
Conference or Workshop Item:
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Optimised PEI impregnation of activated carbons - Enhancement of post-combustion CO_2 capture

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Abstract

An activated carbon was successfully modified through Polyethylenimine (PEI) impregnation. Virgin and PEI-impregnated samples were tested for CO_2 capture under post-combustion conditions (53 °C, 15 % CO_2/85 % 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 CO_2 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 CO_2 sorbents starting from activated carbons. PEI-loaded sorbents are a promising alternative to liquid amines for post-combustion capture of CO_2.

	TGA	N_2 adsorption isotherms		CHNS
Sample ID	**15% CO_2, 53 ºC ($mgCO_2/g_{sorb}$)**	**S_{BET} (m^2/g)**	**V_{mi} (cm^3/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 CO_2 uptakes, textural parameters and nitrogen content for oak wood and commercial carbons.

[1] Virgin carbon
[2] PEI-impregnated carbon; PEI loading=40%; solvent=Methanol; stirring time=1 h
[3] PEI-impregnated carbon; PEI loading=80%; solvent=Water; stirring time=1 h

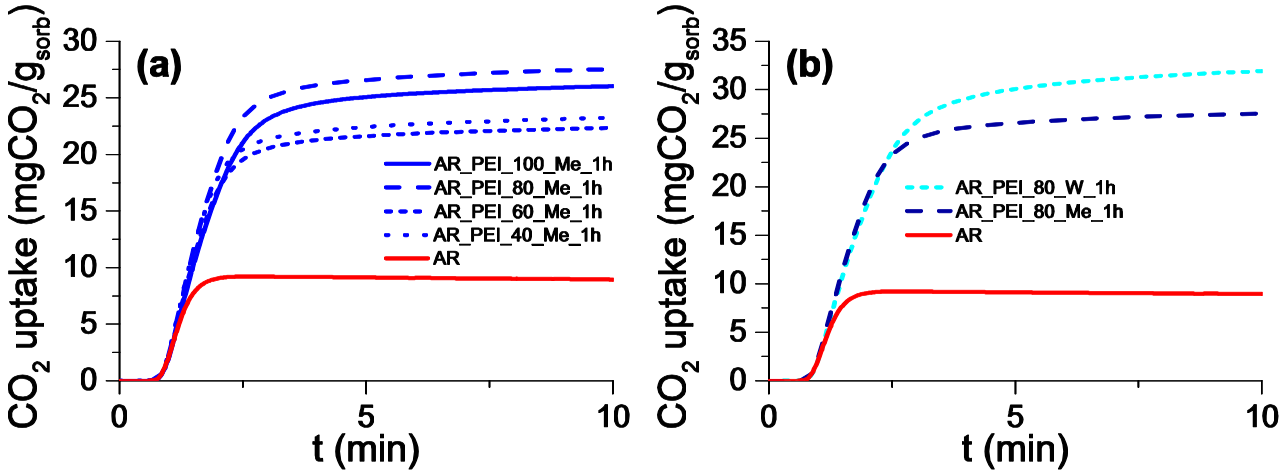

Figure 1. CO_2 uptakes under post combustion conditions (15% CO_2 and 53 °C) for virgin and modified carbons - (a) Effect of PEI loading, and (b) effect of solvent type

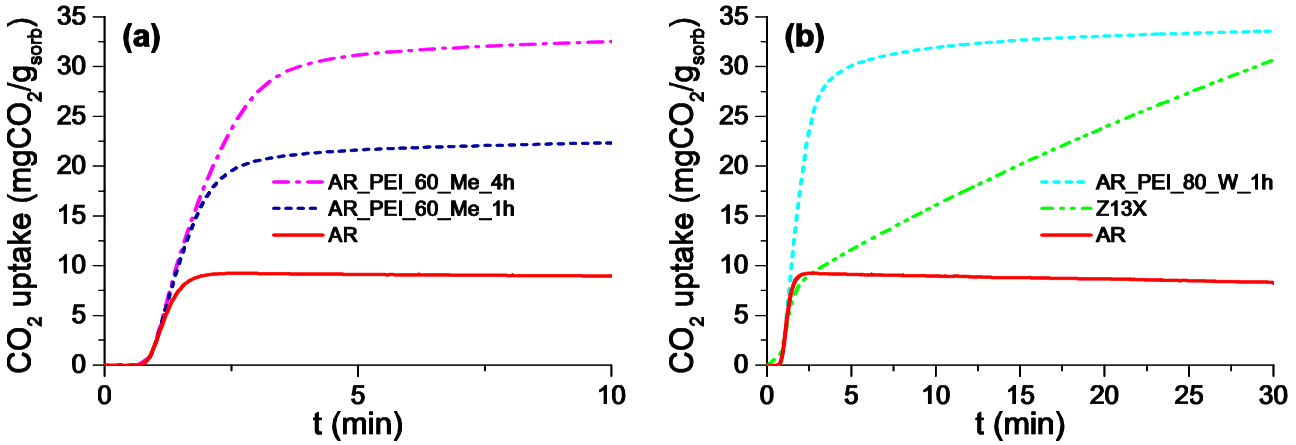

Figure 2. CO_2 uptakes under post combustion conditions (15% CO_2 and 53 °C) for virgin and modified carbons - (a) Effect of stirring time, and (b) comparison between optimal PEI-impregnated AC and Z13X

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.