TREATMENT OF DYE WASTEWATER USING GRADED CHARCOAL GENERATED IN THE DYEING PROCESS

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ABSTRACT
The wastewater from dyes and their intermediate manufacturing industry causes serious impact on natural water bodies and land surfaces in the surrounding area. High values of BOD and COD, presence of particulate matter and sediments and the colour itself are causing problems. The dye wastewater is treated by using many effective physical, chemical or biological techniques in the world. Some of them are costly while some of them require hi-technology. There are nine dyeing cottage industries functioning at Maruthamunai and a huge amount of effluent is generated. The specific objective of this part of on-going research was to find a simple and cheap method of remove (or reduce) the colour intensity of the dye industry effluents. The color removal of dye wastewater was tried with using freely available natural adsorbents, such as paddy husk, sawdust, graded charcoal (a by-product of the dyeing industry itself) and different types of sands. Paddy husk showed 4.55% intensity reduction, sawdust reduced 29.50% of intensity reduction, charcoal showed 56.8% of intensity reduction, washed sawdust involved 33.86% of intensity reduction, river sand showed 44.10% of intensity reduction, lower layer sand lowered 4.52% of intensity, while some adsorbent increased the intensity, sawdust (powder) 28.71% and washed sawdust (powder) 9.12%. Comparing all natural adsorbents used here, graded charcoal had higher percentage intensity reduction due to their high surface area. Sorption properties of charcoal (powdered form) can be used for treating dye wastewater, which is cheap and easily available from the dying industry itself.

Keywords: Dye, Wastewater, Colour removal, Adsorbent, Charcoal

INTRODUCTION

Color is an important aspect of human world. We like to wear clothes of all kinds of colors and hues and eat food decorated with colors. Even our medicines are colorful. The textile industry is the largest consumer of dyestuffs. During the coloration process large percentage of the synthetic dye does not bind & is loss of the waste stream (Weber & Adams 1995) approximately 10-15% dyes are released into the environment during dyeing. The effluent from textile industries thus carried a large number of dyes and other additive which are added during the coloring process. These are difficult to remove in conventional water treatment procedures and can be transported easily through sewers and rivers especially because they are designed to have high water solubility. They may also undergo chemical change under environment condition and the transformation products may be more carcinogen and toxic than the parent molecule on various living organisms such human, animals, birds & etc.

Dyeing industry is one of the largest water consuming industries. The effluent coming out of a dyeing industry contains various chemicals and coloring compounds and the effluent requires proper treatment before it is discharged into any water body. But, the dye house effluents are very difficult to treat satisfactorily because they are highly variable in composition. In most situations, the use of a combination of different methods of treatment is necessary in order to remove all the contaminants present in the wastewater. Adsorption is one of the most effective methods to remove color from textile wastewater (Malik and Grohmann, 2011). Despite the frequent use of adsorption in wastewater treatment systems, commercially available activated carbon remains an expensive material (Paul and Dhas, 2008).

Many sources obtained from the environment were used for the removal of dyes from synthetic dye house effluents by various researchers (Sivamani & Leena, 2009). The two methods of processing adsorbents are physical and chemical methods. Physical method of treating adsorbent involves activation by heating in an oven. Chemical method of treating adsorbent involves activation by adding acid or alkali. The addition of inorganic acids makes the method polluted and expensive. Cost is an important factor for comparing the feasibility of adsorbents in treating dye house effluents. However, in any report, cost analysis is not stated and the expense of adsorbents varies depending on the method of processing and availability of source materials. In general, an adsorbent is said to be low cost if it requires little processing, abundant in nature with high adsorption capacity.

Dyeing industry is predominantly functioning at Maruthamunai, traditionally for a long period. It is one of the major sources of income of the villagers. Local dye industry use huge amount of water for dying process and hence release a large quantity of waste water which contain lots of unbind dye. In most cases these dyes are synthetic and organic origin. They are potential threat to the environment and they reach ground water. There is hardly any effective treatment process is found, may be due to the high cost involvement in the treatment process. We undertook a study with the objective to find a simple and cheap method of colour removal from dye wastewater by using natural environmental substances.

METHODOLOGY

Maruthamunai is in the eastern province of Sri Lanka at the border between the Ampara and Batticalo districts. There are 09 dyeing industries operating and 08 of them are located along the beach site. Two different (dark & light colored) effluent samples were collected and colour removal was attempted at the research laboratory at Faculty of Applied Sciences, Sammanthurai.

The effluents were subjected to the following trails. Different weights of alum (1g, 2g, 3g, and 4g) were mixed with 100ml sample separately. They were mixed well & filtered using Buchner funnel. Intensities of treated samples were measured using spectrophotometer (HACH).

Sample (100ml) and 10g of paddy Husk were added into the reagent bottle and were shaken for 20 minutes. Then it was filtered under Buchner funnel. The solution was collected and intensities were measured by using Spectrometer. Each natural substance was tested by above process.

Different types of absorbent materials (sands with different grain size and grades charcoal of different particle size) were packed into (50 cm long) tubes separately. Then dark and light colored dye effluents were passed through them, retention periods were noted and the filtered solutions collected, as well as the original effluents, were measured for their colour intensities.

RESULTS AND DISCUSSION

Table 1: Colour reduction with alum

Trial No.	Amount of Alum Added (g) to 100 ml effluent	Colour intensity	Colour intensity reduction	% Colour intensity reduction
1	0	48,400		
2	1	23,500	24,900	52.44
3	2	22,125	26,275	54.29
4	3	25,250	23,150	47.83
5	4	27,500	20,900	43.18

Maximum colour removal was obtained at an optimum mass of absorbent added.

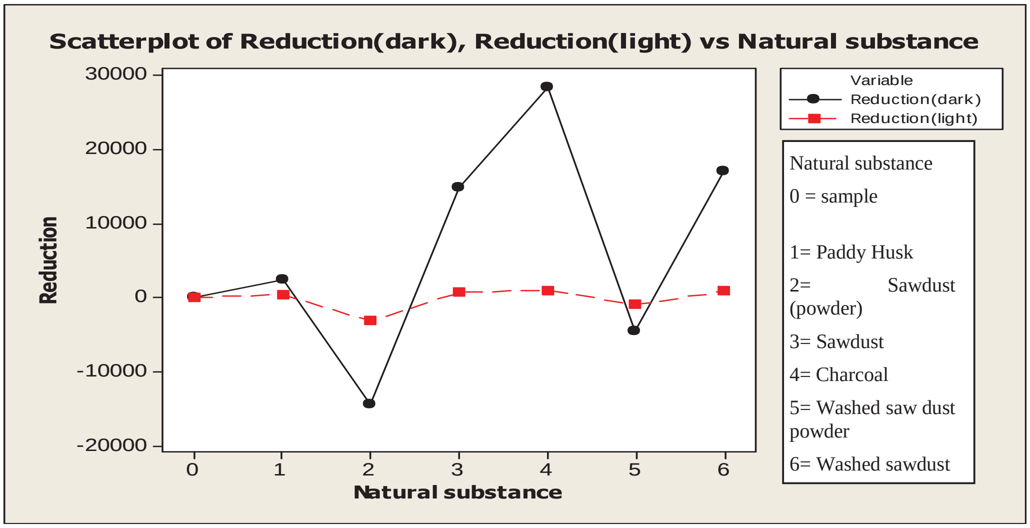

Figure 1**:** Colour intensity reduction of (dark & light coloured) effluents Vs Natural substance as adsorbents

Some adsorbents (paddy husk, saw dust, charcoal and sand) reduced colour intensity of effluent while some other (e.g., powdered saw dust) increased the colour intensity. Graded charcoal reduced more colour intensity of dye effluents than other. Of the two types of dye effluents, intensity of percentage reduction for dark coloured dye solution was lower than that of light coloured effluent for a constant amount of adsorbent.

Table 2: Intensity of untreated sample and treated sample with different forms of charcoal

Different form of charcoal	Intensity	Reduction	% Reduction
Untreated sample	48,100	-	-
Charcoal (granule)	28,144	19,956	41.49
Charcoal (powder)	22,125	25,975	54.00

Charcoal effectively reduced the intensity; of the two forms (granular and powdered form of charcoal) powder form reduced more extend of intensity than granular form of charcoal. This may be due to larger surface area possessed by the powders.

Table 3: Various sized charcoal as adsorbents

Size of charcoal	Intensity (Light)	Reduction (Light)	% Reduction (Light)	Intensity (dark)	Reduction (dark)	% Reduction (dark)
Sample	1150	-	-	51000	-	-
> 6.30mm	450	700	60.87	29740	21260	41.68
4.0 – 6.30mm	210	940	81.74	22770	28230	55.35
2.0 – 4.0mm	150	1000	86.96	10320	40680	79.76
1.0 – 2.0mm	50	1100	95.65	7700	43300	84.90
0.5 – 1.0mm	25	1125	97.83	6280	44720	87.68
0.25 – 0.5mm	10	1140	99.13	4390	46610	91.39

The percentage intensity reduction increased in significant amount with decreasing the particle size of adsorbent, intensity reduction percentage for dark dye solution was lower than for that of light dye solution for a constant amount of adsorbent.

When the particle size of adsorbent is decreased the surface area for adsorption rate increased, dark dye solution had bulk amount of particles comparing with light dye solution, therefore proportions of surface area of adsorbent per particle of adsorbate is very low in the case of dark dye solution.

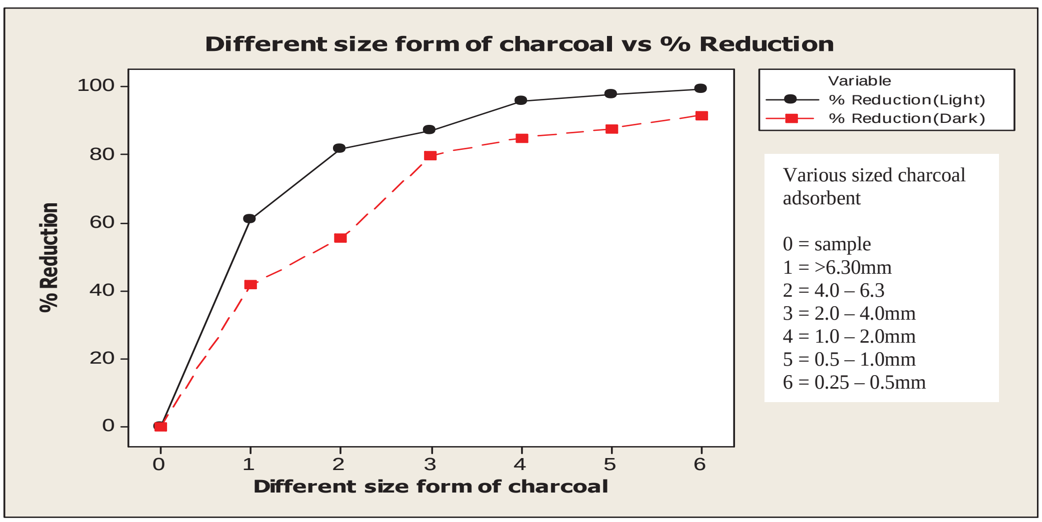

Figure 2: Graded charcoal particles as adsorbent vs % Reduction

Colour removal also depends on particle size of the adsorbent. Smaller the particle size, resulted in higher % reduction. Therefore for adsorption charcoal can be used as adsorbent for hydrophobic compound, including dye molecules. The technology is simple and effective with low cost. However, desorption process is problematic and not cost-effective .therefore bound substance, including dyes, need to be disposed off. Coagulation, together with either flocculation or sedimentation, is often use in the textile industry.

CONCLUSION

Among the natural substances used colour reduction was effectively done by charcoal produced during the dyeing process. This is a cheap material compared to commercially available activated charcoal, which is costly. Charcoal with fine particles (≤ 2mm) and river sand can be used for removing the color of dye solutions in dye industries.

The other parameters, observed to be influencing the extent of adsorption (colour reduction) were nature of dye particles (causing light and/or dark colour), particle size of adsorbent used, retention time and height of the tube and temperature of the system.

Under the above similar conditions, fine grains of charcoal obtained from dying process itself was found to be the most efficient and economical among all other materials tested.

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REFERENCES

Jaya Paul and A. L Arumai Dhas (2008). Removal of COD and colour from textile wastewater using limestone and activated carbon, University Sains Malaysia, 3-4.

Sivamani S, Leena Grace B (2009). Removal of Dyes from Wastewater using Adsorption - A Review. International Journal of Biosciences and Technology (2009), Volume 2, Issue 4, Page(s):47-51.

Weber, E. J., Adams, R. L., (1995) Chemical and sediment mediated reduction of the azo dye Disperse Blue 79. Environmental Science & Technology, 29, pp 1163-1170.

Abdul Malik and Elisabeth Grohmann, (2011). Environmental Protection Strategies for Sustainable Development, Springer Science & Business Media, Sep 18, 2011. Page 113.