

# ADSORPTION STUDIES OF COLOUR REMOVAL BY ACTIVATED CARBON DERIVED FROM MANGIFERA INDICA (MANGO) SEED SHELL

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## Abstract

The removal of colour from silk filature composite wastewater by adsorption on activated carbon prepared from Mangifera Indica (mango) seed shell has been carried out at room temperature  $32 \pm 1^\circ \text{C}$ . The removal of colour from silk filature composite wastewater sample by adsorption on chemical activation (Magnesium chloride) with Impregnation ratio's (I.R) 0.25, 0.50, 0.75 for optimum time, optimum dosages and variation of pH was studied. It is observed that as dosage increases the adsorption increased along with the increase in Impregnation ratio. It was also noted that as I.R. increases the surface area of Mangifera Indica shell carbon increased. Hence the maximum removal efficiency is obtained at I.R ratio of 0.75. The optimum contact time, dosage and pH for carbon with I.R-0.75 was 45min, 100mg and 5.5 with removal efficiency of 81.11%, 96.66% and 96.66% respectively.

**Keywords:** Colour, Contact time, Dosage, Kinetics, pH, Mangifera Indica.

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## 1. INTRODUCTION

The main sources of colour pollution in the water derives from industrial production process such as textile, paper and pulp, carpet, leather, distillery and printing industries pose severe pollution problem. Colour being a visible pollution it often causes more trouble for industry than invisible pollution. Various processes tried so far for the removal of colour are aerobic and anaerobic microbial degradation, chemical oxidation, membrane separation, dilution, electrochemical treatment, adsorption etc. Adsorption by activated carbon is of interest because of the large surface area they present for pollution removal. Activated carbon made from easily available agricultural wastes can serve as an economically available alternative. In this research the shell of Mangifera Indica (Mango) is used as an adsorbent, which is a waste material causing litter. The present study is undertaken to study the suitability of activated carbon derived from Mangifera Indica (Mango) shell for colour adsorption from wastewater sample and its characteristics were studied.

Zehra Sapci, Beyza Ustun (2003) has been studied on removal of COD and colour from textile wastewater using Waste pumice as an adsorbent. Lime ( $\text{Ca}(\text{OH})_2$ ) as the main chemical reagent and also  $\text{FeSO}_4$  as a co-reagent were used in this study. The combination of these chemicals and adsorbent was given maximum colour and COD removal efficiency as 87% and 91% respectively. [1]

Milind R. Oidde, Julie Dutta, Snehal Jadhav (2008) have been studied on activated Rice Husk (ARH) and Rice Husk Ash (RHA) was used as adsorbents for decolourisation of wastewater containing methylene blue. Colour removal efficiency was found to be 88% to 94% at the dose of 20 g/L for ARH and 80% to 95% at the adsorbent dose of 2.5 g/L for RHA. The studies were carried out at methylene blue concentration of 50 mg/L, 30 mg/L and 10 mg/L. The Linear, Langmuir and Freundlich adsorption isotherms are good fitted for the experimental data. [2]

Gang sun and Xiangjing Xu (2010) have studied the adsorption using sunflower stalks as adsorbents for two basic dyes (methylene blue and basic Red 9) and two direct dyes (Congo Red and Direct Blue 71) in aqueous solutions were studied with equilibrium isotherms and kinetic adsorptions. [3]

### 1.1 Objectives of the Study:

The objectives of the present study are the preparation of chemically activated carbon by using magnesium chloride as an activating agent, to study the physico-chemical properties of the prepared carbon and detection of colour removal as a function of contact time, dosage and pH.

## 2. MATERIALS AND METHODS

### 2.1 Material

The material used for preparing carbon was shell of *Mangifera Indica* (Mango). The scientific name of this fruit is *Mangifera Indica*, from family Anacardiaceae..

#### 2.1.1. Characteristics of *Mangifera Indica* (Mango)

##### Shell Carbon:

Before using the *Mangifera Indica* (mango) shell carbon as an adsorbent, the characteristics such as moisture content, ash content, pH, decolorizing power, surface area, specific gravity and bulk density of the prepared carbon are studied. The results are shown in **Table-1**

All the methods of analysis are as per "Standard Methods for the Examination of Water and Wastewater", 19<sup>th</sup> edition [4].

**Table-1** Characteristics of Prepared Activated Carbon

Sl.No.	Characteristics	Chemically activated		
		MgCl <sub>2</sub>		
		0.25	0.50	0.75
1	Moisture content (%)	19.00	20.00	20.50
2	Ash content (%)	20.37	23.75	24.52
3	Decolorizing power, (mg/g)	27.00	28.50	31.50
4	Surface area, (m <sup>2</sup> /g)	505.84	859.94	935.81
5	pH	6.8	6.4	5.9
6	Specific gravity	0.465	0.823	1.023
7	Bulk Density, (g/cm <sup>3</sup> )	0.423	0.423	0.406

### 2.2 Methods

#### 2.2.1 Preparation of Activated Carbon Using MgCl<sub>2</sub> as

##### Activating Agent:

The known quantity of washed and dried *Mangifera Indica* (Mango) shell powder of size 300 Micron was mixed with the activating agent (MgCl<sub>2</sub>), in required quantity, depending upon the impregnation ratio (I.R).

$$\text{Impregnation ratio (I.R)} = \frac{\text{Weight of the active agent added}}{\text{Weight of carbonizing material}}$$

In that mixture required quantity of distilled water was added and boiled on hot plate till most of the water evaporated and slurry like mixture was retained. After that the mixture was oven dried in a clean tray for 24 hours maintained at 105±5°C which helps in evaporation of moisture from the mixture. Preheated carbonizing material was filled in the small container in three layers, by compacting each layer without any air space to avoid the loss in weight of the powder; otherwise it would result in burning of the material directly leaving behind only the ash. The small container is then placed into a big container, such that sand surrounded the small container completely, the lid of the big container was tightly fitted. Pin hole has been made on the lids of the containers for the escape of organic vapours. Then the setup is kept in Muffle furnace and heated at steady rate to attain the temperature of 800°C. Thirty minutes after attaining the 800°C temperature the furnace was allowed to cool for about 10 hours and then the container is taken out. Activated carbon thus prepared was washed with 0.1N HCl to remove the activating agent, followed by hot distilled water for about 8 times to remove the excess HCl present in the activated carbon. The activated carbon was dried at 105±5 °C then packed in polythene bags and kept in desiccator. [5]

#### 2.2.2 Batch Sorption Experiment

In batch sorption, a pre-determined powder of adsorbent is mixed with the sample, stirred for a given contact time and subsequently separated by filtration. Powder adsorbent is more suitable for the batch type contact process.

#### 2.2.3 Selection of Optimum Contact Time:

The adsorption is strongly influenced by the contact time. To study the effect of contact time, 25mL of filtered wastewater (10% dilution) sample, was mixed with 0.1g of activated carbon, stirred at different contact times varying from (5mins, 10mins, 15mins up to 60mins). Then filtrate was analyzed for residual colour concentration using spectrophotometer.

#### 2.2.4 Determination of Optimum Dosage of

##### Adsorbent:

To determine the optimum dosage of activated carbon, adsorbent is added to the conical flask in different dosage varying from (20mg, 40mg, and 60mg up to 300mg), containing 25mL of filtered wastewater (10% dilution) sample. The solution in the conical flask is subjected to stirring for pre-determined optimum contact time, filtered and analyzed for residual colour concentration.

The dosage which gives minimum residual concentration is chosen as optimum dosage.

**2.2.5 Selection of Optimum pH:**

The extent of adsorption is strongly influenced by the pH at which adsorption is carried out. The effect of pH on colour adsorption was studied by performing equilibrium adsorption tests at different initial pH values. i.e. from 4.5 to 8.0 at an interval of 0.5. The pH of solution was adjusted by using 0.1N H<sub>2</sub>SO<sub>4</sub> or 0.1N NaOH. The maximum concentration of colour removal forms optimum pH.

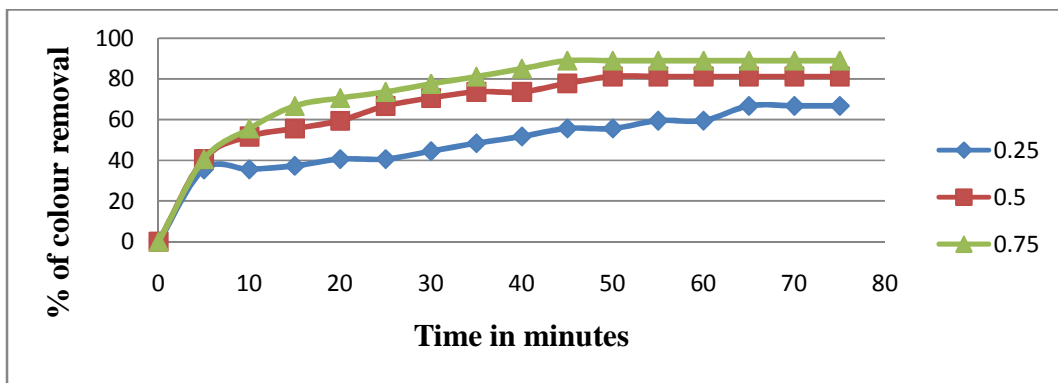
**3. RESULTS AND DISCUSSIONS**

The efficiency of removal of colour is studied in terms of:

- a) Effect of contact time
- b) Effect of dosage
- c) Effect of pH

**3.1 Effect of Contact Time:**

Contact time has greater influence in the adsorption process. The effect of contact time on removal of colour from wastewater sample using chemically activated (MgCl<sub>2</sub>) carbon prepared from MangiferaIndica (Mango) shell with I.R. 0.25, 0.50 and 0.75 are shown in figure 1. As I.R. increases optimum time decreases due to the increase in surface area. Optimum contact time for all prepared carbons is listed in table-2.

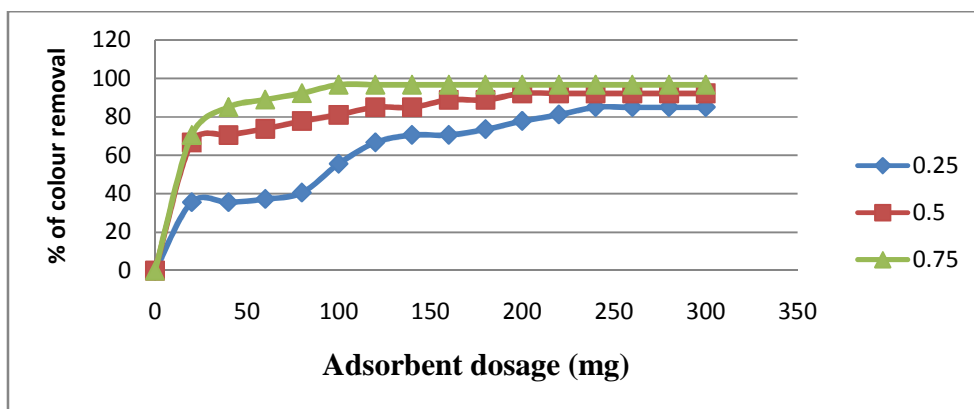


**Fig1** Effect of Contact Time on Colour Removal by Chemically (MgCl<sub>2</sub>) Activated Carbon

**3.2 Effect of Adsorbent Dosage:**

Effect of adsorbent dosage is studied and graph of percentage of residual colour removal versus dosage is plotted as shown in figure 2. From the graph it is observed that, as the dosage of carbon increases, amount of residual colour decreases sharply and attains equilibrium. The dosage, at which maximum

removal is attained, is taken as optimum dosage. After this not much change is observed even after increase in the amount of carbon dosage. The optimum dosage for all prepared carbon are listed in table-2



**Fig.2.**Effect of Adsorbent Dosage on Colour Removal by Chemically (MgCl<sub>2</sub>) Activated Carbon

### 3.3 Effect of pH on Colour Removal:

The pH of solution has influence on the extent of adsorption removal efficiencies of colour by prepared activated carbon at different pH values are shown in figure 3. From the figures, it is observed that colour is removed more effectively in acidic

range. As pH increases, the removable efficiency decreases appreciably. This is due to the precipitation of carbon surface by nucleation. The optimum pH for all prepared carbon are listed in table-2

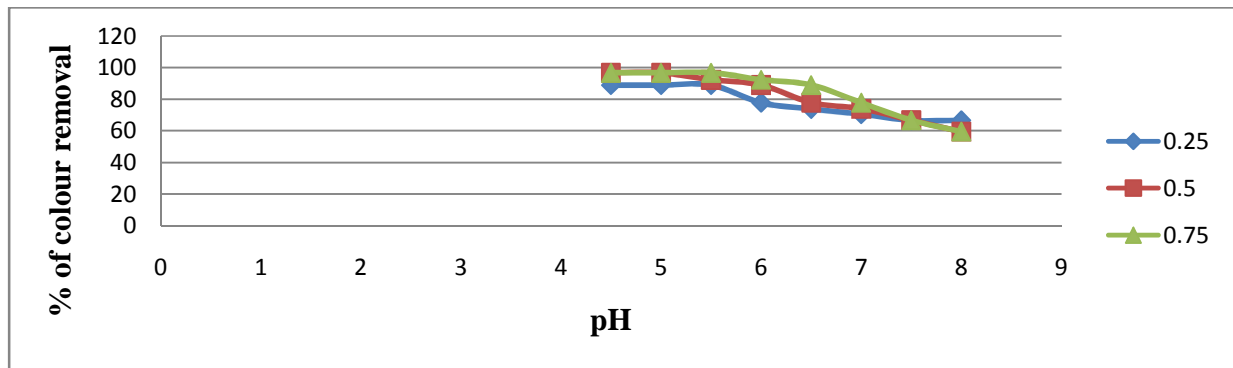


Fig.3.Effect of pH on Colour Removal by Chemically (MgCl<sub>2</sub>) Activated Carbon

Table 2. Optimum Time, Optimum Dosage and Optimum pH for Prepared Carbons

Initial concentration = 90 mg/L

Volume of sample = 25mL Temperature = 32 ± 1 °C

Type Of Carbon	I.R	Optimum Time (min)	Optimum Dosage (mg)	Optimum pH
Chemically activated (MgCl <sub>2</sub> )	0.25	65	240	5.5
	0.50	50	200	5.5
	0.75	45	100	5.5

[2] Milind R. Oidde, Julie Dutta, Snehal Jadhav. "Comparative adsorption studies on Activated Rice Husk and Rice Husk Ash by using Methylene Blue as dye". International Congress on Environmental Research at Bits Pilani Goa (2008).

[3] Gang sun\*- and Xiangjing Xu J. Chem. Eng. Data, 2010, 55 (11), pp 4660-4668.

[4] APHA, "Standard Methods for the Examination of Water and Wastewater", 19<sup>th</sup> edition (APHA, AWWA, and WFF Washington DC) (1995) pp 3.58-3.60.

[5] Rayala Azath, "Colour Removal Studies on Silk Filature Composit Wastewater", M.Tech. Env. Engg. P.D.A.C.E.G, (1996).

### CONCLUSIONS

Based on the experimental study the following conclusions were drawn. The extent of colour adsorption increases with increase in time and attains equilibrium. The result of experiment on optimum dosage of adsorbent reveals that increase in amount of adsorbent added increases the removal of colour from the sample and almost becomes constant after saturation dose for different I.R.'S. The removal of colour increases mainly due to the enhanced total surface area of the adsorbent. The adsorption of colour is pH dependent. The removal efficiency of adsorbent increases with decrease in the pH value

### REFERENCES

[1] Zehra Sapci, Beyza Ustun. "The Removal of Color and COD from Textile Wastewater by Using Waste Pumice". Electronic Journal of Environmental, Agriculture and Food Chemistry (2003). [286-290].