

ACTIVATED CARBON ADSORBENTS FOR THE REMOVAL OF CHROMIUM FROM AQUEOUS SOLUTIONS

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INTRODUCTION

The removal of chromium from aqueous solutions by adsorption on activated carbons has been the subject matter of several investigations. It has been observed that not only the microporous structure and the surface area but the chemical structure of the carbon surface plays an important role in the adsorption of chromium from aqueous solutions. The present paper describes some of the results obtained on the adsorption of Cr (VI) and Cr (III) from aqueous solutions on four samples of activated carbons, two of which are fibrous.

EXPERIMENTAL

The activated carbon fibres (ACF) used were obtained from Ashland Petroleum Company (USA) while the granulated activated carbons (GAC) are from Norit N.V. Netherlands. The activated carbons were used as such and after degassing at 400, 650 and 900°C and after oxidative treatments in H₂O₂, (NH₄)₂S₂O₈ and HNO₃.

0.1g of each carbon sample was contacted for 24 hrs. with 50 ml solutions of chromium, varying between 10 and 1000 mg/litre. The concentration of the solution before and after adsorption was determined spectrophotometrically using standard procedures.

RESULTS AND DISCUSSION

Adsorption Isotherms of Cr (VI):
Adsorption isotherms of Cr (VI)

from aqueous solutions of Cr.(VI) ions (Fig. 1) are type I of the BET classification in the case of ACF while they correspond to Type V in the case of GAC. The adsorption generally increases with increase in surface area but there is no direct relationship between the amount adsorbed and surface area of the carbon. It may be worthwhile to mention here that Cr (VI) in potassium dichromate solution is present as an anion and that Cr (VI) can be reduced to Cr (III) in highly acidic solutions. Consequently, the nature of the carbon surface and the pH of the solution are important parameters which will determine the adsorption of Cr (VI).

The nature of the carbon surface was altered by degassing of the carbons at 400, 650 and 900°C and by different oxidative treatments. The former treatments eliminate gradually the carbon-oxygen surface chemical structures which are evolved as CO₂ and CO. The oxidation in H₂O₂, (NH₄)₂S₂O₈ and HNO₃ solutions enhances the surface chemical structures. Thus by these treatments we have activated carbons associated with varying amounts of the different carbon-oxygen surface chemical structures.

The adsorption isotherms of Cr (VI) on the degassed samples are very interesting. The adsorption increases on the 400°C-outgassed sample, becomes maximum in the case of 650°C-outgassed sample

and shows a small decrease in the 900^o- outgassed carbon samples. Since degassing upto 650^oC eliminate most of the surface - oxygen structures which are evolved as CO₂ while outgassing at 900^oC eliminates almost completely the whole of chemisorbed oxygen. It appears that it is not the total amount of oxygen which determines the adsorption of Cr (VI) but the nature of the surface-oxygen chemical structure which is present on the carbon surface. As the surface oxygen complexes eliminated upto 650^oC are largely acidic groups, it is clear that the acidic chemical groups suppress the adsorption of Cr (VI). When these structures are removed almost completely at 650^oC, the adsorption of Cr (VI) becomes maximum at all concentrations. A small decrease in adsorption in the case of 900^o-degassed samples may be attributed to a partial break down of the microporous structure and to an almost complete removal of the surface oxygen chemical structures.

This view receives support from the adsorption isotherms obtained on oxidised carbon samples. The adsorption of Cr (VI) decreases considerably when the carbon samples are oxidised. The decrease in adsorption on oxidation is in accordance with increase in surface acidity of the carbon surface.

Thus the results clearly show that the presence of acidic groups on the carbon surface suppresses the adsorption of Cr (VI) presumably since these groups tend to make the carbon more and more negative in character.

Adsorption Isotherms of Cr(III):

Adsorption isotherms of Cr (III) on different carbons from aqueous solutions of chromium chloride show that all the carbons adsorb Cr (III) but the amount adsorbed is much smaller compared to the adsorption of Cr (VI). The lower adsorption in this case may be attributed partly to the larger size of Cr (III) ion and partly to the nature of the carbon surface. The adsorption of Cr (III) increases on oxidation and shows a considerable decrease on outgassing.

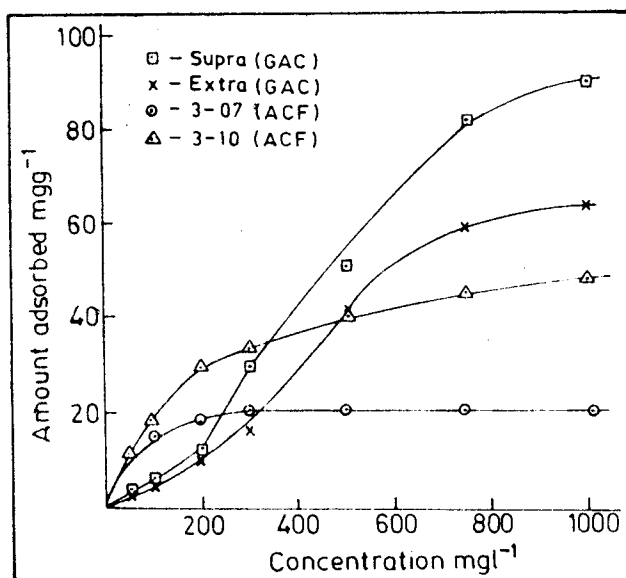


Fig.1 Adsorption Isotherms of Cr(VI) on Different Activated Carbons

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