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Fischer-Tropsch to Higher Alcohols

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Abstract

Higher linear alcohols are valuable chemicals. The state-of-the-art synthesis process is based on hydroformylation, which is homogenously catalyzed, fossil fuel dependent and contains multiple process steps [1]. To overcome fossil fuel dependency and meet modern environmental goals highly selective and low energy consuming alternatives have to be found. Early literature results indicate high alcohol selectivity on iron-based catalysts applying moderate Fischer-Tropsch conditions [2]. Additionally, more recent literature shows that alcohols synthesized on iron appear to be mainly linear [3]. Nevertheless, the influence of process conditions and promoters on alcohol selectivity is not satisfyingly clarified.
Unpromoted and promoted precipitated iron catalysts were comprehensively characterized (porosimetry, ICP-OES, XRD, TPR, FESEM, EDX) and catalytically tested. The influence of operating conditions and different catalyst promoters on alcohol selectivity were tested in a fixed bed reactor. It is well-known that activity and selectivity of iron-based catalysts are governed by carbide and oxide phases on the catalyst surface. In order to get a deeper understanding of the underlying mechanisms and surface processes the prepared iron catalysts have been investigated using in-situ XRD characterization tools [4,5].
Variation of process conditions showed that high pressures, low temperatures and low residence times lead to an increased alcohol selectivity. The application of different chemical promoters indicate that copper and sodium offer a promising potential for alcohol formation, whereas potassium increases selectivity to other oxygenates. In-situ XRD measurements allowed the depiction of the development of different iron oxide and iron carbide phases during catalyst reduction and synthesis. While potassium accelerates the reduction of hematite to iron, alumina decelerates this process. During the synthesis, different iron carbides were detected, quantitatively analyzed and matched with the occurring product spectrum.

Literature

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