ACTIVATED CHARCOAL AS LOW COST ADSORBENT FOR THE REMOVAL OF LEAD

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Abstract *- The purpose of present study is to develop a methodology for the removal of a toxic metal from its aqueous solution. Activated carbon is the adsorbents whose adsorption properties are well known for metal ions. In this work, batch adsorption experiments were carried out to investigate the suitability of activated carbons in removing Pb^{2+}. Batch adsorption of Pb^{2+}reveals the dependence on adsorbent dose, time, pH and adsorbate concentrations. Adsorption of the metal was found to be pH dependent. Optimum operating conditions was Pb^{2+} = 50 mg/l, pH = 5.0, and adsorbent dosage = 1.0 g/50 ml.*

Key Words

Lead, Activated carbon, Adsorption efficiency, adsorbent dosage, batch studies etc.

1. INTRODUCTION

Heavy metal ions are detected in the waste streams from tanneries, mining, electronics and petrochemical industries. Heavy metals have harmful effects on human beings when they exceed the tolerance levels (1). Heavy metals are non-biodegradable and accumulate in living organisms, causing various diseases and disorders. There are so many methods for removing heavy metals from wastewaters such as chemical precipitation, ion exchange, reverse osmosis, evaporation, membrane filtration and adsorption (2-4).

Adsorption is widely accepted in environmental applications. Adsorption is based on the ability of solids to specific substances from solutions onto the surfaces. This principle is used for the removal of pollutants. Most of these methods have some drawbacks, such as high cost, disposal of the residual metal sludge and not suitable for small industries.

Activated carbon is relatively cost effective in the comparison of other inorganic adsorbents. High surface area, micro porous character of activated carbons has made it good adsorbent for the removal of heavy metal (Pb^{2+}) from wastewater.

2. Material and method

2.1 Materials

Activated charcoal was purchased from Aldrich Company, lead sulphate was procured from central drug house Pvt. Ltd. New Delhi, India.

2.2 Batch adsorption studies

Batch experiment were basically investigate the effect of pH, adsorbent dosage, contact time and initial concentration of Pb^{2+} ions on adsorption over activated charcoal. After that flask was shaken for different time intervals, the content of each flask was removed (5). The solutions were filtered through 0.22 µm filter membranes and the concentration of Pb^{2+} ions was measured by atomic absorption spectrometer.

Adsorption capacity and removal efficiency (%) were calculated using the following equations respectively.

$$qe = \frac{(Co-Ce)\times V}{m} \quad (1)$$

$$\textbf{Removal efficiency (\%)} = \frac{(C0-Ce)\times 100}{C0} \quad (2)$$

Where: qe (mg g−1) is the amount of metal adsorbed, Ci (mg L−1) is the initial Pb^{2+}concentration, Ce (mg L−1) is the concentration of Pb^{2+} in solution at equilibrium, V (L) is the volume of $Pb^{2+}$and m (g) is the mass of the adsorbent.

2.3 Effect of operating variables

The effect of variables on the adsorption of Pb^{2+} was studied using the synthetic Pb^{2+} solutions and in each case the optimum condition is surmised. The influence of agitation time on the adsorption of Pb^{2+} (50 ml of 50 mg/l) was studied in a batch system containing activated carbon. The flasks were corked and agitated at 350 rpm within different contact times (0, 20, 40, 60and 80 min) and aliquots were taken, filtered and analyzed using AAS.

In order to determine the effect of adsorbent concentration, stimulated solution of Pb^{2+} (50 ml) was added into the batch reactor containing 0.5–2.5 g of activated carbon, and agitated at 350 rpm between 40 and 100 min (6). The contents in the flasks were filtered and each filtrate was analyzed using AAS.

On the other hand, the influence of adsorbate concentration (Pb^{2+} mg/l) was studied between concentrations of 40–80

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mg/l. Lead solution (50 ml) was agitated until equilibrium was attained.

After the adsorption, the residual suspension was filtered and filtrate was measured using atomic absorption spectrophotometer.

The optimum conditions from the above experiments were maintained, but the pH of each five set of solutions were adjusted using 0.1 mol/l HCl and 0.1 mol/l NaOH (7). The content of each flask was filtered and the filtrate was analyzed using AAS.

3. RESULTS AND DISCUSSION

3.1Effect of contact time

Adsorption efficiency strongly depends upon adsorption time. Therefore, the effect of contact time on adsorption was studied. The result is shown in figure 1. Equilibrium was attained after 50 min with adsorption capacities of 87.53. It was observed that percent removal efficiency increased with time and after equilibrium it become constant (7-8).

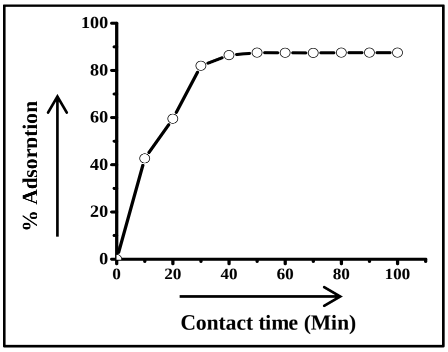

Figure: 1 Effect of contact time on the adsorption of Pb^{2+} on activated charcoal

3.2 Effect of initial concentration:

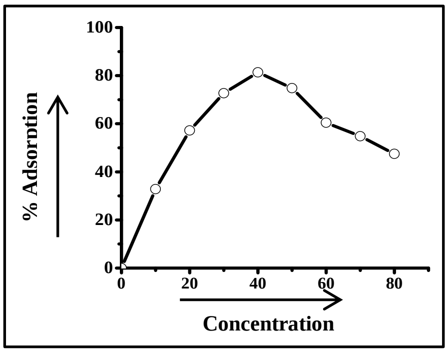

Figure: 2 Effect of Pb^{2+} concentrations on the adsorption capacity of the activated charcoal

The effect of initial heavy metal concentration was studied within the range of (10-80 mg/l). The concentration (40 mg/l) was selected as optimum and used in the study to investigate the effect of contact time, pH and adsorbent dosage. The figure 2, shows in the removal efficiency of Pb^{2+} increases with increasing adsorbate due to the availability of adsorption sites on the activated carbons. Beyond the optimum concentration (50 mg/l), the removal efficiency declines (9). This concentration was selected as optimum and used in the study to investigate the effect of contact time, adsorbent dosage and pH. Mechanism for metal removal is related to the surface properties of activated carbons.

3.3 Effect of adsorbent dosage:

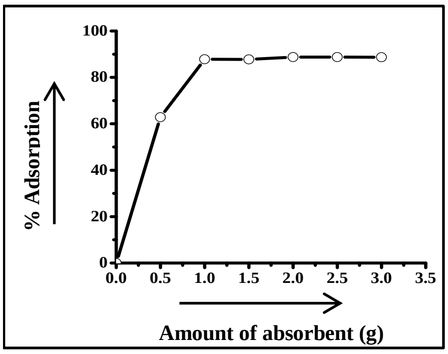

Figure: 3 Effect of adsorbent dosage

The effect of adsorbent dosage was investigated using 50 mg/l initial adsorbate concentration with adsorbent concentration 0.5 g/50 ml to 2.5 g/50 ml. The result of the investigation of lead removal is shown in figure 3. At the initial stage, removal efficiency of Pb^{2+} gradually increase with corresponding increase in adsorbate concentration which may be due to the increasing adsorption sites (10). As the binding sites of the activated carbons get saturated the curve becomes independence on concentration of the adsorbate. The optimum dose for effective Pb^{+2} removal over was 1.0 g with adsorption capacities 87.80%.

3.4 Effect of pH:

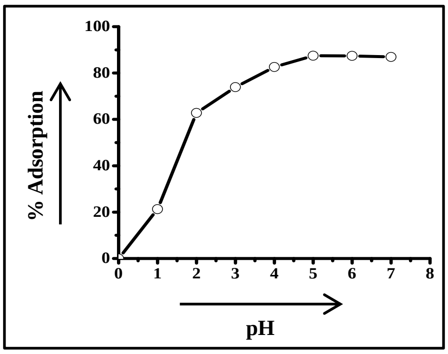

Figure: 4 Effect of Pb^{2+} concentrations at different pH

The pH of the aqueous suspension of adsorbent is an important parameter that controls the adsorption of metal pb^{+2}. It can be seen from figure 4, that for the maximum removal capacity of lead was observed at pH 5. Pb^{2+} is precipitated as $Pb(OH)_2$ above pH 5. The removal of this metal was observed using activated charcoal at the optimum conditions of pH 5.0, adsorbent dose (1.0 g/50 ml) and initial lead concentration (40 mg/l).

3. CONCLUSIONS:

Activated carbon prepared is an agricultural waste. It can be used as potential adsorbent for the removal of lead from aqueous solutions (9, 12).

The adsorption data suggest that the pH of the solution is most important parameter for adsorption of metal ion on activated charcoal. Adsorption of metal ion was found to be highly pH dependent and the results indicated that the optimum pH was 5 for the removal of lead. The percent metal ion removal increases with increasing adsorbent dose.

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