Karlsruher Institut für Technologie

Institut of Catalysis Research and Technology (IKFT)

Master Thesis

Your contribution to Power-to-Chemicals: Impact of renewable H_2 on methanol synthesis

Research field

- ☐ Catalyst Development
- ☒ Process Engineering
- ☒ Catalyst Deactivation

Ausrichtung

- ☒ Experimental
- ☐ Modeling/Simulation
- ☒ Literature
- ☐ Lab Synthesis
- ☒ Plant Operation
- ☒ Material Characterization
- ☐ Development of Measurement Techniques

Studies

- ☒ Chemical Engineering
- ☒ Chemistry
- ☒ Material Science
- ☒ Physics
- ☐ Economical Engineering

Start

15.10.2025

Contact

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Motivation

The deactivation of copper/zinc-based catalyst materials in methanol synthesis is a challenge, especially with regard to future use with CO_2 and renewably generated H_2.[1–3] Potential impurities in low-emission hydrogen can have a significant impact on deactivation behavior and thus on catalyst activity. Your task is to test and evaluate this influence in a parallel reactor for methanol synthesis. For this purpose, a targeted operating program will be discussed and implemented within the team. In doing so, you will contribute to the improvement of catalyst systems. In addition to scientific work, this work in our team will allow you to gain knowledge.

- You will learn how to operate parallel reactor systems.
- You will learn how industrial-scale methanol catalysts work and which parameters are important.
- You will learn how to ensure high-quality quantitative measurements.

References

(1) Warmuth, L.; Steurer, M.; Schild, D.; Zimina, A.; Grunwaldt, J.-D.; Pitter, S. Reversible and irreversible structural changes in Cu/ZnO/ZrO_2 catalysts during methanol synthesis. *ACS Appl. Mater. Interfaces* **2024**.

(2) Fichtl, M. B.; Schlereth, D.; Jacobsen, N.; Kasatkin, I.; Schumann, J.; Behrens, M.; Schlögl, R.; Hinrichsen, O. Kinetics of Deactivation on Cu/ZnO/Al_2O_3 Methanol Synthesis Catalysts. *Appl. Catal. A-Gen.* **2015**, *502*, 262–270. DOI: 10.1016/j.apcata.2015.06.014.

(3) Kung, H. H. Deactivation of methanol synthesis catalysts - a review. *Catal. Today* **1992**, *11* (4), 443–453. DOI: 10.1016/0920-5861(92)80037-N.

The work is divided into the following steps:

- Familiarization with the literature on deactivation processes in methanol synthesis
- Plant operation to test a simulated gas mixture with potential impurities from electrolysis
- Evaluation of operating data with regard to activity, selectivity, and stability with and without impurities
- Combination of results to determine a deactivation mechanism

Notes

We offer excellent support and the opportunity to work in an interdisciplinary team on a future-oriented subject area. Independent work and the motivation to familiarize yourself with new subject areas are required. You can get more information from Lucas Warmuth at any time.

Prof. Dr.-Ing. Jörg Sauer