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CO₂ Capture Using Triamine-Grafted SBA-15: The Impact of the Support Pore Structure

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Abstract

The impact of the support pore structure on the CO₂ adsorption performance of triamine-tethered SBA-15 silica was studied. Six SBA-15 silica supports with different pore sizes and intrawall pore volumes were synthesized, followed by triamine functionalization through dry and wet grafting (i.e., with and without added water). CO₂ adsorption measurements showed the positive impact of support large pore size and high intrawall pore volume on adsorptive properties, with the former being dominant. Large-pore supports exhibited the highest surface density of amine groups (up to 35 $\mu\text{mol}/\text{m}^2$), highest CO₂ uptakes (up to 1.88 mmol CO₂ /g) and CO₂/N ratios (up to 0.33 mol CO₂/mol N), and fastest adsorption kinetics. When the intrawall pore volume decreased by 53% for samples with identical pore sizes, lower CO₂ uptakes (up to 63%) and CO₂/N ratios (up to 62%), and slower adsorption kinetics were observed, particularly for the lowest adsorption temperature (i.e., 25 °C). It was inferred that large pore size and/or high intrawall pore volume of the support improve the adsorptive properties via enhanced amine accessibility. Large-pore supports also allowed higher surface amine density to be achieved because of reduced steric hindrance between grafted triamine species.

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