ADSORPTION OF CR-(VI) FROM AQUEOUS ENVIRONMENT USING NEEM LEAVES POWDER

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Abstract

This study is aimed at utilizing Neem Leaves powder as low cost adsorbent material for removal of Cr-(VI) from aqueous solution. Adsorption is an important process used for removal of colour, odour, turbidity, metal ions and reduction of COD. In adsorption, the solute present in dilute concentration in liquid or gas phase is extracted by contacting with suitable solid adsorbent so that the transfer of the component first takes place on the surface of solid and then into the pore of the solid. Neem Leaves powder Adsorbent used in present study is prepared at Laboratory scale which is very effective to remove chromium from its aqueous solution. This study describes the detailed experimental procedure to obtain Adsorption Equilibrium and the Effect of various parameters such pH, agitation time, initial metal ion concentration & adsorbent doses on batch technique.

Keywords: *Hexa-valent Chromium, Neem Leaf Powder, Adsorption, Batch process, UV-Vis Spectrophotometer.*

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1. INTRODUCTION

Due to increased urbanization as well as industrialization, generation of large amount of toxic contaminants especially heavy metals are to be produced. These received widespread attention because of their persistent nature, toxicity, carcinogenicity or mutagenicity even at very low concentrations. Among these heavy metals chromium is more toxic. Chromium ion in industrial wastewater occurs in two forms; trivalent Cr3+ and hexa-valent Cr6+. The increase in concentration levels of heavy metals in the environment particularly in water is a cause for concern. The major contributor for this rise in the concentration level is in the extensive development of heavy & manufacturing industries that uses metals & related compounds.

Discharge of treated industrial wastewater containing metal ions such as nickel, lead, copper, zinc, chromium and aluminium are common in nearby water sources like river. This may result in affecting the quality of aquatic & human life. Therefore, the removal of heavy metals from wastewater is essential.

1.1 Sources of Cr-(VI)

Main sources of chromium-(VI) pollution are 1) Mining industry 2) Leather Tanning industry 3) Cement industry 4) Electroplating industry 5) Production of steel and other metal alloys industry 6) Photographic material and corrosive paints 7) Nuclear Power-plants 8) Textile industries. Chromium is the naturally occurring element which is found in the volcanic-ash, volcanic-gases, soil and rocks (Abbasi and Soni, 1985). Chrome plating, leather tanning, combustion of natural fuels (gas, oil, coal), catalysts, fertilizers, dye manufacturing industries, battery making, printers, emission from cooling towers, air condensers and incineration of sewage sludge, municipal refuse and other solid wastes, are the anthropogenic sources of chromium emission in the environment (Faisal and Hasnain, 2004). More than 1, 70,000 metric tonnes of chromium wastes are discharged annually in environment as a result of industrial and manufacturing activities (Abassi et al, 1998). The leather industry is the major cause for the high influx of chromium to the biosphere, accounting for 40% of the total industrial use (Baruhart, 1997). Chromium exists in food, air, water and soil, mostly in the trivalent form. It is only as a result of human activities that substantial amounts of Cr-(VI) become present in environment. Cr-(III) is comparatively insoluble while Cr-(VI) is quite soluble and is readily leached from soil to groundwater or surface water.

1.2 Cr-(VI) Metal Impacts on Health

The hexa-valent form is 500 times more toxic than the trivalent (Kowalski, 1994). It is toxic to micro-organisms, plants, animals and humans. Human toxicity includes lung cancer as well as kidney, liver, and gastric damage (US Department of Health and Human Services, 1991; Cieslak-Golonka, 1995). The tanning process is one of the largest polluters of chromium all over the world. Most of the tanneries in India adopt the chromium tanning process because of its processing speed, low costs, and light color of leather and greater stability of the resulting leather.

In the chromium tanning process, the leather takes up only 60–80% of applied chromium, and the rest is usually discharged into the sewage system causing serious environmental impact. Chromium ion in liquid tanning wastes occurs mainly in trivalent form, which gets further oxidized to hexa-valent Cr-(VI) form, due to the presence of

organics. For nearly a century, heavy metal-laden wastewater discharged from industries, are posing a serious challenge to environmental, public health, scientists and Engineers. Numerous investigations on effects of heavy metal on environment and human have been carried out. Unlike organic pollutants, which in most cases can be destroyed, heavy metal discharged into environment tend to persist indefinitely, circularly and eventually throughout the food chain thus causing a series of threats to human and organisms (Cooke et al, 1990; Deniseger et al, 1990;Sag et al, 1995b; Chua and Hua, 1996). Even if the heavy metal ions in water present in dilute, undetectable quantities, their recalcitrance and consequent persistence in water bodies imply that through natural processes, such as biomagnification, concentrations may become elevated to such an extent that they begin exhibiting toxic characteristics (Atkinson et al, 1998).

1.3 Permissible Limits of Cr-(VI)

The maximum levels permitted in waste-water are 5 mg/L for trivalent chromium and 0.05 mg/L for hexavalent chromium (Acar and Malkoc, 2004). With this limit, it is essential for industries to treat their effluents to reduce the Cr to acceptable levels.

The Ministry of Environment and Forest (MOEF), Government of India has set mini-mal national standards (MINAS) of **0.1 mg/L** for safe discharge of effluent containing Cr(VI) in surface water and in potable water is **0.05 mg/L** .

2. BATCH ADSORPTION EXPERIMENT ANALYSIS

Study reports the use of Neem leaves powder as a low cost adsorbent and investigation of various parameters such as pH, metal ion concentration, adsorbent dose and contact time by using batch adsorption technique.

1. Using Neem Leaves adsorbents in 250 ml stopper conical flask containing 100 ml of Cr (VI) solution batch adsorption were carried out. pH of the solution adjusted by adding H_2SO_4 or NaOH or HCL solution as required. Then the flasks were shaken for the desired contact time.
2. The time required to reach the equilibrium was estimated by withdrawing conical flask containing treated solution at regular intervals of time. The content flasks were filtered through filter paper (Whatman no.1).
3. UV-visible Spectrophotometer employed to determine the remaining Cr (VI) concentration in the sample solution using 1, 5-diphenylcarbazide method as laid down in standard methods for examination of water and wastewater, APHA, AWWA, WEF, 1998 edition.
4. The removal percentage (R %) of chromium was calculated for each run by following expression:

$$R\ (\%) = [(C_i - C_e)/ C_i] \times 100$$ Where,

C_i- initial concentration of chromium in the solution. C_e- final concentration of chromium in the solution

3. CHEMICALS & INSTRUMENTS

3.1 Chemicals/ Materials Required

1. Distilled water/ De-ionized water
2. Standard buffer solution-For pH meter calibration
3. H_2SO_4 / NaOH/ HCL- For adjusting pH of Solution
4. 1,5-Diphenyl Carbazide (DPC)
5. Neem leaves
6. Potassium chromate/ Potassium dichromate

3.2 Equipments Required

- pH meter/ pH paper
- UV-VIS Spectrophotometer
- 250 ml Stopper Conical flask
- What-man Filter Paper
- Muffle furnace
- Digital Weighing Balance
- Glass Beakers
- Measuring Cylinders
- Burettes & Pipettes

4. EXPERIMENTAL METHOD

4.1 Adsorbent Preparation

1. Neem leaves were collected from local nearby area & washed with several times to remove dust particles.
2. Adsorbents were oven dried to remove the adherent moisture content.
3. Dried leaves were crushed with domestic mixture.
4. Adsorbent in a powder form was obtained. After drying, adsorbent sieved to obtain particle size of 250 - 350 μm prior to being used for adsorption studies.

4.2 Preparation of Standard CR-(VI) Solution

The stock solution containing 1000 mg/L of Cr-(VI) was prepared by dissolving 2.828 g of A. R. grade potassium dichromate($K_2Cr_2O_7$) in 1000 ml double-distilled water. Required initial concentrations of Cr-(VI) standards were prepared by appropriate dilution of the stock Cr-(VI) solution.

4.3 Determination of Maximum Absorptive Wavelength for Operation

Absorbances were recorded at different wavelengths by using UV-vis Spectrophotometer. Up to certain wavelength absorption increases and then decreases, at the point where the % absorption is maximum that point is considered as maximum wavelength of operation.

4.4 Construction of Standard Calibration Curve for Chromium

For this purpose, solution of chromium of different concentrations were prepared and their absorbance recorded by using UV Spectrophotometer. The Spectrophotometer is set to Zero absorbance with the reference solution (Distilled water) and then the absorbance of standard solution was measured. With the help of these Reading standard calibration curve plotted between Absorbance and standard chromium solution of various concentrations.

Table-1 Standard Calibration Curve For Cr^{+6}

Concentration (ppm)	Absorbance	Concentration (ppm)	Absorbance
1	0.1	6	0.5
2	0.19	7	0.64
3	0.32	8	0.7
4	0.38	9	0.87
5	0.48	10	0.99

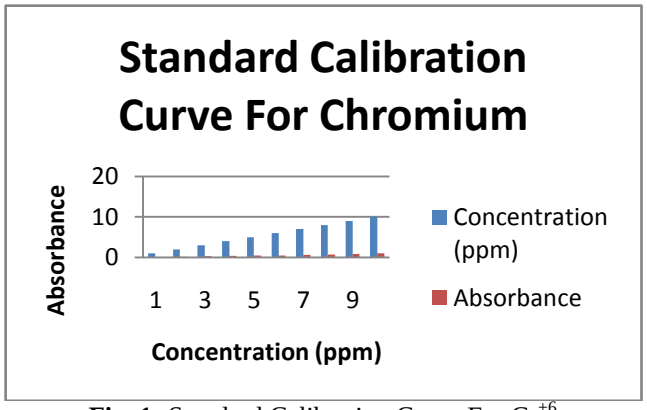

Fig. 1- Standard Calibration Curve For Cr^{+6}

Graph shows as chromium concentration increases absorbance also increases. Curve to be used as a standard curve for determining concentration of an unknown Cr solution by observing Absorbance with the help of UV-VIS Spectrophotometer.

5.0 RESULTS & DISCUSSIONS

5.1 Effect of pH

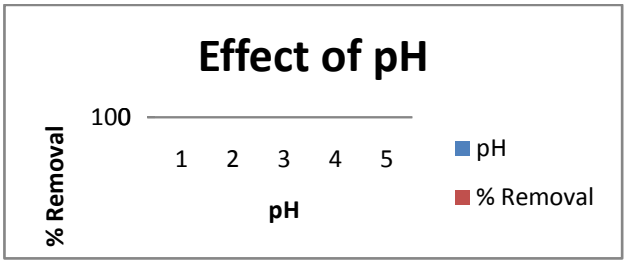

Fig.2- Effect of pH on removal of Cr (VI) ion

pH affects the solubility of chromium ion to a great extent. The pH of aqueous solution is the controlling factor in the adsorption process; hence it become necessary to determine at what pH, max adsorption will takes place. Percentage removal of Chromium goes on decreasing with increase in pH values. The maximum removal efficiency was 67.5% at 2 pH value. The Chromium removal was higher at lower pH values**.**

5.2 Effect of Contact Time

Graph shows that Removal efficiency of Cr-(VI) ion increases with respect to increase in contact time (in min.) of adsorbent.

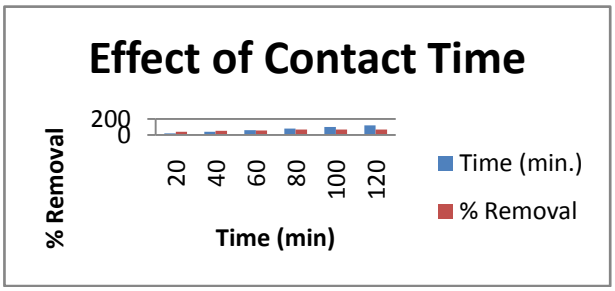

Fig.3-Effect of contact time on removal of Cr- (VI) ion

5.3 Effect of Initial Metal Ion Concentration

It was observed that the activity of adsorbent material falls sharply with an increase in initial concentration of chromium ion. The max Cr removal efficiency for all the set of optimized parameter was found to be 98% for Neem Leaves at initial concentration of 30mg/100ml.

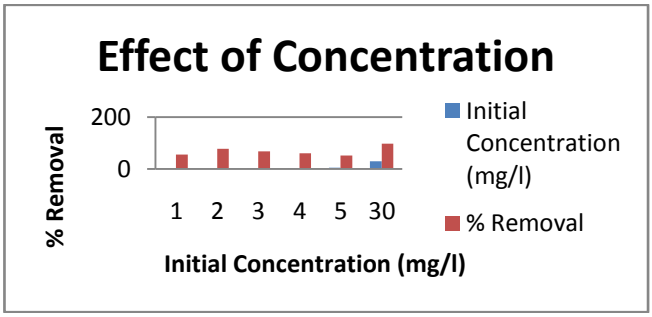

Fig.4-Effect of initial concentration on removal of Cr-(VI) ion

5.4 Effect of Adsorbent Dose

It can be seen that the rate of the removal of chromium ions increases with an increase in the amount of adsorbent dosage (in gm). The amount of adsorbent dose varies from 2gm/100ml to 10gm/100ml. The removal efficiency is maximum at dose of 8gm/100ml which is up to 85%.

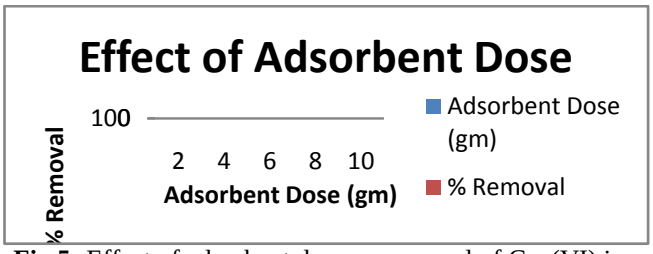

Fig.5- Effect of adsorbent dose on removal of Cr- (VI) ion

6. CONCLUSIONS

Maximum removal efficiency achieved up to 85% for bio-sorbent prepared from Neem Leaves at the optimum values of parameters. Percentage adsorption decreases with increase in initial metal ion concentration & increases with increase in adsorbent dosage & contact time. Study clearly shows that Neem leaves powder which is cheap and abundantly available can be used as an effective adsorbent for removal Cr-(VI) from effluent.

Also adopted and used widely in industries, not only to minimize cost but also to improve profit. In addition to this, living organisms and surrounding environment will also be benefited from the decrease or elimination of the potential toxicity created due to heavy metal like Cr-(VI). Maximum adsorption occurs at pH value- 2 hence, it is taken as optimum pH value for further experiments.

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BIOGRAPHIES

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