

POSTER

REMOVAL OF CHROMIUM(VI) FROM WASTEWATER WITH A PACKED BED OF ACTIVATED CARBON FIBERS

S. K. Ryu, J. W. Shim, H. H. Jung, W. Z. Oh*, C. H. Jung*

Department of Chemical Engineering, Chungnam National University,
Taejon, Korea, 305-764

*Korea Atomic Energy Research Institute, Taejon, Korea, 305-600

INTRODUCTION

Chromium is one of the major trace metals in wastewater from different industries. Particularly, the chromium(VI) is a serious problem in some areas due to its effect on human body and other biological systems.

The Activated Carbon Fiber has a good physical and mechanical characteristics such as high surface area, molecular sieving effect, and shows fast adsorption rate due to externally exposed micropores.

In designing the adsorption column, one of the considerations is to forecast the efficiency of adsorption column by the break-point. The aim of the present work is to investigate the chromium(VI) adsorption behaviors of ACF packed column in dynamic conditions.

EXPERIMENTALS

The pitch-based ACFs(A-10, A-15, A-20) used in this experiment were obtained from AD'ALL Co. Japan, and their specific surface areas by N_2 adsorption were 1300 m^2/g , 1570 m^2/g , 1800 m^2/g , respectively. In order to compare the adsorption capacity, the granular AC, F400(12 \times 40mesh, 1100 m^2/g , Calgon Co.), SCL(8 \times 30mesh, 1110 m^2/g , SAMCHULLY Co.), was employed. The adsorption isotherm was gained from using the model Autosorb-1 MP (Quantachrome, USA). The chromium(VI) solution was prepared by adding $Na_2CrO_4 \cdot 4H_2O$ (99.5% grade, Merk Co.) to distilled water to get desired concentrations.

The temperature of glass column (inner diameter 1cm, height 10cm) having the glass jacket (I.D.=3cm) was maintained constant by circulating water. The ACF was chopped about 5cm length prior to packing in column upto 8.5 cm height. The top of the column was plugged with silicon rubber stopper having the sample tap to prevent the packing density changes. The AC was sieved, washed, and dried in vacuum for 24 hours prior to use.

The solution containing the chromium(VI) was supplied by the polystaltic pump at the rate of

1~2 ml/min from bottom to upward to avoid the channeling. The solution pH was set at pH 3 because the hydrogen and hydroxyl ion activities are the same at this value [1]. The effluent was analyzed by Atomic Absorption spectrophotometer (Perkin Elmer, Model 1100B) and U.V. spectrophotometer at 540nm. The operating conditions such as concentration, flow rate were tried to investigate the dynamic adsorption behaviors of ACF packed column.

RESULTS AND DISCUSSION

Fig. 1 shows that in the beginning the chromium(VI) concentration of the effluent from AC packed column was higher than that of ACF, and until 26 hours the relative concentration of effluent from AC and ACF packed column is same. Huang et al. [2] have reported that the removal of the chromium(VI) on AC is carried out by reduction of Cr(VI) into Cr(III) and is affected by surface charge of the adsorbent. Also, the zero point of charge of AC and ACF is different such as 7.0 ± 0.1 , 3.0 ± 0.1 , respectively [3,4], and the chromium(VI) in acidic solution(pH 3) exists as anion ion, dichromate, $Cr_2O_7^{2-}$ [5]. Thus, the difference of zero point of charge between AC and ACF results in different breakthrough curves in the beginning.

It is also evident in Fig. 4 that pH of effluent from AC column is much higher than that of ACF until 10 hours.

Fig. 2 is the results with respect to concentration of chromium(VI) solution. For higher concentration, the adsorption of Cr(VI) is rapidly accomplished, but for lower concentration the adsorption of Cr(VI) is slow. Also, the higher initial concentration was, the larger the relative concentration of breakthrough curve was. Considering that the adsorption of Cr(VI) is performed by reduction as mentioned above, the breakthrough curve like a step is appeared because the reduction is more dominant than adsorption for higher concentration. In other words, the plateau of breakthrough curve in high concentration shows the reduction stage.

Fig. 3 is the breakthrough curves with respect to ACF series, i.e. different surface area. In spite of low specific surface area, the effluent concentration for A-10 is lower than A-20. In Catalin models, the radii of chromate and chromic ion is shown to be 0.5nm and 0.9nm, respectively [6]. Because the average pore radii for A-20, A-10 is 8.3Å, 10Å, respectively, A-10 can provide the reduced chromate with the suitable pore size for adsorbing Cr(III). Consequently, A-10 displays lower relative concentration than that of A-20.

CONCLUSIONS

In conclusion, the removal efficiency of chromium(VI) by ACF column was better than that of AC, and during removal of Cr(VI) the reduction of Cr(VI) into Cr(III) was more

dominant than specific surface area.

REFERENCES

1. G.G. Jayson, J.A. Sangster, G. Thompson and M.C. Wilkinson, *Carbon*, **31**(3) 487 (1993).
2. C.P. Huang and M.H. Wu, *Water Research*, **11** 671 (1997).
3. C.P. Huang and F. Ostovic, 173rd Symp. Chemistry of Wastewater Technology, National Meeting, A.C.S. New Orleans, La. (1977).
4. H.H. Jung (1994), MS Thesis, The Chungnam National University.
5. F.A. Cotton and G. Wilkinson, *Adv. Inorganic Chemistry*, 5th ed., 693, Wiley, New York (1988).
6. Lange Handbook of Chemistry (Edited by J. A. Dean), 13th ed., McGraw-Hill, New York (1985).

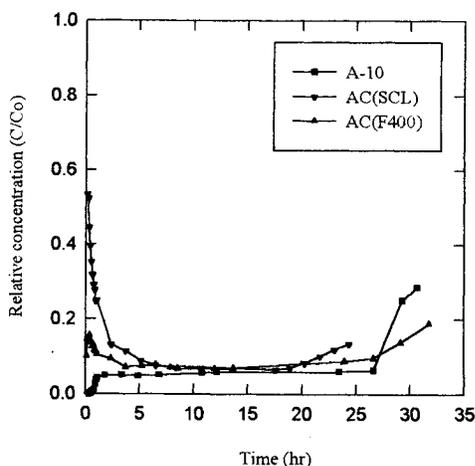


Fig.1 Breakthrough curves of comparison ACF (A-10) with AC(F400, SCL) at $C_0=52\text{ppm}$, flow rate= $1.3\text{ml}/\text{min}$.

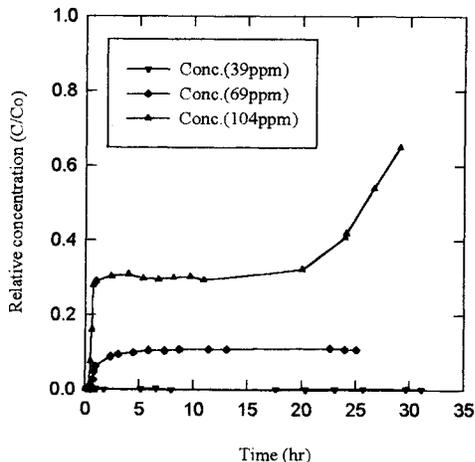


Fig.2 Breakthrough curves with respect to initial concentration of Cr(VI) solution at flow rate= $1.3\text{ml}/\text{min}$, packing density= $0.17\text{g}/\text{cm}^3$.

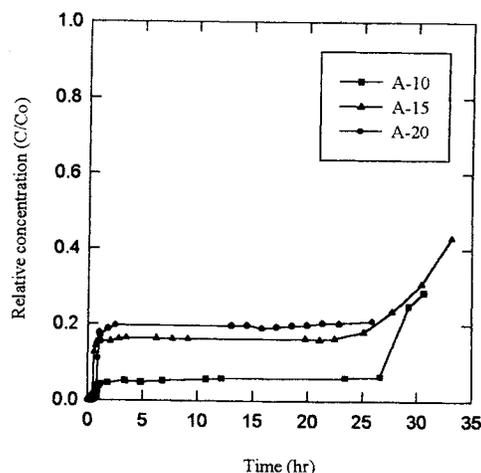


Fig.3 Breakthrough curves with respect to ACF(A-10, A-15, A-20) having different specific surface area at $C_0=52\text{ppm}$, flow rate= $1.3\text{ml}/\text{min}$.

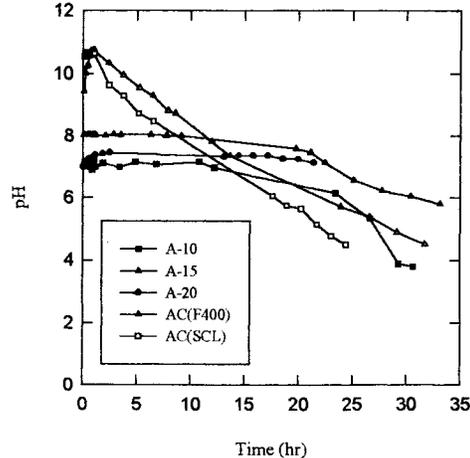


Fig.4 The pH changes of effluent solution through ACF and AC at $C_0=52\text{ppm}$, flow rate= $1.3\text{ml}/\text{min}$.