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Characterization of Waste Water from Textile Industry

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Abstract: ***The STW prepared in this study was prepared by mixing reactive black dye and other chemical in distilled water (DW). The STW, of 200 mg/L dye concentration, prepared in this way, was observed to have 3148 mg/l of COD. Experiments were designed on the basis of the five level central composite (CC) design in combination with response surface methodology (RSM). The operating parameters chosen for the present investigation were, pH = 4–10; current density = 14.17–308.64 mA/cm^2 and reaction time = 30– 180 min. The impacts of these operating parameters on three response parameters i.e., percentage removal of COD and dye and amount of energy consumption, were estimated. Further, to maintain the desirability function of the treatment = 1, the multi response optimization was performed.***
Keywords: Textile, Industry, Waste Water, Treatment, Optimization

I. INTRODUCTION

Industries, dealing with production of textiles, use different types of natural products such as, cotton, wool, etc., and/or also, different types of the synthetic materials. In order to produce the final products, these raw materials are initially, processed in different ways. The processing of raw materials is an energy consuming, chemical-intensive and labor demanding process. For an instance, among the net energy consumption of textile industries, 60% of the energy is consumed while dyeing and finishing operations. Moreover, it was also observed that the major source of pollution emanating from textile industries is attributed to the processing of raw materials, specifically to the natural impurities extracted from the fibres (ref). A large amount of water is also required during the chemical treatment of raw materials. In this way, it was reported that almost 70% of the contaminated water generated from the textile industries is owed to the processes involving chemical treatment (ref). Efficiency of almost all the steps involved in the textile industry, as shown in Fig. 1, is dependent on availability of water. Collectively, the various process involved in textile generation are categorized into wet and dry processes. In case of dry processes, the use of water is minimal. However, wet processes such as, preparation, dyeing, printing and finishing etc., consume a large amount of water and are hence, considered the prominent cause of water pollution (Charoenlarp et.al, 2009). It has been reported that production of single tonne of textile requires 200-250 m^3 of water (CPCB, 2005). The brief description of the amount of waste water generated from different types of industries is mentioned in Table 1.1. Several chemicals are involved in the dyeing process of the fibres and consequently, the effluents generated from textile industries are generally hot, alkaline, strong smelling and colored. Different types of chemicals used during the dyeing process are dyes, salts, acids, xenobiotic compounds etc., and many of them have also been denoted as toxic in nature. It was observed that almost 90%, of the dyes used in textile industry, remains unaffected during the activated sludge treatment process (Lucas et al, 2007). Therefore, they are dumped into the fresh water bodies along with wastewater and hence, cause environmental damages (Pratum et al, 2011). It is important to develop such technologies which could degrade this dyes before wastewater is dumped into the water bodies. Due to the presence of strong electron-withdrawing groups in these molecules, biodegradation has shown ineffectiveness in its treatment (Gregorio et al, 2010). Moreover, other conventional treatment technologies such as: coagulation, flocculation, membrane separation, activated carbon adsorption etc., have proven to be costly and ineffective in its treatment (Sudarjanto et al, 2006; Lucas et al, 2006). Therefore, it is required to develop innovative treatment technologies for dye-containing effluent of textile industries (O. T. Can et.al, 2003). India is considered as a hub of textile industries as major occupancy of several states of India, is associated with it. States which tops of the list textile producing states of India include, Tamil Nadu, Mumbai, Surat, Ahmedabad, Punjab, Panipat, Coimbatore, and Kanpur. Major dyes used in these textile industries are mainly produced by two western states of India viz., Maharashtra and Gujarat. These two states contribute in production of 90% of the dyes in India. Other than that, pigments are also major raw material used in textile industry, which is also produced indigenously by Color Chem. and Sudarshan Chemicals, Atul, Clariant India, Dystar,Ciba Specialties and IDI.

II. OBJECTIVES

A. To carry out physico-chemical analysis residues (scum and sludge).
B. To carry out aluminum mass balance in view of disposal of treated effluent.
C. To carry out adsorptive treatment of electrochemically treated textile wastewater with aluminum electrode.

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III. METHODOLOGY

A. *Levels of Operating Parameters*

To develop a relation between operating parameters and response parameters, it is crucial to carefully decide the five input levels of the operating parameters. In this study, these levels were assessed on the basis of the scientific literature discussed in Chapter 2. The input levels of operating parameters i.e., electric current passing through the electrodes**,** mA/cm^2; reaction time, min and initial pH of the reaction mixture, were denoted as -2, -1, 0, +1, +2 (i.e., minimum, mean and maximum) by the interface of the software. The five levels of the operating parameters which were used for generating the model are shown in Table 1.

Table 1. Coded representation of operating parameters for statistical analysis

S.No.	Operating parameters	Units	Coded values				
			-2	-1	0	+1	+2
1	Current (X_1)	mA/cm^2	14.17	17.72	21.26	24.8	28.34
2	Reaction time (X_2)	min	30	67.5	105	142.5	180
3	Initial pH (X_3)	pH	4	5.5	7	8.5	10

B. *Analysis of Variance*

ANOVA was performed to assess the adequacy of the generated models at 95% confidence level. It can be inferred that the models generated are adequate for the prediction of optimal values of the operating and response parameters as p-values were very low. The values of regression coefficients (R-squared) generated using ANOVA for the response parameters i.e., % removal of COD; % removal of dye and the amount of energy consumed during the treatment were observed to be 0.9187, 0.9103 and 0.9116, respectively. These values being close to 1 show that variations observed among experimental and predicted results are insignificant and models generated are adequate for the present study (Kiely, 1997; Ehrig, 1992). The generated models can also be used satisfactorily to analyze the responses from even more input variables as the values of correlation coefficients were very close to adjusted correlation coefficients (R^2_{adj}) i.e., of 0.8455, 0.8295 and 0.8321, respectively (Ehrig, 1992).

Table 2. Predicted v/s actual responses for different response parameters

pH	Time, t (Minute)	Current (mA/cm^2)	%COD removal (Y_1)		% Dye Removal (Y_2)		Specific Energy Consumed (Y_3)	
			Actual	Predicted	Actual	Predicted	Actual	Predicted
5.5	67.5	17.72	28.94	31.33	79.9	78.58	0.00403	0.00259
8.5	67.5	17.72	45.44	41.42	67.11	68.46	0.00497	0.00435
5.5	142.5	17.72	44.83	43.20	96.13	98.14	0.00851	0.00893
8.5	142.5	17.72	55.54	62.83	91.27	95.64	0.0101	0.01069
5.5	67.5	24.8	50.12	44.37	94.61	89.66	0.00722	0.00791
8.5	67.5	24.8	29.06	32.24	83.11	80.52	0.01076	0.00966
5.5	142.5	24.8	48.28	53.85	95.78	93.86	0.0147	0.01425
8.5	142.5	24.8	52.09	51.25	91.59	92.34	0.02161	0.01601
4	105	21.26	30.5	30.98	95.6	98.39	0.00875	0.00754
10	105	21.26	40.5	38.47	88.97	86.75	0.00928	0.01105
7	30	21.26	9.48	12.35	56.62	60.09	0.0027	0.00296
7	180	21.26	47.66	43.24	94.36	91.47	0.0141	0.01564
7	105	14.18	70.77	69.53	91.67	88.18	0.00467	0.00398
7	105	28.34	71.31	71.00	91.91	95.97	0.0126	0.01462
7	105	21.26	50.1	47.45	82.54	88.16	0.0091	0.00929
7	105	21.26	50.5	47.45	90.44	88.16	0.00875	0.00929
7	105	21.26	48.5	47.45	87.75	88.16	0.00875	0.00929
7	105	21.26	49	47.45	89.71	88.16	0.00823	0.00929
7	105	21.26	38	47.45	87.75	88.16	0.00858	0.00929
7	105	21.26	50.13	47.45	90.2	88.16	0.00858	0.00929

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IV. CONCLUSION

The findings of activated carbon-based adsorption of electrochemically treated STW were concluded as following:

A. At optimum conditions the values of the operating parameters i.e., pH, adsorbent dose and time, were observed to be 3, 35 g/L and 22 h.

B. At the optimum conditions of the operating parameters 88.28% COD removal was observed.

C. Isotherm analysis showed the Langmuir isotherm fits the best to the adsorption process, with $R^2 \sim 1$.

D. For Langmuir isotherm, the values of K_L and q_m were observed to be 0.00004 l/mg and 4509.02 mg/g, respectively. Moreover, high value of q_m depicted that the adsorb ate had higher affinity for adsorbent.

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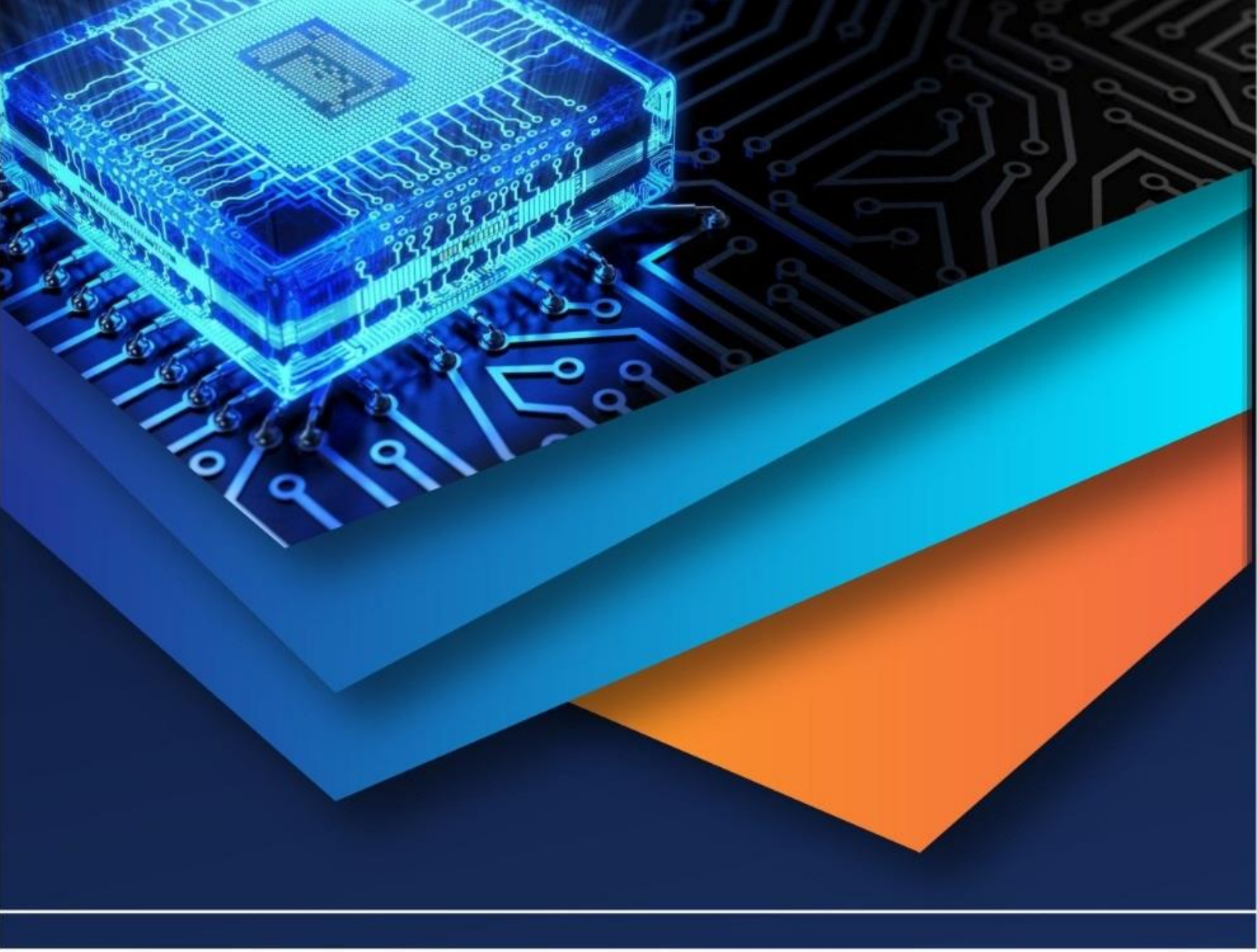

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