Aminopolymer-Impregnated Hierarchical Silica Structures: Unexpected Equivalent CO_2 Uptake under Simulated Air Capture and Flue Gas Capture Conditions

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PEI-impregnated sorbents are prepared using a hierarchical silica support with bimodal meso-/macroporosity. Unexpectedly, the sorbents show almost similar uptake capacities under 400 ppm and 10 % dry CO_2 at 30 °C with exhibiting step-like CO_2 adsorption isotherms. This unusual observation is rationalized via a hypothesized sorption mechanism. While the sorption performance at 30 °C is identical under 400 ppm and 10% CO_2 conditions, there is an optimal temperature at each gas concentration where uptake is maximized. The maximum sorption capacities are 2.6 and 4.1 mmol CO_2/g sorbent at the optimum temperatures using 400 ppm and 10 % dry CO_2, respectively. The presence of water vapor under 400 ppm CO_2 conditions further improves the sorption capacity to 3.4 mmol/g sorbent, which is the highest capacity under direct air capture (DAC) conditions among known amine sorbents impregnated with a similar polymer.