

Spatially resolved concentration measurements for new insights into reaction characteristics of the Fischer-Tropsch synthesis

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The Fischer-Tropsch synthesis (FTS) is ranked among the most challenging reactions to analyze due to a complex reaction network resulting in a diverse product mixture of hydrocarbons with different functional groups and chain lengths. As a well-established process to produce synthetic fuels from syngas the FTS plays a major role in Power-to-X (PtX) concepts and is considered one of the key technologies in the associated transition of the energy system. Therefore, comprehensive understanding of the FTS mechanism is fundamental for profound process optimization. Since fixed-bed reactors are easy to scale, they are of particular importance in the operation of smaller decentralized plants, such as those expected to be implemented for PtX applications. To gain more insights – especially into reaction kinetics – innovative reactor designs are advantageous as studies based on integral reactors suffer in particular from their “black box” character, e.g. by underestimating the influence of secondary reactions.

Reactor concepts such as the compact profile reactor (CPR), allow to monitor differential processes within fixed beds. In detail, axial gas phase composition within the catalyst bed can be measured, providing spatially resolved concentration profiles of feed and product species. These groundbreaking data offer a great potential to gain new mechanistic insights and derive characteristic parameters i.e. reaction rates for each species, olefin-paraffin-ratios, or chain growth probabilities in dependence of the residence time within the catalyst bed.

Within this study spatially resolved concentration profiles for FTS were obtained under industrial relevant operating conditions using a cobalt-based catalyst. First results will be presented in this work showing the reproduction of well-known major effects of the mentioned parameters on conversion and product selectivity as well as shifts in chain growth probability and olefin-paraffin-ratios in dependence of residence time.