Removal of Methylene Blue Dye (Basic Dye) from Aqueous Solution using Saw Dust as an Adsorbent.

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***Abstract*— In the present work, batch adsorption studies were carried out by observing the effect of parameters like p^H, amount of adsorbent, contact time, temperature and dye concentration The optimum condition for dye removal were studied. The results showed that, at p^H of the dye solution is 9 and contact time is 120 minutes the adsorption is maximum. When the temperature increases from 298K, 303K, 308K, the rate of adsorption also increases.**

The Freundlich and Langmuir adsorption isotherm were studied. The amount of adsorption increases with increasing adsorption dose, contact time, p^H and temperature. The ultrasonic velocity of the dye solution was also studied. The result showed that, the velocity increases with adsorption.

This effect is observed due to swelling of the structure of the adsorbent which enables large number of dye molecules adsorbed on adsorbent body.

Keywords*— adsorption, Methylene blue, dye, adsorption isotherms, adsorption kinetics.

I. INTRODUCTION

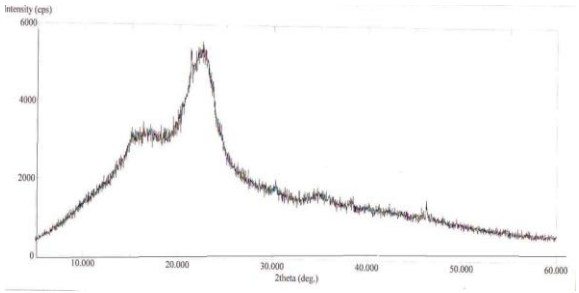
Many textile industries always use dyes and pigments to colour their products. Colour removal from textile effluent is a major environmental problem [1]. The colored effluents have an inhibitory effect [2] on the process of photosynthesis and thus affecting aquatic ecosystem. Basic dyes like Methylene blue will not degradate completely produces toxic amines in water [3]. Dyes have a tendency to produce metal ions in textile water produces micro toxicity in the life of fish [4]. There are many physical and chemical methods for the removal of dyes like co-agulation, precipitation, filtration, oxidation, and flocculation. But these methods are not widely used due to their high cost[5]. Adsorption technique [6] is the best versatile method over all other treatments. Therefore the proposed work will undertaken using agriculture waste like saw dust for the removing dye material [7-11] from aqueous solution.

II. MATERIAL AND METHODS:

Saw dust was collected from a local saw mill in Solapur city. It was then washed with distilled water and dried in an oven at 120^0 C. It was then sieved through sieve no. 100 (150µm). The BET surface area of saw dust was 40.2 m^2/gm. obtained from BET technique. Methylene blue dye used was (Thomas Baker).

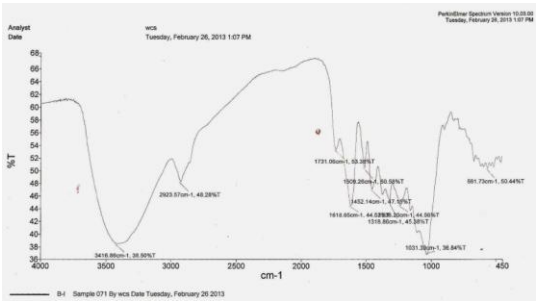
Molecular Formula:$C_{16}H_{18}N_3SCl$

The X-ray diffraction study of saw dust was carried out by X-ray Fluorescence spectrometer (Philip model PW 2400). The morphological and XRD study clearly indicates that the adsorbent is porous and amorphous in nature.



X-ray diffraction pattern of saw dust.

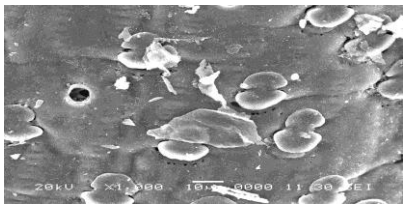
The IR spectrum of saw dust was also studied.



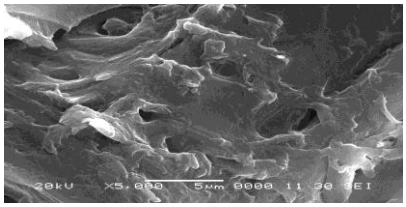
IR spectrum of Saw dust

From the **SEM** analysis it was found that there were holes and cave type openings on the surface of adsorbent which would

have more surface area available for adsorption[12] as shown in fig 1.



Saw dust (Before adsorption)



Saw dust (After adsorption)

Scanning electron micrograph (SEM) of the adsorbent

III. EXPERIMENTAL PROCEDURE:

Batch adsorption experiments were conducted by shaking 150 ml of dye solution having concentration (50mg/l) i.e. 50 ppm with different amount of adsorbent and having different p^H values, at different temperatures as well as different time intervals. The adsorbent was then removed by filtration and the concentration of dye was estimated spectrophotometrically at λ_{max}= 580 nm. The amount of dye adsorbed was then calculated by mass balance relationship equation,

$$q_e = \frac{Co-Ce}{X}$$

C_o = Initial dye concentration

Ce= Equilibrium dye concentration

q_e = Amount of dye adsorbed per unit mass of adsorbent.

x= dose of adsorbent

IV. RESULTS AND DISCUSSIONS:

For getting highest amount of dye removal various factors were optimized.

A. Effect of contact time:

In order to get minimum amount of adsorbent for removal of maximum amount of dye. The contact time was optimized. The results showed that the extent of adsorption is rapid at the initial stage, after 60 minutes the rate of adsorption is constant. About 90% dye was removed. (fig.1)

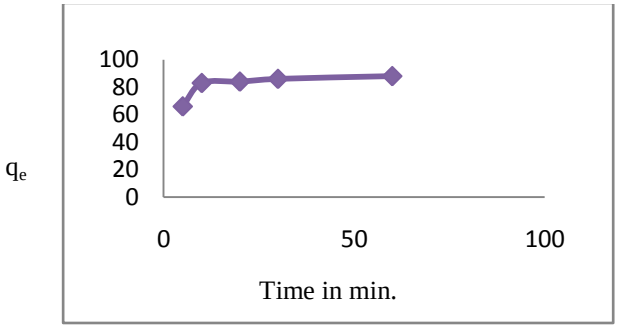


Fig.1 Effect of contact time

B. Effect of p^H:

From fig.2 it reveals that an increase in p^H is accompanied with increase in percentage of dye removal. At p^H= 9, adsorption is maximum. Therefore it is chosen as optimum p^H. The percentage removal of basic cationic dye increases with increase in p^H [13, 14]. When p^H of dye increase, the association of dye cations with negatively charged sites is facilities, the resulting increase in the dye removal. There is an electrostatic attraction between positively charged adsorbate (dye) and negatively charged adsorbent [15].

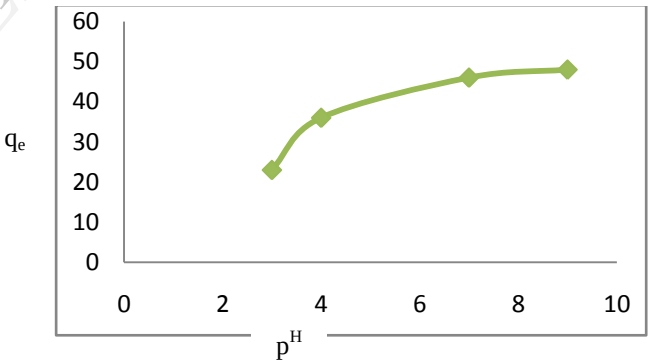


Fig.2 Effect of p^H

C. Effect of adsorbent dose:

From the results, it is clear that the optimum dose is 2gm /150ml. (Fig.3). By further increase of adsorbent dose, the removal of adsorbent decreases due to some of the adsorption sites remains unsaturated during the process [16].

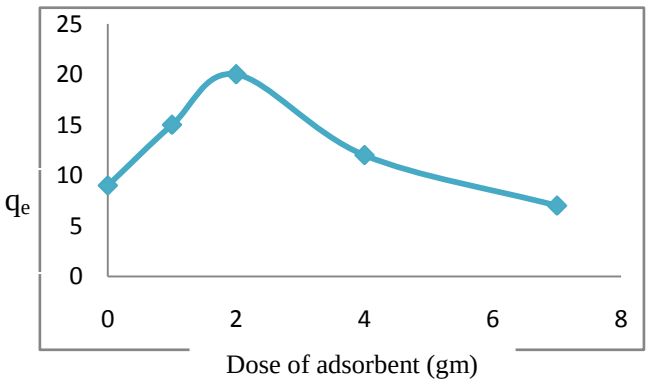


Fig.3 Effect of adsorbent dose

D. Effect of temperature:

The perusal of fig.4 it is clear that adsorption capacity of adsorbent increases as the temperature increases due to increase in the mobility of dye ions increasing temperature also causes a swelling effect within the internal structure of adsorbent. So that large number of dye molecules can easily penetrate through it[17]. The system is studied at three different temperatures, namely **298 K, 303 K, 308 K.**

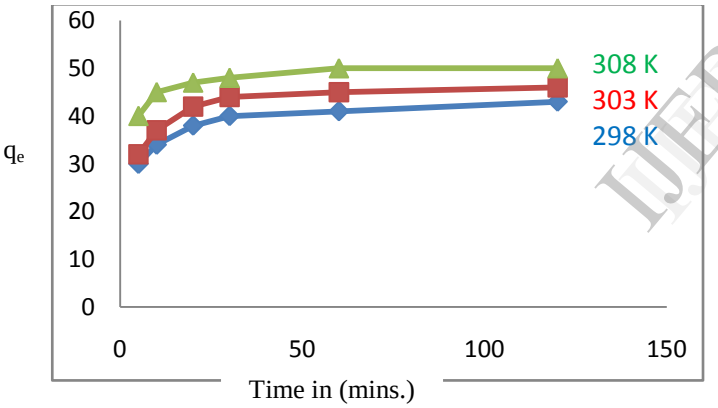


Fig. 4 Effect of contact time

E. Adsorption isotherm:

→ Langmuir Isotherm:

In order to study the adsorption of dye according to Langmuir isotherm, following equation was used.

$$\frac{Ce}{qe} = \frac{1}{Q_m b} + \frac{Ce}{Q_m}$$

A graph of C_e/ q_e against C_e was plotted.

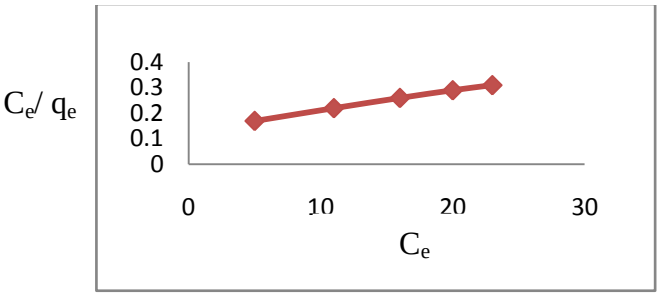


Fig. 5

From the slope and intercept Qm, and b can be calculated.

Q_m	b	Correlation factor
128	0.06	0.9997

The correlation factor is closely related to unity, which indicates that the Langmuir isotherm model is applicable [18, 19]. The formation of monolayer takes place on the surface of the adsorbent [20, 21].

→ Freundlich isotherm:

In order to study the Freundlich isotherm the following equation was used [22].

$$\log q_e = \log k_f + \tfrac{1}{n} \log C_e$$

The graph of ln q_e against ln C_e was plotted.

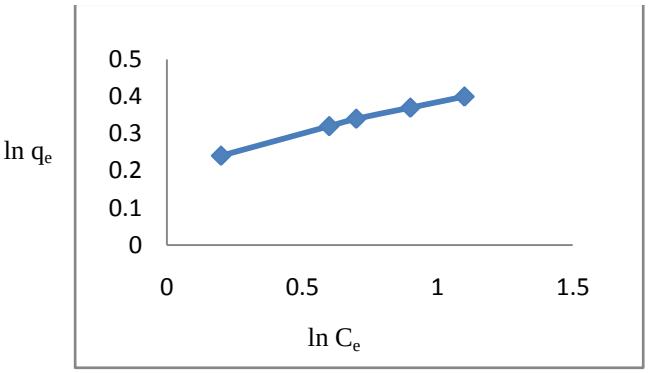


Fig.6

From the slope, the value of n and correlation factor can be calculated.

Slope (1/n)	n	Correlation factor
0.2	5	0.9965

The value of correlation factor is closely related to one. So it indicates that the Freundlich isotherm also satisfied. The value of n is greater than 1. So the Freundlich adsorption develops appropriately.

→ Adsorption kinetics:

Pseudo 1st order model:

The pseudo 1st order kinetics model is used to understand the kinetic behavior of the system [23, 24]. It is given by the equation.

$$\frac{dq}{dt} = k_i (q_e - q_t)$$

Pseudo 2nd order kinetics:

The pseudo 2nd order kinetic model was studied using equation [25].

$$\frac{t}{qt} = \frac{1}{k_2} q^2e + \frac{t}{qt}$$

Where q_e = dye adsorbed at equilibrium

q_t = dye adsorbed at time t

In case of pseudo 1st order kinetic model, the value of slope and correlation factor are negative. While in case of pseudo 2nd order kinetic model, the value of slope and correlation factors are positive. Which implies that, the system is more fevourable for pseudo 2nd order kinetics[26].

V. CONLUSION:

Saw dust an agriculture by-product acts as an effective adsorbant for the removal of basic dye like methylene blue from its aqueous solution. Batch adsorption study was shown that the percentage of colour removal increases with increase in adsorbant dosage upto certain limit, increasing contact time, increasing p^H as well as increase in temperature. The optimum conditon for equilibrium is achieved after 120 min. When adsorbent dose increases above 3gm., the adsorption decreases. The Langmuir isotherm model is applicable for this system, which shows that, there is a formation of monolayer, present on the surface of adsorbent. Similarly the kinetic study shows that the pseudo 2nd order kinetic model was more fevourable for the present system.

VI. ACKNOWLEDGEMENT

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