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Title Key: Ecofriendly Adsorbent For Dye Removal...

Ecofriendly Adsorbent For Dye Removal

C.S. Patil [1] and Sonali S. Chine [2]

1st Associate Professor,
Deprtment of Chemistry, Deogiri College, Aurangabad
(Dr.B.A.M.U, Aurangabad), MS, India
Email: chabu251962@yahoo.co.in

2nd Assistant Professor,
Department of Engg. Sciences,
Sanjivani College of Engineering, Kopargaon
(S.P.P.U,Pune), MS, India
Email: sonalichine85@gmail.com

Abstract
Textile, food, plastic industries produce large amounts of coloured effluents that are normally discharged to surface water bodies and ground water aquifers cause major source of water pollution. Dyes are generally stable to light and oxidation and hence they cannot be treated by conventional methods of aerobic digestion. Amongst ample of techniques of pollutant removal, adsorption is an efficient process, but only that of adsorption is considered to be superior in comparison with the other techniques of waste water treatment when adsorbents with low cost, easily available, high efficiency, ease of operation, biodegradability and the ability to treat dyes in high concentration form. This study investigates the potential use of saw dust pretreated with concentrated acids, for removal of Congo red dye from synthetic solution through varying dye concentration, adsorbent dosage, contact time and pH. The sorption data were then correlated with the freundlich and the Langmuir adsorption isotherm models. The maximum color removal efficiencies of saw dust at dosage of 40 mg/l for time duration of 90 min found to be up to 86% of the dye from an aqueous solution also it shows better results in acidic nature. From the study it is understood that pH, contact time and adsorbent dosage plays a vital role in removal of congo red dye.

Keywords: adsorbent, Congo red, dye, ecofriendly, saw dust,

1. Introduction

Industrial, agricultural, and domestic activities of humans have affected the environmental system and the generation of wastewater containing high levels of pollutants. The release of color materials from industrial wastewaters into streams, rivers etc. causes water pollution. The color organic material in the effluent is nothing but dyes.

Dyes are ionic, aromatic organic compounds with structures including aryl rings having delocalized electron system. The color of dye is due to the presence of chromophore and increases due to presence of auxochrome[1]. When question of textile mill is to be arise conventional technologies are used for dye

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removal include ion exchange, chemical precipitation, chemical adsorption, reverse osmosis, etc. which are expensive and also harmful to environment The conventional methods of dye removal also includes use of alum, ferric chloride, activated carbon, lime etc.(3) Dyes cannot be treated by conventional methods of aerobic digestion because of stability towards light and oxidation(2). Textile industry effluent generally treated by either physical or chemical processes. Most commonly used and effective method of dye removal is adsorption (5). In this activated carbon used as an adsorbent. The commercially available activated carbon is very expensive & it's preparation in laboratory poses several problems such as pore blocking, hygroscopy etc.(4) Thus it's necessary to give efficient & cheaper adsorbent for dye removal.

Recently use of low cost adsorbent material to remove dyes has been reported by several workers [18]. Saw dust is the byproduct of woodworking operations like milling, planning, routing, drilling etc. Generally it's being considered as waste material. We search out the potential of such low cost adsorbent material in removal of dye from solution. We have investigated adsorption characteristics of Congo red dye-saw dust systems on a laboratory scale.

2. Materials & Methods:

Importance of Activation:

Activation of adsorbent material increase the surface area available for adsorption, thus increasing the adsorption efficiency of a material that is to be used as an adsorbent.. Chemical activation is preferred over physical activation owing to the lower temperatures and shorter time needed for activating material.

we have used saw dust as adsorbent material. Saw dust principally consists of Fe_2O_3, Al_2O_3,SiO_2, MgO, CaO (Wet chemical analysis). These components make the saw dust to be a potential adsorbent material for dye removal from aqueous solution.

Experimental Work:

Preparation of Adsorbent materials:

a. Process before activation:-

Saw dust were collected from saw mill and dried in natural sunlight for 4 to 5 days and then sieved through 300 micron sieves. The 300 micron particles size powdered material of saw dust was selected for adsorption and PH study.

b. Process of activation:-

The above made saw dust was then washed with distilled water for 2 to 3 times and activated using acid solution. 10 gm saw dust mixed with 200 ml water and 5 ml of HCl was added to it. It was then stirred for about 30 minutes at 80^0C on magnetic stirrer. The saw dust was filtered and dried in natural sunlight for one day, bio adsorbent was ready.

Procedure for preparation of congo red solution:-

For preparation of Congo red solution, 1 gram Congo red powder mixed with 1 liter distilled water. A stock solution of congo red dye with concentration of 1000 ppm was prepared.

Characteristics of Congo red dye:

Congo red dye is benzene based dye. This dye has been known to cause an allergic reaction and to be metabolized to Benzedrine. Its decomposition results in carcinogenic products .It acts as a skin, eye and gastrointestinal irritant. It impresses blood factors such as clotting and induces drowsiness and respiratory problems. As suggested by its intense red color, Congo red has important spectrophotometric properties. Aggregation of the dye and binding to amyloid fibrils tends to red-shift in the absorption spectrum, whereas binding to cellulose fibers has the opposite effect.[21]

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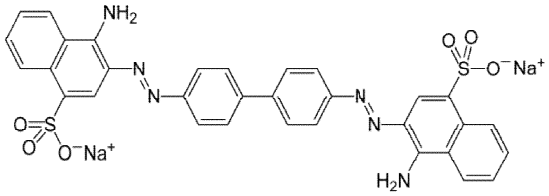
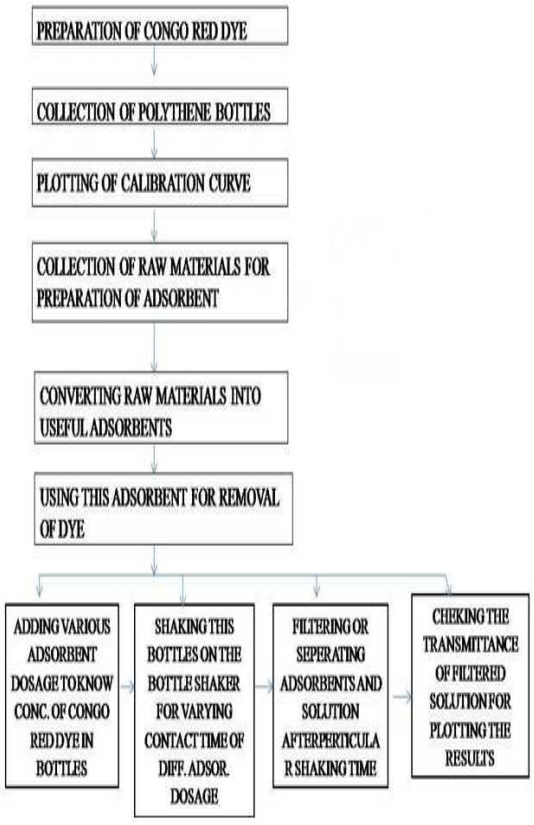
2.1. Figure Structure of congo red dye



As various methods are available to us to carry out the adsorption process we have chosen bottle shaking method for our experiments as this method provides complete and continuous mixing of materials (adsorbent as well as adsorbate) in the bottle for a particular time period we set.

2.2. Figure Experimental flow chart



In each adsorption experiment, dye solution of known concentration and pH was added to adsorbents in bottles at room temperature and the mixture stirred on a rotary orbital shaker at 150 rpm. The sample withdrawn from the shaker at the predetermined time intervals for 10 minutes each. At the end of 10 min, the agitated sample taken from the shaker. The sample was filtered using Whatman no. 42 filter paper and the filtrate was analysed for residual congo red dye concentration by standard method by A.P.H.A (16^{th} edition 1985) UV-Visible Spectrophotometer at the wavelength of 570nm described in standard methods of examination of water and wastewater.

The percent removal of the congo red dye was calculated as follow

$$\% \text{ Removal} = \frac{\text{Ci} - Ce}{\text{Ci}} \text{X } 100$$

Where Ci is the initial Congo red dye concentration ($mg.l^{-1}$), Ce is the equilibrium concentration of Congo red dye solution ($mg.l^{-1}$).

3. Results And Discussion:

Effect of Agitation time and concentration of dye on congo red dye removal:

In dye removal, agitation time and concentration of dye plays important role. The effect of agitation time on adsorption of congo red dye onto saw dust is shown in Fig.3. The color removal efficiencies of the adsorbents have a break through at 90 minutes duration, in which there is no further considerable color removal takes place. The congo red found to be much effective with color removing efficiency of 86%.

Effect of adsorbent dose on adsorption

Studies on effect of adsorbent doses were conducted by varying adsorbent doses between 20 to 100mg/l. The pH was maintained at 4, while initial phosphate ion concentration was fixed at 100 mg/L and contact time was kept as 90 minutes. The response of adsorbent dose on the removal

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of Congo red dye is presented in Fig.3. The results showed that saw dust was efficient for 86 % removal of Congo red dye at the dose of 40 mg/l.

Effect of pH on Adsorption

The pH of the aqueous solution is a controlling factor in the adsorption process. Thus, the role of pH at 4, 7, & 9 was observed. The influence of pH on extent of sorption is shown in Fig.5.It shows better results in acidic nature as in alkaline, whereas from pH 7 onwards it remains constant.

4. Conclusion:

The Congo red dye removal from aqueous solutions using low cost, biodegradable adsorbent material saw dust has been studied by considering the effect of time, adsorbent dosage and pH. Adsorption capacity of saw dust is about 86% but less than that of activated carbon.

Future Outlook:

An economical treatment process for the removal of dye from industrial effluents can be designed and optimized using this study.

Table 1: Dye removal % efficiency at diffierent concentration for varying time

Concentration	10 min	20 min	30 min	40 min	50 min	60 min	70 min	80 min	90 min	100 min
20mg/l	68.2	69.5	71.1	73.2	73.49	74.7	76.2	77.5	78.2	77.9
40 mg/l	75.6	77.1	79.5	80.2	81.9	83.45	84.2	85.1	87.2	86.3
60 mg/l	74.3	76.51	77.8	79.4	79.9	80.2	80.8	81.2	83.3	82.6
80 mg/l	61.4	62.4	66.41	67.5	70.1	72.3	74.1	79.81	80..1	81.9
100mg/l	58	61.3	63.5	65.8	66.9	68.6	71.4	74.27	75.2	73.19

2.3 Figure Effect of agitation time and concentration of dye on CR removal

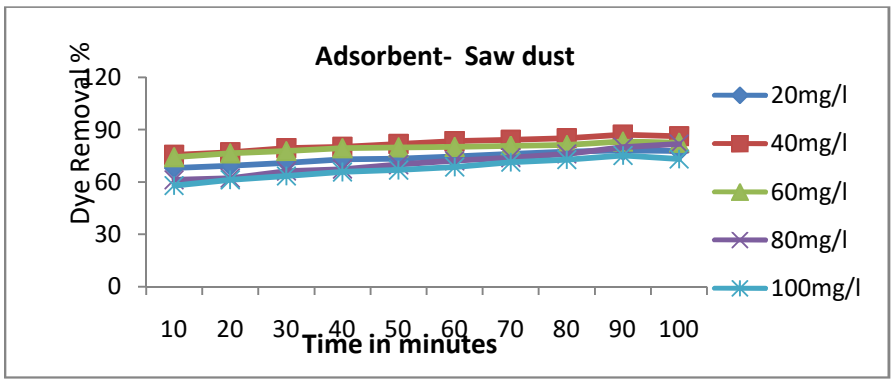

Table 2: Dye removal % efficiency at conc. 40mg/l for varying time

Concentration	10 Min	20 Min	30 Min	40 Min	50 Min	60 min	70 min	80 min	90 min	100 min
Saw dust 40mg/l	75.6	77.1	79.5	80.2	81.9	83.45	84.2	85.1	87.2	86.3

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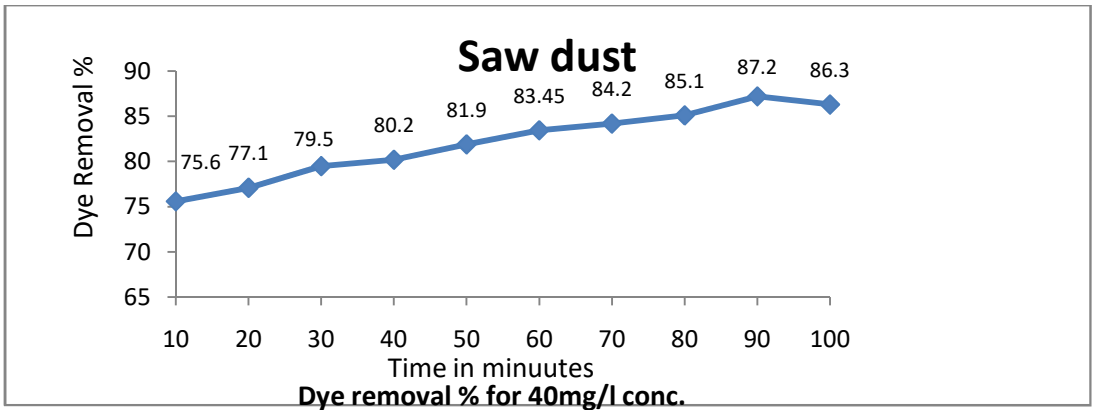
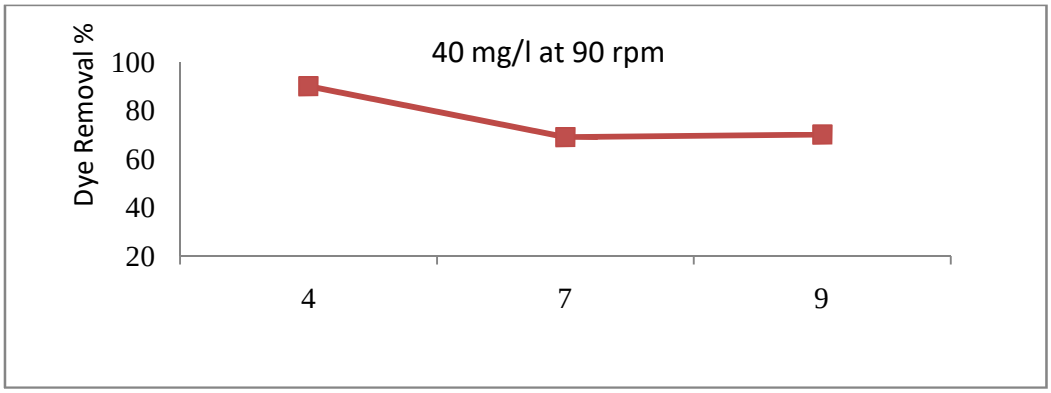
2.4. Figure Effect of agitation time and initial concentration of dye on CR removal



2.5. Figure Effect of pH of Solution (40 mg/l) on Congo red dye removal for saw dust



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