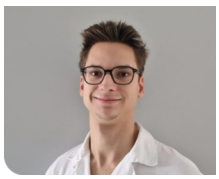
Investigation of Bifunctional Copper-Based FAU Catalyst For Hydrocarbon Synthesis

Sustainable Aviation Fuels

Graduate



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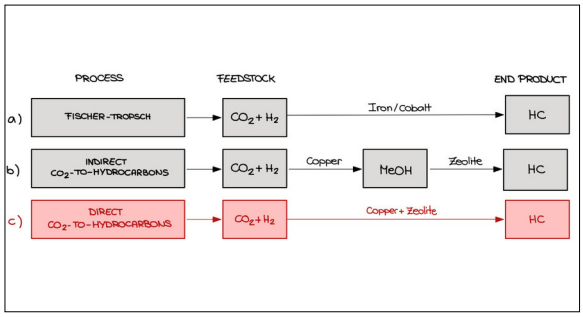
Introduction: The aviation sector is one of the most challenging industries to decarbonize, as it requires high-energy-density fuels capable of supporting long flights or cargo operations. The currently available alternatives, such as batteries or hydrogen, are not yet able to meet these requirements. For this reason, Sustainable Aviation Fuels are considered the most promising solution for reducing CO2 emissions in air transport.
According to the federal law on climate protection targets in Switzerland, the transport sector must reduce its emissions by 57% by 2040. In 2019, Switzerland consumed 1.85 million tons of aviation fuel, a figure that highlights both the scale of the challenge and the potential of the market. However, global production of sustainable aviation fuels remains extremely limited: in 2024 it accounted for only 0.3% of the available aviation fuel, with an expected increase to 0.7% in 2025.
Among emerging technologies, the Methanol-to-Jet process is gaining increasing attention. This approach enables the production of hydrocarbons from methanol derived by CO2 captured from the atmosphere or industrial exhaust gases, and the green hydrogen can be produced via electrolysis powered by renewable energy sources, making the entire value chain potentially sustainable. Moreover, compared to the Fischer-Tropsch process, the Methanol-to-Hydrocarbons route allows for greater control over product selectivity thanks to the use of zeolite-based catalysts.

Objective: The aim of this project is to investigate how zeolite structure, Si/Al ratio, and the introduction of metals (Cu, Zn, Mg) affect catalytic performance in the Methanol-to-Hydrocarbons process. The study examines the role of acidity, strategies to reduce coke formation, the impact of metal content on reactivity and stability, the behavior of physically mixed Cu/ZnO/Al2O3–Y catalysts, and catalyst stability during long-term operation and after different regeneration cycles.

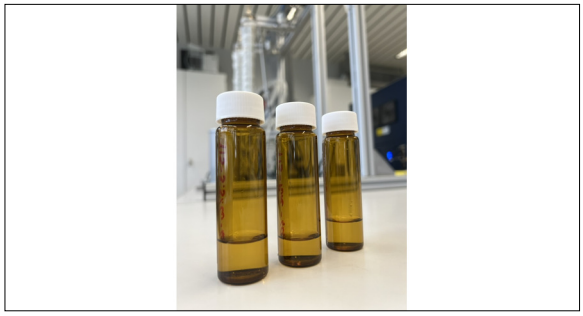
Result: The results obtained show that the Cu/ZnO/Al2O3 catalyst physically mixed with Y zeolite exhibits intermediate catalytic properties compared to the pure catalyst and the ion-exchanged Cu catalyst, suggesting that further experiments should be conducted to better understand its catalytic behavior. In addition, it is recommended to explore new methods to reduce coke formation, such as oxidation with air or oxygen, or steam gasification. To reduce the formation of aromatic compounds, it is also suggested to decrease the residence time of the molecules, for example by increasing the weight hourly space velocity.

(a) Fischer-Tropsch process; (b) Indirect CO2-to-Hydrocarbons; (c) Direct CO2-to-Hydrocarbons process (our process)
Own presentment



Catalyst Y used for the synthesis of methanol into hydrocarbons
Own presentment

Liquid samples collected for composition analysis
Own presentment



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Subject Area
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