CO$_2$ capture with the phase-change absorbent of a mixed AFIL and alcohol solution

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Abstract

The environmental problems caused by excessive emissions of carbon dioxide are increasingly serious, so carbon capture and utilization is extremely urgent. Phase-change absorbents have attracted much attention because of their unique phase-change characteristics, which can greatly reduce the energy consumption of regeneration. In the present work, we adopted an efficient absorbent of amino-functional ionic liquids (AFILs) as a main absorbent to absorb CO$_2$ by dissolved separately in ethanol and 1-propanol. The absorption of CO$_2$ was carried out at certain mass ratios of tetramethylammonium glycinate ([N$_{1111}$][Gly]) to alcohols (1:0, 1:0.5, 1:1, 1:2, 1:3, 1:4), temperature (303K) and CO$_2$ pressure (0.1MPa). Precipitation could be found after CO$_2$ was absorbed by mixed absorbents and was easy to be separated (Figure 1). The CO$_2$ absorption capacity of [N$_{1111}$][Gly]-ethanol absorbent was about 0.85mol CO$_2$/mol IL at the mass ratio of 1:2 while that of [N$_{1111}$][Gly]-1-propanol absorbent was about 0.98mol CO$_2$/mol IL at the mass ratio of 1:4 (Table 1). The reaction and phase change mechanisms of [N$_{1111}$][Gly]-alcohols absorbent for CO$_2$ capture were clarified based on the FTIR and $^{13}$C NMR analysis results. During the absorption, CO$_2$ reacted with [N$_{1111}$][Gly] to form carbamate and carbamate could react with alcohol to form carbonate, which resulted in higher CO$_2$ absorption capacity. Besides, the products gradually precipitated in the lower layer since their limited solubility and larger density.

Keywords: Phase-change absorbent; amino-functional ionic liquids; alcohol; carbon dioxide; capture.

Table 1 The CO$_2$ absorption capacity of [N$_{1111}$][Gly]-alcohols absorbent at different mass ratios (mol CO$_2$/mol IL).

<table>
<thead>
<tr>
<th>Absorbent</th>
<th>1:0</th>
<th>1:0.5</th>
<th>1:1</th>
<th>1:2</th>
<th>1:3</th>
<th>1:4</th>
</tr>
</thead>
<tbody>
<tr>
<td>[N$_{1111}$][Gly]-ethanol</td>
<td>0.41</td>
<td>0.51</td>
<td>0.78</td>
<td>0.85</td>
<td>0.82</td>
<td>0.74</td>
</tr>
<tr>
<td>[N$_{1111}$][Gly]-1-propanol</td>
<td>0.41</td>
<td>0.82</td>
<td>0.81</td>
<td>0.90</td>
<td>0.75</td>
<td>0.98</td>
</tr>
</tbody>
</table>

References


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