Removal of Organic Pollutants In Dyeing Effluent By Using Activated Carbon Prepared From Henna Leaves

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Abstract- *The removal of organic pollutants from dyeing effluent by batch adsorption technique using low-cost adsorbent was investigated. The objective of the study was to find out a suitable low cost, environmental friendly and highly effective adsorbent. In the present study, low cost adsorbent Henna leaves was used. Physico-chemical studies of activated carbon from Henna Leaves were studied to identify its adsorption nature. The influence of contact time on the selectivity and sensitivity of the removal process was investigated with the help UV visible spectrophotometer. The removal of organic pollutant was more at 150 minutes.*

Keywords- Organic Pollutants, Dyeing effluent, UV visible spectrophotometer, Low cost, adsorbent

I. INTRODUCTION

Water is essential and inevitable for the survival of all known forms of life on earth. The current pattern of industrial activity alters the natural flow of materials and introduces novel chemicals into the environment[1]. Due to industrial revolution and improper treatment of effluents, the concentration of organic pollutants is constantly increasing in environment. One among the industrialization is dyeing and dye manufacturing industry. Effluents from this type of industries are the important sources of water pollution, because dyes in water undergo chemical as well as biological changes which consume dissolved oxygen and destroy aquatic life. Moreover, some dyes and their degradation products may be carcinogen and toxic[2.3]. Since synthetic dyes are complex aromatic compounds, they are more stable and more difficult to biodegradation. “Now-a-days, there are more than 10,000 types of dyes available commercially. The annual production of dyes worldwide is around 7×105 tonnes; 10–15% of the dyes are discharged into water bodies as effluents” [4, 5]. Dyeing effluents contains various organic pollutants like acetates, anhydrides, dyes, anthracene, benzene etc. They are responsible for a variety of adverse health effects. They impair human health and produce different behavioral, physiological and cognitive changes to an exposed individual. Hence, the presence of organic pollutants beyond the permissible level may cause poisoning, dysfunction of human organs like liver, kidney, reproductive system, central nervous system etc. Thus a greater effort needs to be put in for minimising these hazardous pollutants to avoid their dangerous effects on the biome.

The conventional dye effluent treatment methods like coagulation, flocculation, oxidation, photochemical destruction, ion exchange and membrane filtration are costly and require some additional chemicals [6,7].Hence, these methods are not much suitable to treat organic dye effluents. Among these methods adsorption is the most convenient method for treating the waste water. Activated carbon is the most commonly used adsorbent for the removal of various pollutants from wastewater[8, 9].

Adsorbents like acid activated carbon, Prosopis cineraria sawdust, micro- and mesoporous rice husk-based active carbon, de-oiled soya, hen feathers, neem leafs and mesoporous aluminophosphate molecular sieves have been used for the dyes removal [10-15].

A. Adsorption:

Adsorption is the most attractive method because it is a well established and powerful technique for treating domestic and industrial effluents. Activated carbons are used in various forms: powdered activated carbon (PAC), granular activated carbon (GAC) and fibrous activated carbon (FAC). Among these, the powered activated carbon is difficult to handle because of its finer particles size and as it causes a higher pressure drop in fixed beds which are difficult to regenerate.

The granulated activated carbon (GAC) has granules of 0.6 to 4mm in size and is hard, abrasion resistance and relatively dense to withstand operating conditions.GAC can be used again after regeneration by heat treatment in steam. The adsorption capacity of an activated carbon generally depends on the physico- chemical characteristics of the carbon surface, which include surface area, poresize distribution, electro-kinetic properties, and the chemistry of the carbon surface and nature of pollutants in the solutions. The activated carbon is characterised by strongly developed internal surface and possess a complex porous structures that consist of pores of different sizes and shapes. Consequently, the adsorption in micro pore is essentially a pore filling process in which the pore volume is the main controlling factor [16].

The adsorption process has many advantages such as low cost of adsorbent, easy availability of adsorbent, utilization of industrial, biological and domestic wastes as adsorbent, low operational cost, ease of Operation compared to other processes, re-use of adsorbent after regeneration, capacity of removing heavy metal ions over a wide range of pH and to a much lower level, ability to remove complex form of metals that is generally not possible by other conventional method, environment friendly, cost effective and technically feasible alternative due to utilization of biomaterials.

II. MATERIALS AND METHODS

Henna leaves were collected from nearby agricultural field in Salem District, Tamil Nadu. The collected materials were washed thoroughly with double distilled water and then dried at 80°C for about 36 hr. Finally, the dried matter was grinded by clean electric mixer and stored in clean plastic bag. The powder was activated by the addition of concentrated sulphuric acid (1:1) and the excess acid was removed by washing with double distilled water. Finally, acid activated carbon was placed in hot air oven at 110°C for 24 hr[3].

III. RESULTS AND DISCUSSIONS

A. Surface Morphology:

Surface Morphology of henna leaves activated carbon shows the activated carbon is porous. It can be seen from the figure 1 that the plant materials after carbonization have regular porous structures, which may be due to the change in lattice structure on carbonization and also due to evaporation of water of crystallization as well as free water molecule, additional cleavages in the lattice structure were created thereby increasing the porosity in the adsorbing material. SEM image of henna leaves activated carbon is given as Fig 1.

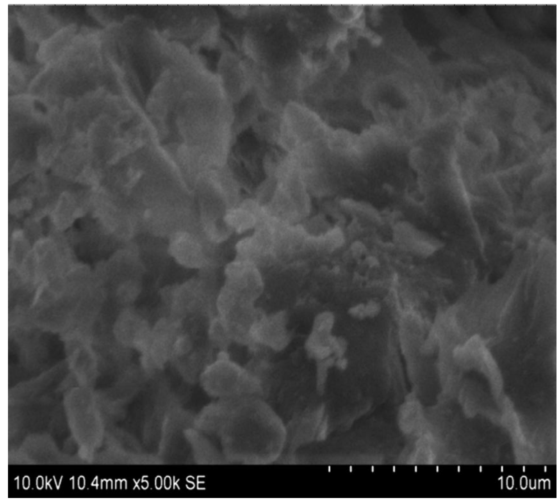

Fig.1 – Surface morphology of Henna Leaves Carbon

B. Powder X-ray Diffraction

Powder X-ray Diffraction (XRD) is one of the primary techniques used by chemists to examine the physicochemical make-up of unknown materials. The data are represented in a collection of single-phase X-ray powder diffraction patterns for the most intense d values in the form of table 1and XRD of Henna leaves is given as Fig 2.

Table - 1

Pos.(^{0}2ø)	Height (cts)	FWHM (^{0}2ø)	d-spacing (A^0)	Rel.Int.(%)
72.5204	62.48	0.5760	1.30238	100.00

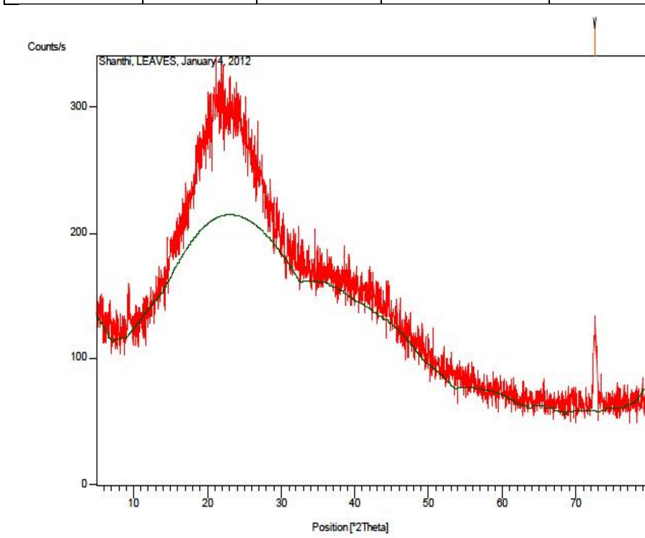

Fig 2 – XRD of Henna Leaves Carbon

C. BET theory

BET theory aims to explain the physical adsorption of gas molecules on a solid surface and serves as the basis for an important analysis technique for the measurement of the specific surface area of a material. BET equation is given by

$$\frac{1}{v\left[(P_0/P)-1\right]} = \frac{c-1}{v_m c}\left(\frac{P}{P_0}\right) + \frac{1}{v_m c}$$

where P and Po are the equilibrium and the saturation pressure of adsorbates at the temperature of adsorption, v is the adsorbed gas quantity (for example, in volume units), vm is the monolayer adsorbed gas quantity and c is the BET constant. The constants vm and c can be determined from slopes and intercepts of graph plotted between the relative pressure and the quantity adsorbed. Here the monolayer adsorbed gas quantity for henna leaves carbon Vm is 0.07385 and BET constant is 173.5973. It is tabulated in table.2. Fig 3 gives the idea of the BET isotherm of Henna leaves.

Table – 2

Adsorbent	Monolayer adsorbed gas Quantity (Vm)	BET constant(c)
Henna Leaves Carbon	0.07385	173.5973

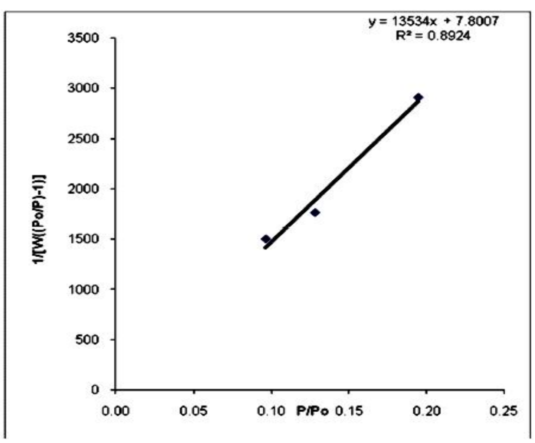

Fig 3 – BET isotherm of Henna Leaves Carbon

The physical values show that the activated carbon of henna leaves can be used for adsorption process.

D. Spectral Studies

Spectra indicate the effect of contact time on removal of organic pollutants. The effect of contact time was studied in the range of 60, 120,150,180 and 210. The spectra have taken for effluent also. It was found that equilibrium time to remove these metal ions was 150 min. These results are important, as equilibrium time is one of the important parameters in adsorption, when the time consumed for industrial wastewater disposal should be considered.

Before adding activated carbon to the effluent shows the peaks at within 372nm there are many sharp peaks and nearing 554nm they begins to reduce. The activated carbon was added to effluent in the time variation of 60,120,150,180 and 210. The spectra 1 show sharp peak within 372nm. For 120 minutes there were no peaks. The spectra 2, 3,4 and 5 (60,120,150 and180) shows clear spectra, whereas spectra 6 shows sharp peak at 210.

Fig 4 spectra1 shows many peaks within 372. This shows the detection of isolated chromophores. Many other kinds of conjugated pi-electron systems also act as chromophores and absorb light in the 200 to 800 nm region.

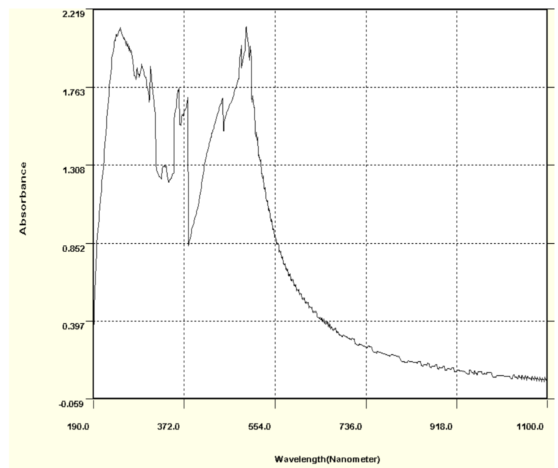

Fig.4 – Spectra 1for effluent

Compounds that are colored to our eye must be much conjugated (the lowest wavelength human eyes detect is ~370 nm). Normally the peaks appeared within 190 -372 nm indicates the presence of C=O, N=O, C-X X=Br or I and the absorption between 420 to 520nm gives color to the pollutant. It is the indication of the presence of unsaturated aldehydes and ketones and aromatic ring compounds. In fig 4 spectra1within 554nm there are two sharp peaks. So the effluent may contain unsaturated aldehydes and ketones and aromatic ring compounds and it gives the reddish yellow to the effluent. Fig 5, 6, 7 and 8 shows no significant peaks. Fig 9 spectra 6 shows one sharp peak within 260nm and it indicates that readsorption begins.

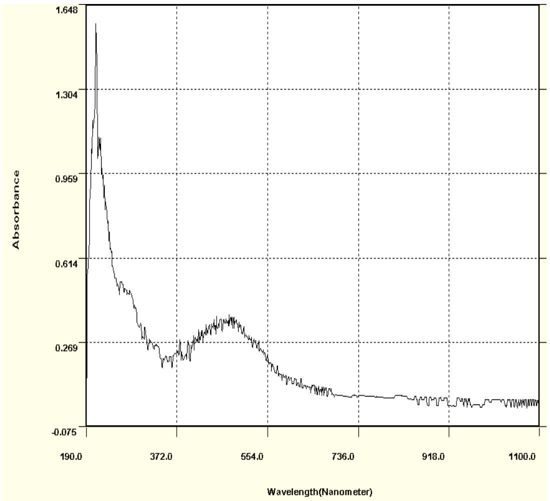

Fig.5 – Spectra 2for 60 minutes

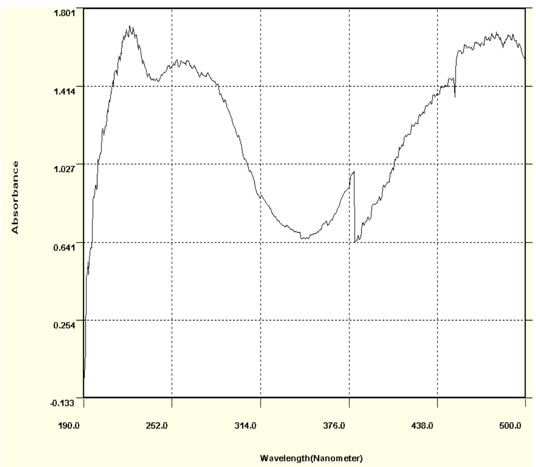

Fig.6 – Spectra 3 for 120 minutes

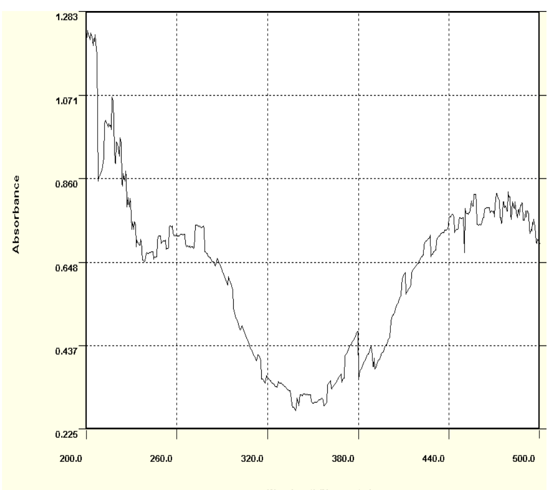

Fig.7 – Spectra 4 for 150 minutes

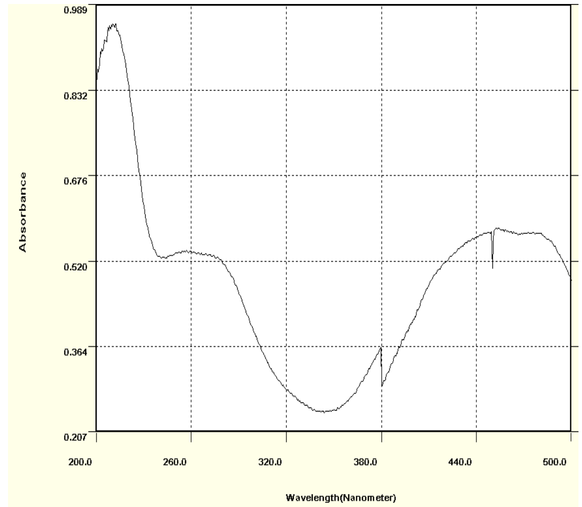

Fig.8 – Spectra5 for 180 minutes

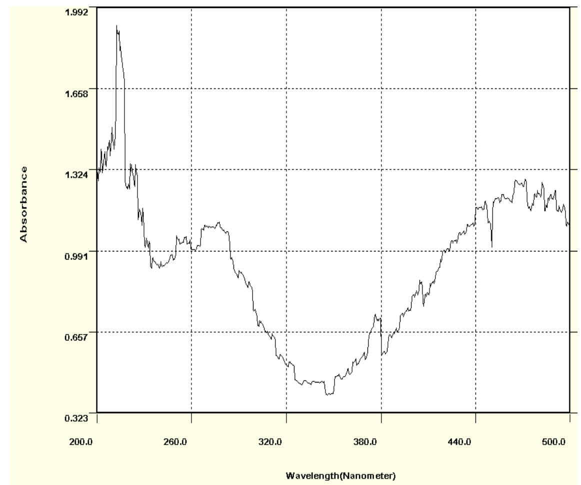

Fig.9 – Spectra 6 for 210 minutes

IV. CONCLUSION

Spectra 4 sharp peak shows the presence of 1,3 butadiene, unsaturated aldehydes, carbonyl group conjugated with a double (=) bond and quinine yellow. Spectra 5, 6, 7 and 8 show the absence of organic substances. Spectra 9 show the presence of 1, 3 butene-3-yne. So the optimum time taken for the removal of organic pollutants was 150 minutes. Agricultural wastes like henna leaves can be used for the removal of organic pollutants.

V. SCOPE FOR FURTHER STUDY

Carbons from leaves can be prepared by other activation methods such as steam activation, phosphoric acid activation, thermal, $ZnCl_2$ activation, KOH activation etc and applied for the removal of persistant organic pollutants.

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