

# Synthesis setup for CO<sub>2</sub> conversion to hydrocarbons

## Graduate



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**Introduction:** Since the usage of the first steam engines during industrialization, the increased consumption of fossil fuels has led to an increase in greenhouse gases (GHG) in the atmosphere. Through the combustion of fossil fuels, carbon dioxide (CO<sub>2</sub>) as well as other GHG are released, changing the Earth's climate system. However, these changes have proven to be detrimental for humanity and the Earth's biosphere. Therefore, reducing the emission of GHG is more important than ever.

The transportation industry relies primarily on fossil fuels. As a replacement for fossil fuels, alternatives such as batteries have been proposed. However, due to the significantly lower energy density of batteries compared to gasoline, diesel or kerosene, batteries work best for smaller vehicles. Hence, synthetic fuels are a promising short-term alternative for heavy-duty vehicles, ships, and aircraft. The two most common pathways for the commercial production of synthetic fuels are the methanol to hydrocarbons (MtH) conversion and the Fischer-Tropsch (FT) process. However, the current MtH and FT process still rely on fossil fuels. Therefore, the incentive is to investigate alternative production routes, starting from CO<sub>2</sub>.

**Definition of Task:** The goal is to construct a lab-scale experimental setup, comprising a reactor performing the MtH conversion. The setup should also allow the implementation of a second reactor in which the CO<sub>2</sub> to methanol conversion can be implemented. Therefore, it needs to be capable of achieving high temperatures (up to 500 °C) and withstanding high pressures (up to 64 bar), allowing the investigation of a wide range of conditions.

**Result:** To verify the functionality of the setup, two common catalysts base of zeolites, have been tested for the MtH conversion. The first zeolite is ZSM-5 and the second one is zeolite Y. They have also been tested with a copper loading to assess the effect of copper on the MtH conversion. The data obtained from X-ray diffraction (XRD) and N<sub>2</sub> physisorption for the characterization of the zeolites, as well as from online mass spectrometry, match expectations, making the setup a success. It shows that zeolite topology and its acidity can be tuned to favour a range of hydrocarbons. The effect of copper on MtH conversion also indicates that the copper loading has to be adjusted carefully to minimize the impact on the yield.

## Advisor

Prof. Dr. Andre Heel

## Co-Examiner

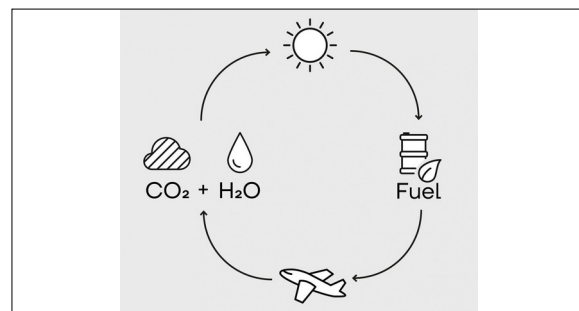
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## Subject Area

Energy and  
Environment

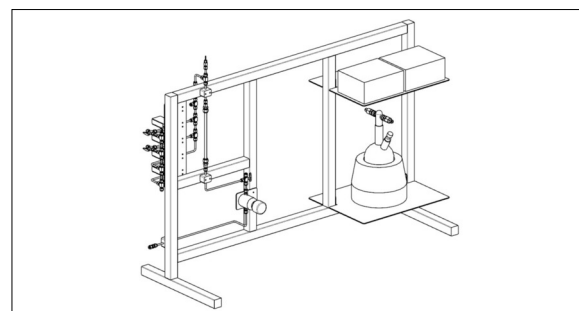
## Idealization of the closing of the carbon cycle with synthetic fuels

[Synhelion.com/solar-fuels-and-plants/solar-fuels](https://synhelion.com/solar-fuels-and-plants/solar-fuels)



## Drawing of experimental setup

Own presentment



## Experimental setup comprising reactor for MtH conversion

Own presentment

