A POLYETHYLENEIMINE – SILICA COMPOSITE SORBENT FOR CO₂ CAPTURE: SHAPING and H₂O

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Abstract: Recent global warming has been attributed to the growing concentration of greenhouse gases within the atmosphere [1]; the CO₂ emissions from fixed air fired fossil fuel power generators are considered the main driver [2]. Technologies for the post combustion capture (PCC) of CO₂ emissions are thus being considered as part of broader Carbon Capture and Storage (CCS) technologies, as one strategy to help address this problem [3]. Adsorption type capture technologies are of interest to provide a cheaper alternative to traditional absorption based technologies [4].

Mesoporous silica – polyethyleneimine composites are of particular interest to provide a simple, highly selective and water tolerant, high capacity solid sorbent option to facilitate PCC of CO₂ via adsorption processes [5, 6]. However, most assessments of the fitness for purpose of these sorbents have ignored the impact of the typical water content of flue gases and the requirement for shaped, rather than powder, type sorbents.

Previously we reported on the preparation of shaped forms of key interest meso-cellular siliceous foam - polyethyleneimine (MCF-PEI) composite type sorbents as prepared via a manual press, in accord with a recently patented process [6], and their potential for PCC [6]. To further investigate this sorbent type, ~200 g of an MCF-PEI type composite sorbent powder incorporating an 80 % MCF pore volume equivalent load of branched PEI (av. 1200 MW) was prepared, and shaped into pellets, via an automated single punch tablet press. The products were selectively subjected to CO₂ partial pressure swing processing within a thermogravimetric analyser in both anhydrous and highly wetted atmospheres, at 90, 105 and/or 115 °C. Cycling experiments were carried out to explore the effect of “ageing” the sorbent within a simulated flue gas at 105 °C.

The powder product could be readily transformed into pellets via the tablet press. The products did not appear to adsorb water from the highly wetted atmospheres at the preferred process temperature (105 °C), nor was their capacity for CO₂ immediately effected by the water in these atmospheres. In experiments designed to facilitate “accelerated ageing” of the sorbent, the sorbent’s initial working capacity was observed to be maintained after 60 h exposure to the highly wetted simulated flue gas; a similar sorbent was previously found to lose >50 % of its capacity after just 36 h exposure to an anhydrous simulated flue gas. Thus the highly wetted atmospheres were found useful to preserve the CO₂ working capacity of the sorbent.

References:

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