RADON ADSORPTION IN ACTIVATED CARBON BY OPEN AND CLOSED SYSTEMS

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INTRODUCTION

Previous studies [1,2,3] have shown the elution behavior of radon from activated carbon (AC) of an open system. The elution times were affected by using different kinds of AC and carrier gases. The shortest elution time was for carbon dioxide and the longest time was for helium. Results suggested that radon behavior is closely related to the pore characteristics of AC.

In the present paper, we used 5 kinds of AC to study the adsorption behavior of radon in closed systems and compared the results between the open and closed systems.

EXPERIMENTAL

Five kinds of commercial activated carbons (AC-1E, AC-2C, AC-3D, AC-4B, and AC-5H) of Kuraray Chemicals were used. A schematic diagram of an open system is shown in Figure 1 and of a closed system in Figure 2.

![Figure 1 Schematic diagram of an open system.](image)

![Figure 2 Schematic diagram of a closed system.](image)

Table 1 Apparent surface area of active carbons.

<table>
<thead>
<tr>
<th></th>
<th>N₂</th>
<th>H₂O (&lt;1 nm)</th>
<th>H₂O (&gt;1.5 nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC-1E</td>
<td>&lt;5</td>
<td>309</td>
<td>7</td>
</tr>
<tr>
<td>AC-2C</td>
<td>350</td>
<td>192</td>
<td>17</td>
</tr>
<tr>
<td>AC-3D</td>
<td>910</td>
<td>706</td>
<td>24</td>
</tr>
<tr>
<td>AC-4B</td>
<td>1180</td>
<td>310</td>
<td>75</td>
</tr>
<tr>
<td>AC-5H</td>
<td>1590</td>
<td>95</td>
<td>333</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSIONS

1) Open system radon adsorption in AC.

The radon elution times from AC and the effect of carrier gases were studied. The dynamic adsorption coefficient (DAC) was calculated by equation (1).

\[ \text{DAC} = \frac{F_i}{w} \]  

where \( F_i \) and \( w \) are flow rates of carrier gas, elution time and weight of AC, respectively.

The maximum DAC value is AC-3D and the other values in descending order are AC-2B, AC-4H, AC-2C, and AC-1E. These results suggested that DAC was closely related to the surface area of 1 nm or less.

2) Closed system radon adsorption in AC.

Figure 3 shows curves of radon concentration (Bq/m³) in the air of a closed system with adsorption by the AC. AC-1E curve is the same as the non-AC curve within the range of experimental error. AC-3D and AC-4C show equilibrium between AC and air.

\[ \text{EC} = \frac{\text{RNAC}}{\text{RNAIR}} \]  

where RNAC and RNAIR are radon concentration in AC and radon concentration in air of the closed system, respectively.

Figure 4 shows EC of the AC's. AC-3D and AC-4B show about 1 and 0.7 of EC, which is slowly decreasing. AC-5H shows only temporary, but increasing equilibriums. In this closed system AC-5H is the best adsorbent of the three. AC-5H has the largest surface area of the 1.5 nm or larger diameter pore samples. Those results suggest that pores of 1.5 nm or larger diameter are important in this closed system. These results are different from the conclusion in the open system.

Another adsorption mechanism is effective in open and closed systems. In the former, radon moved dynamically in the system where quick equilibrium and longer holding time in the pores were important. In the latter, radon circulated in the system, where statistical equilibrium between radon in air and in AC and quick equilibrium were not important, but where larger EC was very important.

CONCLUSIONS

1) Radon adsorption in the open system is controlled by pores with surface area of 1 nm or less, because of their quick equilibrium and longer holding time.

2) Radon adsorption in the closed system is controlled by pores with surface area of 1.5 nm or larger, because larger equilibrium constants are important.

3) Activated carbon for radon adsorption must be selected on the basis of their use.

REFERENCES


[3] Y. NAKAYAMA, H. NAGAO, I. MOCHIDA, and