An Approach for the Capture of Carbon Dioxide via Polymerized Ionic Liquids

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Abstract : A potential alternative or next-generation CO_2-selective separation medium that has lately been suggested is ionic liquids (ILs). It is more facile to "tune" the solubility and selectivity of CO_2 in ILs compared to organic solvents via modification of the cation and/or anion structures. Compared to ionic liquids at ambient temperature, polymerized ionic liquids exhibited increased CO_2 sorption capacities and accelerated sorption/desorption rates. This research aims to investigate the correlation between the CO_2 sorption rate and capacity of poly ionic liquids (pILs) and the chemical structure of these substances. The dependency of sorption on the ion conductivity of the pILs' cations and anions is one of the theories we offered to explain the attraction between CO_2 and pILs. This assumption was supported by the Monte Carlo molecular dynamics simulations results, which demonstrated that CO_2 molecules are localized around both cations and anions and that their sorption depends on the cations' and anions' ion conductivities. Polymerized ionic liquids are synthesized to investigate the impact of substituent alkyl chain length, cation, and anion on CO_2 sorption rate and capacity. Three stages are involved in synthesizing the pILs under study: first, trialkyl amine and vinyl benzyl chloride are directly quaternized to obtain the required cation. Next, anion exchange is performed, and finally, the obtained IL is polymerized to form the desired product (pILs). The synthesized pILs' structures were confirmed using elemental analysis and NMR. The synthesized pILs are characterized by examining their structure topology, chloride content, density, and thermal stability using SEM, ion chromatography (using a Metrohm Model 761 Compact IC apparatus), ultrapycnometer, and TGA. As determined by the CO_2 sorption results using a magnetic suspension balance (MSB) apparatus, the sorption capacity of pILs is dependent on the cation and anion ion conductivities. The anion's size also influences the CO_2 sorption rate and capacity. It was discovered that adding water to pILs caused a dramatic, systematic enlargement of pILs resulting in a significant increase in their capacity to absorb CO_2 under identical conditions, contingent on the type of gas, gas flow, applied gas pressure, and water content of the pILs. Along with its capacity to increase surface area through expansion, water also possesses highly high ion conductivity for cations and anions, enhancing its ability to absorb CO_2.

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