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CO2 loading capacity and precipitation.

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Amino acid salt solutions as solvents in CO2 capture from flue gas; CO2 loading capacity and precipitation

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**CO2 absorption into amino acid salt solutions is a biomimetic approach to CO2 capture, because of its similarity to CO2 binding by hemoglobin and other proteins present in the blood**

Amino acids have the same amine functional group as alkanolamines, and alkaline amino acid solutions react with CO2 similar to alkanolamine solutions.

The reactions taking place between CO2 and amino acid salt solutions are as follows:

\[
\text{OOC-R-NH}_2 + \text{CO}_2 \rightarrow \text{OOC-R-NHCOOH} + \text{H}^+ \quad \text{Carboxylation formation}
\]

\[
\text{CO}_2 + \text{OH}^- \rightarrow \text{HCO}_3^- \quad \text{Bicarbonate formation}
\]

\[
\text{OOC-R-NHCOOH} + \text{H}_2\text{O} \rightarrow \text{HO}_2^- + \text{H}_2\text{O} + \text{R-NH}_2 \quad \text{Carboxylic acid hydrolysis}
\]

\[
\text{R-NH}_2 + \text{H}^+ \rightarrow \text{R-NH}_3^+ \quad \text{Protonation of the amino acid}
\]

**General structure of an amino acid**

Before the amino acid can react with CO2 it is activated by adding an equivalent amount of strong base. The activated amino acid is represented as: -OOC-R-NH2

In comparison to alkanolamine solutions, amino acid salt solutions have desirable properties including:

- High stability towards oxidative degradation
- Low volatility
- Environmental friendly (as they are naturally present in plants, animals, humans, etc.)

**Dynamic flow set-up to study CO2 absorption**

A synthetic gaseous mixture, containing approximately 10% CO2 is continuously bubbled through the solvent, at a total pressure very close to atmospheric pressure.

The concentration of CO2 is being monitored in the effluent stream, using infra red (IR) spectroscopy. The method allows the calculation of the CO2 absorption, by integrating over time the concentration of CO2 in the effluent stream.

**Validation of the set-up with MEA**

The dynamic flow set-up was validated using aqueous solutions of monoethanolamine (MEA) with concentrations between 2-8 molal, at a partial pressure of CO2 ~ 10 kPa, at 40°C and a total pressure of ~100 kPa. The obtained data were validated against calculations of the Extended UNIQUAC thermodynamic model [1].


**Using the dynamic flow set-up the CO2 absorption ability of 4 amino acids were studied**

![Figure 1-4](image)

**Figure 1-4:** CO2 loading capacity of aqueous solutions of the potassium salt of lysine, glycine taurine and proline. The experimental conditions were: 40°C, partial pressure of CO2 ~ 10 kPa, and total pressure ~ 100 kPa. Yellow points indicates that precipitation occurred during the CO2 loading experiment. According to literature, precipitation has the ability to increase the CO2 loading capacity of the solution [2-3].

**Figure 5:** The results from figure 1-4, together with similar results for MEA, obtained at the same experimental conditions.

[2] M. Majchrzewska et al. GHGT8 Trondheim

**Conclusions**

The amino acids tested showed good CO2 loading capacities when compared with MEA.

With increased amino acid salt concentration precipitation was observed for glycine, taurine and proline.

There is no increase in CO2 loading capacity due to precipitation under the experimental conditions used.

Lysine offers high CO2 loading capacity without precipitation.