The effects of external surface barriers on zeolite catalysts

M. Alkhunaizi[1]*, T. Weissenberger[1], G. Sankar[2], M. O. Coppens[1]

[1]Department of Chemical Engineering, University College London, London, UK
[2]Department of Chemistry, University College London, UK
*m.alkhunaizi.17@ucl.ac.uk

Zeolites are attractive heterogeneous catalysts due to their crystalline structure, high surface area and thermal stability. However, conventional zeolites display diffusion limitations in many relevant catalytic processes. The slow diffusion rate through the extended network of micropores leads to low catalyst utilisation and can, furthermore, lead to reduced selectivity and catalyst lifetime. Thus, hierarchical zeolites have received considerable attention over recent years. The pore network of hierarchical zeolites contains at least one additional, larger pore system, interconnected to the zeolite micropores. This allows for the efficient transport of reagents to, and products away from the active sites confined in the micropores by shortening the diffusion path length [1]. Thus, the incorporation of hierarchical porosity can enhance the diffusion and reduce or even eliminate diffusion limitations in zeolite catalysts [2]. In addition to enhanced catalyst utilisation, increasing the external surface area and maximising the rate of intracrystalline diffusion could also lead to improved catalyst life times.

Nevertheless, recent experimental and computational work suggests that external surface barriers in zeolite-based, hierarchical catalysts might play a significant role in affecting overall transport and reaction rates in such catalysts [3]. Rao *et al.* [4] demonstrated the existence and impact of surface barriers on the alkylation of benzene with ethylene by comparing reactor simulations with experimental results.

In recent work in our group, ZSM-5 zeolites with similar bulk properties were prepared with different external surface properties, using different synthesis methods and conditions. The synthesized materials were studied extensively using different characterisation techniques to determine their chemical, structural and textural properties. This set of catalysts was then used for appropriate catalytic experiments to investigate the impact of surface barriers on the catalytic properties of zeolites. This knowledge will be important to understand how surface barriers can be either avoided or exploited.

References

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