

This is a repository copy of *Optimised PEI impregnation of activated carbons* - *Enhancement of CO2 capture under post-combustion conditions*.

White Rose Research Online URL for this paper: <u>https://eprints.whiterose.ac.uk/89494/</u>

Version: Accepted Version

Conference or Workshop Item:

Salituro, A, Westwood, AVK, Ross, A et al. (1 more author) Optimised PEI impregnation of activated carbons - Enhancement of CO2 capture under post-combustion conditions. In: International Forum on Recent Developments of CCS Implementation, CO2QUEST FP7 Technical Meeting, 26-27 Mar 2015, Athens, Greece.

Reuse

Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

Takedown

If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.



eprints@whiterose.ac.uk https://eprints.whiterose.ac.uk/

Optimised PEI impregnation of activated carbons - Enhancement of post-combustion CO₂ capture

A. Salituro *¹, A. Westwood ¹, A. Ross ² and R. Brydson¹

*Presenting author's email: pmasal@leeds.ac.uk

¹ Institute for Materials Research; School of Chemical and Process Engineering, University of Leeds, Leeds, LS2 9JT, UK ² Energy Research Institute; School of Chemical and Process Engineering, University of Leeds, LS2 9JT, UK

Abstract

An activated carbon was successfully modified through Polyethylenimine (PEI) impregnation. Virgin and PEIimpregnated samples were tested for CO₂ capture under post-combustion conditions (53 °C, 15 % CO₂/85 % N2) by using a thermogravimetric analyser (TGA). The influence of different factors (e.g. PEI loading, type of solvent and stirring time) onto the CO_2 sorption capacity of the modified carbons was assessed. In particular, compared to the conventional procedure [1], a longer agitation of the mixture PEI solution/carbon entailed attaining higher uptakes, likely due to a better dispersion of the polymer onto the support's pores. Moreover, using water as solvent rather than methanol allowed achieving better performances, with the additional advantage of carrying out a more eco-friendly route. Despite a moderate pore blockage exhibited by all the modified samples, after the chemical treatment the virgin carbon's CO₂ capacity increased more than three folds. This outstanding enhancement was attributed to the N-based functionalities incorporated onto pristine carbon's surface after the PEI impregnation. These were detected by XPS analyses, which confirmed the effectiveness of the surface modification. This result is corroborated by the increased N content measured for PEI-modified samples by elemental analysis (CHNS). Basic groups ensured a higher selectivity of the sorbents toward carbon dioxide molecule. Furthermore, PEI-impregnated carbon showed larger uptakes and faster kinetics than those attained by Z13X included for comparison purposes. Overall, it was demonstrated that the improved PEI impregnation was an effective route to obtain selective CO₂ sorbents starting from activated carbons. PEI-loaded sorbents are a promising alternative to liquid amines for post-combustion capture of CO₂.

	TGA	N ₂ adsorption isotherms		CHNS
Sample ID	15% CO₂, 53 ºC (mgCO₂/g _{sorb})	S _{вет} (m²/g)	V _{mi} (cm³/g)	N (%)
AR ¹	8.3	1531	0.569	0.37
AR_PEI_40_Me_1h ²	24.0	933	0.346	4.87
AR_PEI_60_Me_1h	23.0	893	0.330	4.91
AR_PEI_60_Me_24h	33.7	880	0.331	6.71
AR_PEI_80_Me_1h	28.3	943	0.355	5.53
AR_PEI_80_W_1h ³	33.6	843	0.319	6.04
AR_PEI_100_Me_1h	26.9	936	0.349	5.88

Table 1. Post-combustion CO₂ uptakes, textural parameters and nitrogen content for oak wood and commercial carbons.

³ PEI-impregnated carbon; PEI loading=80%; solvent=Water; stirring time=1 h



CO₂QUEST

¹ Virgin carbon

² PEI-impregnated carbon; PEI loading=40%; solvent=Methanol; stirring time=1 h

International Forum on Recent Developments of CCS Implementation Athens Ledra Hotel, Athens, Greece



Figure 1. CO₂ uptakes under post combustion conditions (15% CO₂ and 53 °C) for virgin and modified carbons - (a) Effect of PEI loading, and (b) effect of solvent type



Figure 2. CO₂ uptakes under post combustion conditions (15% CO₂ and 53 °C) for virgin and modified carbons - (a) Effect of stirring time, and (b) comparison between optimal PEI-impregnated AC and Z13X

References

1. Xu X, Song C, Andresen JM, Miller BG, Scaroni AW. Novel Polyethylenimine-Modified Mesoporous Molecular Sieve of MCM-41 Type as High-Capacity Adsorbent for CO2 Capture. Energy & Fuels 2002;16:1463–9.



CO₂QUEST