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ELECTROPLATING AND TEXTILE WASTEWATER TREATMENT BY COMBINED EFFECT OF ADSORPTION AND UV

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ABSTRACT

The treatment of textile and electroplating wastewater for reuse using adsorption combined with UV is reported in this paper. The goal of this work is to study the performance of the adsorption coupled with UV radiation process and to develop a potential wastewater treatment system for reuse. The combined process has reduced the chemical oxygen demand from 1200 mg/L to 160 mg/L for textile effluent, and from 1440 mg/L to 200 mg/L electroplating waste water. For the adsorption process, the adsorbent is prepared from the Ayurvedic plants, Dashmool (mixture of ten Ayurvedic plants such as *Aegle marmelos* corr, *Tribulus terrestric* linn, *Urauiapicta* desv etc). For both the textile and the electroplating waste water sample, the results showed clearly that the combined treatment has a high removal efficiency (86%) of the chemical oxygen demand (COD), and total dissolved solids are removed upto 73% from textile sample, whereas from the electroplating wastewater 62% of the dissolved solids are removed. This combined treatment hold great promise to provide alternative for better treatment and protection of environment.

Key words: Ayurvedic medicine (Dashmool), Adsorbent, Textile waste water, UV, Electroplating waste water.

INTRODUCTION

The use of conventional textile and electroplating wastewater treatment processes become drastically challenged to environmental engineers with increasing more and more restrictive effluent quality by water authorities. In textile industry, chemical processing contributes about 70% of pollution. Due to the nature of various chemical processing of textiles, large volumes of wastewater with numerous pollutants are discharged. Since these streams of water affect the aquatic eco-system in number of ways such as depleting the dissolved oxygen content or settlement of suspended substances in anaerobic condition, a

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special attention needs to be paid. Thus, a study on different measures, which can be adopted to treat the waste water discharged from textile chemical processing industries to protect and safeguard our surroundings from possible pollution problem has been the focus point of many recent investigations. The main cause of generation of this effluent is the use of huge volume of water either in the actual chemical processing or during re-processing in preparatory, dyeing, printing and finishing. In fact, in a practical estimate, it has been found that 45% material in preparatory processing, 33% in dyeing and 22% are re-processed in finishing[1]. But where is the real problem ? The fact is that the effluent generated in different steps is well beyond the standard and thus, it is highly polluted and dangerous.

Electroplating processes are one of the major industrial contributors to pollution. Consequently, the characteristics of wasted electroplating solution exhibit high acidity (pH = 0.18–0.42) and ionic strength. All the above features make the solution hard to be treated by the conventional treatment processes. Due to high capital investment and running costs, conventional chemical (neutralization/precipitation) or physical (ion-exchange, membrane technology) treatment techniques are inherently problematic in their application to waste streams[2]. Optimum HRT (Hydraulic residence time) for complete chromate reduction was obtained for different pH. Although more acids were used to lower influent pH to reduce HRT, effluent pH was higher due to more hydrogen ion reacting with chromate. Eventually, fewer bases are required to fulfill the discharge pH requirement of wastewater[3]. The application of direct ultraviolet spectral analysis with advanced deconvolution techniques for the monitoring of aromatic amines in textile effluent treatment is present[4]. Actual textile wastewater and synthesized wastewater containing various textile dyes were photocatalytically degraded by the UV-H_2O_{2FS}-TiO_2 process in an annular-flow photocatalytic reactor[5]. Textile waste water can be reused, if treated with combined process of membrane filtration step followed by electrochemical oxidation step. With widely studied electrodes, this research offers a promising way for recycling textile wastewater[6] to use a central effluent treatment plant

Lower levels of parameters could make the proposed central treatment plant cheaper. To maintain even at greater efficiency[7]; certain pollutants in textile wastewater are more important to target for pollution prevention than others. Reuse of wastewater of the textile industry after its treatment with a combination of physico-chemical treatment and membrane technologies by Bes-Pia et al.[8] and 100% COD removal is obtained. Initially, the ozonation influence on the coagulation-flocculation process has been studied in textile waste water from a dyeing, printing and finishing industry. Short time preozonation enhanced the coagulation process, achieving after sedimentation COD and turbidity reductions of 57% and 95%, respectively[9]. Wightii biomass was found to be an effective biosorbent for nickel removal from electroplating industrial effluents[10]. Biosorption system with acid-washed crab shells in a packed bed up-flow column is used for the removal of nickel from electroplating industrial effluents[11]. Ashes produced from *Saccharomyces cerevisiae* contaminated biomass was used to recover each metal with high yield and purity (99.9%, 92% and 99.4% for copper, nickel and zinc, respectively). The purity of the metals recovered allows selling them in the market or being recycled in the electroplating process without waste generation[12]. Ozonation combined with UV radiation was employed as an effective way for the removal of 2-naphthalenesulfonate (2-NS) in the electroplating solution[13]. The Langmuir model was found to describe well all sorption processes. Also synthetic zeolite was found to have 10 times greater sorption capacities (*b*Cr = 0.838 mmol/g, *b*Ni = 0.342 mmol/g, *b*Zn = 0.499 mmol/g, *b*Cu = 0.795 mmol/g, *b*Cd = 0.452 mmol/g) than natural zeolite (*b*Cr = 0.079 mmol/g, *b*Ni = 0.034 mmol/g, *b*Zn = 0.053 mmol/g, *b*Cu = 0.093 mmol/g, *b*Cd = 0.041 mmol/g), appearing and therefore, is most suitable to perform metal wastewater purification processes[14].

Our aim is to adopt technologies giving minimum or zero environmental pollution. Effluents treatment plants are the most widely accepted approaches towards achieving environmental safety. But, unfortunately, no single treatment methodology is suitable or universally adoptable for any kind of effluent treatment. Since the conventional treatment methods are inadequate, there is the need for efficient tertiary treatment process In this process, photoactive catalyst illuminates with UV light, generates highly reactive radical, which can decompose organic compounds. Our work includes adsorption process and irradiation by UV lamp for textile waste water which reduces COD up to 86%. We propose a simple system, which is effective, affordable and highly efficient for water treatment; thus protecting the natural environment.

EXPERIMENTAL

Materials and methods

(i) Dashmool as an adsorbent, Dashmool is a combination of 10 herbs that are Bilva root (*Aeglemarmelos*), Agnimantha root (*Premna integrifolia*), Shyonaka root (*Oroxylum indicum*), Patala root (*Stereospermym suaveolens*), Kashmari root (*Gmelina arborea*), Bruhati root (*Solanum indicum*), Kantakari root (*Solanum xanthocarpum*), Shalaparni root (*Desmodium gangeticum*), Prushniparni root (*Uraria picta*), Gokshura root (*Tribulus terrestris*).

(ii) 0.1 M HCl for the activation.

(iii) Distilled water.

(iv) Cotton, etc.

Dashmool (adsorbent) was filtered with distilled water. Sample was washed with 0.1 M HCl and vacuum filtered three times and then rinsed with distilled water and again filtered. This washing step ensures the removal of most of the alkaline residues. The cleaned samples were dried in an oven at 100^{o}C for 1 hour.

Table 1: Properties of wastewater from textile and electroplating industry before treatment

Property	Textile wastewater	Electroplating wastewater
pH	8	7.5
BOD (mg/L),3 days	380	440
COD (mg/L), day	1200	1440
Total dissolved solids (mg/L)	3000	2100

Step 1: Column experiments: Continuous flow adsorption experiments were carried out in a glass column (2 cm i.d. and 35 cm height) by loading 10.00 g of Dashmool to yield 30 cm bed height. Raw effluent was pumped upward through the column at 5 mL/min. The flow rate was adjusted to 5 mL/min. After elution, distilled water was used to wash the bed until the pH of the wash effluent stabilizes near 7.0. Dashmool was regenerated and adjusted to pH using HCl. The desorbed and regenerated Dashmule bed was reused for the next cycle. All batch and column experiments were done in duplicates. The data were the mean values of two replicate experiments. Error bars were indicated wherever necessary .The flow of the samples of wastewater was controlled and after every half an hour, both the samples were tested for all the wastewater characteristics. Emphasis was given on COD, BOD, pH and total dissolved solids. The waste from textile industry was analyzed and the analysis is shown as in Table 2.

Table 2: Properties of waste water from textile industry after adsorption

Property.	Textile wastewater	Electroplating waste water
pH	7.4	7.3
BOD (mg/L), 3 days	270	300
COD (mg/L), day	650	800
Total dissolved solids (mg/L)	1250	1800

Step 2: After adsorption, the samples were irradiated with UV lamp of 24 Watts for 5 hrs. After irradiation, again the samples were analyzed for wastewater characteristics.

RESULTS AND DISCUSSION

Because of its inherent advantages (i.e. no sludge formation, significant reduction of COD in relatively short reaction times and easy handling), UV system has remained as the most often applied AOP for the treatment of hazardous/pollutants observed in water or wastewater. The adsorption process is used with UV treatment. The best form of this association, after or before, depends of the characteristics of the wastewater to be treated.

At regular time intervals, samples were collected and analyzed for COD, BOD, pH and TDS. Initial results demonstrated that the Dashmool adsorbent is very strong to reduce COD from 1200 to 650. After adsorption, while UV treatment, the deactivation of •OH is more important when the pH of the solution is high. The photochemical degradation rate of reaction is variable under certain pH conditions and this can affect the UV reaction to degrade different contaminants. The COD removal after UV treatment reduces the COD value for textile wastewater and electroplating wastewater from 650 mg/L to 150 mg/L and from 800 mg/L to 200 mg/L, respectively as shown in Fig 1. COD removal efficiency increases after adsorption and UV treatment. Total dissolved solids are reduced for wastewater from 3000 mg/L to 800 mg/L. BOD values are reduced from 270 mg/L to 30 mg/L for textile waste water. The combined treatment of adsorption and UV can reduce COD, BOD and TDS values, which are shown in Table 3.

Table 3: Properties of waste water from textile industry after combined adsorption and UV treatment

Property	Textile wastewater	Electroplating wastewater
pH	7.2	7.3
BOD (mg/L), 3 days	30	35
COD (mg/L), day	150	200
Total dissolved solids (mg/L)	800	780

If we compare the values with original effluent, they are very less, and are much below the limits set by the EPA (Environmental Protection Agencies); thus, the wastewater can be reused. The adsorbent used here is Dashmool has strong activity for removal of waste characteristics. According to the results, 86% COD removal was obtained after 5 hr.

irradiation time. The graphs of the concentration versus irradiation time yielded straight line indicating pseudo-first order reaction. The first order COD removal rate constants by these processes were evaluated using a linear regression. The first order plot of COD removal with time is as shown in Fig. 4. The reaction rate constant (k) for COD removal was 0.126 (R^2 = 0.986). Results also proved that the pseudo-first order kinetic model is in good agreement with the experimental data.

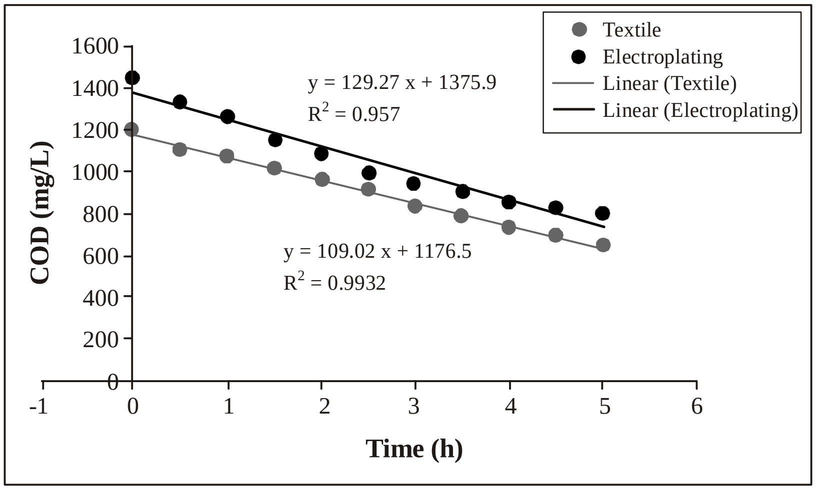

Fig. 1: COD removal with respect to time after adsorption for textile and electroplating wastewater

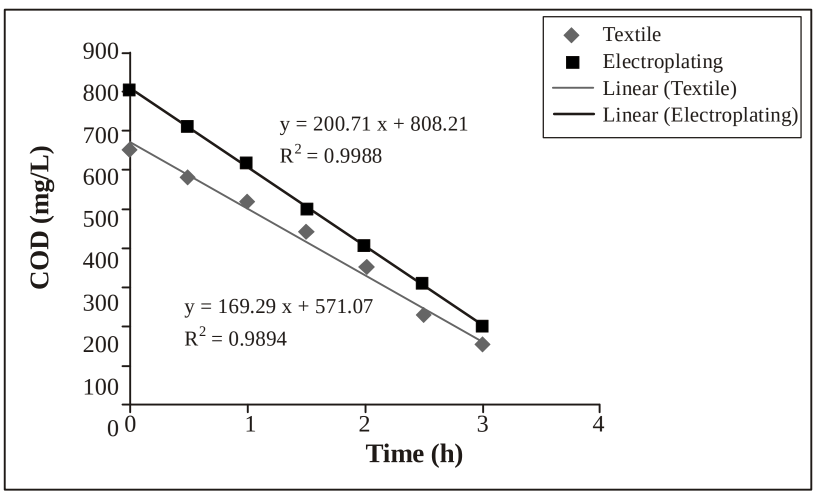

Fig. 2: COD removal with respect to time for combined treatment of adsorption and UV for textile and electroplating wastewater

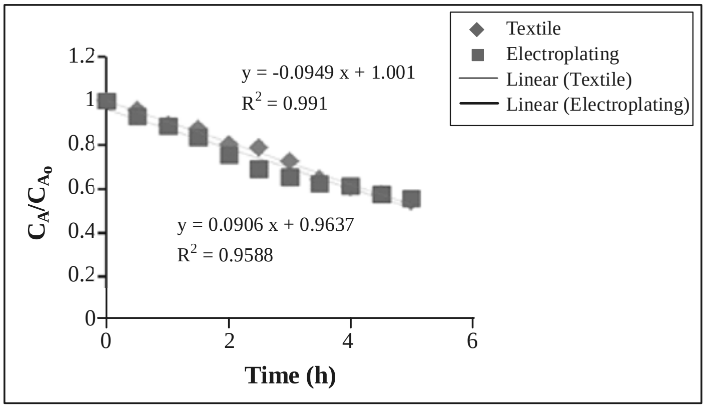

Fig. 3: Effect of sorbent on textile and electroplating wastewater during adsorption

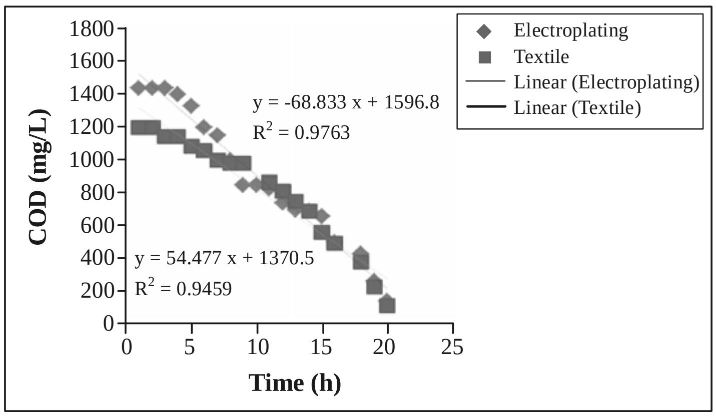

Fig. 4: Total COD removal with respect to time for combined treatment of adsorption and UV for textile and electroplating wastewater

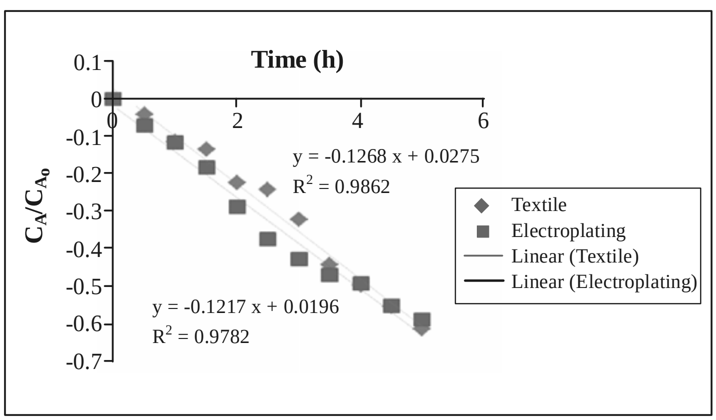

Fig. 5: First order plot for textile and electroplating wastewater for adsorption

CONCLUSION

The following conclusions can be drawn from the present study:

(i) The adsorption along with UV treatment holds a key solution for both; the textile and electroplating wastewater.

(ii) Dashmool was found to be an effective adsorbent for the removal of COD, BOD and TDS from textile and electroplating industrial effluent.

(iii) The batch experiments provided the fundamental information regarding the potential of the adsorbent on waste characteristics and its dependency on pH.

(iv) In column regeneration studies, the Dashmool was reused for five cycles. The regenerated adsorbent maintained relatively good adsorption capacity from both effluents in subsequent cycles.

(v) Thus, Dashmool can be used as a potential adsorbent for the treatment of textile and electroplating industrial effluents.

(vi) The COD removal rate of the textile waste water and electroplating waste water reached upto 86%.

(vii) The TDS removal rate of the textile wastewater is 73% and that of electroplating wastewater is 62%

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