Adsorption of Copper from Copper Sulphate Solution on Carbon Black "Spheron 9"

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Summary: Adsorption studies of copper from copper sulphate solution by carbon block "Spheron 9" were made under varying conditions of time and solution concentration. The results showed that adsorption equilibrium was established within two hours in case of copper solutions of 10 μg/ml concentration. In case of copper solutions of higher concentrations, however, equilibrium was attained after longer duration of time, which was thought to be due to high repulsive forces between copper ions adsorbed in large amounts from concentrated salt solutions, compared to that from dilute solutions.

Introduction

Activated carbon, a highly porous carbonaceous material has gained world wide importance for the removal of organic and inorganic contaminants usually present in ground and surface water. These contaminants are usually toxic to human health. More than 700 organic compounds have been identified by EPA (Environmental Protection Agency) of the United States [1] in drinking water, some of these are carcinogenic in nature. Granulated Activated Carbon (GAC) exhibits great potential as an adsorbent for the removal of wide range of these toxic organic compounds present in drinking water [2].

In addition to the presence of organic pollutants, ground and surface water may also contain considerable amount of inorganic substances, some of these are considered to be toxic in nature even if present in trace quantities and are thus of much environmental concern. These toxic inorganic elements are mainly transition metal salts of such elements Hg, Pb, Cd, Mo, Cr, Ni, Cu, and Zn, etc. Removal of these elements are thus as important as the removal of organic substances. Activated carbon which has proved to work effeciently in the removal of organics may also be a good adsorbent for inorganics removal. Earlier work on the use of activated carbon and related material like carbon black for the removal of trace metals is not significant enough. Some of the earlier workers have utilized brown coal activated at 150- 300^{o}C [3] and activated carbon [4] for the purpose of recovery of precious metal from waste water, whereas other have directed their attention towards studying the effects of surface characteristics of carbon on the course of adsorption of trace metals [5].

The present work was undertaken to investigate the adsorption characteristics of carbon black "Spheron 9" for adosprtion of copper from copper sulphate solution. Carbon black "Spheron 9" is a relatively non-porous carbonaceous material compared to activated carbon and thus any complicating effect due to the microporosity encountered in using activated carbon, is avoided in the case of carbon black "Spheron 9".

Experimental

Determination of surface Area of Carbon Black

Surface area of carbon black "Spheron 9" was determined by Snow's iodine adsorption method [6].

Determination of Equilibration Time.

The equilibration time of adsorption of copper from copper sulphate solution on carbon black "Spheron 9" was determined by taking 0.2 gram of carbon in quickfit conical flasks, into which were then added 50.0 ml of 10,100 and 500 mg/ml copper sulphate solution through a 50 ml pipette. The flasks were put on water bath at 35^{o}C for different lengths of time with occasional hand shaking. The pH was measured before and after adsorption with a pH meter. The contents were then filtered and measured volumes of the filtrates were titrated with

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0.001M EDTA solutions using murexide as indicator. Blank determinations were made similarly. The amount of copper apparently adsorbed per gram of carbon at different duration of time was calculated as follows. Apparent adsorption $\mu g/g$.

$$= \frac{(V1-V2) \times M \times \text{atomic weight of copper} \times 1000}{\text{wt of carbon in grams.}}$$

M = Molarity of E.D.T.A. = 0.001 M depending on standerization.

V1 = Volume of 0.001M E.D.T.A. used for 50ml blank copper salt solution.

V2 = Volume of E.D.T.A. used for 50ml copper salt solution, containing carbon sample.

Results and Discussion

Table-1 shows, the surface area of carbon black "Spheron 9" determined by Snow's iodine adsorption method [6]. The table also shows the reported values determined by the same method as well as BET method. Surface area determined by iodine method in the present investigation agrees well with the reported value determined by the same method. However, it was quite low when compared to the value determined by BET method. This difference in the surface area determined by the two methods, for the same carbon, was attributed to the surface acidity of carbon by earlier workers [6]. Carbon showing acidic properties will be polar in nature and will thus have greater affinity for polar water molecule, which will greatly reduce the extent of adsorption from aqueous phase compared to adsorption from gaseous phase. Another reason for the low value of iodine adsorption method may be the difficult penetration of large iodine molecules into the micropores of carbon compared to the case of penetration of smaller nitrogen molecules [7]. However, the effect of size of adsorbate on the surface area of carbon black "Spheron 9" will not be significant in this case, because of negligible microporosity of "Spheron 9" as indicated by its low surface area.

The adsorption of copper by 0.2 gram of carbon from copper sulphate solutions of different strengths at different times are given in Figs. 1-3. It

Table-1: Surface Area of Carbon Black "Spheron 9"

Exerpimental Value (m^2/g)by Snow's Iodine Adsorp.Method	Literature Value(m^2/g) Determn.by Snow's Iodine Adsorp. Method[6]	Literature Value (m^2/g) Determn. by BET Nitrogen Adsorp. Method [6]
66 $m^2.g^{-1}$	66$m^2.g^{-1}$	116$m^2.g^{-1}$

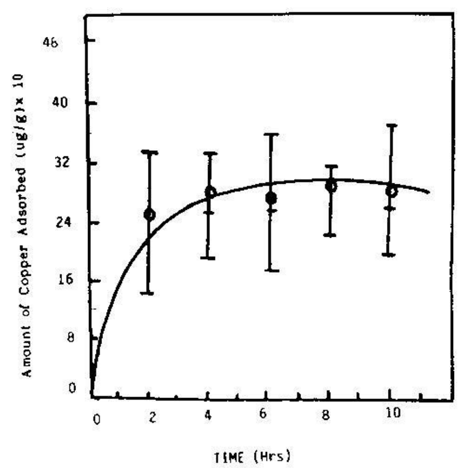

Fig.1: Adsorption of Copper from Copper Sulphate Solution at Different Duration of Time (occasional hand shaking) pH = 4.24- 5.1 Carbon Dosage = 0.2 g Concn. of Copper = 10 PPm.

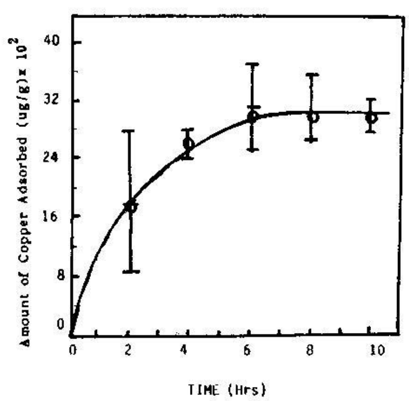

Fig.2: Adsorption of Copper from Copper Sulphate Solution at Different Duration of Time(occasionl hand shaking) pH = 4.25-5.1 Carbon Dosage = 0.2 g Concn. of Copper = 500 PPm.

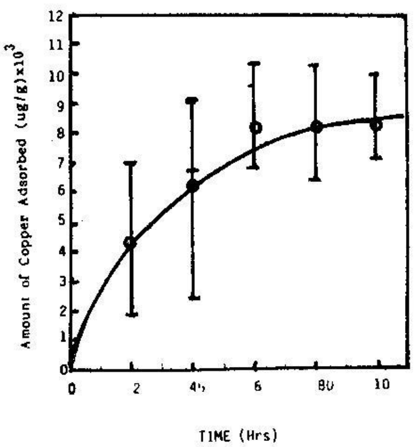

Fig.3: Adsorption of Copper from Copper Sulphate Solution at Different Duration of Time (occasional hand shaking) pH = 4.1-4.3 Carbon Dosage = 0.2 g Conc. for Copper = 1000 PPm

can be seen that equilibrium was established within two hours in case of copper solution of 10 μg/ml concentration. However, longer duration of time was required for adsorption from concentrated solutions. The slow rate of equilibration in case of concentrated copper solutions might be due to high repulsive forces among copper ions, when they are adsorbing in large amounts from concentrated solutions compared to the amount of adsorption from dilute solutions. It can be noticed that the amount of copper adsorbed from concentrated solutions is quite high compared to that from solutions of low concentration. The figures show that the triplicate results of adsorption from one and the same solution are quite scattered. The scatter was thought to be due to ineffective dispersion of carbon in the copper solution which resulted in quite variable extent of adsorption from one and the same original solution in the triplicate set of repeated experiments.

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