Fuel Gas Storage – The Challenge of Methane

Adam Pugsley, Nuno Bimbo, Andrew Physick, Antonio Noguera-Diaz, Jessica Sharpe, Valeska P Ting and Timothy Mays.

URL: http://people.bath.ac.uk/cestjm; http://people.bath.ac.uk/vt233
Department of Chemical Engineering, University of Bath, UK
Centre for Doctoral Training in Sustainable Chemical Technologies, University of Bath, UK

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 as 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

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

Materials

Advantages:
- Reversible, lightweight and cheap
- Wide variety of structural forms
- Good thermal stability
- Ability to modify the structure

Porous Materials

- Nanotube, Pillared Graphene, carbon beads
- Metal-organic frameworks
- Metal centres strongly bonded to organic linkers
- High surface area
- Highly tuneable
- MAST TE7 Carbon Beads
- MIL-101 (Cr) and Basolite samples (HKUST-1)

Results

- 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

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<tr>
<th>TE7</th>
<th>MIL-101</th>
<th>HKUST-1</th>
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<td>1.90</td>
<td>1.69</td>
<td>0.88</td>
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Comparative density of adsorbed methane at 300 K

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