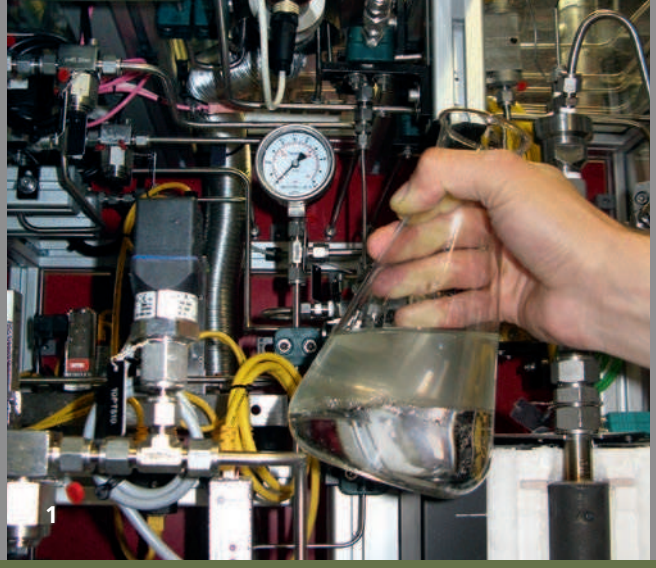

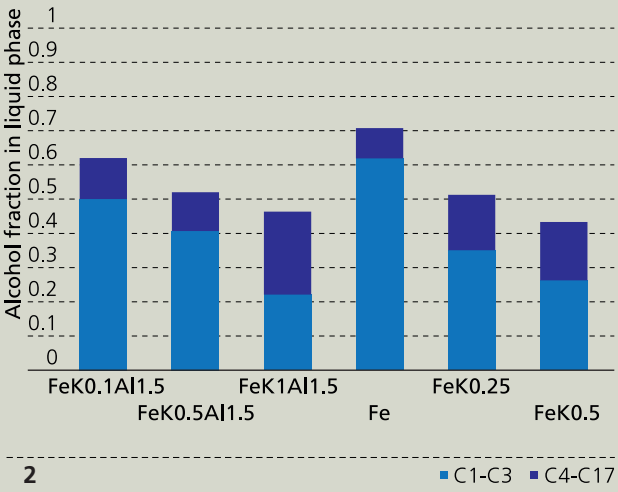

SYNTHESIS OF HIGHER ALCOHOLS ON IRON-BASED CATALYSTS

Dipl.-Ing. (FH) Erik Reichelt, M. Sc. Max Schaller, Dr. Matthias Jahn

Higher alcohols are important basic chemicals that are used in detergent production or as fuel additives. Currently these compounds are mainly synthesized by hydroformylation of olefins. These olefins are generally produced by refining of crude oil. However, not only because of sustainability reasons but also because of the established route having several complex process steps, the development of a technology for direct synthesis from synthesis gas is the subject of current research activities. Besides modified methanol synthesis, which mainly produces branched alcohols, Fischer-Tropsch synthesis offers a potential pathway towards higher alcohols. Here, research is focused on molybdenum disulfide-based catalysts. A disadvantage of this route is the risk of contamination of the product with sulfur. In both cases, the high pressure levels (p = 50–100 bar) are disadvantageous for the application of the process. From early works on Fischer-Tropsch synthesis, it is known that iron catalysts are active for the synthesis of alcohols with high selectivity under certain conditions. Besides process conditions ($\vartheta \approx 200$ °C, $p < 40$ bar), the low catalyst costs make this type of modified Fischer-Tropsch synthesis an attractive alternative to the mentioned processes.

The studies on aluminum- and potassium-promoted precipitated iron catalysts show that activity and selectivity strongly depend on pretreatment of the catalyst and on process conditions. High alcohol selectivities are reached at low temperatures and mild pretreatment conditions. Because alcohol synthesis is favored at low residence times, the technical realization of the process necessitates the development of a recycle process. The selectivity can also be influenced by the applied promoters. An increasing amount of potassium on one hand leads to a lowered overall alcohol selectivity but on the other hand increases the selectivity towards higher alcohols. The addition of aluminum does not influence the selectivity in the investigated range but can have a positive influence on the long-term stability of the prepared catalysts.

Besides studies on the alcohol selectivity of different promoted iron catalysts and the influence of process conditions, the overall process, including synthesis gas production, is considered. Apart from large-scale industrial application of the Fischer-Tropsch-based alcohol synthesis process, small-scale applications for decentralized production are interesting. Here, the work at Fraunhofer IKTS is focused on the coupling of the synthesis step with high-temperature electrolysis. By utilizing the waste heat from the highly exothermic synthesis step for the vaporization of water, it is possible to achieve a highly efficient process. Different process designs are compared with the help of process simulation software in order to identify a promising concept.

1 *Product fractions obtained from Fischer-Tropsch synthesis.*
2 *Alcohol fraction in the liquid product for catalysts of differing composition (ϑ = 250 °C, p = 20 bar.)*

Contact Matthias Jahn • Phone +49 351 2553-7535 • matthias.jahn@ikts.fraunhofer.de