Extraction of Dye from Textile Effluent Using Waste Bricks

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***Abstract*— A brick is a building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick is referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar. A brick can be composed of clay-bearing soil, sand, and lime, or concrete materials. Although bricks are used for costruction some of them tend to become wastes, this may be due to improper manufacturing process involved or due to improper construction activities. Some brick wastes are also produced as a result of demolition of buildings. Dumping of these brick wastes becomes a problem as they need large areas. Hence there is a need to reuse and recycle these wastes. Using these bricks as a coagulant in extraction of dye from effluents can be considered as a novel step in recycling these wastes. Coagulation in water treatment is a process in which coagulant is added to waste water to destabilise colloidal suspensions. Coagulants are the substances that aid coagulation. Several studies have shown that bricks too possess the properties of coagulants. In this project the efficiency of brick wastes as coagulants in the removal of dye from the effluent is being assessed. Various factors were also noted.**

Keywords—Bricks, Coagulation, Dye removal

I. INTRODUCTION

Dyes may be defined as substances that, when applied to a substrate provide color by a process that alters, at least temporarily, any crystal structure of the colored substances . Such substances with considerable coloring capacity are widely employed in the textile, pharmaceutical, food, cosmetics, plastics, photographic and paper industries . The dyes can adhere to compatible surfaces by solution, by forming covalent bond or complexes with salts or metals, by physical adsorption or by mechanical retention . Dyes are classified according to their application and chemical structure, and are composed of a group of atoms known as chromophores, responsible for the dye color. These chromophore-containing centers are based on diverse functional groups, such as azo, anthraquinone, methine, nitro, arilmethane, carbonyl and others. In addition, electrons withdrawing or donating substituents so as to generate or intensify the color of the chromophores are denominated as auxochromes. However, due to the toxic nature and adverse effect of synthetic dyes on all forms of life the interest in natural dyes has revived throughout the world. Nevertheless even the natural dyes are rarely low-impact, due to certain mordants that have to be used with them. Mordants, are substances, (such as chromium), used to "fix" color onto the fabric. They may be are very toxic and may have a high impact on the wastewater quality. Natural dyestuffs require large quantities of water for dyeing. (Almost equal to or double that of the fiber's own weight).

.Coagulation-floculation is a chemical water treatment technique applied prior to sedimentation and filtration to enhance ability of a treatment process to remove particles. Coagulation is a process used to neutralize charges and form a gelatinous mass to trap particles thus forming a mass large enough to be trapped in a filter[3] Coagulant selection is very important role, hence Take Jar test / Pilot study using with available Coagulants along with your different process content effluent and conclude the result, which one is affordable. Once if it is selected, so it is to be implement to the bulk process hence plan and design / fabricate the equipment and choose civil construction accordingly. Adequate detention time must be allowed, it is also enhance the successive rate of coagulation and flocculation process. so take care equipment selection and its sequence.

Effluent treatment methods can be classified into chemical, physical and biological methods. Single treatment method is insufficient to remove color so; there is not an exclusive treatment technique among these three methods of treatments to deal with the textile effluent. Dyes exhibits different behaviour to different methods like dyes are not easy to biodegrade, certain acidic dyes are not easily absorbed by active sludge; hence they escape treatment and few particularly the hydrolysed reactive. Various treatment methods can be combined to eliminate more than 85% of unwanted matter. Two mechanisms adsorption and ion exchange are involved in decolonization, and is affected by various factors including adsorbent's surface area, dye & adsorbent interaction, particle size, pH, contact time and temperature. Surfactants and dyes with high molecular weights are easily removed by the coagulation processes followed by flotation, filtration and sedimentation respectively.

In the present study, the synthetic waste water was treated by using red brick dust. Its evaluation was done by measuring alkalinity, hardness and Color removal percentage. The experiment carried out with different concentration of red brick dust to measure the dosage suitability of these as coagulants for dye color removal. The pH of synthetic dye was maintained at 4, 7 and 9 then passed through the red brick dust .Dosage variability showed very significant results and 10grams of red brick dust was found favourable for color removal of dye. The material was capable of removing color up to 78% at normal temperature. The experimental result showed that the material has good potential to remove color from effluent and good potential as an alternate low cost coagulant. There are many physical and chemical treatment methods available for removal of color but all these methods have problems associated such as secondary effluent, hazardous and harmful end products, high energy consuming, non-economic etc. These problems can be overcome by the use of physical treatment method (adsorption and coagulation method) which is not hazardous for environment.

In an article published by IWA(the International Water Association) it explained the importantance of coagulation in wastewater treatment operations. A common example is chemical phosphorous removal and another, in overloaded wastewater treatment plants, is the practise of chemically enhancing primary treatment to reduce suspended solids and organic loads from primary clarifiers. The factors on which coagulation depends are temperature, sequence of chemical addition, residual aluminium, detention time and rapid mixing.

V D Talnikar(2013) in his paper "Natural Coagulants of Wastewater Treatment"[8] explained coagulant as a substance which in solution, furnishes ionic charges opposite to those of the colloidal turbid particles present in water. Coagulants neutralize repelling the charges on the colloidal particles and produce a jelly- like spongy mass called a flock. Flocculation causes considerable increase in the density and size of coagulated particles resulting in an effective rate of settling of the particles in a solution or in the wastewater.

Haili Cheng(2015) in his paper "Reuse Research Progress on Waste Clay Brick" explained waste clay brick as silicate solid waste, its recycling has great environmental and social significance. The application of WCB as recyclable coarce and fine aggregate in concrete and mortar, wall materials, as well as raw material or addition in the production of recyclable cement were also discussed.

Ragaganesh K et.al.(2016) in their paper "Physico-Chemical Characteristics of Textile Dye Effluents Collected from Tirupur, Tamilnad, India and Their Impact on The Ecosystems" [10] studied the charachterestics of textile effluent collected from Tirupur and foun out that the effluents from Tirupur textile industries was exceedingly polluted. Hence there is urgent need to follow the affordable Ecofriendly treatment methods before their discharge into the environment for reducing their potential environmental hazards.

Sujith Alen et.al.(2016) in their paper "Studies on colour removal efficiency of textile dyeing wastewater using Moringo Olifera"[11] used Moringo Olifera as a coagulant in removal of dye from tannery effluents and was found to be effective. In his study synthetic Blue CA dye was prepared at various concentrations and 250ml of the sample was taken in a beaker. Moringa powder was added to the dye and the reaction was allowed to settle and the supernatant was tested for various parameters. The colour removal was observed using a double beam UV spectrophotometer and the efficiency of removal was calculated using the absorbance value before and after treatment. All the experiments were conducted in room temperature. Insights from this experiment was taken in conducting the experiment.

Shahzada Zakira Owas(2015) in her paper , "Application of natural coagulant for removal of dye from synthetic textile wastewater", discussed in detail about the experimental setup for the extraction of dye from textile effluent. This paper was taken as the main reference paper the help of this paper. In this journal he studied each and every factor that affects the efficiency by keeping other factors constant. Thus the efficiency of dye removal from the effluent was measured.

Patel H et.al. (2014) in their paper, "Comparison of naturally prepared coagulants for removal of COD and colour from Textile Wastewater", checked the feasibility of natural materials such as Surjana seed powder, Maize Seed Powder and Chitosan as coagulants. Comparitive study was conducted between these and surjana seed powder was found better than the other two. Various factors like Coagulant dose, flocculation time and temperature was investigated in which coagulant dose was found to be more preferable than other parameters for removal of COD. And flocculation time was considered effective than other parameters when removal of colour was concerned.

Himanshu Patel et.al. (2015) in their paper, "Removal of Congo Red dye from its aqueous solution using natural coagulants", analysed the feasibility of Congo Red Dye using naturally prepared coagulants with surjana seed powder, maize seed powder and chitosan. Various parameters like pH, coagulant dose, flocculation time and temperature were investigated. Surjana seed powder was found to be more preferable than the other two. When turbidity was concerned chitosan was found to be more effective.

Sharma T et.al.(2015) in their journal, " An Experimental Investigation on Treatment of Tannery Wastewater by Electrocoagulation method", used electrocoagulation as a method the treat Tannery Wastewater. Based on the experimental observations, the electrolysis time of 60min, pH 6.0 and 8V were found to be critical operating parameters for the treatment of wastewater using Galvanised iron electrodes appeared to be feasible alternative for the treatment of tannery industry wastewater. The volume of produced sludge is less than that of common methods of water treatment. The sludge produced by this process could easily be removed by discharge.

The main objectives of the study include: To determine the efficiency of dye removal using red brick dust, to determine the effectiveness of red brick dust as a coagulant and to understand the various parameters on which the efficiency depends on.

Considering the fact that the textile dyeing process is recognized as one of the most environmentally unfriendly industrial processes, it is of extreme importance to understand the critical points of the dyeing process so as to find alternative, eco-friendly methods. There are many physical and chemical treatment methods available for removal of color but all these methods have problems associated such as secondary effluent, hazardous and harmful end products, high energy consuming, non-economic etc. These problems can be overcome by the use of physical treatment method (adsorption and coagulation method) which is not hazardous for environment. Due to the toxic nature and adverse effect of synthetic dyes on all forms of life the interest in natural dyes has revived throughout the world. It was concluded that the synthetic textile dyes represent a large group of organic compounds that could have undesirable effects on the

environment, and in addition, some of them can pose risks to humans. The increasing complexity and difficulty in treating textile wastes has led to a constant search for new methods that are effective and economically viable. The main scope of the work is using the natural coagulants for the treatment of waste water which is an economically feasible and eco-friendly technology. This would provide potable water by means of natural treatment especially for underdeveloped communities. By the use of natural adsorbents the entire process becomes more efficient with less cost. Thus this cost effective method is highly appreciated. In the present study, the synthetic waste water was treated by using red brick dust. Its evaluation was done by measuring alkalinity, hardness and Colour removal percentage. The experimental result showed that the material has good potential to remove color from effluent and good potential as an alternate low cost adsorbent.

II. MATERIALS AND METHODS

Waste Bricks

The main material used in this project is waste bricks. They are used as a natural coagulant. Waste bricks were collected from a nearby construction site were demolition of a building took back months before. The fungal matter that grew on the surface was cleared and the bricks were sun dried for a day. After them being sundried the bricks were broken into pieces using a hammer. The powdered bricks were then stored in containers.

Fig.1 Waste bricks

Fig.2 Waste Bricks Powder

Wastewater Sampling

Textile effluent was collected from Khadi Industries, Avannissery, Kerala. The wastewater collected in plastic bottles was stored in refrigerator to avoid further contamination. The collected wastewater is analyzed for initial characteristics such as alkalinity, hardness and spectrophotometer reading.

The effluent collected was jet black in color and had very low consistency. It was a mixture of a lot of dyes.

Alkalinity refers to the capability of water to neutralize acid. This is really an expression of buffering capacity. A buffer is a solution to which an acid can be added without changing the concentration of available H+ ions. Alkalinity is determined by titrating 20ml of the sample with a standard acid and adding 2 drops of phenophtalein indicator. At once the color disappears 2 drops of methylene orange indicator is being added and titration is continued till colour changes from yellow to orange yellow. Here the total alkalinity was obtained as 550mg/l ac $CaCo_3$.

Hard water is water that has high mineral content (also called as soft water). Hardness in an sample can be tested by first diluting 20ml of sample to 40ml with distilled water and thereafter titrating it with EDTA adding EBT as an indicator. Hardness obtained for the textile effluent is 160mg/l as $CaCo_3$.

Absorbance is a measure of the capacity of a substance to absorb light of a specified wavelength. It is equal to the logarithm of the reciprocal of the transmittance. Spectrophotometer techniques are used to measure the concentration of solutes in solution by measuring the amount of the light that is absorbed by the solution in a cuvette placed in the spectrophotometer. The initial spectrophotometer reading obtained was 0.130.

Fig.3 Wastewater Sample

Methadology

The experimental design or experimental method used here is coagulation jar test experiment. The very fine particles and colloidal matter cannot settle in sedimentation tank of ordinary detention period by the addition of certain chemicals the smaller particles are coagulated into larger ones which cause higher hydraulic settling velocities. The four mechanisms by

which colloids can be coagulated are double layer compression, charge neutralization, entrapment in precipitates. The colloidal particles may provide condensation sites where the precipitates may form and hence the turbidity becomes entrapped in the precipitate and settles with it. The settling precipitate further entraps colloids while settling. The factors affect after coagulation are kind of coagulant, quantity of coagulant, amount, character and turbidity of water, pH value of water, time of mixing, flocculation, temperature and intensity of agitation. The experiments were conducted at Malabar Engineering College, Desamangalam.

Coagulation experiments using jar test were performed in the laboratory comprises of five paddle rotators and five 1000ml beakers, all tests were conducted in room temperature. 250ml of the sample is taken in each of the five beakers and coagulant in the order of 5, 10, 15, 20 and 25grams were added to the wastewater and stirred at a flash mixing speed of 100rpm for one minute and the speed is reduced to 40rpm to keep the floc particles uniformly suspended for 30minutes. Settling time of 1day was given to the sample. The most efficient sample was noted, filtered using filter paper Whatman No 42. and was taken for spectrophotometer reading.

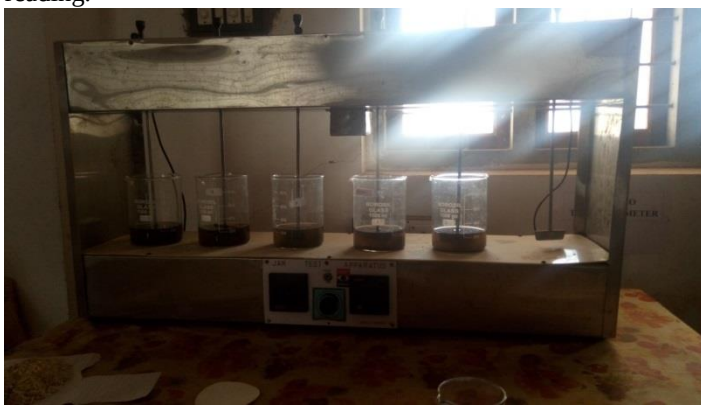

Fig.4 JarTest Apparatus

Fig.5 Supernatant kept for filtering

III. Results and Discussions

Parameters such as alkalinity, hardness and spectrophotometer readings were taken and following results were obtained.

TABLE I
Initial Wastewater Charachterestics

Parameters	**Initial Characteristics**
Colour	Black
Alkalinity	550mg/l as $CaCo_3$
Hardness	160mg/l as $CaCo_3$
Absorbance	0.130

Jar tests were conducted on the samples as explained before. The results obtained after one hour setting time were not satisfactory hence the samples were kept for a setting time of 24hrs and those results are tabulated below:

TABLE.II
Jar Test Results

Coagulant dosage	Nephelometer reading
5g	1.50
10g	1.16
15g	1.22
20g	1.83
25g	1.84

Thus from the above results 10g can be concluded as the optimum coagulant dosage. The sample also showed mark able reduction in the dye colour.

Fig.6 Reduction in Colour Concentration after one day

As the sample with 10g coagulant dosage showed the most significant reduction in dye concentration this sample was taken to check alkalinity and hardness values. The values obtained are enlisted below in the form of a table:

TABLE.III

. Before and After Characteristics of Wastewater Sample

Serial no.	**Characteristics**	**Before treatment**	**After treatment**
1	Alkalinity	550mg/l as $CaCo_3$	320mg/l as $CaCo_3$
2	Hardness	160mg/l as $CaCo_3$	80mg/l as $CaCo_3$
3	Absorbance	0.130	0.012
4	Colour	Jet Black	Light Brown

In order to know the concentration of the dye in the treated effluent a calibration curve is to be made first. For this the reference frequency was set to 520nm in a spectrophotometer and the absorbance was measured for various known concentrations of dye solutions. The calibration curve was drawn using these values with this calibration curve, unknown concentration of the dye solution can be easily found out.

TABLE IV

Absorbance Reading at various Concentrations

Serial No.	Concentration mg/l	Absorbance
1	1	0.003
2	2	0.014
3	3	0.026
4	4	0.035
5	5	0.044
6	6	0.054
7	7	0.066
8	8	0.075
9	9	0.092

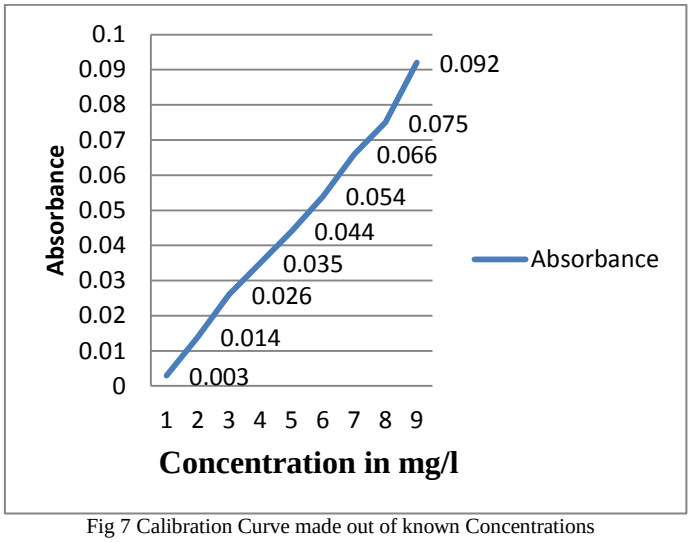

Fig 7 Calibration Curve made out of known Concentrations

Thus with the help of this calibration curve, final dye concentration can be found out and thus percentage of removal of dye can be determined.

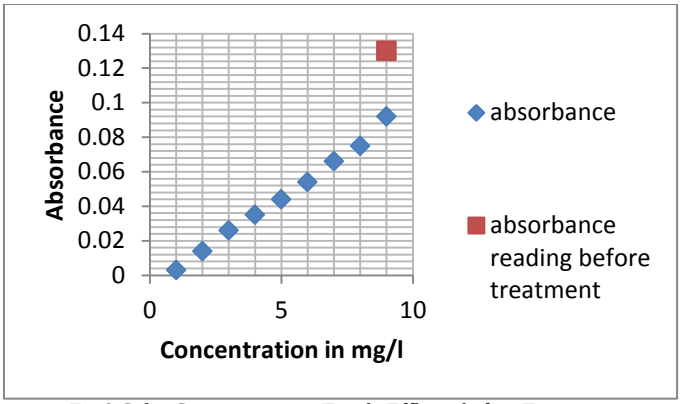

Fig 8 Color Concentration in Textile Effluent before Treatment

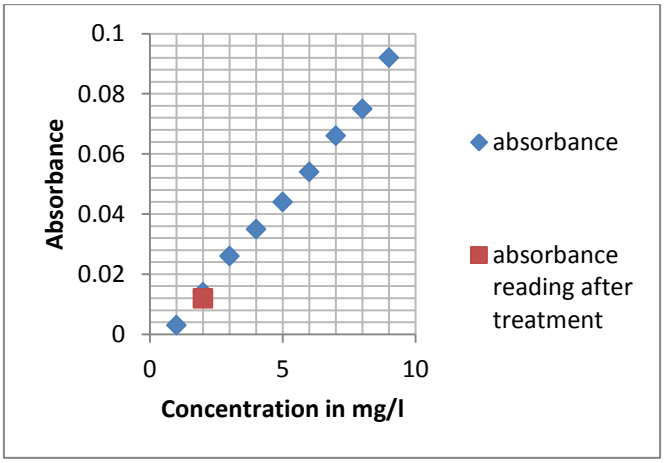

Fig 9 Color Concentration in Textile Effluent after Treatment with Waste Bricks

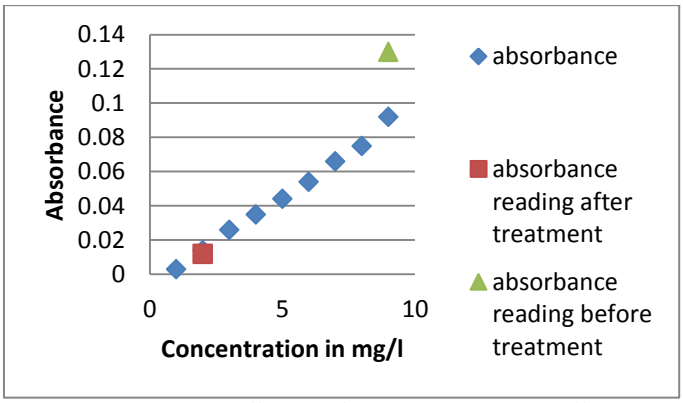

Fig.10 Dye Removal Efficiency of Waste Bricks in Textile Effluent

The above graph denotes the final and initial spectrophotometer readings along with the calibration curve. From the above graph following datas are obtained.

Initial concentration of dye in effluent = 9mg/l

Final concentration of dye in effluent = 2mg/l

Percentage of dye removal =

{(Initial Concentration- Final Concentration)/ Initial Concentration} * 100

This implies, {(9mg/l – 2mg/l)/ 9mg/l}* 100 = 77.77%

Thus the removal efficiency of waste bricks is obtained as 77.77% i.e. 78%

Similarly alkalinity and hardness values were also found out.

Percentage of reduction on alkalinity =

{(Initial Reading - Final Reading)/ Initial Reading} * 100

This implies, {(550-320)/550}*100 = 41.81%

Thus there is a reduction of 42% on alkalinity of the effluent.

Percentage of reduction on hardness =

{(Initial Reading - Final Reading)/ Initial Reading} * 100

This implies, {(160-80)/160}*100 = 50%

Thus there is a reduction of 50% on hardness of the effluent.

TABLE V

Percentage of Removal of various Parameters

Characteristics	**Percentage of removal**
Alkalinity	42%
Hardness	50%
Dye removal	78%

IV. CONCLUSIONS

This project has been about the use of waste bricks in extraction of dye from the textile effluent. Jar test for various concentrations of waste bricks were done. Best results were obtained when 10g of the coagulant was added. This sample was also tested for other parameters such as alkalinity and hardness. There was 42% of reduction on alkalinity, 50% of reduction on hardness, 78% of dye removal was also obtained which is quite satisfactory. Thus it can be concluded that waste bricks powder can be used for dye removal from textile effluents. After analysing the results of experiments it has come to an conclusion that waste bricks is very effective in extraction of dye from textile effluent. the project can be modified by varying the speed of rotators of jar test apparatus and also by varying stirring time.

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