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# Congo Red Dye removal from aqueous solution using low cost adsorbent

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**Abstract-**The treatment of dyes in industrial wastewaters poses several problems as dyes are generally stable to light and oxidation and hence they cannot be treated by conventional methods of aerobic digestion. Amongst the numerous techniques of pollutant removal, adsorption is an effective and useful process. Specifically when searching for natural raw materials as a possible source that could provide a successful low cost solution for adsorption. This study investigates the potential use of groundnut shells and coconut shells pretreated with concentrated acids, for removal of Congo red dye from synthetic solution through varying dye concentration, adsorbent dosage, contact time and pH. The maximum color removal efficiencies of groundnut shell at a dosage of 120 mg/l for time duration of 120 min found to be up to 57% and for coconut shell at a dosage of 120 mg/l for time duration of 120 min found to be up to 71% of the dye from an aqueous solution also it shows better outcomes in acidic nature. With this cheap and ecofriendly adsorbent considerable dye removal can be achieved. So, it can be substituted for expensive activated carbon. With the experimental data obtained in this study, it is possible to design and optimize an economical treatment process for the dye removal from industrial effluents.
**Keywords-**Congo red dye, adsorbent, Groundnut shell, Coconut shell, dose

## "I. INTRODUCTION"

The various industries such as textile, paper, plastic, food, dye etc. produces color organic effluent. The release of color materials from industrial wastewaters into streams, rivers, etc. causes serious water pollution. The color is an organic material in the effluent is nothing but dyes. The color of the dye is due to the presence of chromophore group. Along with the chromophore presence of auxochrome results in maximum adsorption of the compound providing bonding affinity & having high stability [1]. The conventional methods of removal of dye using alum, ferric chloride, activated carbon, lime, etc. are the treatments of dyes in industrial wastewater creates several problems as the dyes are generally stable to light & oxidation, hence they cannot be treated by conventional methods of aerobic digestion [2]. It is usually treated by either physical or chemical processes.

The adsorption process is one of the effective methods for removal of dyes from effluent [5]. The commercially available activated carbon is very expensive & preparation of activated carbon in laboratory accompanied by several problems such as combustion at high temperature, pore blocking, hygroscopy etc. [2].Thus the growing demand for efficient & low cost treatment methods has given rise to use of low cost adsorbents.

In this paper adsorption characteristic of Congo red dye-coconut shell & Congo red dye-ground nut shell systems on a laboratory scale have been investigated.

 

## "II. MATERIALS AND METHODS"

### 2.1. Importance of Activation

A material is processed to be riddled with small, low-volume pores that increase the surface area available for adsorption or chemical reactions. An activation level sufficient for useful application may be attained solely from the high surface area; however, further chemical treatment often enhances adsorption properties. We have used two materials as adsorbent materials. Preparation of these materials has been carried out in a similar way, and procedures followed as given below:

### 2.2Preparation of Adsorbents

#### 2.2.1. Groundnut Shells

**Process of activation:-**The above made powder of shells was then washed with distilled water for 2 to 3 times for removing dust particle present in it. Then this powdered mixture and distilled water was sieved by using sieve having size 300 micron, after that collect the retained mixture that. The powder was kept in open for air drying and then placed it in oven at $30^0$C for one hour, then this powder was again dried in sunlight for 5 to 6 hours, that bio-sorbent was ready.

#### 2.2.2. Coconut Shells

**Process of activation-**The dried coconut shell was then activated by washing it with distilled water for 4 to 5 times, and then it was dried in sunlight. The dried coconut shells were then grind to make it powdered form. Collect powder which is passing through 600 micron sieve and retained on 300 micron.

#### 2.2.3 Procedure for Preparation of Congo-Red dye Solution

Congo red dye solution is prepared by using 1 lit distilled water and 1 gm of Congo red powder through mixing properly. A stock solution of Congo red dye with a concentration of 1000 ppm was prepared and dilutions were made with distilled water to make different concentrations ranging from 10- 50 ppm.

### 2.3Characteristics 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 problem.

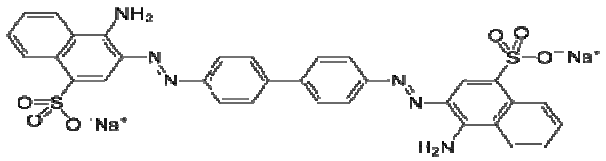


*Figure 1.Structure of Congo red dye*

### 2.4 Experimental Work

Removal of Congo red dye from aqueous solution by using adsorption process. The batch study was performed to determine the optimum condition and to study the effect of pH, adsorbent

 

dose and contact time on the test solution. At the end of the desired contact time, the samples was filtered using Whatman no. 42 filter paper and the filtrate was analyzed for residual congo red dye concentration by standard method by A.P.H.A, (16th edition1985),(UV-VIS spectrophotometer: Model No. Shimadzu UV 1240) at the wavelength of 570 nm described in the standard methods of examination of water and wastewater.
The percent removal of the congo red dye was calculated as follow

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

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

## "III. RESULTS AND DISCUSSION"

Understanding of adsorption technique is possible with knowledge of the optimal conditions, which would herald a better design and modeling process. Thus, the effect of some major parameters like effect of contact time and Initial Congo red dye concentration. pH, dose of adsorbent were investigated from kinetic viewpoint. Adsorption studies were performed by batch technique to obtain the equilibrium data. All the experiments were conducted at room temperature ($29 \pm 0.5$ $^{o}$ C).

### Effect of Agitation time and Initial Congo red dye concentration

Contact time plays a very important role in adsorption dynamics. The effect of contact time on adsorption of Congo red dye onto groundnut shell and coconut shell is shown in Fig.2 & Fig.3. In each adsorption experiment, dye solution of known concentration at defined pH was added with adsorbent in shaking bottles at room temperature and the blend stirred on a rotary orbital shaker at different rpms.The sample withdrawn from the shaker at the fixed time intervals,then agitated samples from the shaker are tested for its transmittance in spectrophotometer to know color removal efficiency of the adsorbent. The color removal efficiencies of the adsorbents have a breakthrough at 120minutes duration, in which there is no further considerable color removal takes place. The coconut shell found to be much effective with color removing efficiency of71%.The results for dye removal efficiencies of both adsorbents with respect toagitation time and concentrations are given in Table 1 and Table 2.

### Effect of Adsorbent dose on Adsorption

Studies on effect of adsorbent doses were conducted by varying adsorbent doses between 20 to 120mg/l. The pH was maintained at 4, while initial phosphate ion concentration was fixed at 100 mg/L and contact time was kept as 120 minutes. The response of adsorbent dose on the removal of Congo red dye is presented inFig.2 & Fig.3. The observations reveal that an increase in the adsorption occurs with the corresponding increase in the amount of adsorbent. The increase in the removal efficiency with simultaneous increase in adsorbent dose is due to the increase in surface area, and hence more active sites were available for the adsorption of Congo red dye. The results showed that coconut shell was efficient for 71 % removal of Congo red dye at the dose of 120 mg/l, and groundnut shell shows 57 % removal of Congo red dye at the dose of 120 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.

 

**Comparison of Adsorbents**

Also in present study comparison of removal efficiency of groundnut shell and coconut shell is carried out is shown in Fig.4

***Table 1. Colour dye removal (%) for Groundnut Shell***

| Concentration (mg/l) | 5 min | 10 min | 20 min | 30 min | 40 min | 50 min | 60 min | 80 min | 100 min | 120 min |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 49.25 | 49.49 | 49.96 | 50.43 | 50.91 | 51.38 | 51.85 | 52.8 | 53.74 | 54.68 |
| 40 | 49.88 | 50.12 | 50.59 | 51.07 | 51.54 | 51.90 | 52.48 | 53.43 | 54.37 | 55.32 |
| 60 | 50.2 | 50.1 | 51.22 | 51.3 | 52.13 | 52.64 | 53.11 | 54.06 | 55 | 55.35 |
| 80 | 51.15 | 51.38 | 51.86 | 52.33 | 52.8 | 53 | 53.75 | 55 | 55.63 | 56.58 |
| 100 | 51.78 | 52.02 | 52.49 | 52.96 | 53.43 | 53.6 | 54.38 | 55.17 | 55 | 57.21 |
| 120 | 52.41 | 52.65 | 53.12 | 53.59 | 54.06 | 53.6 | 55.01 | 55.95 | 56.9 | 57.84 |

***Table 2. Colour dye removal for (%) Coconut Shell***

| Concentration (mg/l) | 5 min | 10 min | 20 min | 30 min | 40 min | 50 min | 60 min | 80 min | 100 min | 120 min |
|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 32.16 | 33.78 | 37.15 | 40.24 | 43.48 | 46.7 | 49.9 | 56.4 | 62.87 | 69.34 |
| 40 | 32.63 | 34.24 | 37.48 | 40.7 | 43.94 | 47.18 | 50.41 | 56.87 | 63.34 | 69.81 |
| 60 | 33.09 | 34.71 | 37.94 | 41.18 | 44.41 | 47.64 | 50.88 | 57.34 | 63.81 | 70.27 |
| 80 | 32.79 | 34.4 | 38.41 | 41.64 | 44.88 | 48.11 | 51.34 | 57.81 | 64.27 | 70.74 |
| 100 | 34.03 | 35.64 | 38.88 | 42.11 | 45.34 | 48.58 | 51.81 | 58.27 | 64.74 | 71.21 |
| 120 | 34.49 | 36.11 | 39.34 | 42.58 | 45.81 | 49.8 | 52.28 | 58.74 | 65.21 | 71.67 |

***Table 3. Comparative Dye removal % efficiency at Concentration 120 mg/l for varying time***

| Adsorbent | 5 min | 10 Min | 20 min | 30 min | 40 min | 50 min | 60 min | 80 min | 100 min | 120 Min |
|---|---|---|---|---|---|---|---|---|---|---|
| Groundnut Shell | 52.41 | 52.65 | 53.12 | 53.59 | 54.06 | 53.6 | 55.01 | 55.95 | 56.9 | 57.84 |
| Coconut Shell | 34.49 | 36.11 | 39.34 | 42.58 | 45.81 | 49.8 | 52.28 | 58.74 | 65.21 | 71.67 |

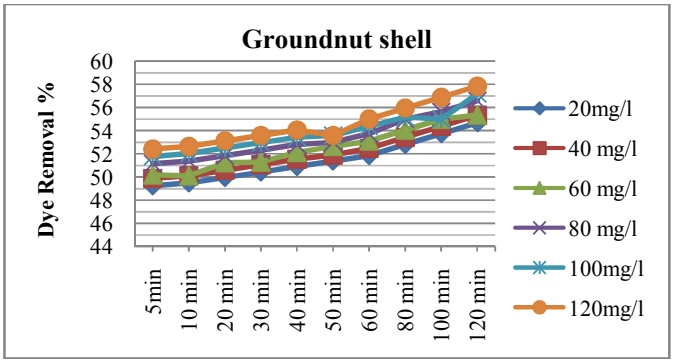


***Figure 2. Effect of Agitation time and Initial concentration of dye on Congo red dye removal for Groundnut Shell***

 

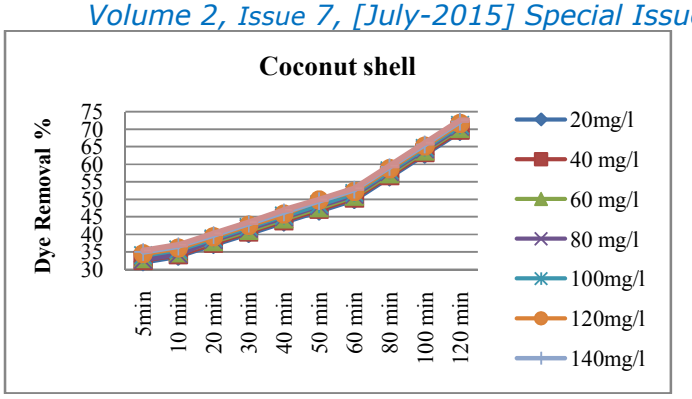


*Figure 3. Effect of Agitation time and Initial concentration of dye on Congo red dye removal for Coconut Shell*

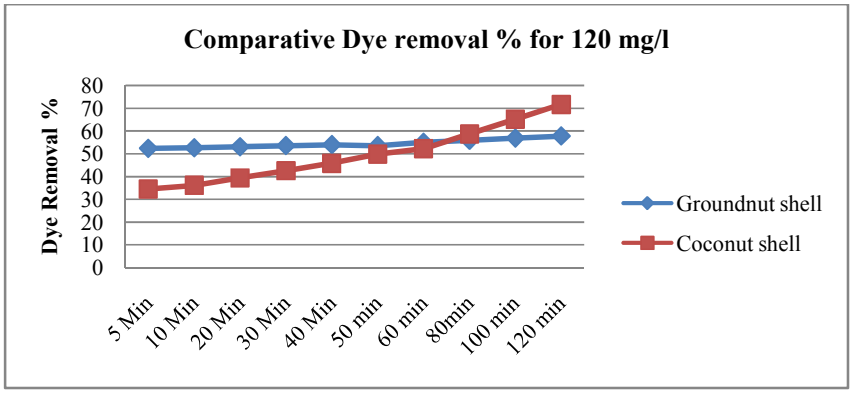


*Figure 4.Comparisonof Congo red dye removal for Groundnut Shell and Coconut Shell*

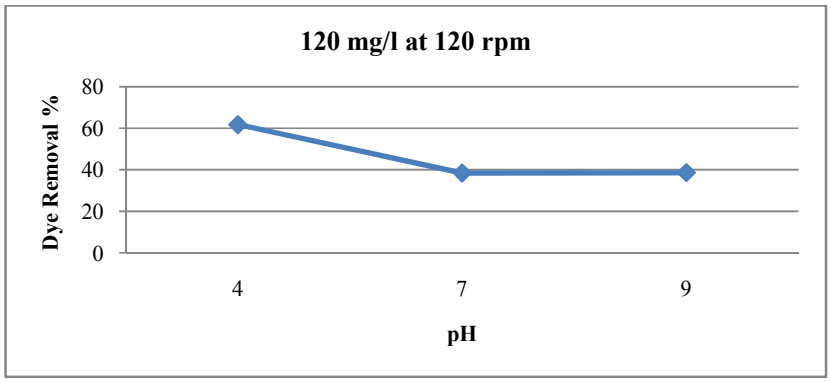


*Figure 5. Effect of pH of Solution (120 mg/l) on Congo red dye removal for Groundnut Shell and Coconut Shell*

## IV. CONCLUSION

The removal of color from aqueous solutions and wastewaters using two low cost adsorbent materials coconut shell and groundnut shell has been studied by considering the effect of agitation time, adsorbent dosage. Even though the adsorption capacity of treated materials is less than that of activated carbon but they are agro-industry waste & are cheaply available.

With this low-cost and ecofriendly adsorbent considerable dye removal can be achieved. So, it can be substituted for expensive activated carbon. With the experimental data obtained in

 

this study, it is possible to design and optimize an economical treatment process for the dye removal from industrial effluents.

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