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Kinetic measurements on monoliths using the Adsorption Differential Volumetric Apparatus (ADVA)

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In recent years, the ever increasing development of manufacturing techniques has allowed the synthesis of a wide range of structured adsorbents designed to address some of the shortcomings of conventional pelletised materials. Channel shapes and flow patterns are engineered to minimise pressure drop, improve adsorption/desorption kinetics and maximise accessibility to the active material. The main challenges in the field of monoliths are commonly associated with the synthesis and production process while it is often neglected that testing and characterise these structured materials is equally challenging. Monoliths are produced in a variety of shapes and sizes and this prevents the use of most conventional and commercial adsorption techniques. Most of these systems (microbalances and commercial volumetric apparatuses, for example) are generally designed to minimise dead volumes, sample units normally house relatively small quantities of powders or pelletised materials and accessibility to the uptake cells is often very limited. This means that in many cases monoliths need to be broken down to smaller pieces or fragments to be tested in the most common apparatuses, providing only partial insights on the performance of the formed material.

The Adsorption Differential Volumetric Apparatus (ADVA) is a novel volumetric system designed with two symmetric branches (sample and reference) and relies on a differential pressure transducer across the sample and reference side for increased accuracy [1]. This allows the system to provide highly accurate equilibrium and kinetic measurements in the entire pressure range using very small sample masses (<100 mg). The system has a modular design that allows to adapt the uptake cell to samples of different sizes and shapes, making it ideal for the characterization of structured adsorbents.

In this work, we present gas transport measurements of CO2 and N¬2 at different pressure levels on a number of monoliths. Samples include zeolite-based adsorbents with different pores sizes extruded as monoliths of different wall sizes manufactured at Vrije Universiteit Brussels.

The measurements provide insights on the process performance of the material as well as the manufacturing process.

References:

1. J. Wang, E. Mangano, S. Brandani, F. Brandani, P. Pullumbi, A novel adsorption differential volumetric apparatus to measure mass transfer in nanoporous materials, Separation and Purification Technology, Volume 283, 2022.

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