Sustainable Process Engineering
Inorganic Membranes and Membrane Reactors

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Development and upscale of DME production via CO_2 direct hydrogenation

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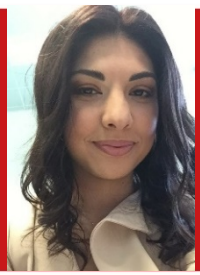


Introduction

In order to reduce the CO_2 emissions, CO_2 can be captured from the industrial off-gases and converted in fuel or energy carriers. In this scenario dimethyl ether (DME) plays a key role because it is a clean burning fuel that can be a substituent of diesel fuel in diesel engines. However DME synthesis through the CO_2 direct hydrogenation route seems to be not competitive with respect to the traditional feedstocks due to thermodynamics limitations: CO_2 favors water formation through reverse WGS reaction, hindering DME production and causing catalyst deactivation.

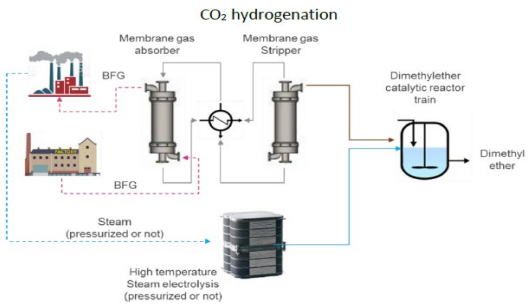
Project summary

Three main reactions are involved in DME synthesis via CO_2 direct hydrogenation:

(1) *CO_2 hydrogenation* $CO_2+3H_2 \leftrightarrow CH_3OH$
(2) *Reverse WGS* $CO_2+H_2 \leftrightarrow CO+H_2O$
(3) *Methanol dehydration* $2CH_3OH \leftrightarrow CH_3OCH_3+H_2O$

The development of a membrane reactor for H_2O in situ removal may bring beneficial effect on CO_2 conversion and DME yield. Alumina-carbon molecular sieve membranes seem to be the most promising, due to their hydrophilicity and pore size. Membranes will be prepared and characterized in order to find the preparation conditions that lead to the optimal properties in terms of water permeation and selectivity. Then, a bifunctional catalyst like Cu-ZnO-Al_2O_3/HZSM-5 will be selected and optimized. After a proper choose of the catalyst and the membranes, the reactor and the overall process can be designed. In the end, a DME experimental setup will be constructed and tested.

Membrane and catalyst selection → Reactor and process design → DME production demonstrator setup and testing



Project goals

- Develop hydrophilic CMMS allowing water removal from the reaction zone
- Demonstrate a multi-tubular membrane reactor at TRL5 up to 40 bar and 250 °C
- Increase the yield of DME by 28% per pass compared with conventional systems working at the same conditions (yield 15% per pass)

Contact information

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