

# Carbon Capture Using Solid Sorbents. CO<sub>2</sub>/N<sub>2</sub> Selectivity with Amine-Tethered Polystyrene and Polyacrylic Polymers

Grimmett, Glenn (School: American Heritage School of Boca Delray)

Removing carbon dioxide (CO<sub>2</sub>) from mixed gas streams is vital for industrial flue gas remediation, fuel gas refining, and chemical production. Existing liquid amine technology is hampered by high regeneration costs due to water's heat capacity and covalent bonding of CO<sub>2</sub>. Solid sorbents are appealing due to lower heat capacities and alternate sorption mechanisms. Using column breakthrough techniques, this study evaluated CO<sub>2</sub> adsorption across thirteen polystyrene and polyacrylic copolymers at typical flue gas CO<sub>2</sub> concentrations (11.4%), comparing between argon and nitrogen carrier gases. A110, a primary amine functionalized polystyrene polymer, and A847, a tertiary amine functionalized polyacrylic polymer, had high CO<sub>2</sub> adsorption capacity ( $Q_e$ ) in nitrogen, removing 2.048 and 1.622 mmol CO<sub>2</sub>/g respectively, rivaling best in literature performance for amine-tethered organic polymers. All three polyacrylic polymers with tertiary and/or quaternary amines had high  $Q_e$  values ranging between 1.245 and 1.622 mmol CO<sub>2</sub>/g due to favorable amine-CO<sub>2</sub> spatial arrangements, which facilitated the hydration of CO<sub>2</sub> by tertiary or quaternary amines. Four polystyrene copolymers functionalized with tertiary or quaternary amines performed poorly, with  $Q_e$  values ranging between 0.08037 and 0.5113 mmol CO<sub>2</sub>/g, due to steric hindrance or decreased amine density if hypercrosslinked.  $Q_e$  decreased by 18% if CO<sub>2</sub> was admixed with argon instead of nitrogen, potentially owing to the higher polarizability of argon. Physisorption of CO<sub>2</sub> was trivial. A847, A110, A830, and A870 show promise for carbon capture technologies. Further study should explore CO<sub>2</sub> adsorption under varying temperature, pressure and humidity; adsorption/desorption kinetics; polymer regenerability; and contaminant selectivity.