



VAMAS

Project 1

## CH<sub>4</sub> Surface Excess Adsorption Isotherms on Zeolite Y

### BACKGROUND

Adsorbents have many potential applications, ranging from fluid catalytic cracking to gas separation and storage to environmental remediation. The performance of an adsorbent is typically determined by measuring an adsorption isotherm - the amount of gas uptake as a function of equilibrium pressure at a fixed temperature. Many of the aforementioned applications require measurements at high-pressures; however, reproducibility of high-pressure measurements has proved to be a challenge, which has slowed the development of new materials and associated applications.

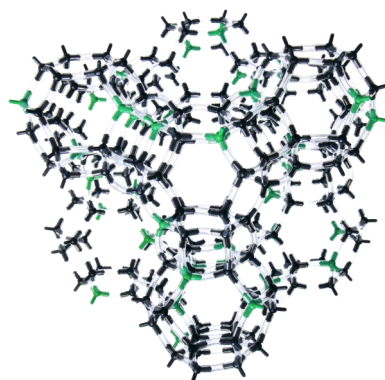
To address the challenge of reproducibility of high-pressure isotherm measurements, an international, interlaboratory study (ILS), was coordinated by the Facility for Adsorbent Characterization and Testing ([FACT Lab](#)) based at the National Institute of Standard and Technology (NIST).

### WORK PROGRAMME

NIST provided reference sorbent materials<sup>1</sup> and an experimental protocol

for the ILS, which proceeded in two phases.

First, participants were asked to replicate an existing reference isotherm for surface excess adsorption of CO<sub>2</sub> on NIST Reference Material 8852 (ammonium ZSM-5, a synthetic MFI-type zeolite). This isotherm had been generated in an early, limited-scope ILS previously sponsored by the FACT Lab. Second, participants were asked to measure the surface excess adsorption isotherm for CH<sub>4</sub> on Reference Material 8850 (Zeolite Y (ZY), a synthetic FAU-type zeolite) at 25 °C to a pressure of 7.5 MPa. In total, twenty laboratories participated in the study and contributed over one hundred CH<sub>4</sub>/ZY adsorption isotherms.



Zeolite Y

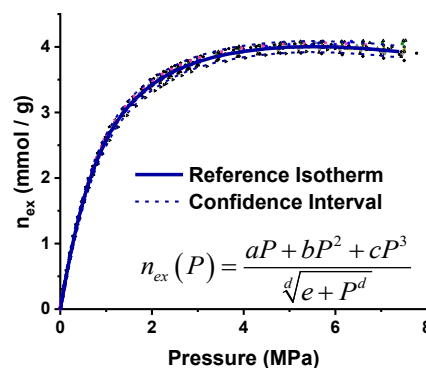
## Solid Sorbents

Technical Work Area 39

## Summary of Results

### REFERENCE ISOTHERM

A variety of statistical tests were used to evaluate the submitted isotherms. Participants were required to replicate the reference CO<sub>2</sub>/ZSM-5 isotherm<sup>2</sup> in order for their CH<sub>4</sub>/ZY datasets to be included in the determination of the reference isotherm for CH<sub>4</sub>/ZY. The CH<sub>4</sub>/ZY datasets were also statistically evaluated to detect outliers. These outliers were removed from further evaluations and a reference isotherm was extracted from the remaining datasets. These datasets and reference isotherm, along with the associated confidence interval, are shown below.

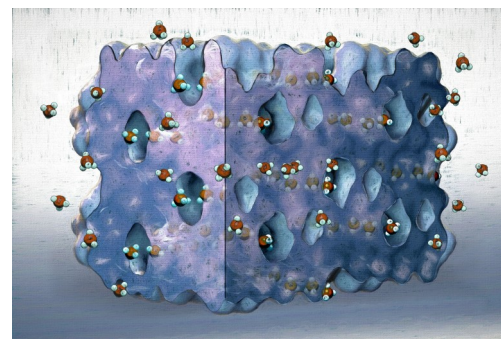


Datasets & Reference Isotherm

The reference isotherm is well characterised by the empirical function shown in the figure ( $n_{ex}$ : surface excess uptake;  $P$ : equilibrium pressure;  $a, b, c, d, e$ : constants).

### DISSEMINATION

The dataset and reference isotherm will be made available in a forthcoming peer-reviewed journal<sup>3</sup> and will also be available through the NIST/ARPA-E Database of Novel and Emerging Adsorbent Materials.<sup>4</sup>



CH<sub>4</sub> on Zeolite Y  
(Artistic Rendition)

### REFERENCES

- [1] S. Turner et al. *Microporous Mesoporous Mater.* **107**, 252 (2008).
- [2] H.G.T. Nguyen et al. *Adsorption* **24**, 531 (2018).
- [3] H.G.T. Nguyen et al. *Adsorption*, submitted (2020).
- [4] <https://adsorption.nist.gov>

### For more information:

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