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 th 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.

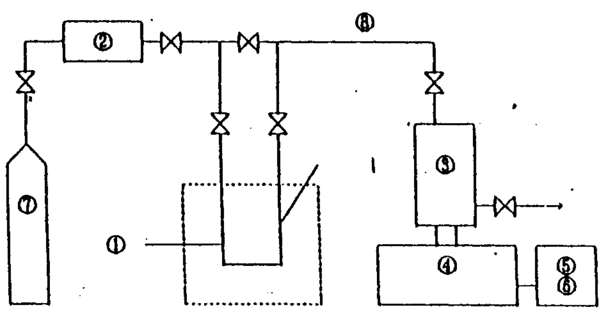

Figure 1 Schematic diagram of an open system. ①:active carbon in U-glass tube.②:gas flow meter, ③:ionization chamber (volume 1500 ml),④:vibrational electrometer (detector of radon radioactivity), ⑤:data recorder,⑥:computer,⑦:gas supply.

Standard experimental conditions were as follows: 3 g of AC were put in the U-tube which was fixed in a thermostated bath at 50℃ and carrier gas flowed at 30 ml/min. Radon was injected into the tube just before the AC.

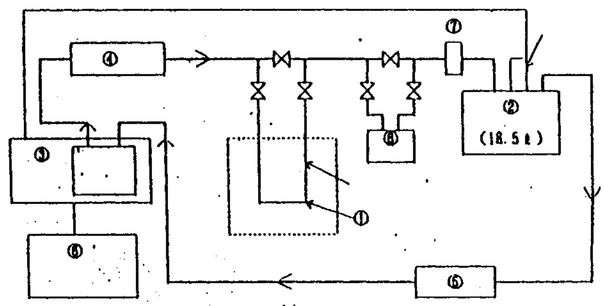

Figure 2 Schematic diagram of a closed system. ①:active carbon in U-glass tube, ②:radon detector, ③:system controller with air circulation pump.④: $CaSO_4$ collum (humidity controller), ⑤:air flow meter, ⑥:data collector (computer), ⑦:air filter, ⑧:radon source.

Standard experimental conditions of a closed system were as follows: 3 g of AC were put in a U-tube which was fixed in thermostated bath at 50℃ and air circulated 500 ml/min. Radon from a 75 Bq radon source was supplied to the system until the level of 2000 Bq/m3 was reached. Then the AC U-tube was connected to the system, and the radon concentration in circulating air was measured by the detector.

Table 1 Apparent surface area of active carbons.

	apparent surface area (m^2/g)		
	N_2 B.E.T.	H_2O (<1 nm)	H_2O (>1.5nm)
AC-1E	<5	309	7
AC-2C	350	192	17
AC-3D	910	706	24
AC-4B	1180	310	75
AC-5H	1590	95	333

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).

$$DAC=Ft/w \quad (1)$$

where F,t 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.

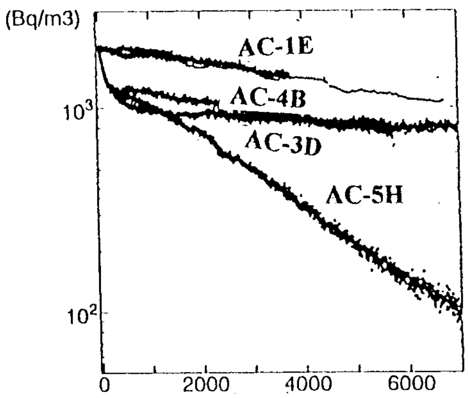

Figure 3. Radon concentrations in air in a closed system.

Equilibrium constants(EC) between radon concentration in air and in AC of the closed system was calculated by equation (2).

$$EC= RNAC/RNAIR \quad (2)$$

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 1.5nm or larger diameter are important in this closed system. These results are different from the conclusion in the open system.

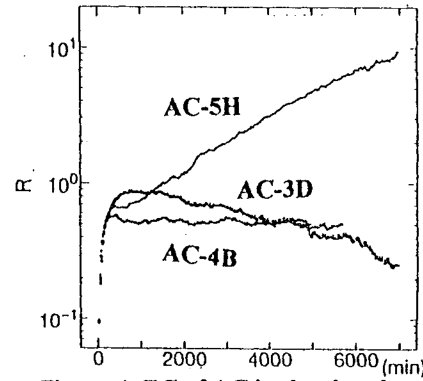

Figure 4. EC of AC in the closed system .

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 1.5nm or larger, because larger equilibrium constants are important..

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

REFERENCES

[1]Y.NAKAYAMA, H.NAGAO, M.MIMURA, H.YAMASITA, E.TANAKA and K.HOSOKAWA, In Extended Abstr., 21st Biennial Conf. on Carbon(Buffalo) 402 (1993).

[2]Y.NAKAYAMA, H.NAGAO, S.KATSURA, T.SASANAGA, E.TANAKA, and K.HOSOKAWA, In Extended abstracts of CARBON'94 (Granada) 196 (1994).

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