

ADSORPTION OF Ni(II) IONS FROM AQUEOUS SOLUTIONS BY ACTIVATED CARBONS

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Introduction

Nickel is one of the important metal used in plating of articles for decoration and higher life. When the plated articles are removed from electroplating tanks and rinsed some of the metal ions pass into the effluent. Several types of carbon adsorbents have been used for the removal of Ni(II) ions from industrial effluents. However, the influence of carbon-oxygen surface groups on the adsorption has not been examined. The present paper is an attempt in this direction.

Experimental

Two samples each of granulated and fibrous activated carbons have been used in these investigations. The amount of carbon oxygen surface groups has been varied by oxidation with HNO₃ and gaseous oxygen at 350°C and by degassing of the oxidised samples at 400, 650 and 950°C. The adsorption of Ni(II) ions has been studied by contacting 0.2 g of each carbon samples with 20 ml. Solutions of different concentrations of nickel ions. The concentration of each solution before and after adsorption has been determined spectrophotometrically.

Result and Discussion

The adsorption of Ni(II) ions from aqueous solutions of nickel nitrate in the concentration range 50-1000 mg/L on four activated carbon samples are presented in Fig. 1. The adsorption follows Freundlich equation $x/m = KC^n$, the log-log scale Freundlich isotherms are shown in Fig. 2. The adsorption follows Freundlich adsorption isotherms are shown in Fig. 2. The plots are linear with an intercept on the adsorption axis. The Freundlich equation constants K and n were calculated. The value of n which is a parameter characterising quasi-Gaussian energetic heterogeneity of the adsorption surface was always less than unity indicating that none of the activated carbons has a completely homogenous surface.

The adsorption isotherms in Fig. 1 show that the adsorption of Ni(II) ions is much large on granulated GAC-E and GAC-S than the fibrous ACF -307 and ACF - 310 activated carbons. This can not be attributed to surface area alone because ACF - 307 and GAC -E which have about the same surface area adsorb appreciably different amounts of Ni(II) ions. Since these two types of activated carbons have been prepared from different raw materials and have a different history of preparation, it appears that the chemical nature of the carbon

surface also influences the adsorption of Ni(II) ions from aqueous solutions.

To examine the influence of surface oxygen groups on the adsorption of Ni(II) ions more clearly, the adsorption isotherms were determined on carbon samples after oxidation with nitric acid and oxygen gas. The adsorption increases considerably on oxidation. The increase in adsorption is considerably larger in case of the samples oxidised with nitric acid as compared to oxidation with oxygen gas. This may be due to the fact that nitric acid is a stronger oxidative treatment and results in the formation of larger amounts of carbon - oxygen surface groups which provide sites for the adsorption of Ni(II) ions.

It has been shown that the oxidation with nitric acid creates surface groups which are largely acidic in character while the treatment with oxygen gas produces both acidic and non acidic surface groups. The larger increase in adsorption of Ni(II) ions on oxidation with nitric acid is due to the formation of larger amounts of acidic surface groups.

The carbon-Oxygen surface groups were gradually eliminated by degassing at 400, 650 and 950°C and the adsorption isotherms redetermined. This treatment eliminates varying amounts of different types of surface chemical groups. The adsorption of Ni(II) ions decreases gradually as the oxygen surface groups are being eliminated from the carbon surface. The decrease in adsorption is only slight on degassing at 400°C and much larger on degassing at 650°C. This can be attributed to the elimination of only a small part of the acidic surface groups on degassing at 400°C and a larger elimination of these groups on degassing at 650°C.

Conclusions

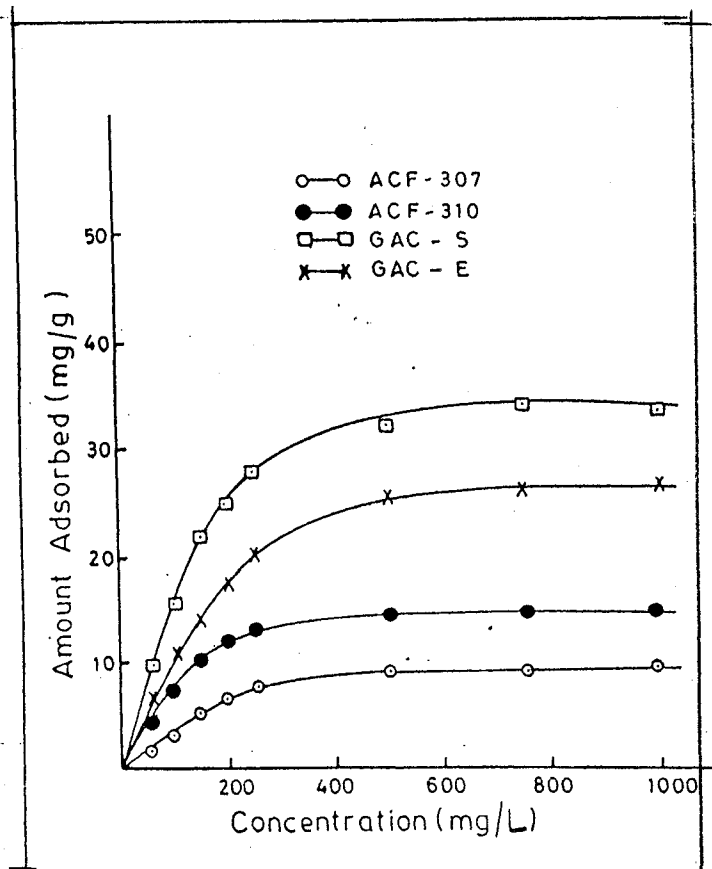
The adsorption of Ni(II) ions from aqueous solutions depends upon the amount of acidic surface oxygen groups present on the carbon surface, the non-acidic surface groups having little or no effect. The acidic surface groups which have been postulated as carboxyls and lactones when placed in aqueous solutions ionise to produce H⁺ ions which are directed towards the liquid phase and are exchanged by Ni(II) ions on the carbon surface. Consequently, the adsorption of Ni(II) ions increases on oxidation and decreases on degassing.

Acknowledgements:

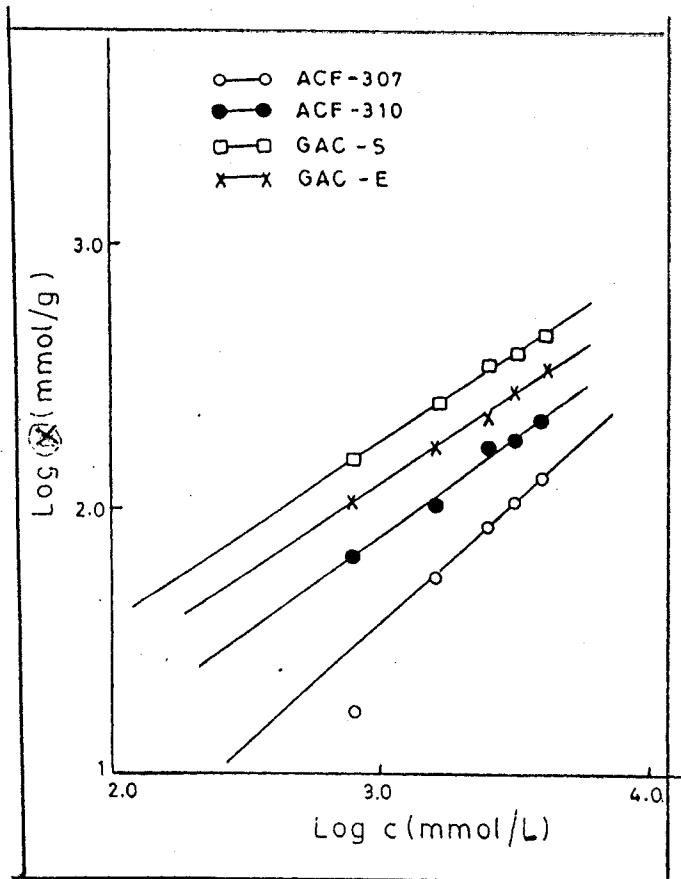
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Surface Areas and Associated Oxygen Evolved on Outgassing Different Carbons at 950°C

Sample	BET Surface Area (m ² /g)	Oxygen evolved as (g.100g)			Total
		CO ₂	CO	H ₂ O	
ACF-307	910	1.00	5.30	1.30	7.60
ACF-310	1184	1.90	4.20	1.40	7.50
GAC-S	1256	2.10	1.05	1.24	4.39
GAC-E	1190	2.13	1.66	1.33	5.12
HNO₃ Oxidised					
ACF-307		12.90	7.47	2.40	22.77
GAC-E		12.40	6.20	1.92	20.52
Oxygen Oxidised					
ACF-307		3.11	8.21	1.20	12.02
GAC-E		3.17	5.97	1.26	10.40
HNO₃ Oxidised and degassed at					
400°C		10.85	7.35	0.85	19.05
650°C		2.15	6.86	0.12	9.13
950°C			Traces		



Adsorption isotherms of as-received activated carbons.



Linear Freundlich adsorption isotherms.