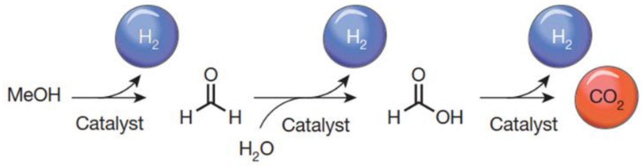
Methanol Steam Reforming at low Temperatures Using Supported Homogeneous Catalysts – Catalyst Development and Reactor Design

H. Junge[1], A. Agapova[1], C. H. Schwarz[2], A. Rehman[2], D. Neu[2], M. Haumann[2]
[1]Leibniz-Institut für Katalyse, e. V.
[2]Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Lehrstuhl für Chemische Reaktionstechnik (CRT)

Abstract

Today, hydrogen storage materials range from simple NH3 to more complex structures like dibenzyltoluene. A promising approach to hydrogen storage is the generation of methanol by hydrogenation of CO2. In a decentralized scenario, even for mobile applications in transport, the hydrogen can be released again by methanol steam reforming. The resulting reformate has a hydrogen to carbon dioxide product ratio of 3:1. From a thermodynamic point of view, high equilibrium conversions can be obtained at higher temperatures since the reaction is endothermic. However, in case the reaction temperatures exceed approx. 200 °C, the stronger endothermic methanol decomposition will result in high CO levels >1%, which would render the gas mixture not suitable for most fuel cell applications.



Noble-metal and base-metal transition metal complexes have been successfully employed for the homogeneously catalyzed dehydrogenation of methanol at temperatures below 160 °C.[1] In order to design potential processes based on such attractive catalysts, continuous operation must be ensured. Here, the purely liquid-phase reaction would be problematic, e.g. as high base concentrations would lead to corrosion of reactor materials.
Supported liquid phase (SLP) materials consist of a high boiling liquid, dispersed as a thin film on the inner surface of a highly porous solid material. By dissolving homogeneous transition metal complexes in the liquid film (here: aqueous KOH), the SLP concept allows tailor making of solid materials with definite properties and a controlled chemical reactivity. Since the liquid is dispersed on the inner surface of the support, a dry solid material is obtained. These materials can be handled like classical heterogeneous catalysts in continuous fixed-bed reactors.
In this work, we present results from immobilization studies using commercially available Ru-Pincer catalysts in standard SLP gas-phase scenarios.[2,3] The catalysts have been optimized by variation of the type of liquid used for coating the support surface. Kinetic data were used to model possible reactor designs in AspenPlus.

References

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