

POSTER

ADSORPTION OF CHROMIUM IONS IN DECONTAMINATION LIQUID WASTE ON ACTIVATED CARBON FIBERS

C.H. Jung, H.H. Jung*, W.Z. Oh, S.K. Ryu*, B.S. Rhee*

Decontamination & Decommissioning Dept., NEMAC, Korea Atomic Energy Research Institute, P.O. Box 105, Yuseong, Taejeon Korea, 305-600

* Dept., of Chemical Engineering, Chungnam National University, Taejeon Korea, 305-764

INTRODUCTION

Activated carbon fiber(ACF) is a new and fibrous adsorbent which has a unique characteristics of greater adsorption rate and capacity for organic and inorganic molecules or ions than granular AC, which is due to a more uniform pore size and greater pore volume of ACF[1].

We investigated the relationship between the pore structure or surface acidity of carbon adsorbent and adsorption behaviors for chromium ions in liquid radioactive waste resulting from chemical decontamination in nuclear facility. And then the influences of the solution pH, temperature and chromium concentration on the chromium adsorption process was studied.

EXPERIMENTAL

Various grade ACFs are obtained from activation of isotropic pitch-based carbon fibers. The activation was carried out heating it at 1123K in a flow of steam diluted in nitrogen for different periods of time. For comparison, commercial grade AC(Dong Yang Carbon Co., Ltd) was also used for adsorbent. The N₂ adsorption isotherm of ACFs and AC was obtained by volumetric gas adsorption apparatus(Autosorb-1 MP, Quantachrome). The specific surface area of adsorbents was determined by applying the BET equation to the N₂ isotherm at 77K.

pH of aqueous suspensions of adsorbents was measured and surface acidity of all samples was determined according to the measurements of base neutralization capacity by Boehm using a titration apparatus (Metrohm titroprocessor Model 602) [2].

Adsorption experiments was performed in a batch system using a Cr(VI) (Na₂CrO₄ · 4H₂O) and Cr(III) (Cr(NO₃)₃ · 9H₂O) solution at various concentration (0.75 × 10⁻³ ~ 10⁻² mol/ℓ) and at three temperatures. The adsorption of chromium ions was followed by adding 0.15g carbon samples to polyethylene vial containing

20ml of aqueous solution of chromium.

Amount of Cr(VI) and total Cr ions were determined by an U-V spectrophotometer (Hewlett Packard, 8452A) and Atomic absorption spectrophotometer (Perkin Elmer, Model 1100B) respectively and the amount of Cr(III) was estimated from the difference of Cr(VI) and total chromium.

RESULTS AND DISCUSSION

Adsorption of chromic ions on ACF as a function of pH shown in Fig. 1. indicates that sudden increase of adsorption at pH 3 and decrease at above pH 8 may be explained by the electrostatic interaction between the surface charge of ACF and the charge of hydrolysis product of chromium ions(pH_{zpc} of ACF : pH 3.0) [3]. The amount differences between two ACF samples may be due to that of geometric size of micropore on ACFs (Table 1). In spite of micropore volume of AC is larger than that of A-7 ACF, adsorption capacity of A-7 is larger than that of AC. It is assumed to the existence of electrostatic repulsion between Cr(III) and AC in the overall pH range of which pH_{zpc} is about 7.2. Reduction of Cr(VI) to Cr(III) in acidic solution was experimentally confirmed, and it has been previously reported in literature[4]. So adsorption equilibrium test for Cr(VI) was performed at pH 6.0. Equilibrium of the adsorption process on ACFs is reached before 20 min while equilibrium time in adsorption on AC is longer than 2hr. Fig. 2. representing the Cr(VI) adsorption isotherm at various temperatures, shows that only for A-7 ACF at 298K was plateau reached with increasing concentration (350 μmol/g). This value is equivalent to the area of 165 m²/g based on a molecular chromate radius of 5Å[5], and which is only one-fourth of the area obtained by nitrogen adsorption. But the amount of Cr(VI) adsorbed increases distinctly as the temperature increases, which means that there is an activation barrier in the chromium

adsorption process. The effect of the amount of chromium adsorbed by ACF on the heat of adsorption shown in Fig. 3 indicates that activated adsorption process involves in higher

Table 1. Textural and Chemical Characteristics of ACFs and AC

		A-7	A-18	AC
Textural property	S_{BET} (m^2/g)	696	1953	750
	total pore volume (cc/g)	0.28	1.07	0.41
	micropore volume (cc/g)	0.26	0.74	0.37
	Ave. pore radius (Å)	7.97	10.9	11.1
Chemical property	surface acidity ($meq.g^{-1}$)	0.31	0.35	-

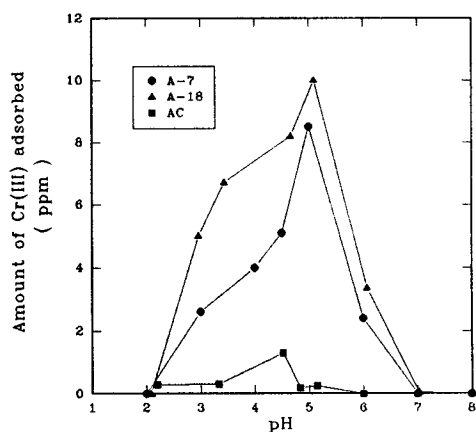


Fig. 1. The effect of pH on the amount of Cr(III) adsorbed at 298K.

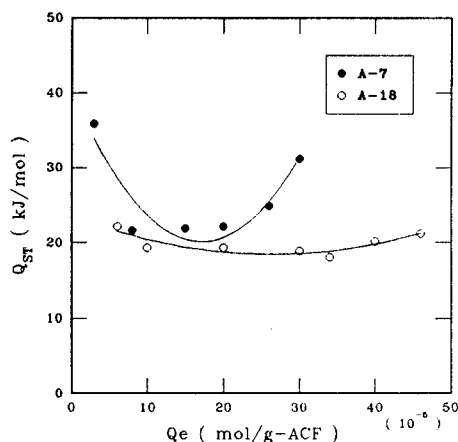


Fig. 3. Isothermic heat of adsorption with the amount of Cr(VI) adsorbed at pH 6.0, 298K.

concentration of chromium ions.

The effect of pH on the amount of Cr(VI) adsorbed and pH differences (ΔpH) was investigated, and the result (Fig. 4) shows that pH differences is nearly parallel to the amount of Cr(VI) adsorbed. It means that the formation of oxygen complexes on the ACF surface is believed to be the major factor on the adsorption of Cr(VI) by ACF.

REFERENCES

1. S.S Barton, *Carbon* **25**, 77 (1987).
2. H.P. Boehm, *Adv. in Catalysis*, **16**, 198 (1966).
3. C.H. Jung (1994), Ph.D Thesis, The Chungnam National University.
4. C.P. Huang and M.H. Wu, *Water Research*, **11**, 673 (1977).
5. Lange Handbook of Chemistry, Edited by J.A. Dean, 14th ed., McGraw-Hill, New York (1992).

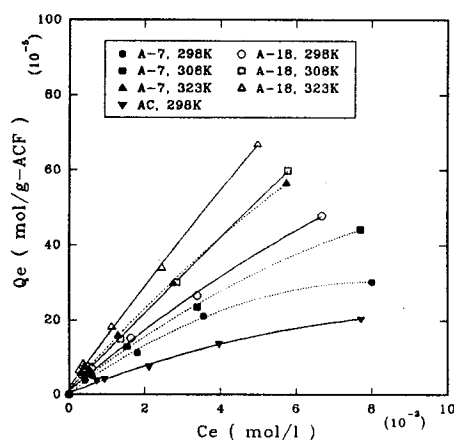


Fig. 2. Adsorption isotherm of Cr(VI) at pH 6.0.

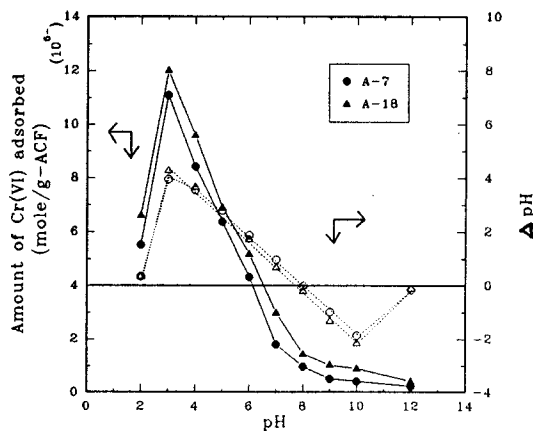


Fig. 4. The effect of pH on the amount of Cr(VI) adsorbed and pH difference. ($\Delta pH = pH_e - pH$)