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Decolourization and COD removal from Textile Waste Water by Chemical, Adsorption and Biological Treatment Methods

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Abstract*: The water pollution is in increasing trend over the past few decades. With the countries moving towards the industrialization for their economic growth, there is a critical threat to bio-nature of the water. The industries generally consume a huge amount of water, and dispose them in the contaminated form which is often toxic. Among the industries, more water is procured for the textile industries especially in the dyeing units. Most of the dyes in the textile industries are reactive in nature and provide several adverse effects. Several methods were employed to remove the contaminated substances to purify the textile based waste water. In the present paper, the effluent water samples from the dyeing unit from Kanchipuram was obtained and analyzed for its initial parameter values following the standard methods. From those obtained values, the chemical oxygen demand (COD) is about 1170 mg/L and the color value was at 1093 Pt-CO. Subsequently, the waste water is chemically treated with the combined Sodium Hypochlorite-lime-ferrous solution. Similarly, the zeolite and prepared coconut charcoal is employed as an adsorbent to treat the wastewater. All the treated samples were tested to analyze the effect of each treatment. The outcomes obtained from the analysis were compared with the initial values to measure the efficiencies of each technique. Almost all the treatment procedure employed in the study yield efficiency about 90% in COD and color removal. From the comparison over the techniques, it is evident that the inorganic adsorbent removes the color and Chemical Oxygen Demand effectively about 94% and 95% respectively.

***Index Terms*: Textile water waste, parameters, chemical treatment, adsorbent, zeolite.**

I. INTRODUCTION

In the contemporary world, the usage of chemicals is wide spread among all the economic sectors like agricultural and manufacturing industries. The application of chemicals was acknowledged as the major contributor for the water pollution and a concern on controlling it was high on the both public and societal authorities [1]. For a country like India, the usage of water for the industries increase with every year and was estimated to be about 63 BCM and almost all of them will be generate as the industrial waste water [2]. Untreated industrial wastewater may result in hazardous impact on the human, plant, animal, and even microbes. It distracts the food web that can which leads to environmental imbalance of creating a problem [3]. The regulation that covers the industrial effluent in liquid form is growing stricter, particularly in the more advanced countries, and enforces the wastewater treatment before deposed to the environment [4].

Among the industries, textile industry is a predominant contributor of effluent wastewater as it consumes more water for its various operations on wet processing. This effluent wastewater comprises of chemicals such as alkalis, acids, hydrogen peroxide, dyes, starch, metals soaps and dispersing agents of surfactants [5]. The role of dye in the textile industry is very important as they impart the colors to the fibres, but most of them are reactive in nature. The dyes used for various fibres are as follows: Direct dyes, Base dyes, Azo dyes and Vat dyes [6]. Because of these dyes, textile wastewater has a high COD / BOD, high color, and salts load that lead to the extremely polluted water which is not readily responsive to biological treatment [7]. Most traditional treatment approaches employed for removing the color and COD in the textile dyeing industry include flocculation / coagulation by chemicals addition, and activated carbon treated effluent adsorption [8]. This paper presents the analysis of the waste water and its treatment through the chemical and adsorption techniques. The major objectives in this work are as follows: i) To estimate the initial parameters of the textile effluent through the corresponding test. ii) To analyze the impact of the chemicals and adsorbent in removal of COD and color. iii) To provide the best option to be practiced for treating the waste water effectively. The rest of the paper was organized as follows: the related works on waste water treatment is deliberated in section 2. The section 3 describes the methodology, which provides the procedures and materials that are employed in the present work. The next section elaborates the results with corresponding explanation. Finally the last section concludes the present work with future scope.

II. RELATED WORKS

A summary of solid–liquid adsorption processes and role of the conventional and nonconventional adsorbents for removal of pollutant from wastewater was detailed extensively [4].

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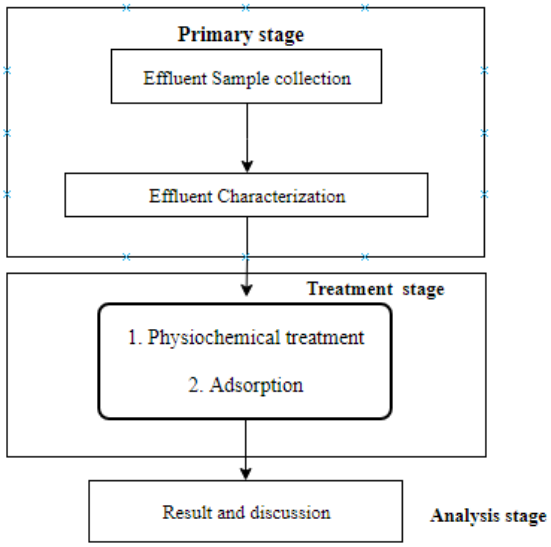
The best raw charcoals are obtained through the plant wastes; for instance, bark of banana is carbonized when subjected to concentrated sulfuric acid and heated for 40 minutes at a temperature about 600°C to eliminate rhodamine B. The capacity of maximum adsorption (qe) of bark of banana is observed to be 40.16 mg/g [9]. The adsorption of methyl red, methylene blue, and Malachite green over the activated carbon was examined from seeds of Annona squamosa. Rhodamine B adsorption using the low-cost acid-activated carbon was accomplished [10]. Fenton's reagent with numerous approaches is conveyed in the form of chemical technique like ozonation, photochemical, electrochemical, etc. But, Fenton's reagent takes the form of heating agent is included of decomposition. A hydrogen peroxide mixture (H_2O_2) and ferrous ion (Fe^{2+}) is prominent as Fenton reagents. [11] The method of Fenton can be alternate as thermic [12].

Fractionation of Ammonium sulphate with 4.8-fold purification was acquired in the peroxidase case mined from Citrus jumbhiri peel with an escalation in specific activity to 2,925 from 751 U/mg [13]. The electrochemical wastewater treatment is reflected as one of the innovative processes of oxidation, potentially a powerful pollution control method, proposing high efficiencies on removal of undesired substances [14]. SLP nearly finally decolorized (>99%) effluent of textile industry at a pH of 5.0, temperature of 55°C, H_2O_2 with 2 mM concentration f, and 40 U/mL enzyme dose. The physicochemical parameters assessment of the effluent from textile industry exhibited reduced toxicity after SLP treatment.[15]

Numerous approaches have been established for treating the wastewater from textile, however lot of them failed to be employed in full scale since the characteristics of wastewater from textile are complex.[16]

III. METHODOLOGY AND MATERIALS



A. *Primary stage*

The primary stage of our work was to collect the effluent samples and characterize them with standard experiments. At the end of this stage, a detailed report on the effluent parameters can be obtained.

i. **Effluent collection**: The samples were collected from Kanchipuram Dyeing units. Kanchipuram is a traditional silk weaving center and industries of handloom for producing well known Kanchipuram Sarees. There are 25 cotton yarns and silk industries, approximately 60 dyeing units generated 1MLD per day in this region. Each dyeing unit generated around 12,000 liters of waste water in Kanchipuram.

ii. **Effluent Characterization**: The effluent characterization was the important process which exhibits the initial parameters of the textile effluents. Table 1 shows the different parameters that were estimated along with their method of measurement.

TABLE 1: TESTING PARAMETERS AND THEIR METHODS

S. No.	Parameters	Method of measurement
1	Chemical Oxygen Demand (COD)	IS 3025 Part 58-2006 (Reaffi:2012)
2	Total Suspended Solids (TSS)	IS 3025 Part 17-1984 (Reaffi:2012)
3	Colour	IS 3025 Part 4 -1983 (Reaffi:2002)
4	pH at 25 deg. C	IS 3025 Part 11-1983 (Reaffi:2012)
5	Temperature	IS 3025 Part 09 -1984 (Reaffi:2012)
6	Oil and grease	IS 3025 Part 39 -1991 (Reaffi:2012)
7	BOD	IS 3025 Part 44 -1993 (Reaffi:2012)

B. *Treatment stage*

The waste water samples were treated by a chemical process and using the adsorbent. The values of the effluents were then compared with the initial parameters of the samples to determine the efficiency of the treatment.

i. Physiochemical treatment: The sample is treated by chemical treatment using Lime, Ferrous sulphate and Sodium hypochlorite. Dosage of Sodium Hypochlorite followed by Lime and Ferrous Sulphate is added to the effluent and mixed rapidly for 10 minutes. Then the process of coagulation starts and ends by 25 minutes followed by sedimentation time of about 4 hours. Finally the effluent was filtered to obtain the treated water and test them for the color and COD parameter.

ii. Adsorbent treatment: in this treatment process, adsorbent material was employed to remove the undesirable materials from the effluent. Two types of adsorbent were utilized in this method as: Organic and inorganic adsorbents.

a. Organic adsorbent - Coconut Shell Activated Charcoal was prepared and employed as the adsorbent to purify the water. The coconut shell was dried in the sunlight for 24 hours initially, and then dried at 200 ° C-250 ° C in the drier. Subsequently the dried material was quenched for 3 times followed by heating at 900 ° C for a day in the microwave oven. The porous activated charcoal thus obtained was crushed in the crusher and segregated with the sieve shaker.

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b. Inorganic adsorbent: Zeolite was obtained from Merck.
c. Procedure: The beaker was filled with the effluent samples and the adsorbents were added separately. The PH value was maintained at a range of 5-6 at room temperature. The samples were covered with aluminium foil and mixed for 30-45 minutes at a RPM of 100 to 500 and allowed to settle for 30 minutes. After these, the water was filtered and tested for the characterization on the color and COD parameters.

This experimental analysis of Decolourization of water is done at L&T Construction, Water & Effluent Treatment lab, Mount Poonamallee Road, Manapakkam, Chennai.

IV. Result and Discussion

A. *Initial Effluent parameters*

From the standard test on the effluent samples, it was observed that the COD was found to be 1170 mg/L and the color parameter was measured about 1092 Pt-Co. The TSS and the Bod was found about 210 mg/L and 459 mg/L whereas the oil and grease was at arrange of 92 mg/L with the PH value of 7.12 at a temperature of 27° C. Table 2 and fig. 1 exhibit the initial parameter values of the sample effluents that are obtained from the standard methodologies.

Table 2: Initial values of the parameters

S. No.	Parameters	Results
1	Chemical Oxygen Demand (COD)	1170 mg/L
2	Total Suspended Solids (TSS)	210 mg/L
3	Colour	1092 Pt-Co
4	pH at 25 deg. C	7.12
5	Temperature	27 ºC
6	Oil and grease	92 mg/L
7	BOD	459 mg/L

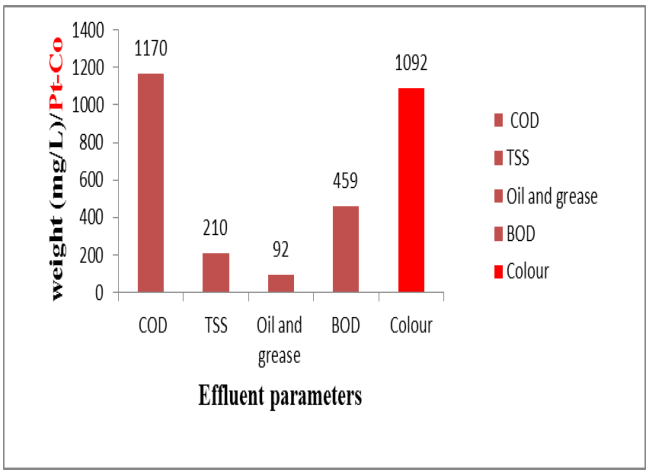

Fig 1: Initial parameters of the effluents

B. *Effluent parameters after treatment*

The parameter values of the effluents after the various treatments are as follows:

1) Physio-chemical treatment

The outcome from the physio-chemical test was provided in the fig 2. The color parameter was reduced to about 340 Pt-Co with a color removal efficiency of about 68.89%. The COD was reduced about 240 mg/L with an efficiency of about 79.48%. this shows that the chemical approach was better for the removal of COD from the sample effluents.

Table 3: Effect of physio-chemical treatment on effluent

S.no	Color		COD	
	Initial	After treatment	Initial	After treatment
1	1093	340	1170	240

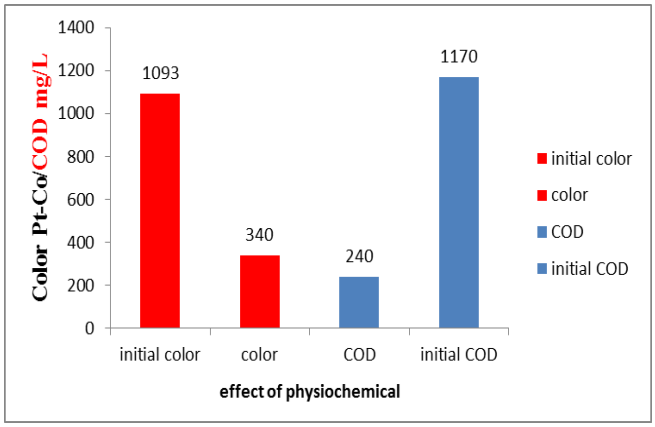

Fig 2: Effect of the physio-chemical treatment

C. *Organic adsorbent*

The coconut charcoal was added in the effluent with varying concentration and the corresponding outcomes from treatments were given in Fig 3. From the fig, it can be seen that the parameter values of COD and color decreases from 30 mg/L upto 120 mg/L after which there was an increase in their trends. The maximum values are attained at 120 mg/L with 82 Pt-Co for color and 76.44 mg/L for COD. This technique provide as the maximum efficiency of 93% on COD removal and 93 % on color removal.

Table 4: Effect of organic adsorbent treatment on effluent

Concentration (mg/L)	color after treatment (Pt-Co)	COD after treatment (mg/L)
30	218.4	176
60	174.72	140
90	131.04	117
120	76.44	82
150	120.12	117
180	120.12	117
210	131.04	117

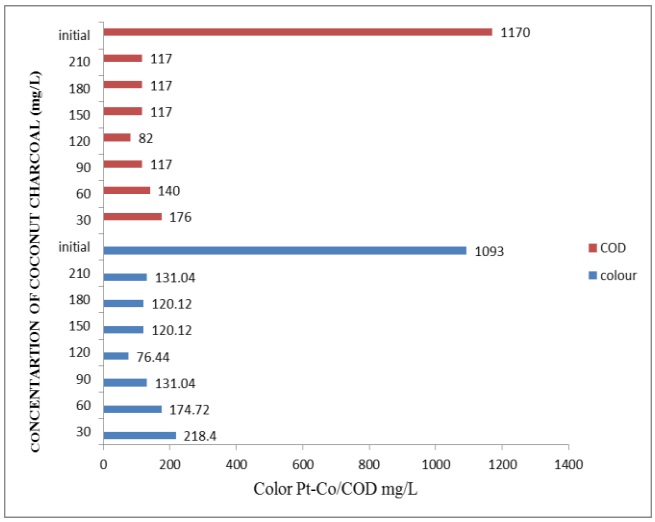

Fig 3: Effect of the varying concentration of activated coconut charcoal on COD and colour

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D. *Inorganic adsorbent*

The zeolite was employed as the inorganic adsorbent similar to that of the coconut charcoal in the previous case. The outcome from this technique was given in the fig.4. Similar to the organic charcoal, the color removal was maximum at the 120mg/L concentration with efficiency about 95%. The COD removal attained the maximum percentage of 94% at both 60 mg/L and 90 mg/L with the value of 58.5 mg/L.

Table 5: Effect of in-organic adsorbent on effluent

Concentration (mg/L)	color after treatment (Pt-Co)	COD after treatment (mg/L)
30	98.28	70.2
60	87.36	58.5
90	87.36	58.5
120	54.6	70.2
150	65.52	93.6
180	109.2	93.6
210	131.04	117

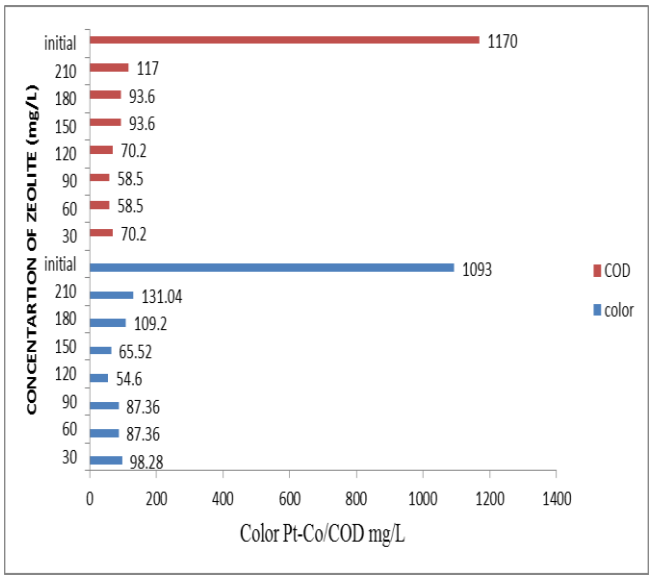

Fig 4: Effect of the varying concentration of zeolite on COD and colour

E. *Comparison on effectiveness of treatment*

Table 6: Comparison of optimum efficiencies on various treatment methods

S.no	Method	Color removal efficiency	COD removal efficiency
1	Phyiso-chemical treatment	68.89%	79.48%
2	Organic adsorbent	93%	93%
3	Inorganic adsorbent	95%	94%

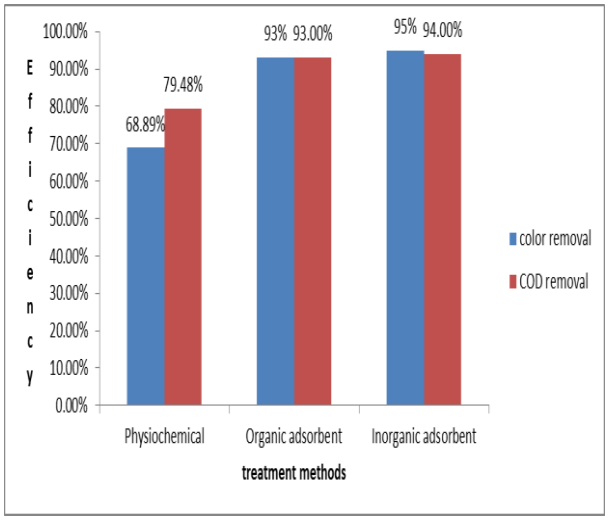

Fig 5: Efficiency of different techniques in COD and color removal.

From the above analysis on the treated wastewater through various techniques, it was observed that both the organic and inorganic adsorbents performed better than the chemical approach. In particular the performances of the inorganic method accomplish the higher efficiencies of about 95% and 94% in COD and color removal. The major aspect to be considered is that this method purify the water within an hour, so it was found to be economical than the other compared techniques.

V. CONCLUSION

The effluent samples were collected from the dyeing units of Kanchipuram and its initial parameters of COD, color, BOD, TSS and oil were measured using the standard methods. The organic adsorbent in the form of activated coconut charcoal was prepared for treating the effluent. The solution with the combination of lime-ferrous sulphate- Sodium Hypochlorite was employed to remove the COD and color form the waste water. Similarly the coconut charcoal and zeolite was employed to analyze the efficiencies as an adsorbent in waste water treatment. The treated water was measured for its COD and color values. The comparison on the efficiencies of the three methods was performed and it showed that the inorganic adsorbent performed better than other techniques. Even though the zeolite provide the efficiencies of 94% in color removal and 95% in COD removal, the 100% removal was not achieved. In the future work, the bio reactors setup or a hybridized approach can be formulated to attain purest form from the effluent water.

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