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REMOVAL OF POLLUTION LOAD FROM TANNERY EFFLUENT BY USING BANYAN SAWDUST (FICUS BENGALENSIS) AS AN ADSORBENT

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ABSTRACT

This research deals with the reduction of Chromium and other pollutants like Chemical Oxygen Demand (COD), Total Solid (TS), Total Dissolved Solid (TDS) and Conductivity 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 ions concentration in tannery effluent was reduced to the level of 61mg/l, COD was removed 28mg/l, TS reduction was found to be at level of 282mg/l, TDS removed was at level of 316mg/l and Conductivity increased was 9.40mS to 18.1mS. 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, 2, 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 various pollutants from tannery effluent..

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

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 m3/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].

METHODS AND MATERIALS

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 dried. Banyan sawdust was treated with Hydrochloric acid (HCl). For this 10 ml of HCl was

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added to 100 ml of deionized water and then 10 grams of Banyan Sawdust was added and the final mixture was stirred and treated at 32ºC for 24 hours till the mixture became thick slurry. The slurry (Treated Banyan Sawdust) 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.

Stock solution of chromium

The stock solutions chromium ions were prepared from AR 1.4145 gram of Potassium Dichromate ($K_2Cr_2O_7$) was added in 500 ml of distilled water in 1000 ml volumetric flask. It was dissolved by shaking and the volume was made up to the mark. Chromium solution concentration of this solution was 500 mg/l.
The initial characteristics of the tannery wastewater collected are shown in table 1:

Table 1: Initial characteristics

S. No.	Properties	Values
01	Chromium ion	500mg/l
02	Total Dissolved Solid (TDS)	1318mg/l
03	Total Solid (TS)	1428mg/l
04	Chemical Oxygen Demand (COD)	200mg/l
05	Conductivity	9.40mS
06	PH	3-5.6

Batch Mode Adsorption Studies

The adsorption of various pollutants 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 ions of synthetic tannery wastewater were found using UV-Visible Spectrophotometer. The pH value was found using pH meter and the conductivity was found using conductivity meter. The C.O.D in the tannery wastewater was found using Open reflux method and other parameters like TDS and TS were tested as per APHA standards (Standard method for examination of water and wastewater, 20th edition,1998).

A known weight of adsorbent (e.g. 0.6 gram adsorbent) was equilibrated with 100 ml of the each chromium ions 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. 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.

RESULT AND DISCUSSIONS

Effect of contact time:

The time required to reach equilibrium for various pollutants adsorption by Banyan Sawdust (BS) is 90 minutes at pH 2. The adsorption of pollutants was dependent on pH of wastewater and increased with decrease in pH of wastewater. The optimally adsorbed within 30 to 150 minutes of contact between the adsorbent. The result determined through this study was very effective on tannery wastewater and they are represented in the graph below, for the Banyan Sawdust (at pH 2, 0.6g/100 ml of adsorbent). In figure 3.1, the reduction of chromium from 500 mg/l to 65mg/l for Banyan Sawdust. In figure 3.2, the reduction of TDS from the tannery effluent, the initially level was 1318 mg/l but after treating the wastewater with contact time variation the reduced TDS was 329mg/l. In figure 3.3, the reduction of TS from the tannery effluent, the initially level was 1428mg/l and after treatment of the wastewater with contact time variation the reduced was 282mg/l. In figure 3.4, the reduction of COD level from 200mg/l to 32mg/l. The increase level of conductivity from 9.40mS to 18.1mS adsorption is shown in figure 3.5.

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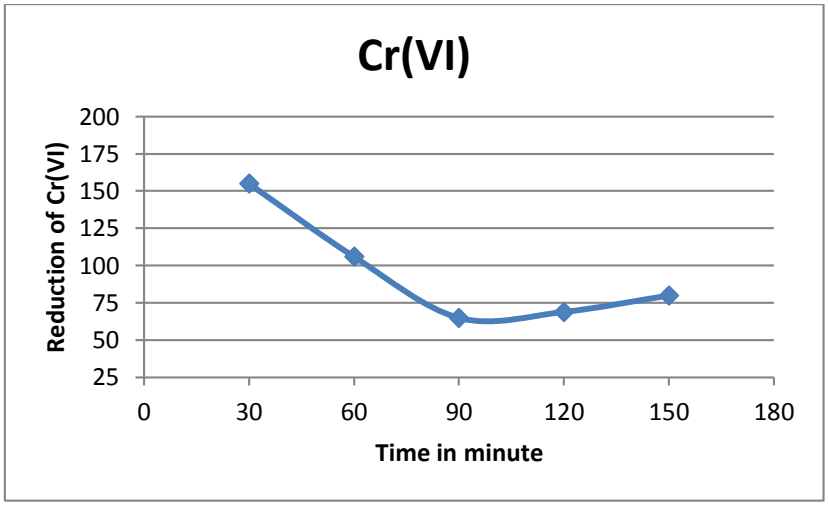

Figure 3.1 Effect of contact time on reduction of Cr(VI) by Banyan Sawdust adsorbent.

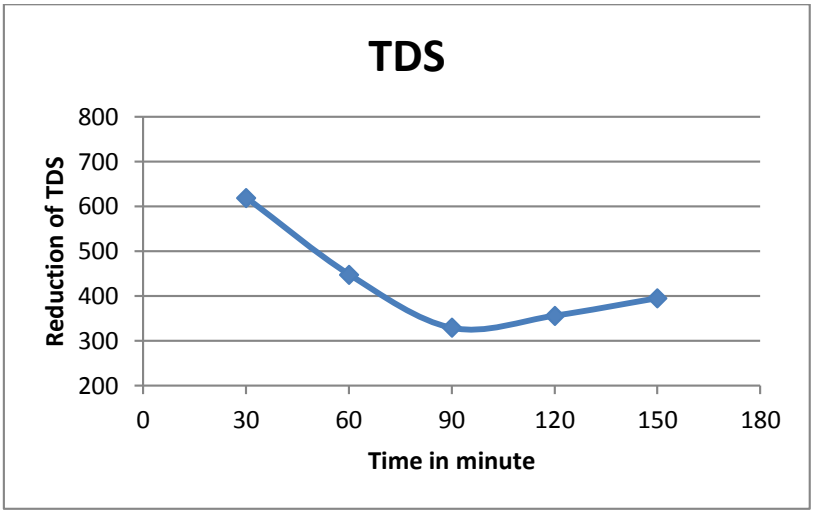

Figure 3.2 Effect of contact time on reduction of TDS by Banyan Sawdust adsorbent.

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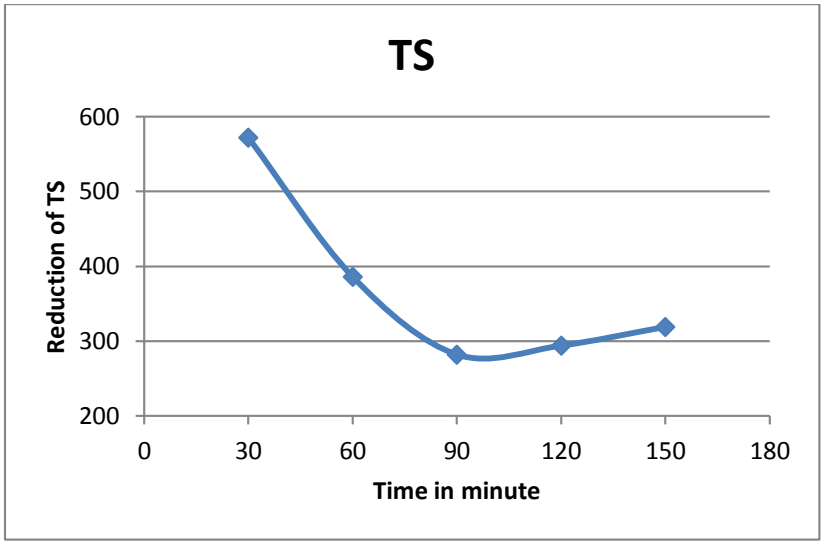

Figure 3.3 Effect of contact time on reduction of TS by Banyan Sawdust adsorbent.

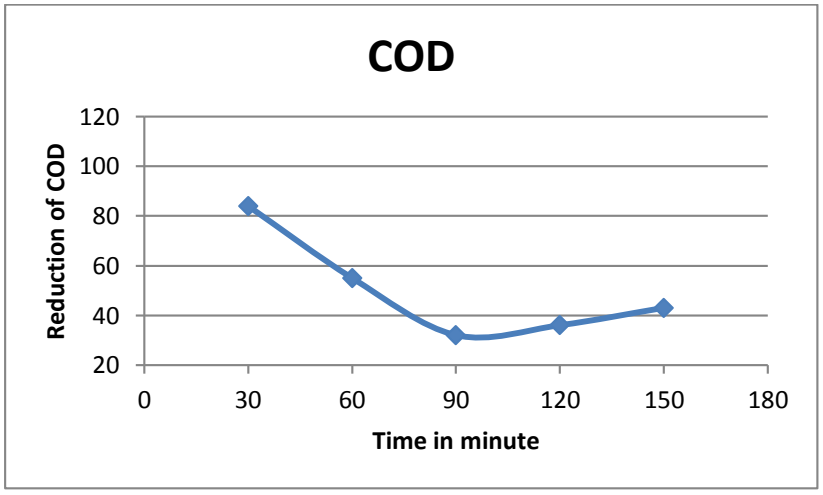

Figure 3.4 Effect of contact time on reduction of COD by Banyan Sawdust adsorbent.

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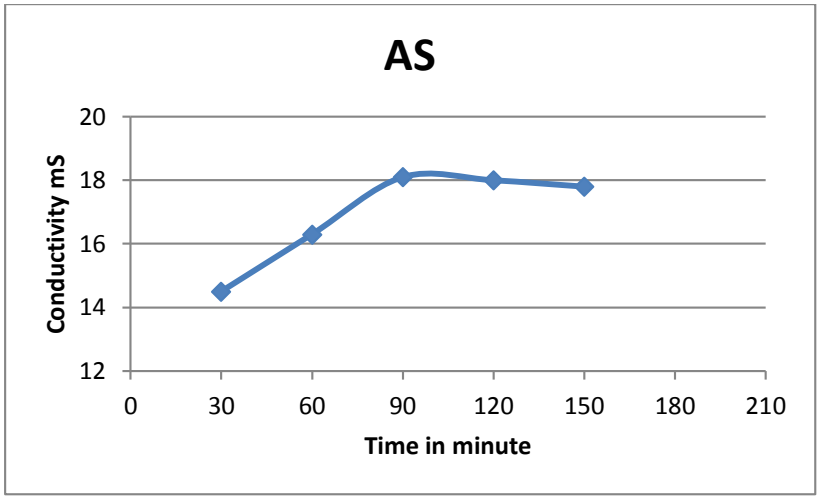

Figure 3.5 Effect of contact time on conductivity by Banyan Sawdust adsorbent.

Effect of pH:

The effect of pH on initial concentration of Cr (VI), TDS, TS, COD and conductivity 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 result obtained through this study was very effective on tannery wastewater for the Banyan Sawdust (at 90 minute contact time, 0.6g/100ml of adsorbent). In figure 3.6, the reduction of chromium from 500 mg/l to 61mg/l for Banyan Sawdust adsorbent. In figure 3.7, the reduction of TDS from the tannery effluent, the initially TDS level was 1318mg/l but after treating the wastewater with pH values variation the reduced was 316mg/l. In figure 3.8, the reduction of TS from the tannery effluent, the initially level was 1428mg/l and after treatment of the wastewater with variation pH values the reduced was 286mg/l. In figure 3.9, reduction of COD from 200mg/l to 28mg/l. The increase level of conductivity from 9.40mS to 18.0mS adsorption is shown in figure 3.10.

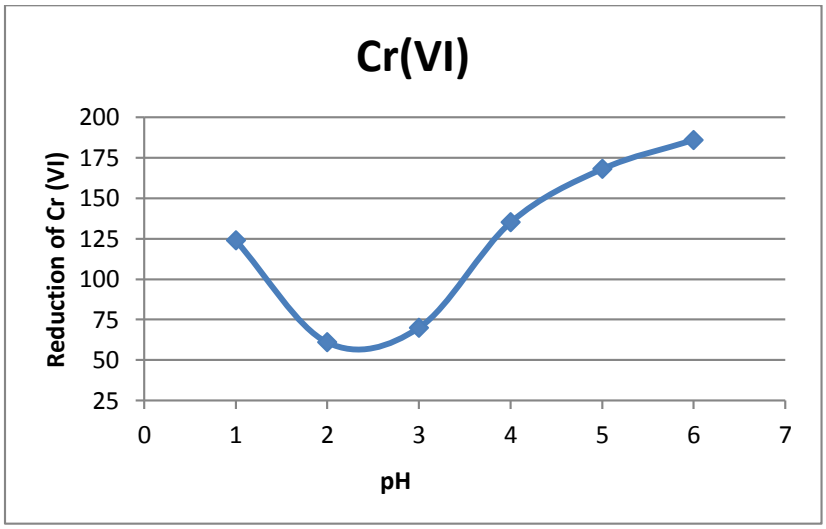

Figure 3.6 Effect of pH on reduction of chromium ion by Banyan Sawdust adsorbent.

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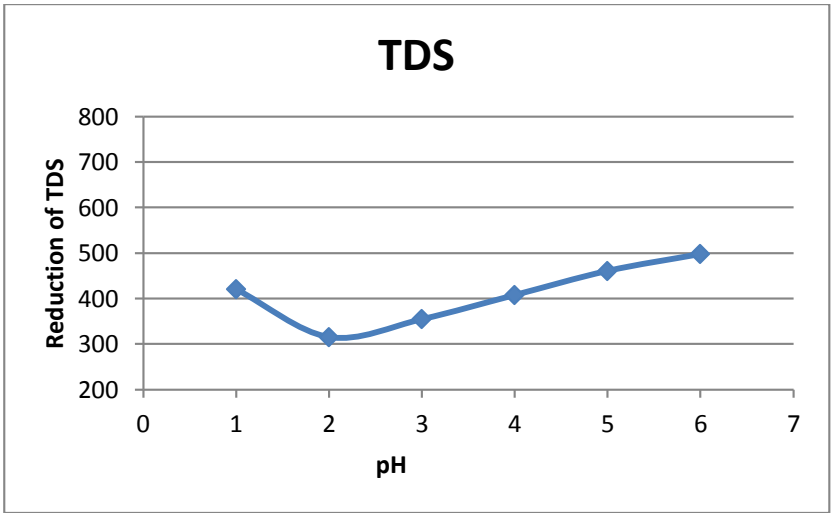

Figure 3.7 Effect of pH on reduction of TDS by Banyan Sawdust adsorbent.

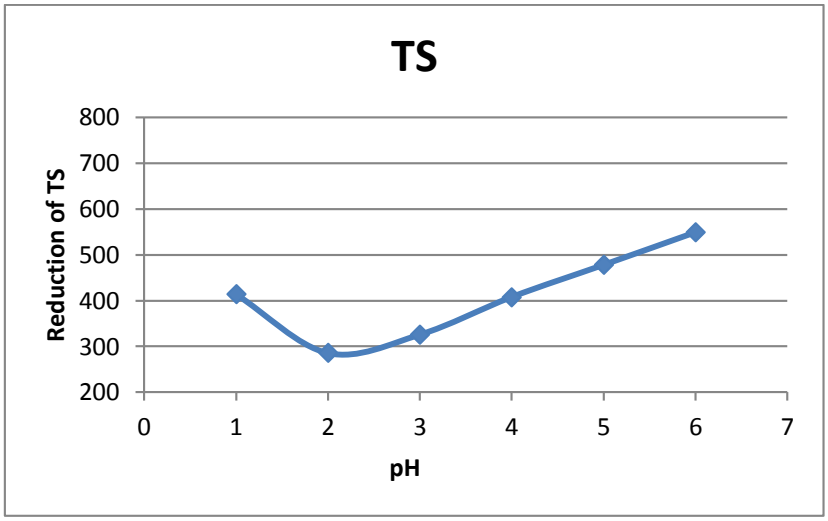

Figure 3.8 Effect of pH on TS by Banyan Sawdust adsorbent.

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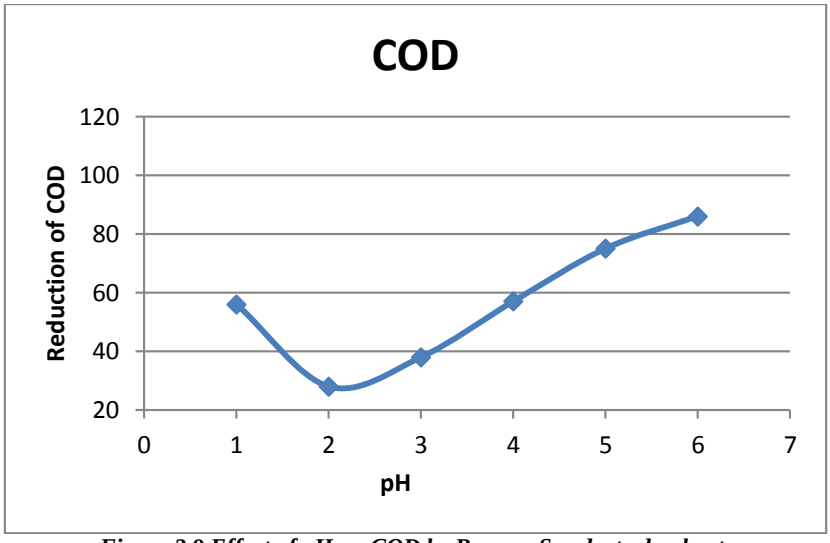

Figure 3.9 Effect of pH on COD by Banyan Sawdust adsorbent.

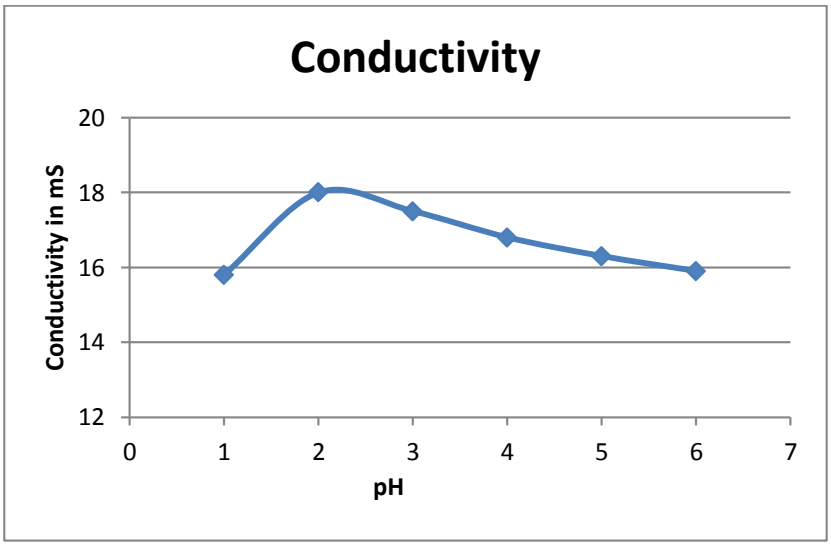

Figure 3.10 Effect of pH on Conductivity by Banyan Sawdust adsorbent.

Effect of adsorbent dosage:

The effect of adsorbent dose on initial concentration of Cr(VI), TDS, TS, COD and conductivity 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. Maximum removal of pollutants by Banyan Sawdust adsorbent (0.6 gram adsorbent dose, pH 2, 90 minute contact time) was reduced from 500mg/l to 70mg/l at optimum contact time, adsorbent dose and pH shown in figure 3.11. In figure 3.12, the reduction of TDS from the tannery effluent, the initially level was 1318mg/l but after treating the wastewater with variation of adsorbent doses the reduced was 332mg/l for BS adsorbent. In figure 3.13, the reduction of TS from the tannery effluent, the initially level was 1428mg/l and after treatment of the wastewater with variation adsorbent dosages the reduced from to 291mg/l. In figure 3.14, reduction of COD concentration from 200mg/l to 34mg/l for Banyan Sawdust. The increase level of conductivity from 9.40mS to 18.1mS adsorption for Banyan Sawdust adsorbent is shown in figure 3.15.

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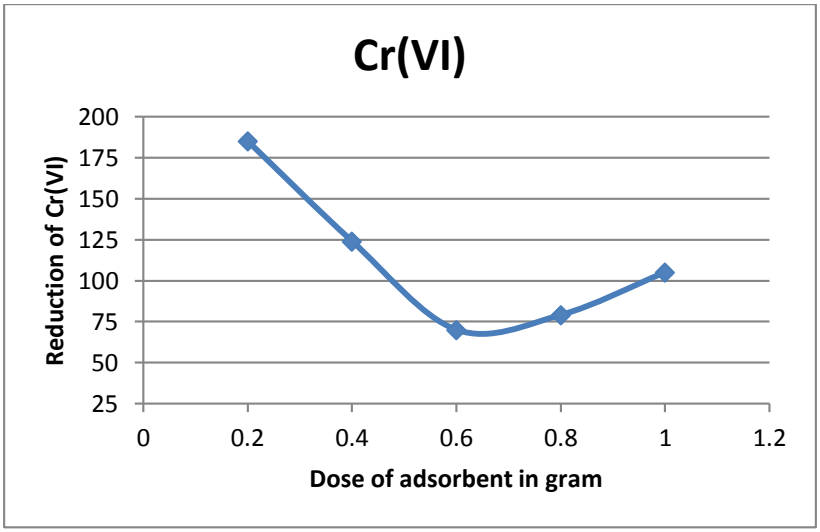

Figure 3.11 Effect of adsorbent dose on Cr (VI) by Banyan Sawdust adsorbent.

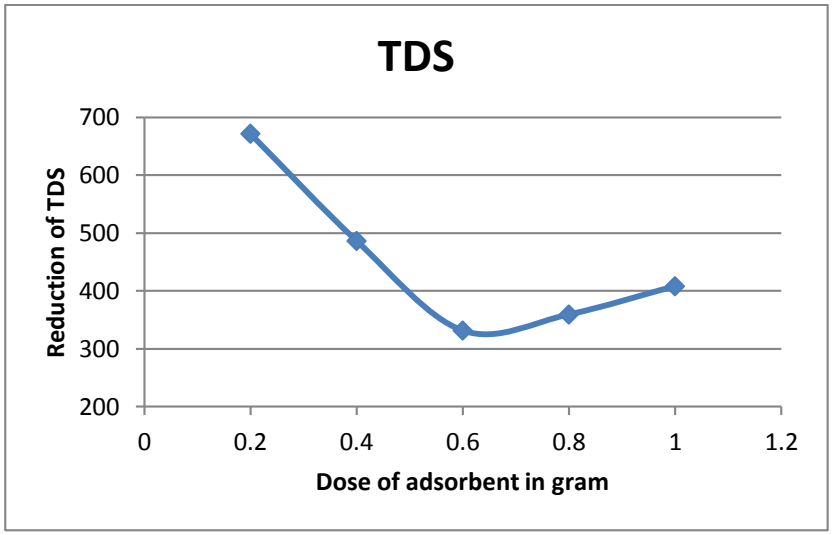

Figure 3.12 Effect of adsorbent dose on TDS by Banyan Sawdust adsorbent.

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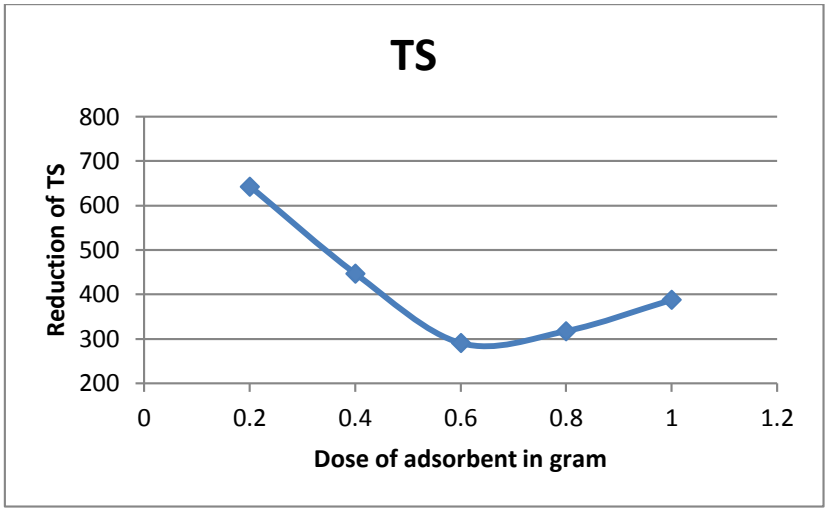

Figure 3.13 Effect of adsorbent dose on TS by Banyan Sawdust adsorbent.

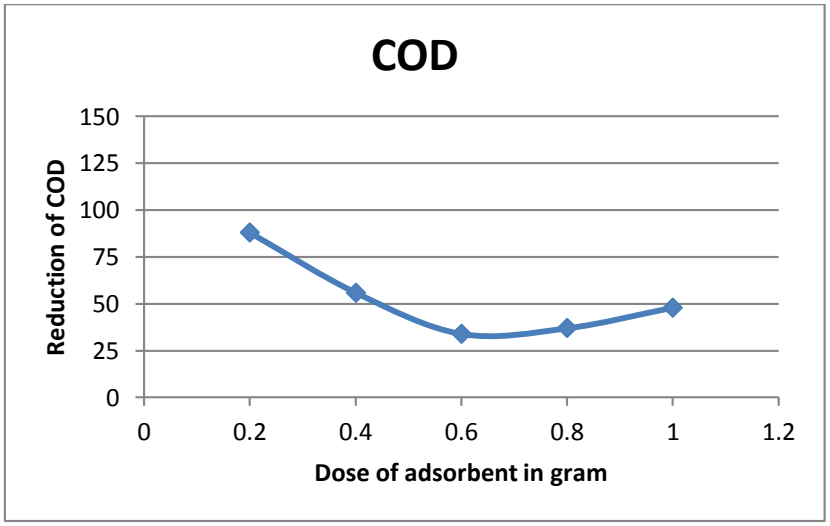

Figure 3.14 Effect of adsorbent dose on COD by Banyan Sawdust adsorbent.

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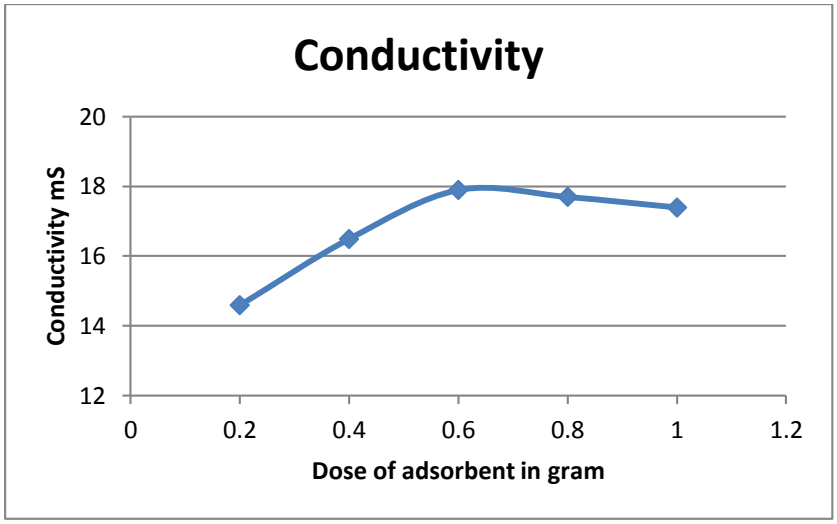

Figure 3.15 Effect of adsorbent dose on the Conductivity by Banyan Sawdust adsorbent.

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 various pollutants of tannery wastewater like hexavalent chromium, COD, TS, TDS and Conductivity were 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.

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 Acis
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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