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A Comparitive Study of Adsorption Behaviour of a Dye Using Agro Wastes as Adsorbents

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Abstract: *The use of cheap and eco-friendly adsorbents are studied as an alternative substitution of activated carbon for the removal of dyes from wastewater. Laboratory investigations were done to find the potential of Rice husk ash(RHA), Activated Rice Husk (ARH) and Azadirecta indica leaves (Neem) powder (NLP)to remove methylene blue dye from aqueous solution . ARH was prepared from rice husk treated with nitric acid and RHA Prepared by heating in muff furnace at 300 ^{0}C. Neem leaves are sundried for few days and then dried at low temperature (<105°C) for 24 hrs in hot air oven to remove moisture content. The effects of various experimental parameters, such as pH , adsorbent dosage and contact time were investigated. Langmuir adsorption isotherm was applied and R^2 value was calculated which shows, Langmuir adsorption is a good fit for the experimental data. The result shows that the 85 % colour removal efficiency can be achieved at the dose of 50 g/l of ARH . 90 % colour removal efficiency is achieved at the adsorbent dose of 40 g/l of RHA. With increase in RHA dose the efficiency increased upto 96 %. 81% of colour removal efficiency is achieved with NLP .*

Keywords*: Rice husk, neem leaves, Activated rice husk, methylene blue, adsorption isotherm*

I. Introduction

Dyes are highly colored polymers and low biodegradable in nature. Wastewater effluents from different industries such as textiles, rubber, paper and plastics, contain several kinds of synthetic dyestuffs [1] Dye being one of the important recalcitrant, persist for long distances in flowing water, retards photosynthetic activity, inhibit the growth of aquatic biota by blocking out the sunlight and utilizing dissolved oxygen and also decrease the recreation value of stream. Numerous studies have been conducted to assess the harmful impacts of colorants on the ecosystem. It was found that dyes may cause problems in water in several ways. Adsorption is quite popular due to simplicity and high efficiency, as well as the availability of a wide range of adsorbents. It has proved to be an effective method for removal of dye from wastewater [2], the most commonly used adsorbent for this purpose has been activated carbon but, due to the relatively high operating costs, this adsorbent had limited application on a larger scale. Recently, numerous approaches have been studied for the development of cheaper and effective adsorbents. The present research tends to investigate RHA,ARH and Neem (Azadirachta indica) leaves as a low-cost adsorbent for the removal of dyes from aqueous solutions.

II. Material And Methods

2.1 Material

Neem Leaves were collected and washed properly under rushing tap water to remove water-soluble impurities and then dried in a thermostatic oven at 105^{0}C for 24 hours. After drying process, neem leaves were ground to fine powder and sieved through 600 µ size. The adsorbent RHA was collected in the form of rice husk . Rice husk was collected from rice mill situated in Dharamshala H.P. Rice Husk was initially burnt in open in a vessel using burner and later heated in the muffle furnace at nearly 300^{0}C. For preparing ARH the rice husk was screened and washed with water to remove the dirt and was sun dried for a day. Then the dried rice husk was soaked in 2.0 mol/L of nitric acid for an hour. It was then rinsed with distilled water for 2-3 times and oven dried at 105°C for 2 hours

The stock solution of dye was prepared by dissolving 1 g of methylene blue in 1000ml of distilled water. The working solutions were prepared by serial dilution of this stock solution. Dye concentration was determined by using absorbance values measured before and after the treatment, at 650 nm with Spectrometer. Experiments were carried out at initial pH value is 7.2 and was controlled by addition of sodium hydroxide and hydrochloric acid.

2.2 Experimental Procedure

The working solution of 10mg/1 was prepared by serial dilution of stock solution. The factors initial pH, contact time and adsorbent dose were varied. The batch adsorption tests were carried out by shaking 50 ml

working dye solution in a conical flask. The conical flasks were placed on rotary shaking machine for the desired time at 150 rpm. The progress of adsorption during the experiment was determined by removing the flask after desired contact time, centrifuging and analyzing the supernatant solution spectrophotometrically at 650nm.The removal efficiency was calculated using

$$\%Q = \frac{(Ci - Cf)}{Ci} \times 100$$

Where % Q = percentage of dye adsorbed, Ci = initial dye concentration (mg/lit) ad Cf = final dye concentration (mg/lit) The Langmuir adsorption isotherms was tried to fit to the experimental adsorption data.

III. Results And Discussions

3.1 Effect of pH

The dye –RHA interaction shows low adsorption rate at pH 2 . Between pH 3-8 adsorption increases from 60 % to 95 %. At pH 9 the adsorption was 92% and at 11 pH the adsorption was 85%. The maximum adsorption capacity was found at pH 8 .So 8 is the optimum pH. For the dye –ARH interaction between pH 3-8 adsorption increases from 60 % to 85 %. At pH 7 the adsorption was 84 % and at 11 pH the adsorption was 80%. The maximum adsorption capacity was found at pH 7. For NLP below pH 6 the solution becomes turbid and changes its colour. Therefore the study is conducted between 6-11pH only. At pH 6-8 adsorption increases from 60 % to 75 %. At pH 8 the adsorption was 75 %. The maximum adsorption capacity was found at pH 8.

Fig.1 Effect of pH on adsoption using ARH

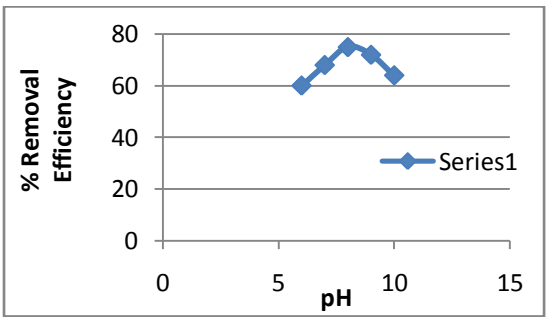


Table:I Effect of pH on adsoption using ARH

pH	% Removal
3	60
4	70
6	75
7	84
8	85
10	80

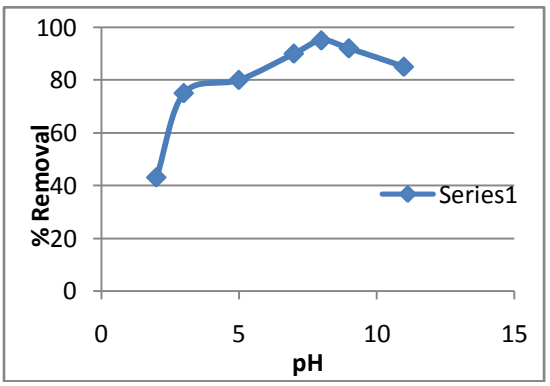


Fig. II: Effect of pH on adsorption using NLP

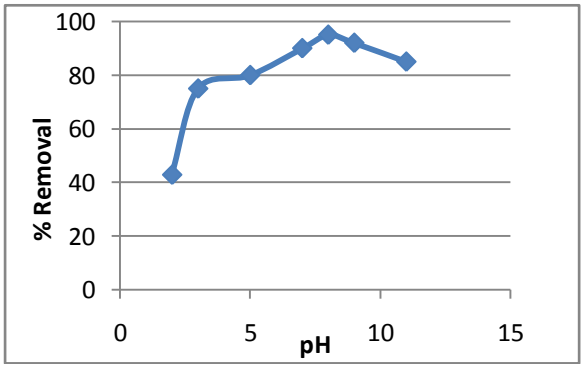


Fig.III:Effect of pH on adsoption using RHA

3.2 Effect of contact time

The effect of contact time on the amount of dye adsorbed was investigated at the 10mg/l of dye concentration . For RHA the effect of contact time was investigated for 10,20,40,60,80,100 and 120 min at the pH 8 and 2 gm/50 ml of sample dosage.The extent of removal of Methylene Blue by Rice husk ash was found to increase with increase in contact time. Reach a maximum at a contact time of 60 minutes. For ARH the maximum adsorption was at a contact time of 80 minutes. Later it almost becomes constant with increase in contact time. The extent of removal of Methylene Blue by NLP was also found to increase with increase with contact time. It reaches a maximum at a contact time of 120 minutes. Later it starts decreasing.

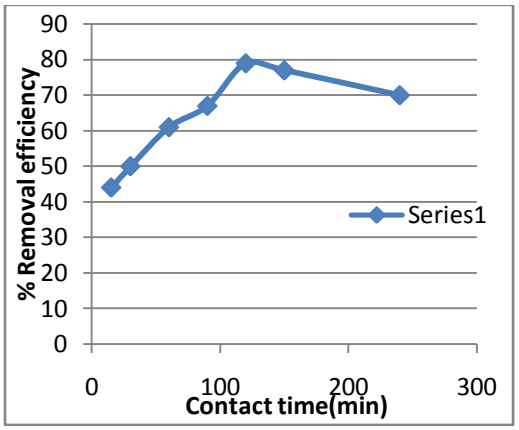


Fig.IV: Effect of time of contact using NLP as adsorbent

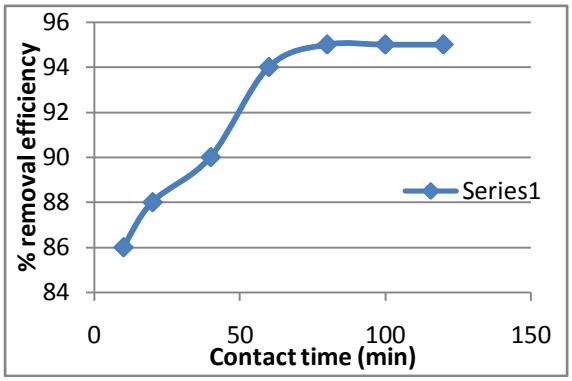


Fig.V: Effect of time of contact using RHA as adsorbent

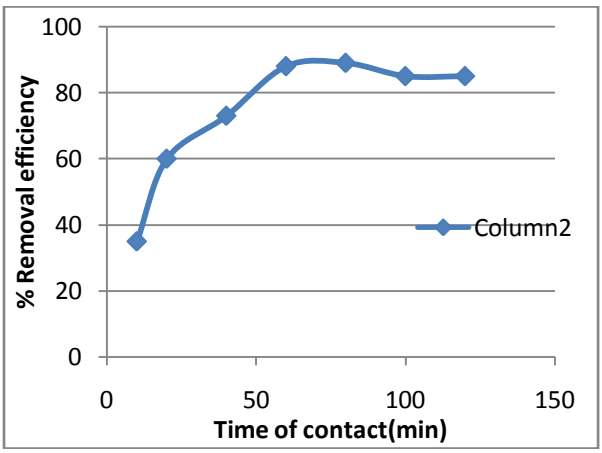


Fig.VI: Effect of time of contact using ARH as

Table:II Effect of time of contact for ARH

Time of Contact	% Removal efficiency
10	35
20	60
40	73
60	88
80	89
100	85
120	85

3.3 Effect of adsorbent dose

The removal efficiency was 90% to 96% was observed at apH of 8 and contact times of 120 min. The optimum dose is 2g/50ml, at which 95% of removal efficiency is achieved. For ARH at a contact times and pH were 120 min and 7, respectively the removal efficiency was 67% to 80% . The optimum dose is 2.5g/50ml at which 85 % of removal efficiency is achieved. For NLP the removal efficiency was 30% to 82%. The optimum dose is 5g/50ml. At which 82 % of removal efficiency is achieved.

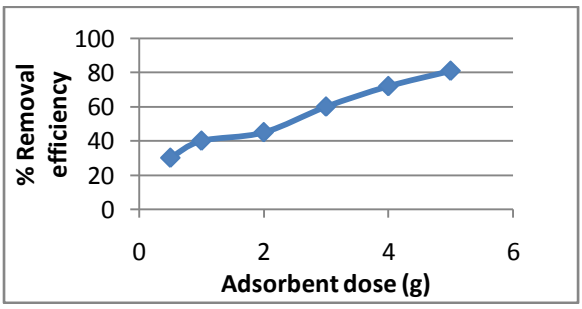


Fig.VII: Effect of NLP dose on adsorption

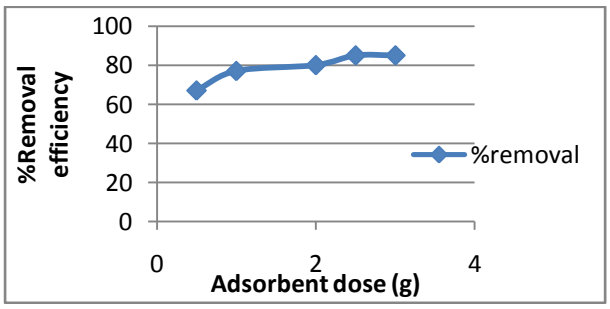
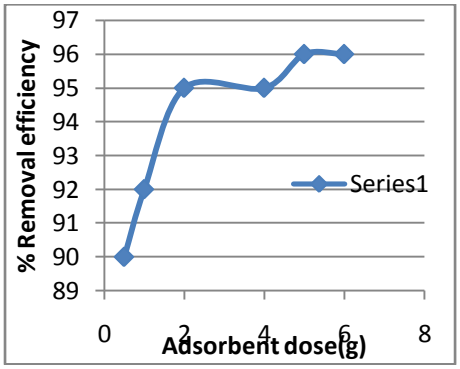


Fig.VIII: Effect of ARH dose on adsorption

Table:III Effect of RHA dose on adsorption



Adsorbent Dose (g/50 ml)	% Removal efficiency
0.5	90
1	92
2	95
4	95
5	96

Fig: IX. Effect of RHA dose on adsorption

3.4 Langmuir Adsorption Isotherm

Langmuir adsorption isotherm graph is plotted with *l/qe* v/s *l/Ce*. Trend line for the adsorption data of methylene blue using different adsorbents are plotted. The linear regression was conducted using plot l/qe *v/s 1/Ce*, it was found that R^2 values are closer to 1, indicating that the Langmuir adsorption isotherm is a good fit for all the adsorption data.

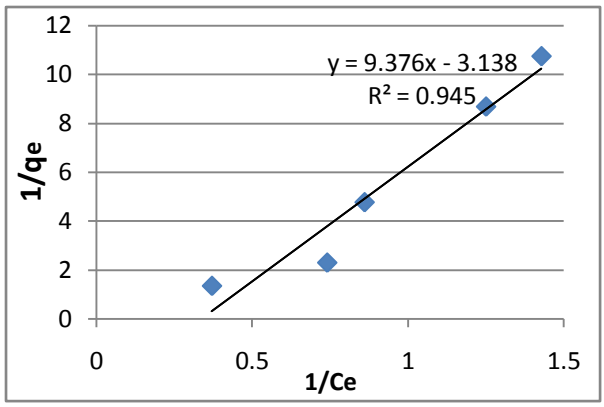


Fig.XI: Langmuir adsorption isotherm for RHA

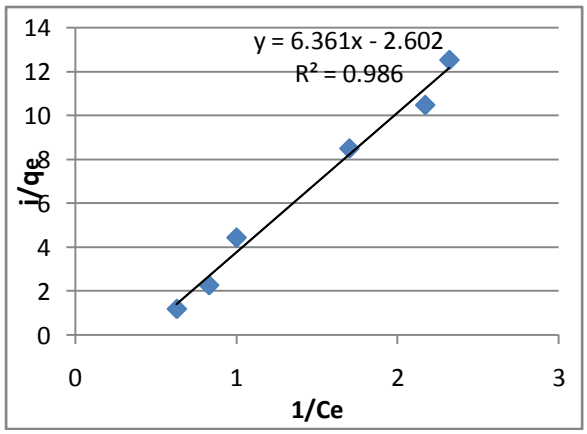


Fig.X:Langmuir adsorption isotherm for ARH

Table:3 Langmuir adsorption isotherm for ARH

1/Ce	1/qe
0.37	1.36
0.74	2.31
0.86	4.78
1.25	8.69
1.428	10.75

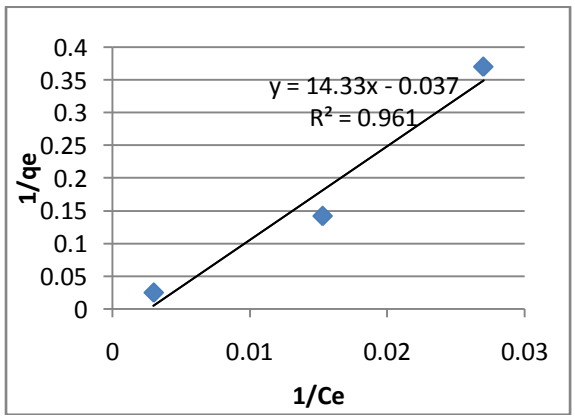


Fig.XII: Langmuir adsorption isotherm for NLP

Table: 4 Summary of Results obtained

Sr.	Name of the Adsorbent	Optimum pH	Optimum Dose (g/l)	Optimum Contact Time(Min)	Maximum % Removal Efficiency	R^2 values using Langmuir Isotherm
1	RHA	8	40	60	96	0.945
2	ARH	7	50	80	89	0.986
3	NLP	8	100	120	81	0.961

IV. Conclusion

The result of present study clearly shows that ARH , RHA and NLP are effective in removal of methylene blue and can provide an economical solution for removal of such colour from the aqueous solution.

a) For ARH 85 % colour removal efficiency can be achieved at the dose of 50 g/l at a contact time of 80 min on further increasing the contact time the % removal efficiency remains constant,The optimum pH obtained is 7.

b) For NLP 81% of colour removal efficiency is achieved at the dose of 100g/l at a contact time of 120 minutes at pH of 8. Below pH 6 the (NLP-dye) solution becomes turbid and changes its colour. Therefore the study is conducted between 6-11pH only

c) For RHA 96 % colour removal efficiency is achieved at the adsorbent dose of 40 g/l of at a contact time of 60 minutes The optimum pH obtained is 8 . Above and under this point, adsorption slightly tends to decrease. . RHA also shows good efficiency in less time than that of ARH and NLP. Less dose of RHA is required.

The Langmuir adsorption isotherms is applied . The result shows that the Rsquare values are closer to 1 for all adsorption isotherm plots. Thus Langmuir isotherm model is good fitted to the experimental data. Thus full utilization of agro-waste and treatment of wastewater is one of the good prospective for good environment. The ARH,RHA,NLP can be proved as good, effective and eco friendly adsorbent .Among these three RHA has maximum % removal efficiency in less time and less dose then the other two.

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