Reduction of *p*-Nitrophenol to *p*-Aminophenol over Supported Monometallic Catalysts as a Model Reaction for Mass-Transfer Investigations

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Generally, mass-transfer limitations play an important role for a valid determination of the reaction rate of liquid-phase catalytic hydrogenation reactions [1]. Catalytic hydrogenations are considered one of the most important reactions in many industrial processes such as upgrading of biomass and transformation of unsaturated to saturated hydrocarbons. Moreover, the reduction of $-NO_2$ and -C=O groups in organic compounds are common conversions in chemicals and pharmaceuticals production [1-2]. Usually, the catalytic hydrogenation reactions require laborious experiments involving high-pressure reactors, elevated temperatures, organic solvents and long experimentation times. Therefore, the assessment of the catalytic activity of supported metal catalysts utilizing the hydrogenation of *p*-nitrophenol (PNP) to *p*-aminophenol (PAP) using $NaBH_4$ as a reduction agent as a model reaction is presented. This conversion can be readily conducted in shorter reaction time (20 min), ambient pressure and temperature and with water as a solvent. Furthermore, the progress of the reaction can be easily monitored using on-line UV/Vis spectroscopy [2-3].

This work was, thus, devoted to investigate the effect of external mass-transfer limitations on the reaction rate of hydrogenation of PNP to PAP using $NaBH_4$ as reduction agent. Catalysts used for this study were 2.2Pt/SiO_2, 3.9Pt/γ-Al_2O_3, 2.1Pd/Al-MCF and 2.0Pd/Al-SBA-15 with different textural properties.

The catalysts were thoroughly characterized via N_2-sorption, elemental analysis, XRD, SEM and TEM. The initial reaction rates of PNP hydrogenation over the supported Pt catalysts obtained at different stirring speed were calculated (Figure 1). Monometallic 2.2Pt supported on SiO_2 shows a correlation between the initial reaction rate and the stirring speed indicating the presence of external mass-transfer limitation. In contrast, the initial reaction rate using 3.9Pt/γ-Al_2O_3 does not increase for stirring speeds above 1000 min^{-1}. Therefore, it can be assumed that under these conditions external mass-transfer is not limiting the reaction rate due to different morphological properties (i.e., smaller catalyst grains) as well as a lower catalytic activity.

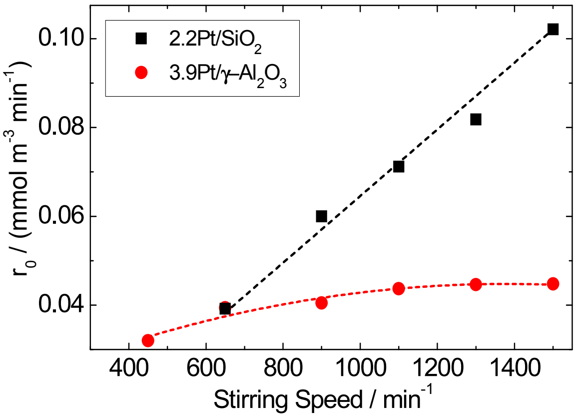

Figure 1: Influence of the stirring speed on the initial reaction rate for the reduction of PNP using 2.2Pt/SiO_2 and 3.9Pt/γ-Al_2O_3.
Reaction conditions: $c_{PNP} = 0.18$ mmol l^{-1}, $c_{NaBH4} = 0.6$ mmol l^{-1}, T = 298 K, $m_{catalyst} = 150$ mg.

References

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