ADSORPTION OF METAL IONS FROM DECONTAMINATION LIQUID WASTE USING ACTIVATED CARBON FIBERS

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Introduction

Activated carbon fiber(ACF) is a relatively new material for adsorption which has a characteristic of higher adsorption rate and larger capacity than conventional GAC. It was investigated on the adsorption behaviors of ACFs for the metal ions such as Cu^{2+}, Co^{2+}, Ni^{2+} in liquid waste resulting from the chemical decontamination of nuclear facilities.

From these isotherms some adsorption parameters have been determined and temperature effect on the adsorption was also investigated.

Experimental

Four kinds of ACFs(A-7, A-10, A-15, A-20) were prepared by activation of isotropic pitch-based carbon fibers in a flow of steam diluted in nitrogen for different periods of time at 1123K. Textural characteristics of ACFs was obtained from the N_2 gas adsorption isotherm of ACFs at 77K. Pore size distribution of ACFs was analyzed by Horvath-Kawazoe method. Surface acidity of ACFs was determined according to the measurements of base neutralization capacity with bases of different basicities by Boehm using titroprocessor(Metrohm, Model 602).

Adsorption experiments were performed in a batch system using $CuCl_2 \cdot 2H_2O$, $CoCl_2 \cdot 6H_2O$, and $NiCl_2 \cdot 6H_2O$ solution at various concentrations and at different temperatures. Metal content was determined by flame AA spectrophotometry (Perkin-Elmer, Model 1100B).

Results and Discussion

Pore size distribution by H-K method shown in Fig.1 indicates that the narrow micropore volumes and the supermicropore volumes increase on activation, and the average pore size is about 10Å, with bimodal pore size distribution.

The equilibrium isotherms are fitted by simplified Freundlich equation of the form $q=kC^{1/n}$, where k and n are the Freundlich constants characteristic of a particular adsorption isotherm. Logarithmic relations between C and q of all metal ions are shown in Figs 2~4 for the adsorption on ACFs. The values of k and n are summarized in Table 1.

From these results, it was found that the magnitude of adsorption of these metal ions was in the following order: Cu>Ni>Co. The values of n are in the range of 1.8 to 2.5 but the values of k is proportion to the pore volume or BET surface area. This fact indicates that the adsorption of metal ions onto ACFs is the coverage of surface of ACF. Since the relationships between volumes of pores smaller than 2nm in diameter of ACF and the values of k, are nearly linear, it is expected that the metal ions are adsorbed perferably into these micropores of ACFs. The results suggest that ACFs having volumes of pores smaller than 2nm in size should be chosen for the present purpose.

Adsorption isotherms of metals on A-20 at 298K, 318K are shown in Fig.5. It is noteworthy that for a given equlibrium concentration, amount of Cu^{2+}, Co^{2+} adsorbed at 298K is higher than those at 318K, which suggested that these adsorption processes are exothermic. However, in the case of the amount of Ni^{2+} adsorbed on ACF at 298K is lower than at 318K, indicating this endothermic process. So, the adsorption extent was enhanced by increasing the adsorption temperature.

In general, the adsorptive behavior of carbon can be explained on the basis of its chemical nature and porous texture. So it was investigated the relations between the amount of adsorption and the surface acidity, and micropore volume.

The result for Cu ion is representatively shown in Fig.6. The amount of adsorption has no relation with surface acidity of ACF, but the degree of adsorption is higher in the order of the pore volume or specific surface area of ACF.

Therefore, it is concluded that porous texture of ACF should be an important variable affecting the adsorption process of these metal ions.

Table 1. Freundlich constants for various ACFs.

	Cu(II)		Ni(II)		Co(II)	
	kx10^{-3}	n	kx10^{-3}	n	kx10^{-3}	n
A-7	0.59	2.37	0.25	1.93	0.21	1.79
A-10	1.12	2.19	0.40	1.93	0.20	2.16
A-15	1.67	2.32	0.51	2.03	0.32	2.23
A-20	1.75	2.47	0.80	2.01	0.36	2.55

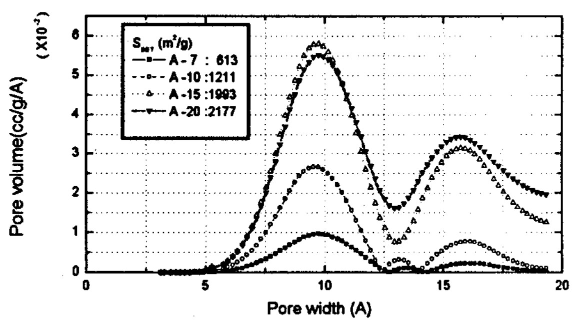

Fig. 1. Pore size distribution of ACFs by Horvath-Kawazoe Method.

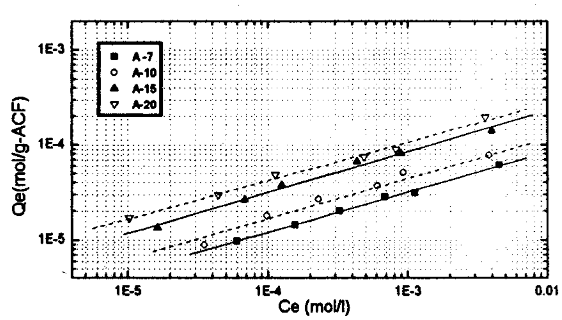

Fig. 2. Freundlich plot for the adsorption of Cu(II) on ACFs at 298K.

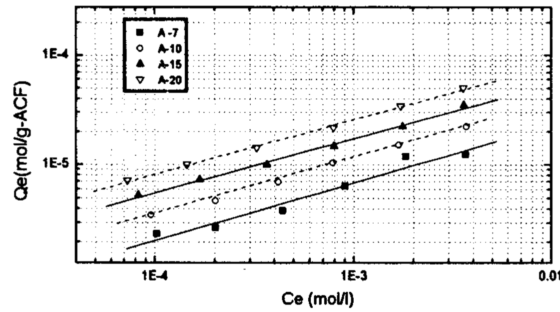

Fig. 3. Freundlich plot for the adsorption of Ni(II) on ACFs at 298K.

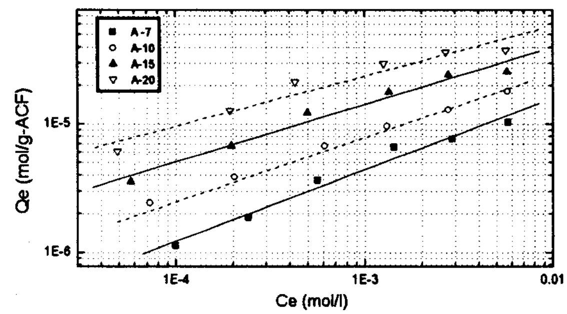

Fig. 4. Freundlich plot for the adsorption of Co(II) on ACFs at 298K.

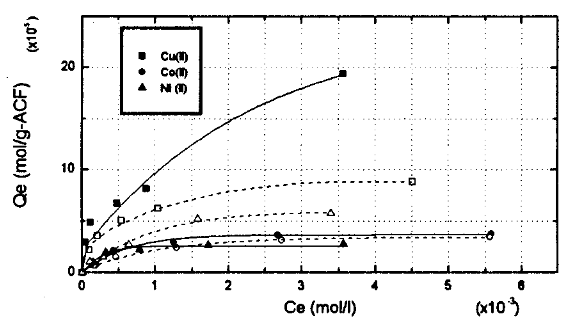

Fig. 5. Adsorption isotherms of metal ions on A-20 with respect to temperature. (Open symbol : 318K, Closed symbol: 298K)

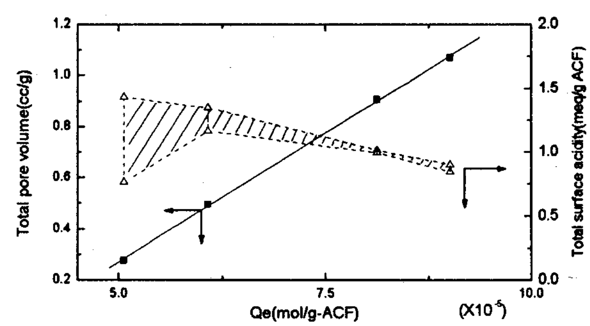

Fig. 6. The pore volume and surface acidity of ACFs with respect to adsorption amount of Cu(II).