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Screening of Green Amino Acid Salt Solutions for Low Temperature Direct Air Capture

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Abstract

Global warming has become one of the important environmental issues in recent years. Various technological solutions have been developed to address this challenge by enhancing energy efficiency, reducing carbon dioxide (CO_2) emissions, and implementing negative CO_2 removal strategies. Among these, absorption is one of the most promising technologies for CO_2 removal across a wide range of applications, including direct air capture.

Previously, a variety of solvents including alkali salts, amines, amino acids, and ionic liquids were explored for pre- and post-combustion carbon capture. However, identifying an optimal solvent for direct air capture remains a significant global research focus due to the high energy demands and costs associated with the process. The ideal solvent must efficiently absorb CO_2 at low concentrations and release it at lower temperatures. Amino acid salts are particularly suitable for carbon capture as they enable efficient CO_2 absorption through chemical reactions, forming stable carbamate or bicarbonate complexes. Their amphoteric nature allows for pH adjustment and protonation balance, enhancing CO_2 reactivity in aqueous solutions. Compared to traditional amines, amino acid salts exhibit lower volatility, reducing environmental and operational hazards.

In this study, the absorption and desorption performance of different amino acid salt solutions was evaluated over a temperature range of 25–98 °C. A rising-bubble apparatus was used to directly capture CO_2 from the air at 25 °C. The CO_2 concentration in each solvent was measured over a 24-hour period using acid titration to determine the equilibrium absorption point for each solution. The CO_2-saturated solutions were then heated to 98 °C to facilitate thermal desorption, with nitrogen gas employed as a sweep gas to dilute the desorbed CO_2. Among all the amino acid salt solvents tested, the one exhibiting the best CO_2 desorption performance was identified, and the underlying reasons for its superior behaviour were analysed.

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