterogeneous catalysis, in which the catalyst is usually present as a solid and catalyzes reactions in the gas phase or liquid phase. Optimizing such processes is particularly interesting for two reasons:

1. The chemical industry has a very large CO2 footprint, which is why even small improvements in processes can have a significant, positive impact on the environment.
2. The transition to a completely sustainable society is inconceivable without catalytic processes. One example of this is the storage of surplus electrical energy, which is crucial for the energy transition. In addition to short-term storage in batteries (to stabilize the grids), medium to long-term storage is also important, with chemical storage being an obvious option. The storage of hydrogen obtained through electrolysis is particularly costly, which is why conversion to more easily storable substances such as methane, methanol or gasoline/kerosene makes sense, provided that the CO2 required for this conversion is taken from the environment. In this way, processes that rely on starting materials such as methanol could be converted in a climate-neutral way.

The project with the University of Marseille is now starting at the fundamental level and aims to use the so-called Knudsen Pumping Effect (KPE) to improve the use of catalysts. The KPE causes a directed movement of gas molecules in porous structures in the presence of a temperature gradient and is therefore also referred to as a pump without moving parts. Since mass transfer to and from the active sites of the catalyst is often limiting in heterogeneous catalysis, clever use of the KPE could increase the reaction conversion in catalytic membranes (porous ceramics coated with active catalyst) and thus reduce the resources required for the overall process.

In order to be able to demonstrate a possible effect, we use a specially manufactured chemical reactor equipped with a porous ceramic tube. Inside this tube, a model reaction takes place with the help of a catalyst, which is exothermic and thus heats up the tube. Reactants can then flow in from outside and accelerate the process. The whole setup will initially be tested in the laboratory using temperature and mass spectrometer measurements. The functioning setup will then be placed in a magnetic resonance

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tomograph (MRT) and the resulting product and the gas temperature can be recorded in 3D using a special, specially developed method.

Tasks and requirements

As a student assistant, you would mainly work in the laboratory and plan and carry out the preliminary experiments. During the experiments, you will work with compressed gases (Ar, H_2 and C_2H_4), which are fed into the reactor to react with a catalyst to form C_2H_6. The temperature is monitored using thermocouples and the gas supply is regulated using mass flow controllers. The composition of the product gas is checked with a mass spectrometer. After possible adaptation of the system, you would of course also be able to take part in the MRI measurements and get an idea of the 3D measurement data recorded in the gas phase. The procedure for this was developed in our working group and is unique in the world of research.

The main requirements are that you are a student of natural or engineering sciences and enjoy working on a new topic and doing practical work. It is also helpful, **but not a requirement**:

- Basic knowledge of the Python programming language
- Basic experience of working in laboratories

If you are interested and/or have any questions, please contact us by e-mail.