Fuel Gas Storage – The Challenge of Methane

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Methane

- Methane combustion emits less carbon dioxide (high H to C ratio) than other fossil fuels and less SO₂ and NOₓ.
- Can be used as a transition fuel for the use of even cleaner alternatives (e.g. hydrogen energy).
- Has a higher heating value of 55.50 MJ kg⁻¹ (compared with hydrogen’s 141.80 MJ kg⁻¹ and gasoline’s 47.30 MJ kg⁻¹).

Methane storage

- As hydrogen, it has a very poor volumetric density (also a gas at normal pressure and temperature).
- To be used in vehicles, it has to improve on its volumetric density (amount per volume) using gas compression, liquefaction or by adsorption.
- The goal is to test new porous materials for methane storage and investigate how adsorptive storage compares with other methods.

Materials

- Carbons
  - Advantages:
    - Reversible, lightweight and cheap
    - Wide variety of structural forms
    - Good thermal stability
    - Ability to modify the structure
  - Nanotube, Pillared Graphene, carbon beads

- Metal-organic frameworks
  - Metal centres strongly bonded to organic linkers
  - High surface area
  - Highly tuneable
  - MIL-101 (Cr) and Basolite samples (HKUST-1)

Equipment

Clockwise from top left: X-ray diffractometer; IsoEx apparatus, Thermal Gravimetric analyser, HTP-1 volumetric sorption analyser, ASAP 2020 sorption analyser (centre), Helium pycnometer and IGA gravimetric sorption analyser

Porous Materials

- High - pressure methane isotherms
  - Experimental high-pressure methane excess for MIL-101
  - Experimental high-pressure methane excess at 300 K for MIL-101, TE7 and HKUST-1

Results

- Comparative density of adsorbed methane at 300 K
  - TE7: 1.90, MIL-101: 1.69, HKUST-1: 0.88
  - Density of materials (in g cm⁻³)

References

- Peng et al., J. Am. Chem. Soc. 2013, 135, 11887–11894
- Mason et al., Chem. Sci. 2014, 5, 32-51