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Removal of Chromium(VI) from Water by Using Activated Carbon Obtained from Butter Oil Cake

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In this paper, the activated carbon obtained by pyrolysis of butter oil cake (*Bassia latifolia*) is used to remove hexavalent chromium ions effectively. Experimental analysis for optimizing carbon dosage, pH and contact time was performed and the results are validated by Freundich adsorption isotherm.

Key Words: Hexavalent chromium, Butter oil cake, Activated carbon.

INTRODUCTION

Among heavy metals causing serious problems to human beings, Cr^{6+} is most important one. It is released in waste discharge of various industries such as pulp,mills, paper board, building paper, board mills, organic chemicals, petrochemicals, alkalies, chlorine, inorganic chemicals, fertilizers, basic steel works, foundries steam generation power plants, *etc*[1].

Several reports are available in literature for the treatment of chromium containing wastes[2-4]. The traditional methods such as reduction, solvent extractions are found to be ineffective to remove Cr^{6+} from solution in wastewater treatment for public water supplies[5].

EXPERIMENTAL

Preparation of activated carbon from butter oil cake: Activated carbon was obtained by pyrolysis process[6]. The raw material butter oil cake (*Bassia latifolia*) was obained from the market. It was washed with water, dried in an air-oven at a temperature of 110 ºC for 3 h.

The dried butter oil cake was carbonized[6] by slow heating over the temperature range of 200-300 ºC. The carbon was ground, sieved and activated at *ca.* 400 ºC. The particles in the range of 40-50 mesh size were retained for characterization study. The results are given in Table-1.

At first a stock solution Cr^{6+} is prepared by using potassium dichromate. A series of standard solutions containing 10 to 50 ppm. All these solutions were added with 1.5 mL of diphenylamine regent to give violet colour. Optical densities of this solution were read in photo electric colorimeter at 530 nm and calibration curve is constructed. This calibration curve is used for subsequent analysis.

TABLE-1
CHARACTERISTICS OF ACTIVATED CARBON OF BUTTER OIL CAKE

S. No.	Properties	Values
1	Apparent density	0.47476 g/cc
2	Moisture content	3.68 %
3	Ash content	11.44 %
4	Fixed carbon content	88.56 %
5	Matter soluble in water	3.08 %
6	Matter soluble in acid	5.03 %
7	pH	7.32 %
8	Decolourizing power	21.00 mg
9	Phenol number	13.00 mg
10	Iron content	Nil

Adsorpton studies: All the experiments were conducted by Batch wise manner.

Optimization of carbon dosage: Different weights of activated carbon ranging from 50-200 mg were weighed and made to contact with 100 mL of 10 ppm Cr^{6+} solution for about 24 h. Solutions were agitated by mechanical shaker. After treatment, the amount of Cr^{6+} present in these solutions were estimated by adding 1.5 mL of diphenyl carbazide reagent to give violet colour and then by optical density measurement at 530 nm using calibration curve.

Optimization of pH: 100 mg of carbon was weighed and made to contact with 100 mL of 10 ppm Cr^{6+} solution of pH 1 to 5 for about 24 h. The amount of Cr^{6+} present in these solutions were estimated by adding 1.5 mL of diphenyl carbazide reagent to give violet colour and then by optical density measurement at 530 nm.

Optimization of contact time: 100 mg of carbon was weighed and made to contact with 100 mL of 10 ppm Cr^{6+} solution whose pH was 1 and the amount of Cr^{6+} present in the solution were determined at regular intervals of time as usual.

Verification of Freundlich adsorption isotherm: The experiment was carried out to study the influences of Cr^{6+} concentration of solution of activated carbon. 100 mL of Cr^{6+} solution of different concentrations (10 to 30 ppm) were treated with activated carbon. Optimum carbon dosage was 100 mg, optimum pH was 1 and optimum contact time was 4 h. The amount of Cr^{6+} adsorption of these solution were determined.

RESULTS AND DISCUSSION

Effect of carbon dosage: The efficiency of adsorption of Cr^{6+} increases with increasing weights of activated carbon. This is mainly due to increase in total area of the adsorbent. The amount of adsorbent required for 100 % removal of Cr^{6+} was 1g/L or 100 mg/L (Fig. 1)

Effect of pH: At lower pH values, the large number of H^+ ions neutralizes the negatively charged adsorbent surfaces, there by reducing hindrance of the dichromate ions. At high pH values, the reduction in adsorption may be due to the abundance of OH^- ions causing increased hindrance to diffusion of dichromate ions (Fig. 2).

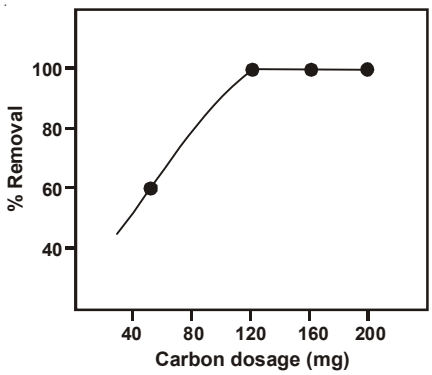

Fig. 1. Optimization of carbon dosage

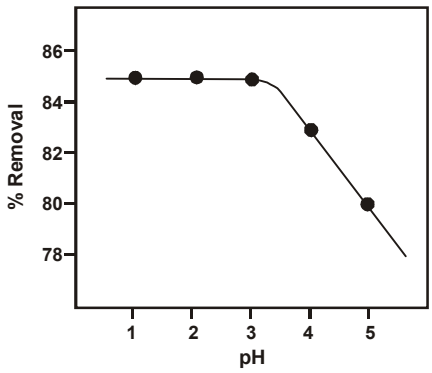

Fig. 2. Optimization of pH

Effect of contact time: The optimum contact time for Cr^{6+} removal was found to be 4 h. It was observed that the adsorption of Cr^{6+} on carbon was not very rapid but remains constant after 4 h (Fig. 3).

Freundlich adsorption isotherm: The experimental results obtained for the adsorption of Cr^{6+} on activated carbon carried out at optimum conditions of dosage, time and pH are given in Table-2. The Fig. 4 depicts the Freundlich adsorption isotherm for carbon from butter oil cake. The plot of (x/m) *vs.* log c was found to be linear indicating the applicability of classical adsorption isotherm to this adsorbate-adsorbent system (Fig. 4). The activated carbon obtained from butter oil cake is efficient in removing Cr^{6+} from aqueous solutions at optimum dosage, pH and time.

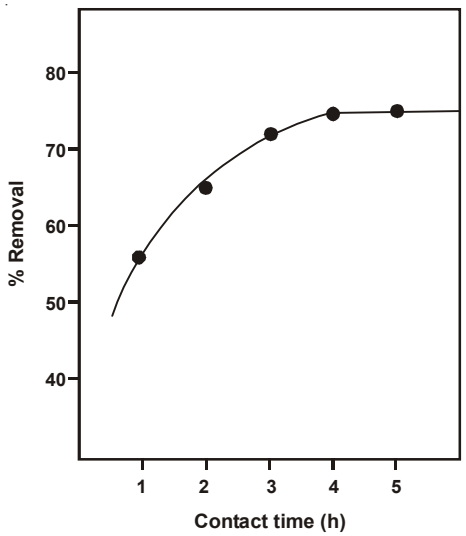

Fig. 3. Optimization of contact time

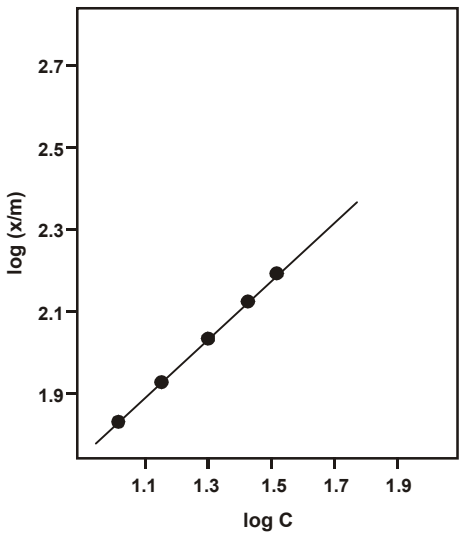

Fig. 4. Freundlich adsorption isotherm

TABLE-2
FREUNDLICH ADSORPTION ISOTHERM
Optimum carbon dosage: 100 mg, Optimum pH: 1, Optimum contact time: 4 h

Conc. of Cr^{6+} (ppm)	log c	Amount of adsorption	x/m	log x/m
10	1.0000	6.5	65	1.8129
15	1.1760	8.9	89	1.9493
20	1.3010	11.7	117	2.0600
25	1.3979	15.0	150	2.1760
30	1.4771	16.5	165	2.2174

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