Synthesis and Characterization of Porous Polymer-based Adsorbents for CO₂ Capture


* Loughborough University, Chemical Engineering Department, LE11 3TU, Loughborough, UK
** Cranfield University, Centre for Combustion, Carbon Capture & Storage, MK43 0AL, Cranfield, UK

*corresponding author. Email: k.a.fayemiwo@lboro.ac.uk

Introduction
Combustion of fossil fuels for energy and transport is highly responsible for CO₂ emission, a major greenhouse gas contributing to an increasing global warming. Carbon capture and storage (CCS) has been regarded as the best approach to reduce CO₂ released into the atmosphere. Various CCS technologies include: physical absorption, chemical absorption, adsorption, membrane separation; however, each of these technologies has its own inherent limitations such as high equipment corrosion rate, high energy requirement, poor selectivity, operational limitation, toxicity and environmental unfriendly. In this work, a Porous Polymeric Material (PPM) with CO₂-philic NH₂ groups from non-toxic, inexpensive and readily available materials was synthesized and its CO₂ adsorption capacity was investigated.

Methodology
Materials
• Methacrylamide (MAAM) – Functional monomer
• Ethylene glycol dimethacrylate (EGDMA) – crosslinker
• Azobisisobutyronitrile (AIBN) – iniator
• Acetonitrile – porogent
• Methanol – solvent
Experimental
MAAM was dissolved in AN followed by adding EGDMA and AIBN. The mixture was degasses and purged with N₂, then sealed up and placed in closed water bath (60 °C) for 24 h. The resultant bulk polymer particles were ground and screened to 90-212 µm, washed with methanol, and dried overnight in a vacuum oven (60 °C).

Conclusions
• A series of simple, inexpensive, non-toxic and environmental friendly PPM was developed for CO₂ adsorption with a promising CO₂ capture capacity.
• The adsorbents retained its -NH₂ functional group of the based monomer and also, the C=O of the monomer, MAAM and cross-linker, EGDMA were completely broken as confirmed in the XPS and FTIR analysis.
• All the adsorption isotherms of PPMs as shown exhibit a typical shape of type II featuring a non-uniform distribution of pore size.
• The PPM exhibited CO₂ uptake capacity up to 0.64 mmol/g at 313 K and 0.15 bar CO₂ partial pressure and consistent in both reusability and reproducibility test run.

References

Experimental results

(a) Global greenhouse gas emissions in 2010 (b) Global carbon emissions from fossil fuel

(c) (d) (e) Prepared mixture placed in water bath (d) the bulk sample after polymerization (e) the final product after grinding, sieving and drying