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Adsorption of pollution load from tannery effluent by using Neem Sawdust as an adsorbent

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Abstract

Adsorption of chromium ions from tannery effluent was studied by using Neem Sawdust with several parameters including contact time, pH of solution and adsorbent dosages. Neem Sawdust (NS) was the effective for removal efficiency reached 84% at contact time 120 minute and pH 2. The results investigated that chromium loaded Neem Sawdust (NS) biomass can be disposed off by incineration or used in furnace as a fuel. The results investigated that Neem Sawdust can be used as a good adsorbent for the removal of Cr(VI). Thus, the adsorbents prepared from Neem Sawdust (NS) could be used for removal of chromium ions from tannery effluent.

Keywords: Adsorption, Chromium (VI), Tannery Effluent, Neem Sawdust.

1. Introduction

Tanning is the chemical process that converts animal hides and skin into leather and related products. More than one hundred different chemicals nearly (3,50,000 tonnes/year of inorganic and heavy metal salts, soaps, oils, waxes, solvents, dyes, etc.) used in tanning processes are found in process wastes and wastewaters [2]. Chromium (III) salts and sulphur compound are main pollutants released in tannery wastewaters and in the atmosphere. The transformation of hides into leather is usually done by means of tanning agents and the process generates highly turbid, colored and foul smell 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 liters of effluent is generated and the total quantity of effluent discharged by Indian industries is approximately 45000-50,000 m³/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 [1]. 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 [7].

However, 90% of tanneries in the world are using chromium salts to produce leather given that it provides better leather flexibility, water resistance and prevents putrefaction, properties that are all important for good leather quality [3]. The World Health Organization (WHO) recommends a maximum acceptable concentration of Cr (VI) as 2.0 mg/L in wastewater which discharging outside. It has been reported that excessive intake of chromium by human leads to hepatic and renal damage, capillary damage, gastrointestinal irritation and central nervous system irritation [6]. The release of untreated tannery effluent to affects the natural water bodies' flora and fauna of the ecosystem and increases the effect of human health and environment [4].

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 [5].

2. Methods and Materials

2.1 Adsorbent preparation

Neem 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. Neem sawdust was treated with Hydrochloric acid (HCl). For this 10 ml of HCl was added to 100 ml of deionized water and then 10 grams of neem sawdust was added and the final mixture was stirred and treated at 32 °C for 24 hours till the mixture became thick slurry. The slurry (Treated neem 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. Now it was ready to use as an adsorbent.

2.2 Stock solution of chromium

The stock solutions chromium ions were prepared from AR 1.4145 gram of Potassium Dichromate (K₂Cr₂O₇) 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

2.3 Batch mode adsorption studies

The adsorption of Chromium ions on adsorbent were studied by batch process. The general method used for this study is described as below:

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 °C) in an 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.

The results of these studies were used to obtain the conditions for maximum Cr(VI) removal from aqueous solution. The percent Cr(VI) removal was calculated using Eq.

$$\text{Metal ion removal (\%)} = [(C_o - C_e) / C_o] \times 100 \dots\dots\dots (1)$$

Where, C_o: initial concentration of test solution, mg/l;
 C_e: final equilibrium concentration of test solution mg/l.

3. Result and Discussions

3.1 Effect of contact time on adsorption of Cr (VI): The result obtained through this studied was very effective on

tannery wastewater and they are represented in below figure 3.1. The effect of contact time on adsorption of Cr (VI) was investigated at contact time variation 30 to 150 minutes. It was observed that increase in percentage removal of Cr (VI) with increase of contact time for neem sawdust adsorbent. The maximum Cr (VI) removal efficiency was 84% at 120 minute and minimum removal efficiency was 58% 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 120 minutes and then gradually decrease at 150 minutes.

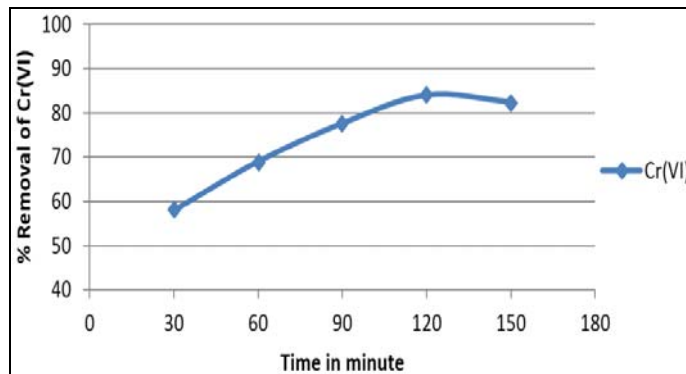


Fig 3.1: Effect of contact time on the removal percentage of Cr(VI) by Neem sawdust adsorbents.

3.2 Effect of pH on adsorption of Cr (VI): The effect of pH on the adsorption of chromium by neem sawdust was investigated at pH values of 1 to 6. Different pH conditions were maintained by adding HCl and sodium acetate buffer. The maximum removal of Cr(VI) was observed at pH 2 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 62.8% at pH 6.0 to 83% at pH 2.0. The maximum adsorption was observed at pH 2.0.

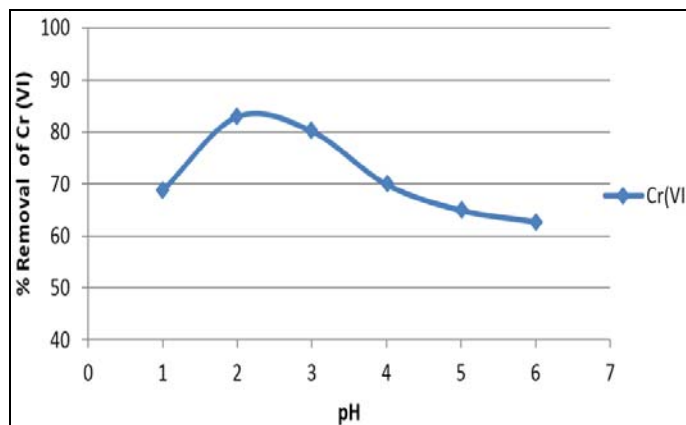


Fig 3.2: Effect of pH on the removal percentage of Cr (VI) by Neem Sawdust adsorbents.

3.3 Effect of adsorbent dosage on adsorption of Cr (VI): The effect of neem sawdust adsorbent dosage is presented in figure 3.3. It was obtained that adsorption increases with the increases in the biomass of adsorbent. The maximum Cr(VI) removal efficiency was 82.2% at the dosage of 6 g/L and minimum removal percent of Cr(VI) 59% 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.

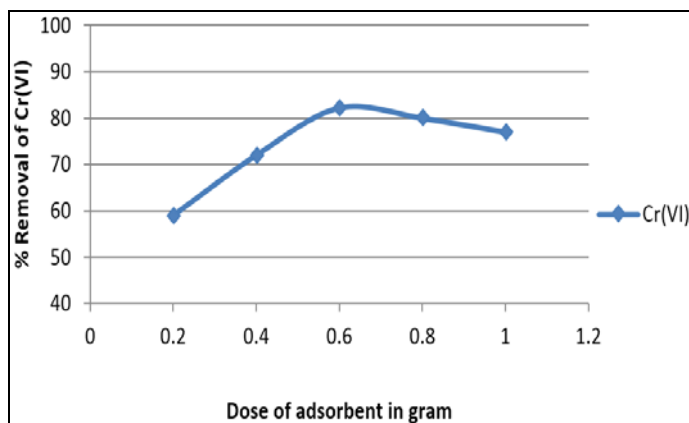


Fig 3.3: Effect of adsorbent dose on removal percentage of Cr (VI) by NS adsorbents.

4. Conclusion

Removal of toxic hexavalent form of chromium from solutions was possible using selected adsorbents. Through this study it was found that Neem Sawdust (NS) can be used as an adsorbent for preliminary treatment of tannery effluent. It was observed that the suitability of the adsorbents used for removal of Cr (VI) from aqueous solution. Dried Neem Sawdust- an bio waste was found to be the most effective one, for which the removal efficiency reached to 84% of Cr(VI) at room temperature, at adsorbent dose of 0.6 gm and contact time 120 minute. The optimum pH for the removal was found to be at 2. So, cactus powder can be used effectively as an adsorbent for pre-treatment for tannery wastewater.

5. References

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