Exploration of diffusional phenomena during LOHC dehydrogenation with Pt/Al_2O_3-catalysts of varying pore sizes

Peter S. Schulz*, Franziska Auer, Andreas Bösmann, Peter Wasserscheid

Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU)
Lehrstuhl für Chemische Reaktionstechnik, Erlangen, Germany
*peter.schulz@fau.de

The use of Liquid Organic Hydrogen Carrier (LOHC) systems has recently gained great interest as they are a promising alternative for energy storage and transport. In a previous work the system dibenzyltoluene/perhydro-dibenzyltoluene (H0-DBT/H18-DBT) was proposed to be a suitable LOHC-candidate [1].

To further forward the LOHC-technology the development of an active dehydrogenation catalyst is of high importance. In this context, Pt/Al_2O_3-catalysts have proven to fit the requirements quite accurately, but, as it is the case in most heterogeneously catalyzed reactions, suffer from diffusional limitations. Thereby the effective diffusivity of the reactant molecules in the pores of the porous catalyst is significantly reduced compared to molecular diffusion. In liquid-phase reactions this becomes significant when the ratio of the molecular diameter of the reactant to the pore diameter of the catalyst support material is in the range of 1:10 [2]. As the H18-DBT molecule has a maximum expansion of approximately 1,4 nm and the pore size of common alumina supported catalysts is about 10 nm, this could strongly affect the dehydrogenation reaction.

To investigate the existence of diffusional limitations in the dehydrogenation of H18-DBT and perhaps overcome them, different alumina support materials with varying pore sizes were used to prepare the Pt/Al_2O_3-catalysts. Batch experiments and PFG NMR experiments were performed to determine the influence of the catalyst pore diameter on the rate of diffusion of reactants and therefore on the activity of the catalyst. As a result, an optimum pore size could be obtained.

References

[1] N. Brückner, K. Obesser, A. Bösmann, D. Teichmann, W. Arlt, J. Dungs, P. Wasserscheid: *Evaluation of industrially applied heat-transfer fluids as liquid organic hydrogen carrier systems*. ChemSusChem **7**, 229-235 (2014).

[2] C. N. Satterfield, C. K. Colton, W. H. Pitcher: *Restricted diffusion in liquids within fine pores.* AIChE J. **19**, 628-635 (1973).