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Adsorption of Cr (VI) from Synthetic Tannery Wastewater by using Banyan Sawdust (Ficus Bengalensis) Adsorbent

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ABSTRACT

This research deals with the adsorption of Chromium (VI) from the tannery effluent. The effect of several parameters including contact time, pH value and adsorbent dosages. From the experiment results, it was found that Chromium (VI) concentration in synthetic tannery effluent was reduced to 76%. The extent of adsorption was studied as a function of PH, contact time, adsorbent dose, and initial adsorbed concentration. Optimum results were found to be 90 minutes, 3, and 6g/l for time contact, PH, and adsorbent dose respectively. Thus it has been proved that the Banyan Sawdust can be used as an adsorbent for the adsorption of hexavalent Chromium from tannery effluent.

KEYWORDS: Adsorption, Chromium (VI), Tannery Effluent, Banyan Sawdust.

1. INTRODUCTION

Tanning is the chemical process that converts animal hides and skin into leather and related products. The transformation of hides into leather is usually done by means of tanning agents and the process generates highly turbid, colored and foul smelling wastewater. The major components of the effluent include sulfide, chromium, volatile organic compounds, large quantities of solid waste, suspended solids like animal hair and trimmings. For every kilogram of hides processed, 30 litres of effluent is generated and the total quantity of effluent discharged by Indian industries is about 50,000 m^3/day. The various components present in the effluent affect human beings, agriculture and livestock besides causing severe ailments to the tannery workers such as eye diseases, skin irritations, kidney failure and gastrointestinal problems (Midha & Dey, 2008). The untreated release of tannery effluents containing high COD, BOD levels, trivalent chromium, sulfides, sodium chloride, Ca, Mg, organics and other toxic ingredients, to the natural water bodies effect flora and fauna of the ecosystem and increases the health risk of human beings (Mandal et al., 2010).

About 30 % of the initial salt amount remains in the out coming stream whereas 70 % reacts within the tanning step (Cassano et al. 2001). The maximum permissible limit of Cr (VI) for the discharge to inland surface water is 0.1 mg/l and in potable water is 0.05 mg/L. The Ministry of Environment and Forest (MOEF), Government of India has set Minimum National Standards (MINAS) of 0.1 mg/l for safe discharge of effluent containing Cr (VI) in surface water. To comply with this limit, industries have to treat their effluents to reduce the Cr (VI) concentration in wastewater to acceptable levels (Das et al., 2011). There are about 2161 tanneries in India; however sustenance of tanneries is becoming increasingly difficult because of alarming level of environmental pollution caused by various tannery operations and practices. The main pollutants of concern in tanneries are BOD/COD, suspended solids and heavy metals [Gupta et al., 2011].

2. METHODS AND MATERIALS

2.1 Adsorbent Preparation

Banyan Sawdust: Banyan wood collected from the local area and was grinded to small particles of size 120-500 µm. It was washed with deionized water for removal of dirt, color and other particular matter and then

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dried. The Banyan Sawdust powder was washed with deionized water until the PH of filtrate was more than 5. Finally, the Banyan Sawdust was dried and then stored in plastic bags at room temperature.

2.2 Stock solution of chromium

An stock solution of 1000 mg/l of Cr (VI) was prepared by dissolving 2.83 g of potassium dichromate ($K_2Cr_2O_7$) in double distilled water. The stock solution was diluted suitably to get 100, 200, 300, 400 and 500 mg of Cr (VI) solutions. It was dissolved by shaking and the volume was made up to the mark. Chromium solution concentration of this solution was 500 mg/l.

2.3 Batch Mode Adsorption Studies

The adsorption of Cr (VI) on adsorbent was studied by batch process. The general method used for this study is described as below:

In this study, the analytical grade chemicals were used for testing various parameters in tannery wastewaters. The absorbance and chromium (VI) of synthetic tannery wastewater were found using UV-Visible Spectrophotometer. The pH value was found by using pH meter. A known weight of adsorbent (e.g. 0.6 gram adsorbent) was equilibrated with 100 ml of the each chromium (VI) solution of known concentration 500 mg/l in 12 stoppered borosil glass flask at a fixed temperature (30 ^{0}C) in a orbital shaker for a known period (30–150 Minute) of time. After equilibration, 100 ml sample collected from each flask, in time interval of 30, 60, 90, 120, and 150 minutes, the suspension of the adsorbent was separated from solution by filtration using Whatman No. 42 filter paper. The concentration of chromium ions remaining in solution was measured by UV visible spectrophotometer at a wavelength 540 nm. The effect of several parameters, such as pH, contact time and adsorbent dose on the adsorption were studied. The pH of the adsorptive solutions was adjusted using sulfuric acid, sodium hydroxide and buffer solutions when required.

The amount of chromium adsorbed qt was calculated using equation 1.

$$Qt = \frac{(C - C)}{M} \qquad (1)$$

where, Co = initial chromium concentration in mg/L
Ct = chromium concentration at time t
mo = mass of activated carbon in g
V - Volume of chromium solution in cm3
The effect of adsorbent dosage, pH, contact time and initial concentration of Cr (VI) were studied by varying any one of the parameters and keeping the other parameters constant.

3. RESULT AND DISCUSSIONS

3.1 Effect of contact time: The time required to reach equilibrium for chromium ions adsorption by Banyan Sawdust (BS) is 90 minutes at pH 3. The adsorption of chromium ions was dependent on pH of wastewater and increased with decrease in pH of wastewater. It was observed that increase in percentage removal of Cr (VI) with increase of contact time for banyan sawdust adsorbent. The maximum Cr (VI) removal efficiency was 75.2% at 120 minute and minimum removal efficiency was 49% at 30 minute are shown in figure 3.1. It is observed that in all cases the reduction in comparatively lower for 30 minutes contact time, higher reduction up to 90 minutes.

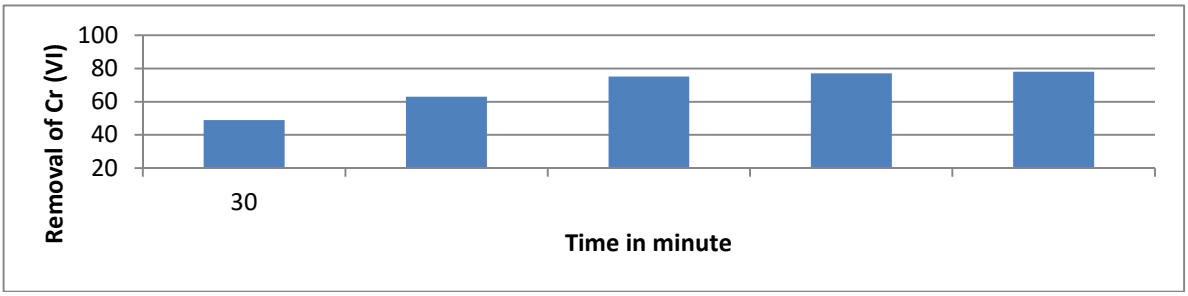

Figure 3.1 Effect of contact time on reduction of Cr (VI) by Banyan Sawdust adsorbent.

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3.2 Effect of pH: The effect of pH on initial concentration of Cr (VI) by Banyan Sawdust adsorbents. The pH varies 1 to 6 are observed. Most of the pollutants at initial concentrations were optimally adsorbed within 1 to 6 pH of contact between the adsorbent. The maximum removal of Cr(VI) was observed at pH 3 and contact time 120 minute as shown in figure 3.2. It was investigated that the removal of Cr(VI) increased with decrease in the solution pH. The adsorption efficiency increased from 43% at pH 6.0 to 76% at pH 3.0. The maximum adsorption was observed at pH 3.0.

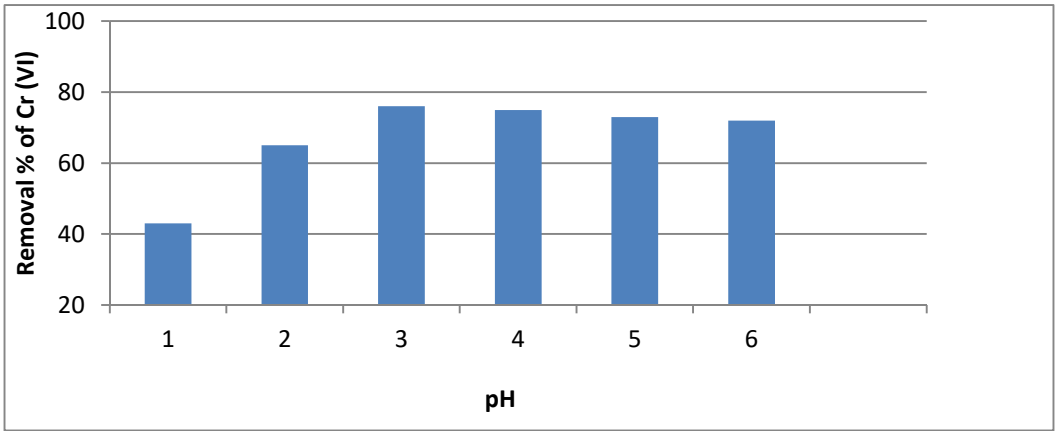

Figure 3.2 Effect of pH on reduction of chromium (VI) by Banyan Sawdust adsorbent.

3.3 Effect of adsorbent dosage: The effect of adsorbent dose on initial concentration of Chromium ions by Banyan Sawdust (BS) adsorbents. The adsorbent doses are varies from 0.2 to 1.0 grams are observed. Most of the pollutants at initial concentration were optimally adsorbed within 0.2 to 1.0 gram of adsorbent between the contact times. The maximum Cr (VI) removal efficiency was 74% at the dosage of 6 g/L and minimum removal percent of Cr(VI) 42% at 2g/L were shown in figure 3.3. It was observed that removal efficiency of chromium ion was directly proportional to the dosage of biomass.

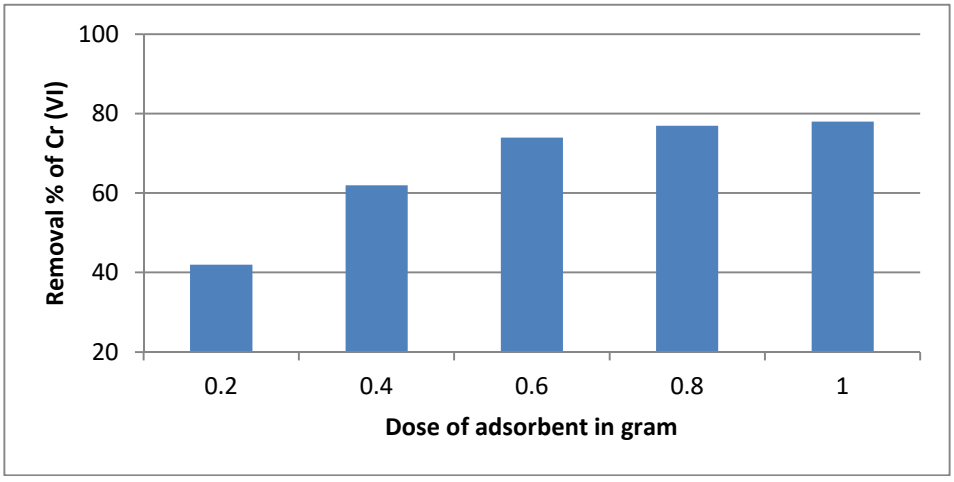

Figure 3.3 Effect of adsorbent dose on Chromium ions by Banyan Sawdust adsorbent.

4. CONCLUSION

The study indicated the suitability of the adsorbents used for removal of pollutants from tannery wastewater. It was found that Banyan Sawdust can be used as an adsorbent for preliminary treatment of tannery effluent. In this study it was obtained that the chromium ions of tannery wastewater was reduced to the concentration of satisfaction, among the primary treatment available for tannery effluent and it was investigated that reduction is the higher available of absorption process for treatment of tannery effluent due to its low cost compare to other processes. So, Banyan Sawdust can be used effectively as an adsorbent for pre-treatment for tannery effluent.

5. NOMENCLATURE

BOD	Biological Oxygen Demand
BS	Banyan Sawdust
^oC	Degree Centigrade
Ca	Calcium
COD	Chemical Oxygen Demand
Cr(III)	Trivalent Chromium
Cr(VI)	Hexavalent Chromium
HCl	Hydrochloric Acid
Mg	Magnesium
MINAS	Minimum National Standards
MOEF	The Ministry of Environmental and Forest
TDS	Total Dissolved Solid
TS	Total Solid
UV	Ultra Violet

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