G304

Enhancement of Permeation for Liquid Membrane Separation of Coal Tar Absorption Oil

1. Introduction

We are applying O/W/O liquid membrane permeation to the separation of coal tar absorption oil into nitrogen heterocyclic compounds and the others, such as homocyclic hydrocarbons\(^{1-4}\). In this work, it was tried to improve the separation performance by the additive into aqueous membrane phase for the absorption oil separation by emulsion by emulsion liquid membrane.

2. Experimental

2.1. Liquid-liquid equilibrium

Absorption oil (abbr. to AO hereafter) and aqueous solution of 1,3-butandiol\(^{5}\) were brought into contact to be equilibrated using Erlenmeyer flask and commercial constant temperature bath. The principal experimental conditions are shown in Table 1.

2.2. Emulsion liquid membrane permeation

The feed AO and membrane liquid were stirred by a commercial high-speed homogenizer to prepare the emulsion. The membrane apparatus for the membrane permeation was a stirring vessel used in the previous work\(^{6}\). The prepared emulsion was brought into contact with the solvent by this vessel. Stirring was started to begin a permeation run (t=0) and was repeated for the several different times to obtain the time courses of the compositions in the extract phase. Table 2 gives the experimental conditions. The membrane liquid was aqueous solution of saponin with methanol or 1,3-butandiol as an additive.

3. Results and Discussion

3.1. Liquid-liquid equilibrium

Distribution coefficient of component \(i\), \(m_i\), was defined as,

\[
m_i = \frac{Y_i}{x_i}
\]

(1)

The \(m_i\) of the nitrogen compounds were larger than those of the other components. The \(m_i\) increased with concentration of 1,3-butandiol in the aqueous phase. The \(m_i\) of nitrogen compounds in the case with 1,3-butandiol was slightly lower than that with methanol\(^7\), (results are omitted, here.)

3.2. Emulsion liquid membrane permeation

The fractional yield of component \(i\) in a batch permeation run, \(Y_i\), was defined by the following equation

\[
Y_i = \frac{E \cdot Y_i}{R_i \cdot x_i}
\]

(2)

Figure 1 shows the time courses of these yields of quinoline and 2-methylnaphthalene. The yield increased by adding 1,3-butandiol or methanol to the membrane liquid, before the yield reached the plateau. The yields in the case with methanol were higher than those with 1,3-butandiol. These results are attributed to the effects of additives to the membrane liquid on the distribution coefficient between oil phase and aqueous phase as mentioned above. Higher stirring velocity gave higher yield, since the interfacial area between emulsion and external oil phase increased. The separation selectivity of quinoline relative to 2-methylnaphthalene was represented by,

\[
\beta_{Q,2MN} = \frac{Y_Q}{x_Q} \cdot \frac{Y_{2MN}}{x_{2MN}}
\]

(3)

This selectivity is plotted against time in Figure 2. Both 1,3-butandiol and methanol in the membrane liquid lowered the selectivity.

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Literature Cited

2) Hara, N. et al.; SCEJ 35th Autumn Meeting, R320 (2002, Kobe)

Table 1 Experimental conditions for liquid-liquid equilibrium

| Mass of AO [g]  | 50 |
| Mass ratio of aqueous 1,3-butandiol | 1 |
| solution relative to AO at initial [-] | yW,AO | 0.2-1 |
| Temperature [K] | 298 |
| Contact time [h] | 72 |

Table 2 Experimental conditions for batch separation with emulsion liquid membrane

<table>
<thead>
<tr>
<th>Feed AO</th>
<th>Membrane AO</th>
<th>Aqueous solution of saponin and additive (1,3-butanediol or methanol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Membrane Toluene</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass of AO [g]</td>
<td>50</td>
<td></td>
</tr>
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<td></td>
</tr>
</tbody>
</table>

Figure 1 Time courses of fractional yields: (a) 1,3-butandiol in membrane liquid; (b) methanol in membrane liquid

Figure 2 Time courses of separation selectivities of quinoline relative to 2-methylnaphthalene: (a) 1,3-butandiol in membrane liquid; (b) methanol in membrane liquid

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