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Research Article

Adsorption studies on tannery wastewater using rice husk

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Abstract: Due to the industrial growth in developing countries like India, the ground water system has been largely polluted, especially heavy metals like chromium which causes severe health problems to human. The removal of such heavy metals from industrial effluents especially from tannery industry has become a subject of keen interest. This paper deals with the removal of chromium and other pollutants like COD, iron and sulphate from the tannery wastewater by using a rice husk as an adsorbent. From the experimental results, it was found that chromium concentration in wastewater was reduced to the level of 0.67 mg/l, COD was removed upto 68%, sulphate removal was found to be at the level of 67 %, BOD was reduced to the level of 73% and iron reduction was at the level of 81%, Thusit has been proven that the chromium from the wastewater has been removed upto the level of satisfaction and other pollutants like COD, BOD, iron and sulphate were also reduced to the satisfactory level. And also it was found that adsorption using rice husk was cheaper, quicker and more efficient than any other primary treatment of tannery wastewater.
Keywords: chromium, pollutants, wastewater

INTRODUCTION

Heavy metal contamination of industrial effluents is one of the significant environmental problems due to their toxic nature and accumulation throughout the food chain as non-biodegradable pollutants[1]. Tannery is the one of the oldest and fastest growing industry in India. 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 [2]. Heavy metals like mercury, lead, cadmium, copper, chromium and nickel are extremely toxic even at minute quantities [3]. Chromium is more abundant in earth's crust and is widely used in electroplating, leather tanning, metal finishing & chromate preparation. It exists in two stable oxidation states Cr (III) & Cr (VI). Cr (VI) is of particular concern as because of its high toxicity, it may cause many adverse effects on human health such as epigastric pain, hemorrhage, severe diarrhea, vomiting, nausea, dermatitis by skin contact, ulcer, lung cancer and tissue necrosis. Thus it becomes essential to remove Cr (VI) from industrial waste water before discharging it into water body or on to land [4].

Conservative technologies for metal control have an increasing interest, as they able to remove pollutants and reuse valuable by-products resulting from the wastes and or side streams from manufacturing processes. Removal of metals from wastewater is achieved principally by the application of several processes such as adsorption[5], sedimentation[6], electrochemical processes [7-8], ion exchange [9], biological operations[10], cementation [11], coagulation/flocculation[12], filtration and membrane processes[13], chemical precipitation and solvent extraction[14]. The search for alternate and innovative treatment techniques has focused attention on the use of biological materials for heavy metals removal & has gained important credibility during recent years because of the good performance and low cost of these materials [15]. So the efforts are being directed towards the use of natural low cost adsorbents for removal of heavy metals. Use of natural materials which are available in large quantities [16] or certain waste products from industries or agriculture may have potential as inexpensive adsorbents. Recently some of these low

cost adsorbent (natural or processed) have been tested as adsorbents for heavy metal removal [2]. Conversion of this waste to a useful adsorbent contributes not only for the treatment of heavy metals contaminated environment but also to minimize the solid wastes. These research activities indicated promising results but further efforts are still required in order to maximize metal removal efficiency and minimize preparation costs.

Nearly 80% of the tanneries in India are engaged in the chrome tanning processes. Most of them discharge untreated wastewater into the environment. In such aqueous waste, Cr (VI) is present as either dichromate ($Cr_2O_7^{2-}$) in acidic environments or as chromate (CrO_4^-) in alkaline environments. Chromium compounds were employed in textile colouring and leather tanning processes. The principal chromium emissions into surface waters are from metal finishing processes such as electroplating, pickling and bright dipping[17].

India is the major the major producers of food items especially rice, Rice is available abundantly in Tamil Nadu, Rice and its by-products are used for several purposes. The major by-product of rice is rice husk. They are used for burning purposes and even its ash is used for several purposes. Due to its abundant availability and low cost rice husk were employed for adsorption studies on tannery wastewater.

Study area

In Tamil Nadu (India) there are large number of leather tannin industries are available. Even discharge of tannery effluents into natural water bodies without proper treatment are prohibited by the government and also enforced by law, some industries removes only colour from the effluent using lime process and discharging it into the water bodies without any treatment process for removal of pollutants from the wastewater. Due to these reasons the natural water bodies which are being used as drinking water source are contaminated. The reason behind discharging the wastewater without treatment is because of the cost of treatment process.

Tannery effluents were collected from a leather tanning industry using a 40 litres can, which is pre-washed using diluted acid for removal of any pathogens present in it. The ssamples were collected using grab sample method. For preserving the wastewater fopr further analysis and study 2N nitric was added at the range of 10 ml/l. Using this sample the experimental investigation was done as batch studies.

The initial characteristics of the tannery wastewater collected is shown in table 1:

Table 1: Initial characteristics

S.No	Parameters	Concentration
1.	pH	7.38
2.	Turbidity	344 NTU
3.	Conductivity	13.24 mS
4.	TDS	9.89 ppt
5.	Absorbance	0.72
6.	Transmittance	18 %
7.	Sulphate	135.19 mg/l
8.	Chromium	3.34 mg/l
9.	Iron	72.92 mg/l
10.	BOD	933.33 mg/l
11.	COD	1400 mg/l

MATERIALS AND METHODS

Adsorbant preparation

Rice husk from nearby rice mill was collected and washed using deionised water. The washed rice husks were sun dried for several hour till it completely loses the moisture content present in it. They were stored in a clean and dry plastic box for further use. The rice husk were weighed accurately using electronic balance.The samples were given with dosage of 2 mg to 10 mg per 250ml of wastewater.

In this study, the analytical grade chemicals from Merck, Rankem and Fisher brands were used for testing various parameters in synthetic tannery wastewaters. The absorbance and transmittance value of synthetic tannery wastewater were found using Elico SL-159 UV-VIS spectrophotometer. The pH value was found using Vanira pH meter and the conductivity was found using Elico conductivity meter. The TDS and turbidity were found using Equiptronics TDS and turbidity meter. The C.O.D in the synthetic tannery wastewater was found using Open reflux method and other parameters like chromium and B.O.D were tested as per APHA standards (Standard method for examination of water and wastewater, 20th edition, 1998).

Experimental setup

The collected samples were taken in clean Erlenmeyer flask for capacity 250 ml. The samples

were maintained at uniform pH (Neutral level) and temperature.The initial parameters of the wastewater were found only after taking it out from container. The studies were conducted in a clean, sterilised conical flask for performing adsorption and were placed in orbital shaker with atmost care for performing better process and obtaining better results. The orbital shaker was operated at the speed of 120 rpm which was optimised before conducting the batch studies Rubber gloves were used to avoid contact of wastewater to skin and cross checked twice before conducting batch studies.

RESULTS AND DISCUSSION

In this study it was found that the adsorption technique is one of the efficient mode of physic-chemical treatment for tannery wastewater. The results obtained through this study was very effective on tannery wastewater and they are represented in the form of graphs below. In figure 1, the pH level of wastewater for different adsorbant dosage is given. Throuughout this study the pH was maintained at same level and it was clear that by giving adsorbant dosages the pH value doesn't vary much. Finally the pH value was brought to a neutral level (pH 7). Figure 2 represents the reduction in turbidity of the wastewater from its initial concentration against varying adsorbant dosages. From the initial concentration of 344 NTU, turbidity was reduced to a level of 147 NTU. In figure 3 the increase in transmittance of the wastewater is shown, initially the wastewater was very turbid and transmittance was found to be at the level of 18%, by the reduction of turbidity from wastewater the transmittance was increased to a level of 72% which shows that the wastewater is decolourised. Figure 4 shows the reduction in absorbance of the wastewater. The major pollutant of the tannery wastewater is the presence of chromium in it, the reduction of chromium from the wastewater is shown in figure 7, initially chromium concentration was 3.34 mg/l and by giving the different adsorbant dosage the chromium was reduced to a level of 0.67 mg/l. The reduction in concentration of iron from level of 61 mg/l to 8 mg/l is shown in figure 9. Sulphate present in the wastewater was reduced from 135.19 mg/l to 54 mg/l is shown in figure 8. Figure 10 shows the reduction in COD from the level of 1400 mg/l to 506.6 mg/l. The change in BOD upon varying adsorbant dosages from the level of 933.33 mg/l to 337.07 mg/l is shown in figure 11. Thus it is shown that rice husk is the best available low cost adsorbant for treatment of tannery wastewater.

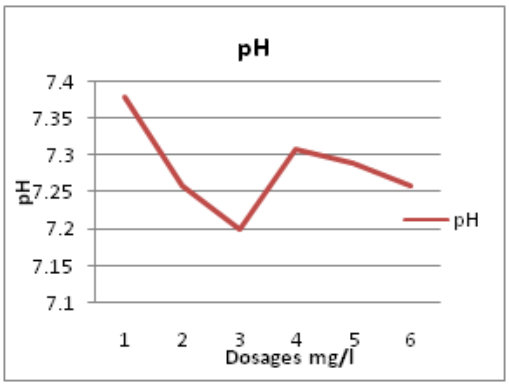

Figure 1 – Adsorbant dosage vs pH

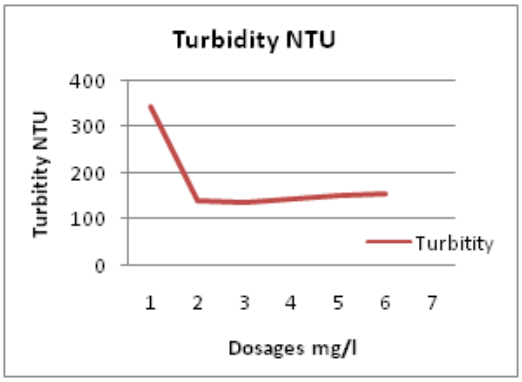

Figure 2 – Adsorbant dosage vs turbidity

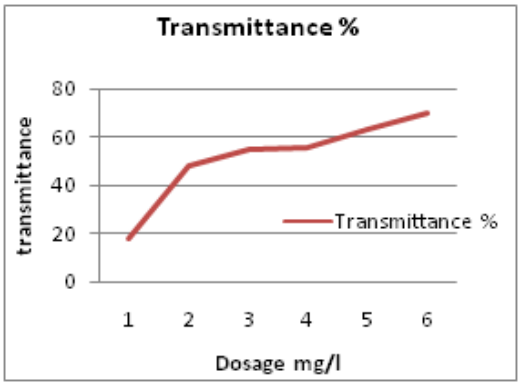

Figure 3: Adsorbant dosage vs transmittance

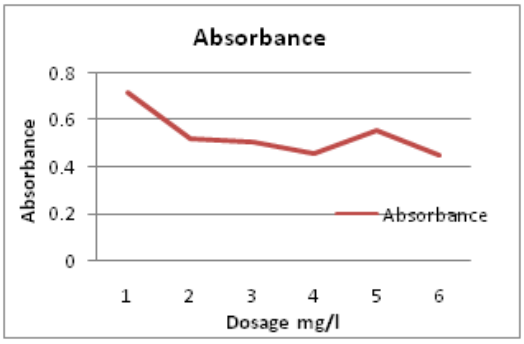

Figure 4: Adsorbant dosage vs absorbance

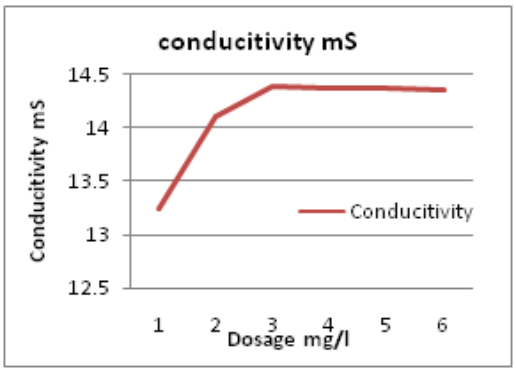

Figure 5 – Adsorbant dosage vs conductivity

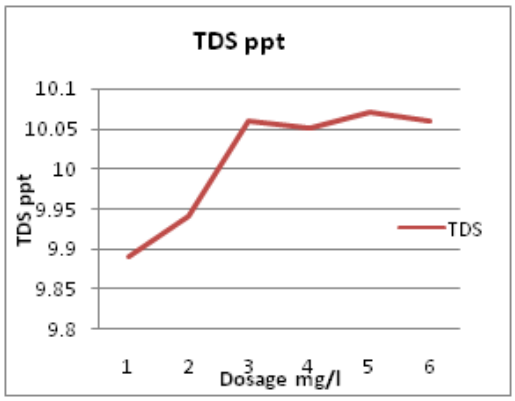

Figure 6 – Adsorbant dosage vs TDS

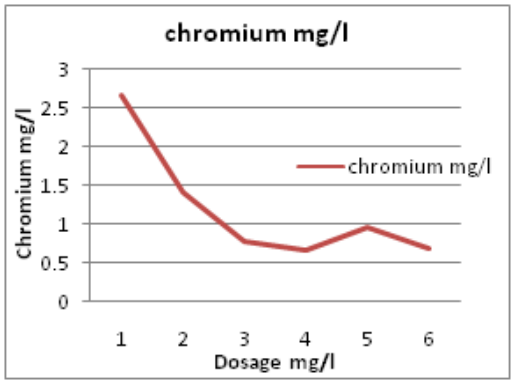

Figure 7 – Adsorbant dosage vs Chromium

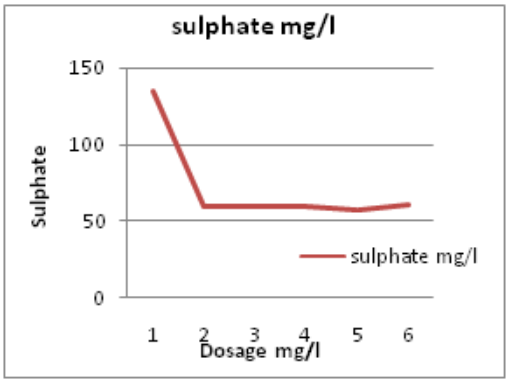

Figure 8 – Adsorbant dosage vs Sulphate

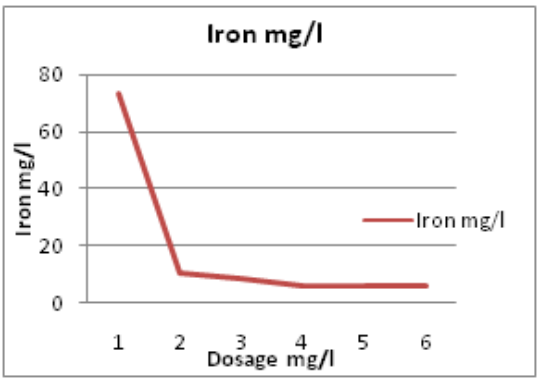

Figure 9 – Adsorbant dosage vs Iron

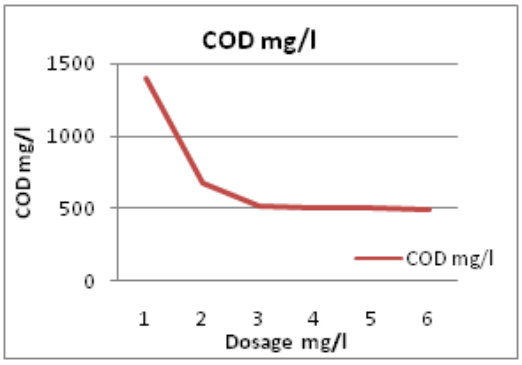

Figure 10 – Adsorbant dosage vs COD

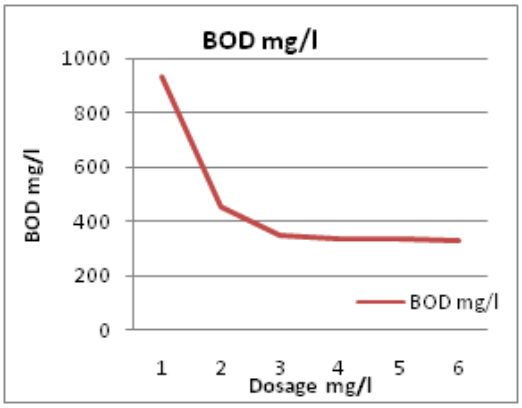

Figure 11 – Adsorbant dosage vs BOD

CONCLUSION

Through this study it was found that rice husk can be be employed as a better adsorbant for preliminary treatment of tannery wastewater. In this study it was found that the pollutant parameters of tannery wastewater like turbidity, BOD, COD were reduced to thye satisfactory level, among the primary treatments available for tannery wastewater like lime treatment ferrous sulphate treatment and coagulation processes it was found that adsorption is the best available method of treating tannery wastewater due its low cost and heavy metal removal. So, rice husk can be used effectively as an adsorbant for pre-treatmentfor tannery wastewater.

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