

INFLUENCE OF CARBON-OXYGEN SURFACE GROUPS ON THE ADSORPTION OF COBALT FROM AQUEOUS SOLUTIONS

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INTRODUCTION

Cobalt is one of the heavy metals which is present in the effluent of several industries. Consequently its removal from water by adsorption on different adsorbents has been studied by several investigators. Activated carbons because of their large surface area and a highly microporous character have also been used for the removal of Co(II) ions from aqueous phase. The adsorption of Co(II) ions has been found to be influenced by the pH and nature of the carbon surface. The present paper describes the adsorption isotherms of Co(II) ions on two samples of granulated activated carbons (GAC-E and GAC-S) and two samples of fibrous (activated carbon fibres) activated carbons ACF-307 and ACF-310. The adsorption isotherms have also been studied after modifying the carbon surface by oxidation with nitric acid, ammonium persulphate and oxygen gas at 350°C and after degassing at 400°C, 650°C and 950°C.

EXPERIMENTAL

0.1 of each carbon sample was placed in contact with 20ml solutions of Co(II) ions of different concentrations in the range 20-1000 mg/l. The amount adsorbed was determined spectrophotometrically using standard analytical procedures.

RESULTS AND DISCUSSION

The adsorption isotherms of Co(II) ions from aqueous solutions on the four samples of activated carbons are presented in Fig.1. All the four samples adsorb appreciable amounts of Co(II) ions although the amount adsorbed is different in the case of

different carbons. In general the granulated activated carbons (GAC-E and GAC-S) adsorb larger amounts than fibrous activated carbons (ACF-307 and ACF-310). This cannot be attributed to surface area alone because GAC-E and ACF-310 which have about the same surface area adsorb widely different amounts of Co(II) ions. This indicates that besides surface area, the chemical nature of the carbon surface also influences the adsorption of Co(II) ions from aqueous solutions.

In order to examine the influence of carbon-oxygen chemical structures on the adsorption of Co(II) ions, the adsorption isotherms were determined on carbons after oxidation. The adsorption increases considerably on oxidation. The increase in adsorption is maximum in case of the samples oxidised with nitric acid, the increase in adsorption being between 80-100%. In case of the treatment with oxygen gas, the increase in adsorption is minimum. This has been attributed to the fact that the oxidation with nitric acid, which is much stronger oxidative treatment, results in the formation of larger amounts of carbon-oxygen surface chemical groups which are acidic in character. These acidic surface groups provide sites for the adsorption of Co(II) ions.

This receives support from the adsorption isotherms of Co(II) ions on oxidised carbon samples degassed at 400°C, 650°C and 950°C. This treatment eliminates varying amounts of the carbon-oxygen surface groups depending upon the temperature of degassing. The adsorption of Co(II) ions decreases gradually as the surface groups are being gradually eliminated. The

decrease in adsorption is very slight in case of the 400°-degassed samples while the decrease is considerably large in case of the 650°-degassed samples. This has been attributed to the fact that degassing at 400°C results in the elimination of only a small amount (~ 15%) of the acidic surface groups. The 650°-degassed samples, on the other hand, have lost a larger proportion (~ 85%) of their acidic surface groups although this sample still retains a larger proportion of the non-acidic surface groups. In case of the 950°-degassed sample the adsorption of Co(II) ions is smaller than the 650°-degassed samples. This is due to fact that these samples have lost the carbon-oxygen surface structures almost completely.

The results show very clearly that the adsorption of Co(II) ions from aqueous solutions on activated carbons is influenced by the chemical structure of the carbon surface. The acidic surface groups present on the carbon surface hydrolyse in water to produce H⁺ ions which can exchange with Co(II) ions.

The adsorption of Co(II) ions is also influenced by the pH of the solution. The adsorption is maximum when the pH of the solution is in the range 2-3. This is due to the fact that the carbon surface has different charge at different pH values. In the range of this pH the carbon surface has a maximum of negative charge and thus shows maximum adsorption of Co(II) ions.

ACKNOWLEDGEMENT

The authors are grateful to Norit Netherlands and Ashland USA for the gift of activated carbons one of the authors D.A. is thankful to CSIR (India) for the award of a Research Fellowship.

FIG.1 ADSORPTION ISOTHERMS OF Co(II) ions ON DIFFERENT ACTIVATED CARBONS.

