Treatment of Tannery Effluents Using Mixed Adsorbents

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Abstract*-The study for removal of organic pollutants from tannery effluents was carried out in batch process using activated coconut shell mixed with laterite. The parameters included contact time, adsorbent dosage and pH. The optimum dosage for the study obtained was 100g/L, with optimum contact time of 60 min. The optimum dosage and time had greater impact on removal of pollutants like COD (86.41%), Turbidity (92.3%), TDS (95.89%) and TC (93.8%). Study on variation in pH was also carried out, where the pH from 2 to 8 was studied, in which at acidic pH i.e. at pH 2, the amount of removal of pollutants was higher i.e. it exhibited 87.92% COD, 97% removal of Turbidity, 95% removal of TDS and 93.3% of TC. As the pH decreased, the removal efficiency increased and decreased gradually by increasing the pH.*

Keywords-Adsorption, Mixed adsorbents, Laterite, Cr+6

I. INTRODUCTION

Tanning is one of the oldest industries in the world; during ancient times it was used to meet the demand of people for the leather and its goods. At an average of 5.5 million tons of raw hides are processed around the globe from different animals. The skin of large animals such as bison, cows etc are referred as hides and those of smaller animals are said to be skin. This processing of hides and skins results in disposal of heavy sludge, with higher concentrations of organic and other ingredients are responsible for high BOD (biological oxygen demand) and COD (chemical oxygen demand) values and represent an immense pollution load. Most of the tanneries in India adopt the chromium tanning process because of its processing speed, better quality of 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, in the form of Cr (VI). Several treatment methods have been developed for the treatment of tannery effluents and chromium, which majorly include chemical precipitation, ion exchange, ultra filtration, membrane separation, electro coagulation, solvent extraction, reverse osmosis etc [3]. This process requires much economy and requires high skilled labors for its operation and maintenance. To avoid such contingencies and economical problems, an alternative method is employed for the treatment of tannery effluents. Adsorption using activated carbons can be employed for the treatment of effluents. These activated carbons are prepared from the agricultural bi products like saw dust [4], coconut shell [5], rice husk [6], corn cobs [7] and even from industrial waste products like fly ash, sludge etc. This method involves less cost of preparation and does not require much skilled labors to operate and maintain it. Coconut shell is agricultural based waste material and the material has the potential to remove organic pollutants from solutions. Abundant availability, high biosorption capacity, cost-effectiveness and renewability are the important factors making this material as economical alternative for water treatment and waste remediation. The activated carbon prepared from coconut shell is highly porous, amorphous solid consisting of microcrystallites with a graphite lattice, it is non-polar and cheap [3]. Keeping this in view, in the present study the potential of agro-waste-Activated coconut shell mixed with laterite was investigated for removal of organic pollutants from tannery effluents.

II. MATERIALS AND METHODS

A. *Effluent collection and analysis*

The effluent was collected by outlet of nearby tannery industry and was stored at 4^0c; in order prevent any changes in its physiochemical parameters. Later the parameters like pH, TDS, COD, Turbidity and Total Carbon (TC) was analyzed as per standard methods.

B. *Preparation of mixed adsorbent*

Coconut shell and laterite was used as mixed adsorbent in the study. The coconut shells were collected from nearby areas and firstly was washed and kept for drying, later they were crushed and made into fine pieces and was activated using H_2SO_4. Laterite was collected from quarry and was grinded into small pieces and sieved through 1mm sieve. Both the adsorbents were sieved and were mixed in same proportion (1:1) ratio [8].

C. *Procedure for preparation of activated carbon*

Preparation of activated carbon mainly contains two phases i.e. carbonization and activation. The carbonization step includes drying and then heating to separate byproducts the carbonized material is then activated by treating them with acids. This can be easily explained by following figure.

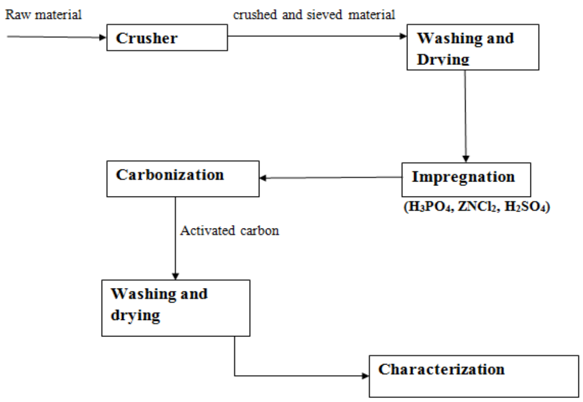

Fig.1. Procedure for preparation of activated carbon

1. Crusher: The sample was firstly cut into small pieces or crushed and is sieved to a pore size of 0.25mm.
2. Washing and drying: The sieved sample was then washed several times with tap water and then with distilled water to remove adhered dust and was dried in oven at 110^0 C for 24hrs to remove hydrocarbon and then taken off the oven and was cooled at room temperature.
3. Impregnation: the cooled sample was chemically treated homogenously. For activation, 100gms of sample was thoroughly mixed with 100ml of activating agents (H_3PO_4, $ZnCl_2$, H_2SO_4) in ratio 4:1.5.
4. Carbonization: The solution was taken into beaker and was placed in the oven at 110^0C in oven for 24hrs. Sample was soaked in distilled water and was subsequently replaced until the pH of solution became stable.
5. Washing and drying: The sample was then washed with2% HCl (v/v) or $NaHCO_3$ (w/v), and then with distilledwater to remove any activating agent. It was then dried at110ºC. The dried samples will be transferred to the mufflefurnace at 650ºC for 6h and the activated carbon was prepared for characterization of the effluents.

D. Batch adsorption process

The experiment was carried using 100ml of diluted wastewater. The sample was diluted for 10 times, so as to carry the process, as it was unfit to conduct tests on raw effluent in lab scale because of its high level of polluting parameters present in it. The dosage of activated carbons was set in the range from 2 to 14g and was added to flasks and was transferred to the orbital shaker for a predetermined interval of time. After the expiry of given time, the flaks were removed from the shaker and was followed by filtration using Watmann filter paper #44. Filtrate was then examined for the COD, color, turbidity and total dissolved solids. The difference in wastewater and filtrate, gives the % removal of COD, BOD, color, turbidity and total dissolved solids. Effects of different factors like solution pH, amount of activated carbon, and shaking time (contact time) were also studied. The effect of contact time was investigated by changing contact time during batch process from 15-60 min, and keeping all the other parameters fixed. Similarly effect of pH and amount of activated carbon was examined by changing one parameter at a time and keeping others constant.

III. RESULTS AND DISCUSSIONS

The effluent was characterized in its pH, COD, TDS, Total solids, Total carbon (TC) and Turbidity using Standard Methods [4]. The characteristics are presented in table 1.

TABLE 1. CHARACTERISTICS OF EFFLUENT

Sl No	Parameters	Values
1	pH	2.7
2	Turbidity	1073 NTU
3	Total solids	2168 mg/L
4	COD	53000 mg/L
5	Total Dissolved Solids	7360 ppm
6	Total Carbon	4877 mg/L
7	Chloride	2460 mg/L

The effects of various operating parameters are discussed below.

A. Effect of Contact time

The optimum contact time was found by determining the efficiency of pollutant removal from the effluent. The efficiency of adsorption increased with increase in contact time from 15 to 60 min in the rotary shaker. The results obtained from Activated Coconut shell and Laterite showed that the mixing time had greater impact on COD reduction. COD reduced from its initial value of 5300mg/L to 720 mg/L, Turbidity reduced from 102.3 NTU to 7.6 NTU, TDS reduced from 736 ppm to 30ppm and total carbon (TC) reduced from 487.7 mg/L to 45.67 mg/L. the following figures from 2 to 5 depict the removal organic pollutants.

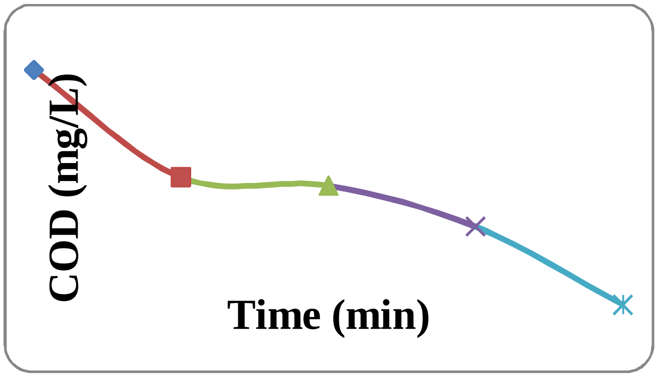

Fig.2. Effect of contact time on COD reduction

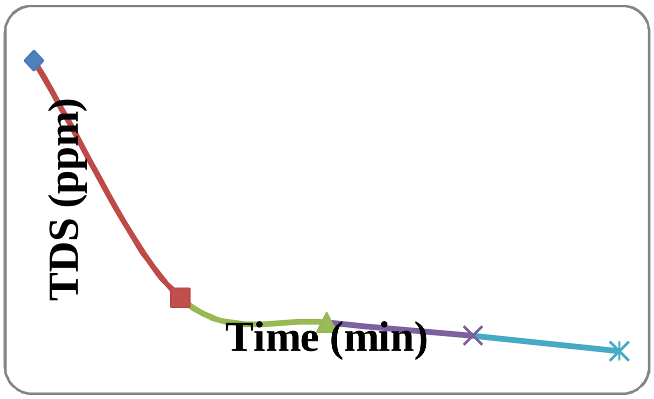

Fig.3. Effect of contact time on TDS reduction

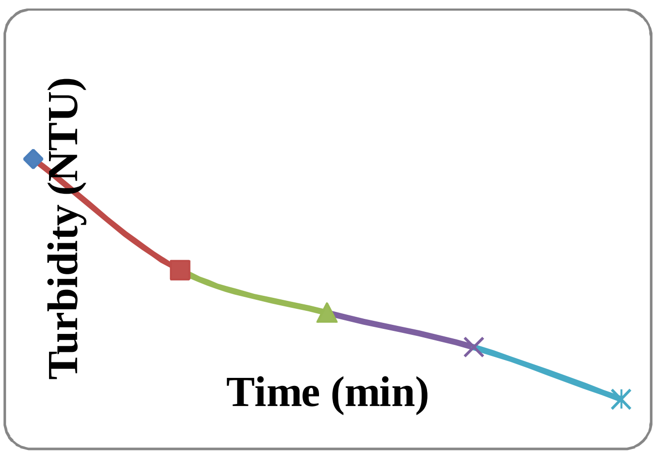

Fig.4. Effect of contact time on Turbidity reduction

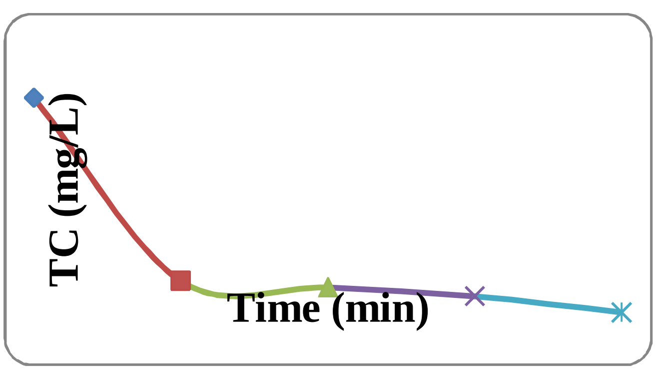

Fig.5. Effect of contact time on TC reduction

B. Effect of adsorbent dosage

Increase in quantity of activated carbon increases the percentage removal of pollutants from the effluent, this is due to more surface area availability and more surface functional groups. As the adsorbent dosage increases, the adsorption also increases. This is due to fact that an increase in adsorbent dosage increases the number of active sites available for adsorption [3]. The optimum dosage for the adsorption process was 10 gm, where the dosage was given in order of 2,4,6,8, 10, 12 & 14gm. After the dosage of 10 gms, the pollutant removal was stationary at 12 and 14gms, so the optimum dosage taken was 10 gm. From fig 6 to 9, it shows the amount of reduction in the organic pollutants. COD reduced from its initial value of 5300mg/L to 720 mg/L, Turbidity reduced from 102.3 NTU to 7.6 NTU, TDS reduced from 736 ppm to 30ppm and total carbon (TC) reduced from 487.7 mg/L to 45.67 mg/L.

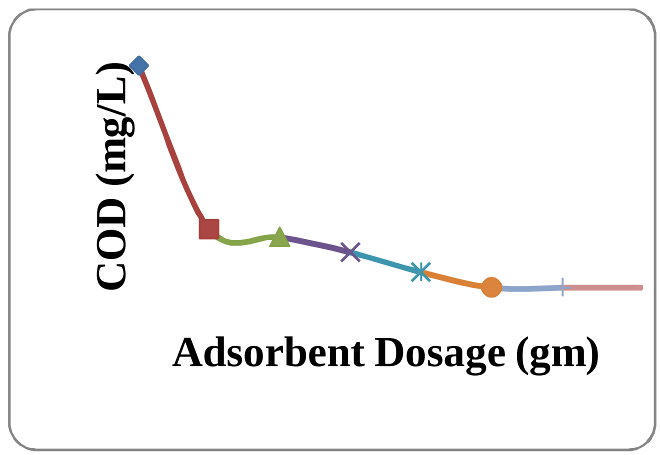

Fig.6. Effect of adsorbent dosage on COD reduction

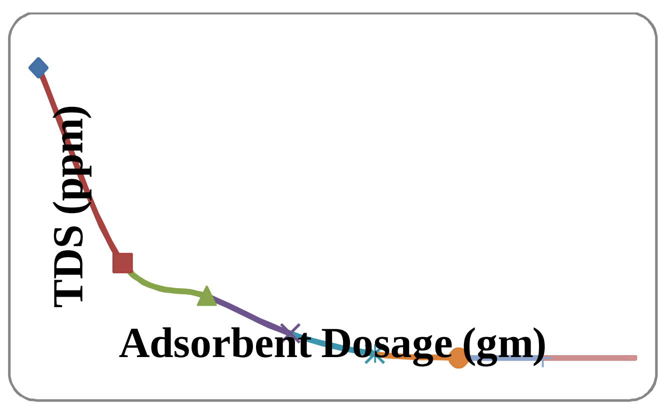

Fig.7. Effect of adsorbent dosage on TDS reduction

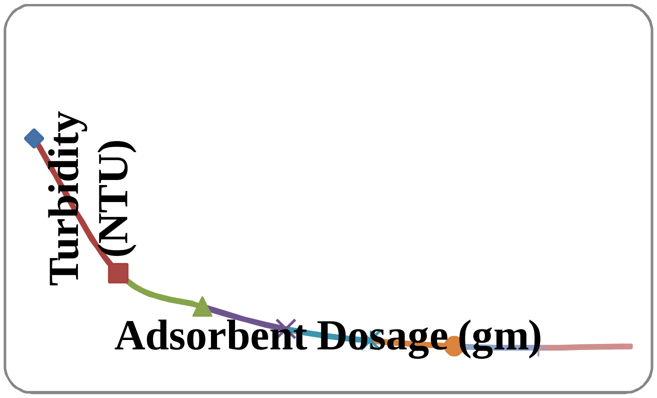

Fig.8. Effect of adsorbent dosage on Turbidity reduction

Fig.9. Effect of adsorbent dosage on TC reduction

C. Effect of pH

pH is an important parameter for adsorption of metal ions from aqueous solution because it affects the solubility of the metal ions, concentration of the counter ions on the functional groups of the adsorbent and the degree of ionization of the adsorbate [9]. The better reduction is due to higher concentration of H^+ ions at acidic state, which combine –ve charged ions and combines with them and attracts OH^- ions and stop causing hindrance, which provides better surface area for adsorption. So it is concluded that as pH reduces, the efficiency of removal of pollutants increases.

Keeping both dosage and time constant, (10 gm and 60 min) the pH was varied i.e. 2, 4, 8 and 10, at pH 2, there is a higher removal of COD, TDS, Color, Turbidity and TC from the effluent. As pH increased, the percentage of removal decreased. COD reduced from 5300 mg/L to 640 mg/L, Turbidity reduced from 102.3 NTU to 4.3 NTU, TDS reduced from 736 ppm to 21 ppm and total carbon reduced from 487.7 mg/L to 32.33 mg/L.

Fig 10 to 13 depict the amount of reduction of the pollutants.

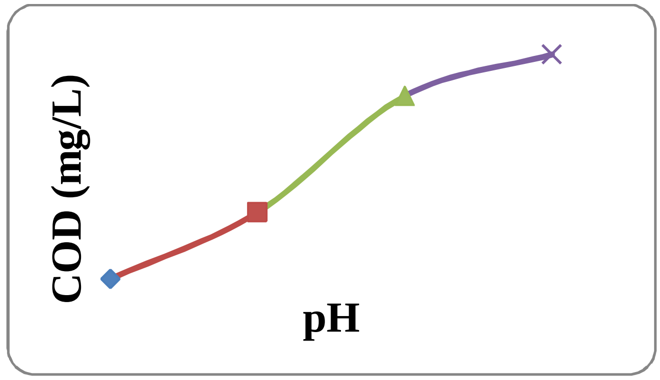

Fig.10. Effect of pH on COD reduction

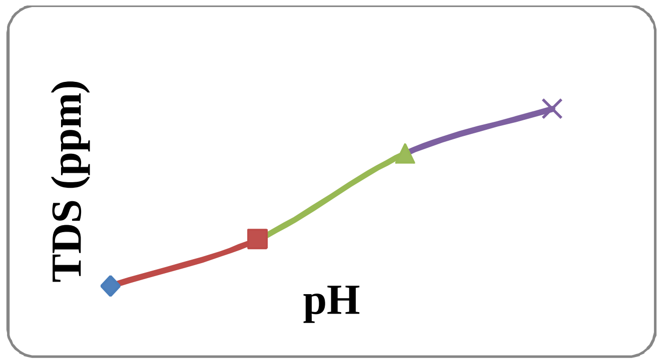

Fig.11. Effect of pH on TDS reduction

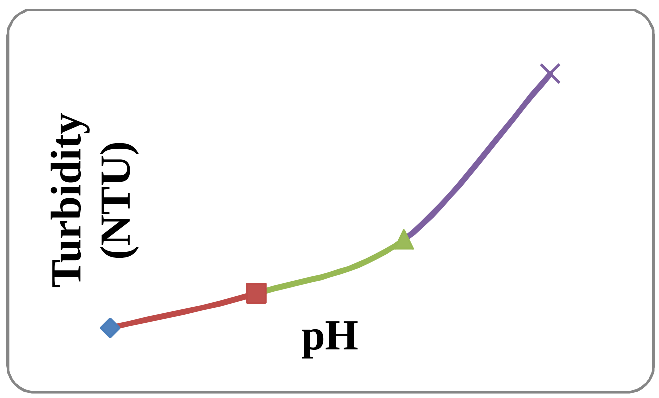

Fig.12. Effect of pH on Turbidity reduction

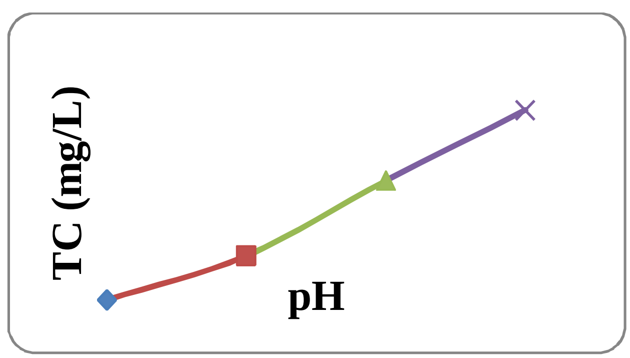

Fig.13. Effect of pH on TC reduction

IV. CONCLUSIONS

The present study deals with the use of mixed adsorbents prepared from coconut shell and laterite. This mixed adsorbent appears to be suitable method for removal of organic pollutants from the tannery effluent.

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