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Original Research Paper

Treatment of Dyeing Industry Effluents by Using Diverse Bioadsorbents

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ABSTRACT

Adsorption as a water and wastewater treatment process has aroused considerable interest during recent years. Activated carbon is most commonly used adsorbent. Dyeing effluents are highly toxic and unaesthetic, therefore, their treatment is mandatory prior to discharge. Hence, in the present work an attempt has been made to study the possibilities of employing tea waste, saw dust, rice husk, groundnut husk and walnut shell has bioadsorbents to improve the quality of dyeing effluents. The main parameters studied were pH, EC, TS, TDS, TSS, BOD, COD, calcium, magnesium, sulphate, chloride and sodium in both treated and untreated effluents. A decline in the levels of all these parameters were observed after the treatment.

INTRODUCTION

The yarn dyeing and textile dyeing industries have major share in polluting aquatic bodies as well as lands. The effluent emanating from these industries have imparted colour to the groundwaters rendering them unsuitable for human consumption. 50 % of the total volume of effluents from textile processing is generated only from dyeing units. More than 8000 chemical products are used for this purpose. The effluents from dyeing industries require proper treatment before being let into the aquatic bodies or agricultural fields for irrigation. The available physicochemical treatment methods are elaborate and expensive. Adsorption as water and wastewater treatment process has aroused considerable interest during recent years. Activated carbon is the most commonly used adsorbent promising alternative method. The present paper deals with the use of some bioadsorbents for remediation of coloured wastewaters discharged by textile industries.

MATERIALS AND METHODS

For the present study, the dyeing effluent was collected from an industry at Tirupur in a 5-litre sterilized polythene can. Plant derivatives such as saw dust, waste tea, walnut shells, groundnut husk and rice husk have been selected as bioadsorbents. Walnut shell was collected from a confectionery. Waste tea was collected from a tea factory which is thrown out as it is considered to have no significance. Saw dust was collected from a timber mart, and rice husk was procured from a rice mill.

Batch experiments were conducted to evaluate the percentage of adsorption by the five selected bioadsorbents. Adsorption experiments were carried out by agitating 0.3g adsorbent in 100mL of dye solution at room temperature (29 ± 2°C) in a mechanical shaker at 150 rpm for 3 hours. After equilibrium period the contents of the flask were filtered using Whatman No. 4 filter paper. The filtrate was then analysed for various parameters following standard procedure (APHA 1998).

RESULTS AND DISCUSSION

The effluent collected from Tirupur for the present study was compared with the IS standard of industrial wastes to be discharged into public sewers (IS: 3306,1974) and was found to bear certain elements above the critical value. The effluent was blue in colour with a slight tinge of green and had an unpleasant odour. The effluent was acidic with a pH 5.72 which was within the tolerance limit (5.5-9.0). The total dissolved solids was slightly above the prescribed level (2860.155 mg/L). The total suspended solids was within the prescribed limit (467 mg/L). The BOD of the effluent was 706.3 mg/L, which exceeded the standard value. Likewise, the COD of the sample was very high 1516.5 mg/L as compared to the prescribed standard of 250 mg/L. The electrical conductivity of the effluent sample was 4.04 mmhos. The collected effluent contained high amounts of calcium (490 mg/L), magnesium (960 mg/L), sulphates (479 mg/L), chlorides (567.2 mg/L) oil and grease (77.8 mg/L) and sodium (272 mg/L). Among the heavy metals, copper was found in traces (0.675 mg/L), iron in small amount (2.28 mg/L), and chromium in high quantities (11.2 mg/L) (Table 1).

A batch experiment was undertaken to study the efficiency of selected bioadsorbents such as pseudo activated tea waste, groundnut husk carbon, activated walnut shell, carbonized rice husk and activated saw dust. The adsorbents were shaken with the dyeing industry effluent for 3 hours and after the equilibrium period the effluent sample was analysed for various physicochemical characteristics and the result of the analysis are presented in Tables 2, 3 and 4.

Influence of activated adsorbents on dyeing industry effluent: pH of the raw dyeing effluent showed little alteration with treatments after 3 hours. The maximum reduction in pH was achieved by tea waste (5.72-5.41). Singh & Lal (1992) was able to bring down the level of chromium by 76.8% at an optimum pH of 2.5 by shaking 0.1 g of the adsorbent for 4 hours. Among the different adsorbents, maximum reduction of EC was observed in tea waste (4.04-0.46 mmhos/cm). Significant reduction in the level of total solids, total dissolved solids and total suspended solids was showed by tea waste (3327.15-419.97 mg/L, 2860.16-304.46 mg/L and 467-72.85 mg/L respectively). The same result was shown by Prabhu & Thangavelu (1995). Treatment with various materials showed maxi-

Table 1. Physicochemical characteristics of dyeing effluent.

S. No.	Parameters	ISI-Standards of Industrial waste waters into public sewers IS: 3306-1974	Raw Effluent
1.	pH	5.5-9.0	5.72
2.	Electrical conductivity	-	4.04
3.	Total dissolved Solids	2100	2860.155
4.	Total suspended solids	750	467
5.	BOD	250	706.30
6.	COD	500	490
7.	Calcium	-	960
8.	Magnesium	-	1000
9.	Sulphate	1000	479
10.	Chloride	600	567.2
11.	Sodium	60	272
12.	Oil and Grease	-	77.8
13.	Iron	-	2.25
14.	Copper	-	0.675
15.	Chromium	0.05	11.2

(All the parameters are in mg/L except pH and EC (mmhos/cm)

Table 2: Influence of bioadsorbents on the physicochemical characteristics of dyeing effluent.

S. No.	Parameters	Raw Effluent	T_1	T_1%	T_2	T_2%	T_3	T_3%	T_4	T_4%	T_5	T_5%
1	pH	5.72	5.41	5.5	4.82	15.8	4.5	20.5	4.6	19.1	4.59	19.8
2	EC	4.04	0.46	88.6	1.43	64.6	1.40	65.3	1.5	62.8	1.65	59.1
3	Total solids	3327	419.9	87.3	1332.6	59.9	986.2	70.3	1343	59.6	1454	56.3
4	Total dissolved solids	2860	304.4	89.3	938.4	67.1	913.3	68.0	1131	60.4	1168	59.1
5	Total suspended solids	467	115.9	75.1	394.1	15.6	72.8	84.4	212	54.6	286	38.7
6	BOD	706.3	57.4	91.8	188.9	73.3	174.2	75.3	178.1	74.7	206.2	78.8
7	COD	1516.5	142.2	90.6	252.2	68.8	289.6	73.6	409.4	73.0	515	66.0

T1 - Effluent treated with activated tea waste; T2 - Effluent treated with activated walnut shell;
T3 - Effluent treated with activated groundnut husk; T4 - Effluent treated with activated rice husk;
T5 - Effluent treated with activated saw dust; % - Percentage reduction

Table 3: Influence of bioadsorbents on the elemental composition of the dyeing effluent.

S. No.	Parameters	Raw Effluent	T_1	T_1%	T_2	T_2%	T_3	T_3%	T_4	T_4%	T_5	T_5%
1	Calcium	490	3.4	99.3	320	34.7	320	34.7	110.2	77.5	39.2	92
2	Magnesium	960	39.7	95.8	198.6	79.3	144	85	290	69.7	720	25
3	Sulphate	479	227	52.6	212	57.7	341	28.8	330	31.1	163	65.9
4	Chloride	567.2	21.4	96.2	127.6	77.5	42.5	92.5	184.3	67.5	106.3	81.2
5	Oil and Grease	77.8	1.6	96.2	53.4	91.7	42	92.5	41.1	38.2	26	58.8
6	Sodium	272	10.2	97.9	22.5	31.3	20.4	46	168	38.1	112	66.5

T1 - Effluent treated with activated tea waste; T2 - Effluent treated with activated walnut shell;
T3 - Effluent treated with activated groundnut husk; T4 - Effluent treated with activated rice husk;
T5 - Effluent treated with activated saw dust; % - Percentage reduction

mum reduction of BOD and COD with tea waste (706.3-57.47 mg/L and 1516.5-142.25 mg/L). Kadirvel (1993) recorded complete removal of BOD and COD from the dyeing wastewater by using carbonized coir pith.

In the present study, a significant reduction in calcium, magnesium, chloride, and oil and grease was achieved with activated tea waste (490-3.43 mg/L, 960-39.72 mg/L, 567.2-21.3 mg/L, 77.8-1.6 mg/L, respectively). Sulphate removal was achieved to the maximum by activated saw dust (479-163 mg/L).

Maximum uptake of iron was observed in effluent treated with activated walnut shell (2.28-0.077 mg/L). Complete removal of copper and chromium was achieved by treatment with activated saw dust and activated walnut shell respectively (0.675-0.00 mg/L, 11.2-0.00 mg/L). Sreenivasan & Sounderraj (1988) have shown that carbonized rice husk can remove up to 88 per cent of chromium, which is in par with the result of the present study. Nag et al. (1999) has shown 90 per cent removal of chromium by charred saw dust.

From the present study it is clear that pseudo activated tea waste is most efficient in removing undesirable compounds present in the effluent. However, the other adsorbents like groundnut husk, rice husk, saw dust and walnut shell seem to possess adsorption capacity. Thus, the batch experiment results showed the possible use of agricultural waters for heavy metal removal and the adsorbents have good potential as metal scavengers from wastewaters.

Table 4: Influence of bioadsorbents on heavy metals of the dyeing effluent.

S. No.	Parameters	Raw Effluent	T_1	T_1%	T_2	T_2%	T_3	T_3%	T_4	T_4%	T_5	T_5%
1	Iron	2.28	1.03	54.5	0.08	96.6	0.24	89.5	0.43	81.1	0.06	97.5
2	Copper	0.67	0.17	74.8	0.04	94.5	0.10	85.1	0.09	86.7	-	100
3	Chromium	11.2	-	100	4.20	62.5	3.10	72.3	0.21	98.1	1.42	87.3

T1 - Effluent treated with activated tea waste; T2 - Effluent treated with activated walnut shell;
T3 - Effluent treated with activated groundnut husk; T4 - Effluent treated with activated rice husk;
T5 - Effluent treated with activated saw dust; % - Percentage reduction

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