International Journal of Applied Research 2015; 1(6): 184-187

ISSN Print: 2394-7500
ISSN Online: 2394-5869
IJAR 2015; 1(6): 184-187
www.allresearchjournal.com
Received: 05-04-2015
Accepted: 29-04-2015

Pushpendra Kushwaha
M. Tech. Research Scholar Department of Chemical Engineering, Ujjain Engineering College, Ujjain-456010, (Madhya Pradesh) India.

Kanjan Upadhyay
Associate Professor, Department of Chemical Engineering, Ujjain Engineering College, Ujjain-456010, (Madhya Pradesh) India.

Correspondence:
Pushpendra Kushwaha
M. Tech. Research Scholar Department of Chemical Engineering, Ujjain Engineering College, Ujjain-456010, (Madhya Pradesh) India.

Removal of pollution load from tannery effluent by Using Amla Sawdust *(Emblica Officinalis)* as an adsorbent

Pushpendra Kushwaha, Kanjan Upadhyay

Abstract
The surface water has been largely contaminated due to the growth of tannery industries in India. One of the most toxic chemical which is dissolving into surface water is hexavalent Chromium. This research deals with the reduction of Chromium and other pollutants like Chemical Oxygenn 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 129mg/l, COD was removed 42mg/l, TS reduction was found to be at level of 315mg/l, TDS removed was at level of 303mg/l and Conductivity increased was 9.40mS to 18.2mS. Thus it has been proved that the Amla Sawdust can be used as an adsorbent for the adsorption of various pollutants from tannery effluent**.**

Keywords: Adsorption, Chromium (VI), COD, TDS, TS, Tannery Effluent, Amla Sawdust.

1. Introduction
Tanning is the reaction of the collagen fibres in the hides with tannins, chromium, alum or other chemical agents. During the tanning process, approx 300 kg chemicals are added per ton of hides. 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 liters of effluent is generated and the total quantity of effluent discharged by Indian industries is approximately 45000-50,000 m^3/day. Tannery industry plays an important role with respect to environmental pollution due to disposal of large volume of solutions of tanning baths. The discharge of chromium rich tannery effluent is a serious threat for environment with high concentrations of organic and inorganic component that they create risk to human health and environmental aspects (Cetin *et al*, 2013) [2]. Tannery industry is one of the important industries in India, which earns large foreign exchange through the leather export. Tannery is the one of the oldest and fastest growing industry in India. Chromium salts used during the tanning process generate two forms of chrome; hexavalent chromium and trivalent chromium and the hexavalent form is 500 times more toxic than the trivalent (Xavier *et al*, 2013) [5].
Tannery industry is one of the important industries in India, which earns large foreign exchange through the leather export. Over half of India's leather manufacturing units are built around Ganga river basin. West Bengal alone 600 tanneries are functioning employing and 20,000 units manufacturing leather products providing employment to more than 200,000 people. Kanpur, which is otherwise known as the "Leather City of the World" has over 1600 functional leather manufacturing units producing semi-finished, finished and value-added products (Mullick, 2012). 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) [3]. The toxic compounds discharged into air, water and soil get into food chain. When toxic substances accumulate in the environment and in food chains, they can greatly disrupt biological processes (Mohanta *et al*., 2010) [4].

2. Methods and Materials

2.1 Adsorbent preparation

Amla sawdust: Amla 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. Amla sawdust was treated with Sulfuric acid (H_2SO_4). For this 5 ml of H_2SO_4 was added to 100 ml of deionized water and then 10 grams of amla sawdust was added and the final mixture was stirred and treated at 32 ^oC for 24 hours till the mixture became thick slurry. The slurry (Treated amla sawdust) was washed with deionized water until the pH of filtrate was more than 5. Finally, the sawdust was dried and then stored in plastic bags at room temperature.

2.2 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 (mg/l)	500
02	Total Dissolved Solid (mg/l)	1318
03	Total Solid (mg/l)	1428
04	Chemical Oxygen Demand (COD) (mg/l)	200
05	Conductivity (mS)	9.40
06	PH	3-5.6

2.3 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-VIS 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. 0.8 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 ^0C) 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.

3. Results and Discussion

3.1 Effect of contact time: The time required to reach equilibrium for all pollutants adsorption by Amla Sawdust (AS) is 90 minutes at pH 2. The adsorption of chromium ions was dependent on pH of wastewater and increased with decrease in pH of Cr (VI). 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 Amla Sawdust (at pH 2, 0.8g/100 ml of adsorbent). In figure 3.1, the reduction of chromium from 500 mg/l to 135mg/l for Amla Sawdust. In figure 3.2, the reduction of TDS from the tannery effluent, the initially TDS level was 1318 mg/l but after treating the wastewater with contact time variation the reduced TDS was 315mg/l. In figure 3.3, the reduction of TS from the tannery effluent, the initially TS level was 1428mg/l and after treatment of the wastewater with contact time variation the reduced TS was 315mg/l. The shown in figure 3.4, the reduction of COD level from 200mg/l to 42mg/l. The increase level of conductivity from 9.40mS to 18.2mS adsorption is shown in figure 3.5.

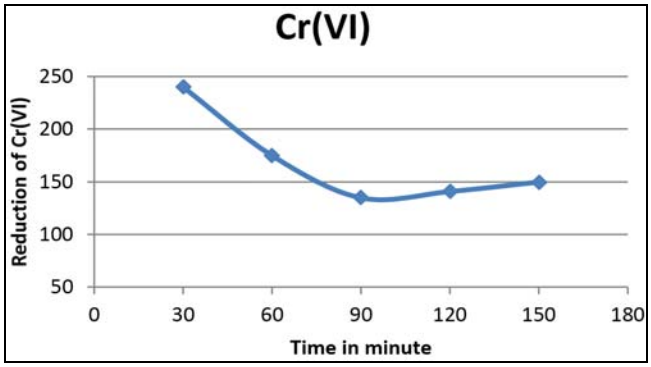

Fig 3.1: Effect of contact time on reduction of Cr(VI) by Amla Sawdust adsorbent.

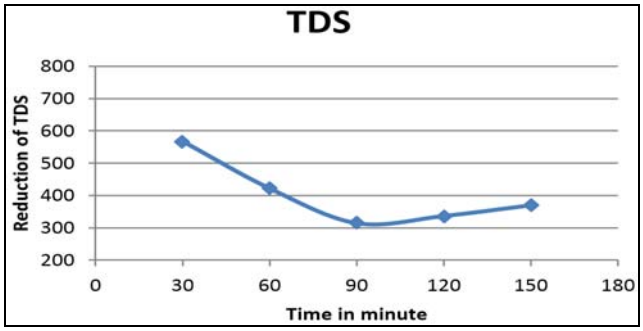

Fig 3.2: Effect of contact time on reduction of TDS by Amla Sawdust adsorbent.

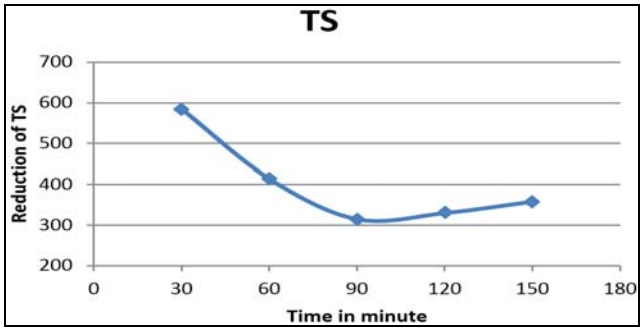

Fig 3.3: Effect of contact time on reduction of TS by Amla Sawdust adsorbent.

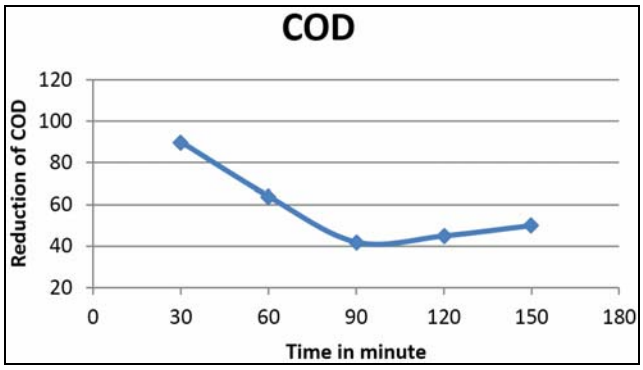

Fig 3.4: Effect of contact time on reduction of COD by Amla Sawdust adsorbent.

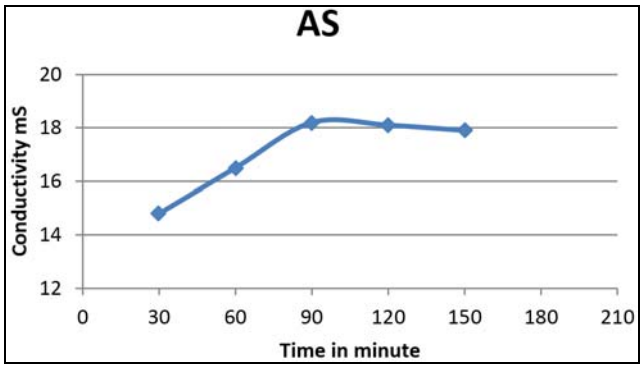

Fig 3.5: Effect of contact time on conductivity by Amla Sawdust adsorbent.

3.2 Effect of pH: The effect of pH on initial concentration of Cr (VI), TDS, TS, COD and conductivity by Amla 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 Amla Sawdust (at 90 minute contact time, 0.8g/100ml of adsorbent). In figure 3.6, the reduction of chromium from 500 mg/l to 129mg/l for Amla 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 303mg/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 328mg/l. The shown in figure 3.9, reduction of COD concentration from 200mg/l to 44mg/l. The increase level of conductivity from 9.40mS to 18.2mS adsorption is shown in figure 3.10.

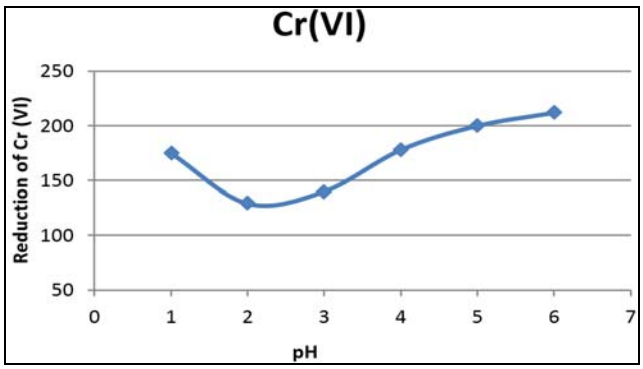

Fig 3.6: Effect of pH on reduction of chromium ion by AS adsorbent.

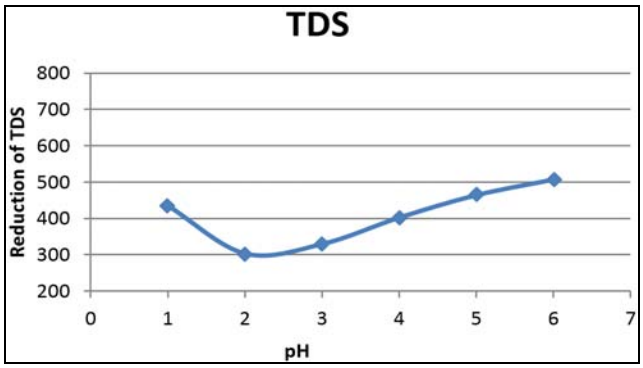

Fig 3.7: Effect of pH on reduction of TDS by AS adsorbent.

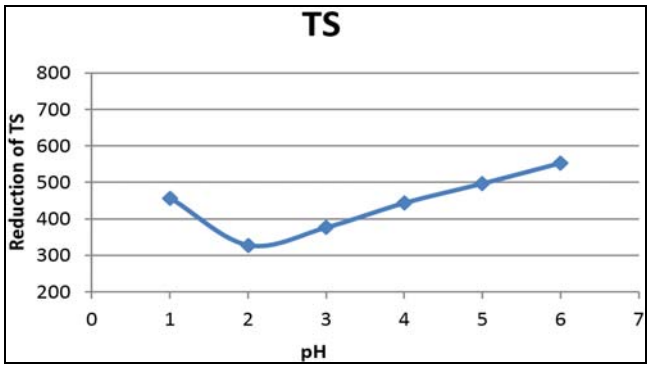

Fig 3.8: Effect of pH on TS by Amla Sawdust adsorbent.

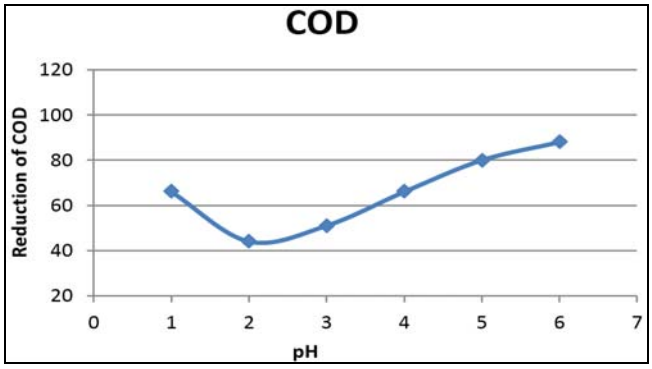

Fig 3.9: Effect of pH on COD by Amla Sawdust adsorbent.

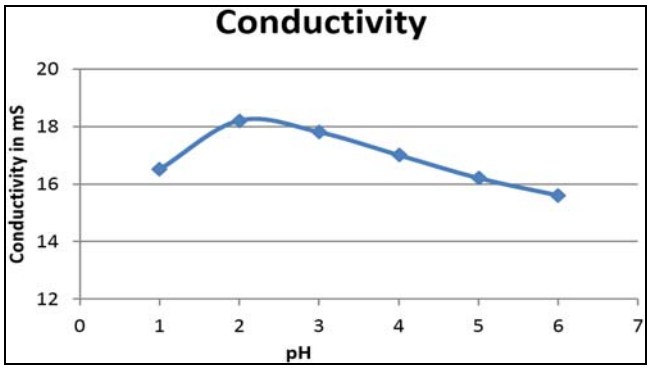

Fig 3.10: Effect of pH on Conductivity by Amla Sawdust adsorbent.

3.3 Effect of adsorbent dosage: The effect of adsorbent dose on initial concentration of Cr (VI), TDS, TS, COD and conductivity by Amla Sawdust (AS) 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 Cr(VI) by Amla Sawdust adsorbent (0.8 gram adsorbent dose, pH 2, 90 minute contact time) was reduced from 500mg/l to 139mg/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 316mg/l for AS 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 342mg/l. The shown in figure 3.14, reduction of COD concentration from 200mg/l to 46mg/l for Amla Sawdust. The increase level of conductivity from 9.40mS to 18.1mS adsorption for AS adsorbent is shown in figure 3.15.

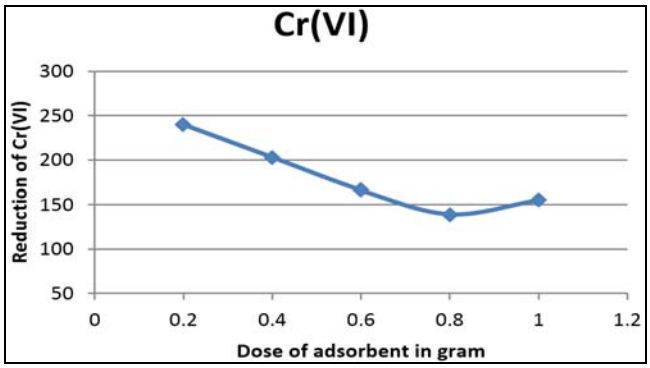

Fig 3.11: Effect of amount of adsorbent dose on Cr (VI) by Amla Sawdust adsorbent.

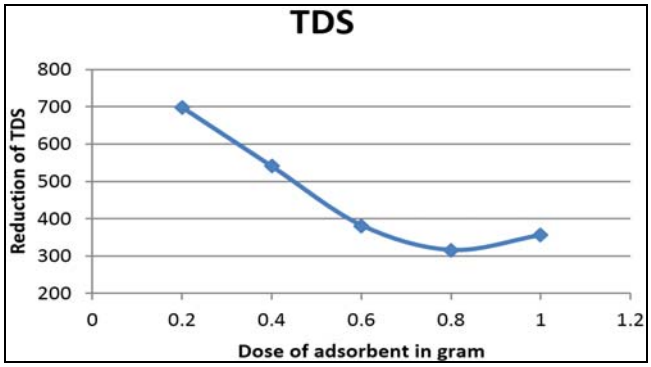

Fig 3.12: Effect of amount of adsorbent dose on TDS by Amla Sawdust adsorbent.

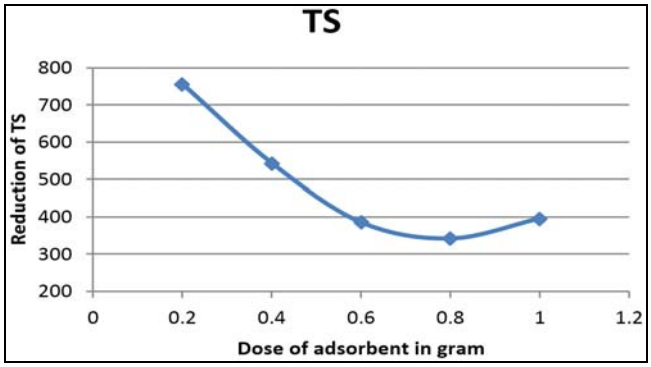

Fig 3.13: Effect of amount of adsorbent dose on TS by AS adsorbent.

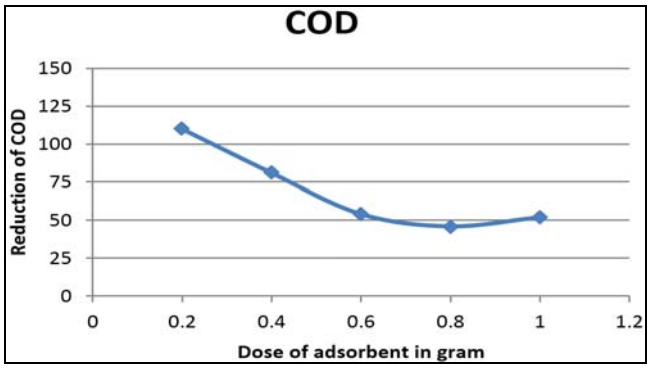

Fig 3.14: Effect of amount of adsorbent dose on COD by AS adsorbent.

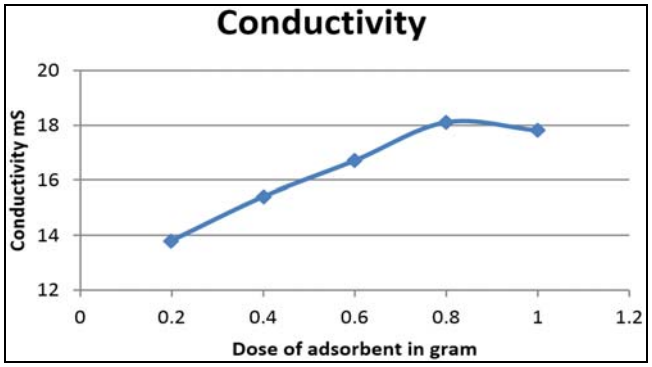

Fig 3.15: Effect of amount of adsorbent dose on the Conductivity by AS adsorbent.

4. Conclusion

Through this study it was obtained that Amla 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, Amla Sawdust can be used effectively as an adsorbent for pre-treatment for tannery effluent.

5. References

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