ADSORPTION REMOVAL OF CHROMIUM (VI) FROM AQUEOUS SOLUTION USING GROUNDNUT SHELL

Anjana Vijay, Rakesh Deshmukh

Abstract: - This project work was undertaken to study the removal of Cr(VI) by groundnut shell by adsoption process. Batch adsorption study determines that groundnut shellhas a significant capacity for adsorption of Cr(VI) from aqueous solution. The parameters used in these study includes contact time, adsorbent dosage, pH, concentration. The maximum adsorbent loading of Cr(VI) was found to be 0.5gm/100ml for maximum removal of Cr(VI) ion of 50 mg/l of initial concentration. Adsorption capacity is 5.25 mg/g for adsorption of Cr(VI).

Key-Words: - Cr(VI), adsorption, adsorbent, groundnut shell

1 Introduction

One of the serious environmental issues is the presence of toxic heavy metals contaminants in aqueous streams, arising from the discharge of untreated metal containing effluents into water bodies. Disposal of heavy metals in ground by human activity is nowadays increased due to urbanization, combustion byproducts, automobile emissions, mining activities. Disposed heavy metals are not biodegradable substances and they tend to accumulate in living organism causing various disease and disorder (Bailey et al.,1999)[1]. Among the toxic heavy metals, chromium in its hexavalent form is known to cause wide ranging human health effect including mutagenic and carcinogenic risks (Park and Jung, 2001)[2].

Chromium is widely used in electroplating, leather tanning, metal finishing and chromate preparation and are usually present in high concentration in the aqueous waste which are usually released directly into the environment without any pretreatment. The commonly used techniques includes chemical precipitation, reverse osmosis, evaporation, ion exchange and adsorption of which adsorption has proved to be very effective. Because of their high surface area and high porous character, activated carbons have been considered as potential adsorbents for Cr(VI) (Jianlong et al., 2000)[3]. Due to the relatively high cost of activated carbon, there is a need to produce low cost adsorbent for Cr(VI) removal from cheap and readily available materials which can be used economically on a large scale.

The aim of this study is to investigate the use of groundnut shellin the removal of Cr(VI) from aqueous solution. The study involves the examination of experimental conditions such as pH of the solution, concentration of the solution, contact time and adsorbent loading on the removal of Cr(VI) from aqueous solution. The Freundlich and Langmiur adsorption isotherms were used to investigate the adsorption process.

2 Materials and Methods

2.1 Adsorbent Preparation

The groundnut shell was obtained from the stalls nearby and was washed with tap water and dried in the sun. Then the groundnut shell was washed repeatedly with distilled water to remove dust and insoluble impurities and dried in the oven at $106°C$ for 2 hours. Then they were crushed and sieved through 1.18mm and 600 microns sieve. The powdered groundnut shell passing through 1.18mm and retained on 600microns sieve was collected and washed with distilled water until washings are free from colour and pH of solution was 7.

The concentration of Cr in adsorbent was determined by placing 2g of adsorbent in 20ml distilled water for 1 hour with continuous agitation, after which it was centrifuged with laboratory centrifuge. The supernatant was carefully decanted and analysed using AAS (Atomic Absorption Spectrophotometer).

2.2 Adsorbate solution
Stock solution of Cr(VI) was prepared by dissolving 1.41g of $K_2Cr_2O_7$ in 100ml distilled water. The solution was diluted as required to obtain standard solutions.

2.3 Batch adsorption experiments

Batch adsorption experiments were conducted by agitating the standard solution for 30 minutes in jar test apparatus. Experiments were carried out by varying the adsorbent amount from 0.2gm/100ml to 1.6gm/100ml solution with a Cr (VI) concentration of 50mg/l. Adsorption isotherm study was carried out with different initial concentration of chromium (VI) from 10-80mg/l while maintaining the adsorbent dosage at 0.4gm/100ml. Then the effect of time and pH was studied with Cr (VI) concentration of 50mg/l and adsorbent dosage of 0.4gm/100ml. The aqueous solution pH was adjusted in the range of 2-12 by using d0iluted H_2SO_4 and NaOH solution. The concentration of free Cr (VI) ions in the effluent was estimated spectrophotometrically at 540nm

using 1,5-dipheny carbazide method (APHA, 1985)[4]. R^2 (regression coefficient square value) and isotherm constants values were determined from the graph.

The amount of metal ion adsorbed per gram of biomass and the sorption efficiency (%) were calculated according to the expressions:

$$Q = \frac{Co - Ce}{M} \; X \; V \qquad (1)$$

$$\text{Sorption efficiency (\%)} = \frac{Co - Ce}{Co} \; X \; 100 \qquad (2)$$

Q_e = adsorbent phase concentration after equilibrum.mg adsorbate /g.adsorbent
C_o = initial concentration of adsorbate (mg/l)
C_e = final equilibrium concentration of adsorbate after absorption has occurred (mg/l)
M = mass of adsorbent
V = volume in litres

3 Results and discussions

3.1 Effect of adsorbent dosage
The effect of adsorbent dosage on the adsorption of Cr(VI) process is shown in **Fig 1**. It is clearly indicated that the removal of Cr(VI) increased with increase of adsorbent dosage. However, the adsorption capacity showed a decreasing trend with increasing dosage. Adsorption capacity was maximum at 0.4g/L. The drop in adsorption capacity is basically due to sites remaining unsaturated during the adsorption reaction.

3.2 Effect of Contact time
The adsorption of Cr(VI) on time is presented in **Fig. 2**. It is apparent from that the percentage removal increases with increasing contact time and the equilibrium was obtained after 50 minutes. Therefore, the adsorption for 50 minutes could be considered for whole batch

experiments. The agitation speed was 150 r.p.m.

3.3 Effect of pH

The effect of pH on the process is presented in **Fig 3**. The percentage adsorption of Cr(VI) is decreasing with increasing pH. The maximum adsorption took place in the pH range 3-4.
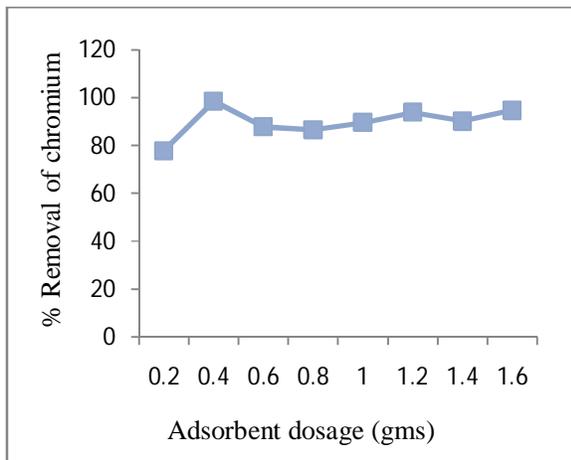

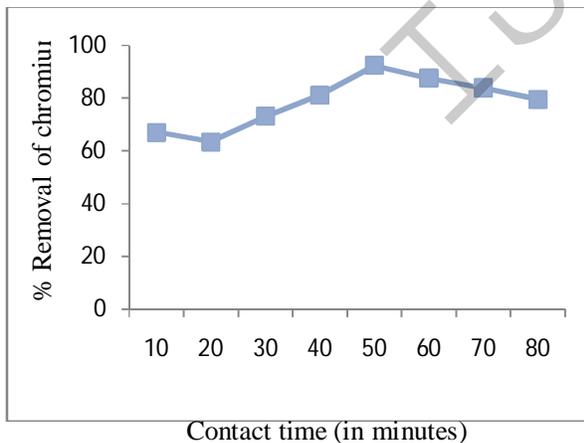**Fig. 1** Effect of adsorbent mass on the adsorption capacity of Sugarcane bagasse

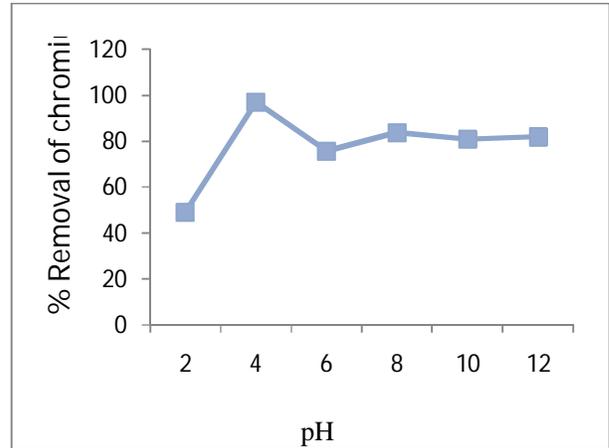**Fig. 2** Effect of contact time on removal of Cr(VI) ions

Fig. 3 Effect of pH on removal of Cr(VI) ions

4 Conclusion

From the present study, it can be concluded that the groundnut shell has a moderate potential to remove chromium (VI). The percentage removal of Cr (VI) depends on adsorbent dose, pH, contact time, and initial Cr (VI) concentration. At 50 minutes contact time and initial metal concentration of 50 mg/L, 70.2% Cr (VI) removal was observed but when the metal concentration was increased to 50 mg/L the removal efficiency dropped to 30.8%. Groundnut shell adsorbed chromium ions best at lower Cr (VI) concentration in the range of 40 to 50 mg/L but the removal efficiency dropped to 19% when the metal concentration was increased to 70 mg/L.

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