

Measurements of spatially-resolved concentration profiles on Fischer-Tropsch synthesis in a fixed-bed compact profile reactor

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Introduction. Fischer-Tropsch synthesis (FTS) has recently experienced renewed interest, as hydrocarbon chains can be built up from hydrogen and carbon monoxide (syngas) via a heterogeneously catalysed chain growth reaction [1]. Therefore, FTS plays a major role in power-to-X concepts and is considered one of the key technologies for the energy transition process. Since syngas cannot only be obtained from fossil but also from renewable carbon feedstocks such as biogas and CO₂ [2], the sustainability of the production of fuels or other valuable products like higher alcohols can be notably increased using FTS. The Fischer-Tropsch synthesis is characterized by a large reaction network and a product mixture of hydrocarbons from different substance groups and chain lengths. The product spectrum is also strongly dependent on the reaction conditions. Although the first insights into this reaction were published in the 1920s [3], the underlying reaction mechanisms and kinetics are still poorly understood due to their complexity. This leads to difficulties in process optimization according to ecological and economic criteria.

Experimental/methodology. Conventional slurry or fixed-bed reactors allow only integral measurements of product selectivity and derived parameters like chain growth probabilities [4]. Hence innovative reactor designs are required to gain more insights than classical integral reactor setups. The application of the so-called compact profile reactor (CPR), developed by *Reacnostics GmbH* (Hamburg, Germany), can give access to previously inaccessible information. This setup allows for the local sampling of the gas phase at distinct positions in the catalyst bed so that using gas chromatographic methods spatially resolved profiles of the individual product species can be obtained [5]. Thus, the CPR offers the possibility to derive differential data within fixed beds at reaction conditions.

Results and discussion. In the first experiments on FTS on iron-based catalysts, spatially resolved concentration profiles could be obtained for short-chain components, leading to promising new insights into the influence of operating conditions as well as of secondary reactions on product selectivity [6]. To also obtain spatially resolved concentration profile data of long-chain hydrocarbons and to determine meaningful reaction kinetics, it is necessary to improve the existing experimental setup. For this purpose, advanced on-line analysis and the possibility of dosing both liquids and gases will be used, which will enable co-feed experiments. The current state of development and future improvement of spatially resolved profile measurements for Fischer-Tropsch synthesis will be presented.

References

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