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ADSORPTIVE REMOVAL OF METHYLENE BLUE USING NON-CONVENTIONAL ADSORBENTS-COLUMN STUDIES

[1] Rohit S. Banate, [2] Prof, Dr. Milind Gidde

[1] Student, [2]Professor,

[1] Dept. Of Environment Science, Bharti Vidyapeeth University Institute of Environment Education and Research, Pune, Maharashtra, India.

[2] Dept. Of Civil Engineering. Bharti Vidyapeeth University College of Engineering, Pune, Maharashtra, India.

***Abstract* — The adsorption of Methylene Blue, by the agricultural waste as Rice Husk, the construction based material Brick powder and the standard material Granular Activated Carbon (GAC), was carried out by varying the parameters such as agitation time, dye concentration, quantity of adsorbent material. By using column adsorption study method, the adsorption capacity was found to be 65% for rice husk, 50 % for brick powder and 85% for GAC. The effect of initial dye concentration, column diameter and the particle size, on the rate of dye removal has been investigated. In the present study the results of continuous process are highlighted. The Comparative results of adsorbent materials as well as continuous process are also shown. The individual effects of time and concentration are mainly studied. The continuous adsorbent processes are performed for a particular bed height and the concentration range between 5mg/L to 100 mg/L. In this study the agricultural material, Rice Husk has shown good result than the construction based Brick powder material. This study was carried out with Conventional material v/s non-conventional material. Result efficiency of Rice Husk achieved up to 82.32% at 50 mg/L concentration and for GAC was 90.13%. As the difference is only 8%, rice husk can be a good adsorbent material for removal of methylene blue dye from waste water.**

***Index Terms* — Activated carbon, Methylene Blue, Fixed bed column, Rice husk and Brick Powder.**

I. INTRODUCTION

The Textile industries are a prominent source of water pollution due to the wastewater produced after the dyeing and the finishing processes. The dyes and chemicals used in these industries are highly toxic as they have metal complex elements in their composition. Large amounts of dye remain in the effluent after the completion of the Dyeing process. This effluent is let off into the nearby streams and rivers causing the quality of that water body to deteriorate by colouring of water accompanied by increase in BOD and COD. To remove the Dye/and the coloring elements in the water, adsorption technique can be used. Activated carbon is used as an industrial standard for adsorption and gives good results. However there are other low cost materials such as Rice Husk and Brick powder, which can be good adsorbent use for removal of dye from textile wastewater. Rice hulls are naturally occurring adsorbents having high silica content. Industrialization of the textile industry and use of a large variety of chemical treatment and dyes has resulted in a public health threat created by water pollution. 17-20% of industrial freshwater pollution is caused by textile dyeing and treatment. Estimations state that 10-15% of total dyestuffs (equivalent to 280,000 tonnes of dyestuffs) used during the manufacturing of textile products is released into the environment worldwide annually.

Most of the dyes are stable against photo degradation, bio-degradation, and oxidizing agent. Several methods have been used for the removal of dyes from the aquatic environment, including physical, chemical, and biological processes. Among these methods, adsorption is a widely used method for the removal of the dye from wastewater.

A. Experimental Preparation of the Adsorbent

1) RICE HUSK

a) Rice husk is brought from Chintamani mill, Bavdhan, Pune. Rice husk has good silica content and it can be used as an adsorbent for removing dye from waste water.

b) Wash with distilled water for 2 to 3 times and dry it in the oven for 2 hours at 80oc. Again wash it with distilled water for 2 to 3 time and dry it for 4 hours at 100^{o}C through 1.000mm meshand retained on mesh 0.250 mm is used.

2) BRICK POWDER

a) Bricks are taken and washed neatly.

b) Then put into the incubator for 3 hours at 100^{o}C. After that the bricks arecrushed with the crusher (to convert it to powder)and made powder form Brick powder passed through 1.000mm mesh and retained on mesh 0.250 mm is used.

B. Column study:

Particular dimensions i.e.50 cm in height and 2.5cm inner diameter, 3mm thickness of column, it's made by acrylic material brought from commercial fabricator, and with the help of drilling machine an made inlet at the bottom and an outlet at top of the column is created, an hose pipe is attached to the peristaltic pumpattach with hoses/pipe to peristaltic pump.The Peristaltic pump isrequired for measuring the flow rate of wastewater by adjusting the speed to 23ml/min. Range of peristaltic pump is 10 to 100 rpm.

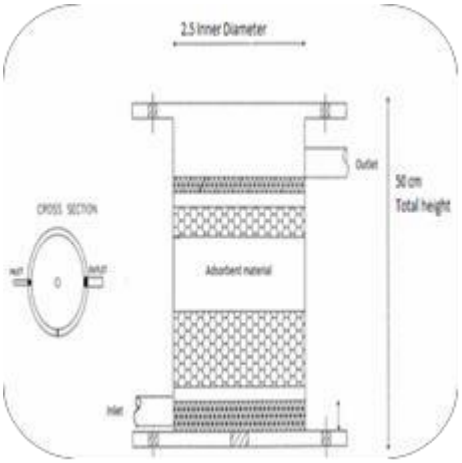

Fig.1. Schematic diagram of fixed –bed column

C. Preparation of dye solution

A stock solution of the dye was prepared by dissolving 1.0 g of methylene blue dye powder in 1000 ml distilled water to make a stock solution of 1000 ppm. Similarly 10 gm into 10 L Distilled water, the experimental solution was prepared by diluting definite volume of the stock solution to get the desired concentration. For absorbance measurement spectrophotometer was employed, the rice husk and the brick powder was used for the experiment. The maximum wavelength λ max for the methylene blue was measured at 400 nm. The concentration during the experimental work was determined from a standard calibration curve.

II. METHODS (USED)

1. Column method
2. Calibration curve method

A. Adsorption studies (Observation):

The Adsorption experiments were carried out by using Methylene blue as dye solution. This solution used at different concentration's with above adsorbent materials and dye concentration measures with standard calibration curve method, which is used for the entire adsorption column experiment studies. These adsorbents filled in the column for running the model with the help of peristaltic pump, and measure the initial and final concentration. The Wavelength considered is 400 to 600 nm.

B. Adsorption studies:

Adsorption using rice husk, brick power and activated carbon with different amount(quantity) were determined at the different time rate of 60 RPM (23 ml/ min) at room temperature and with different concentrations of dye (5 mg/L, 10mg/L, 25mg/L, 50mg/L, 100mg/L)etc. The adsorbent material (based on dry weight of material) was filled in column, and then different initial dye concentration (Methylene blue) were added into a 500ml beaker, initial sample (Methylene Blue) taken into a 500ml beaker and the model run for 20 min for each concentration with the help of a peristaltic

Pump attached at the bottom of the column. The adsorption behaviors of the sample were studied by evaluating the percentage removal efficiency of methylene blue, calculated as

Removal efficiency = [(Co-C)/Co]*100

Where Co is the initial concentration of the methylene blue, C is the solution concentration after adsorption at any time. The effect of adsorption time on the dye removal at various predetermined intervals from (2-20 min) using spectrophotometer for measurement of the concentration at λ max = 400 nm was monitored by concentration of the dye analyzed for the dye content of dye content at the end of each contact time.

C. Adsorption dynamics

The effect of removing dye at different concentration's of methylene blue with contact time of (2 -20min) and different adsorbent materials used. In general it was found that by increasing the amount of the concentration the adsorbent rate increased. This increase was most significant with the amount of concentration within 10 -50 mg/L concentration of methylene blue dye. After for 100 mg/L concentration adsorption capacity decreased due to high concentration of dye. At the beginning of the process the rate of dye removal by the rice husk and brick powder shows more removal efficiency during 10 min and then decreased gradually.

III. ANALYSIS AND RESULTS

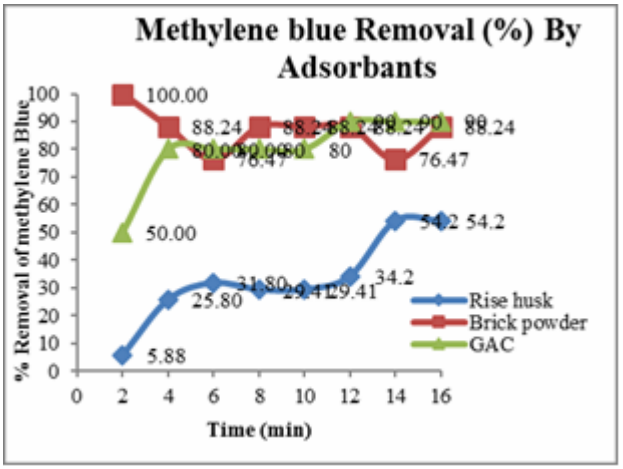

Fig.2. Methylene blue Removal (%) By Adsorbents

Fig.2. Effect of time difference and concentration of Methylene Blue on removal: adsorbent dose: 85 gm of Rice Husk, 200gm of Brick powder, 160gm of GAC in column, dye concentration 5 mg/L, temperature, 31o C

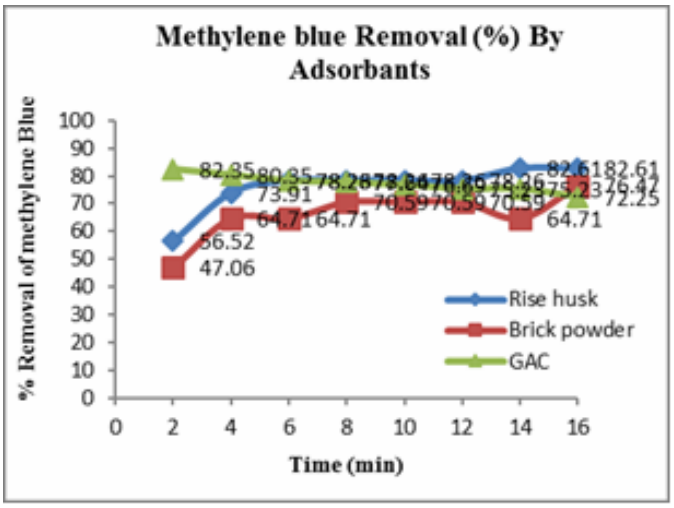

Fig.3. Methylene blue Removal (%) By Adsorbents

Fig.3. Effect of tim edifference and concentration of Methylene Blue on removal: adsorbent dose: 85 gm of Rice Husk, 200gm of Brick powder, 160gm of GAC in column, dye concentration 10 mg/L, temperature, 31º C.

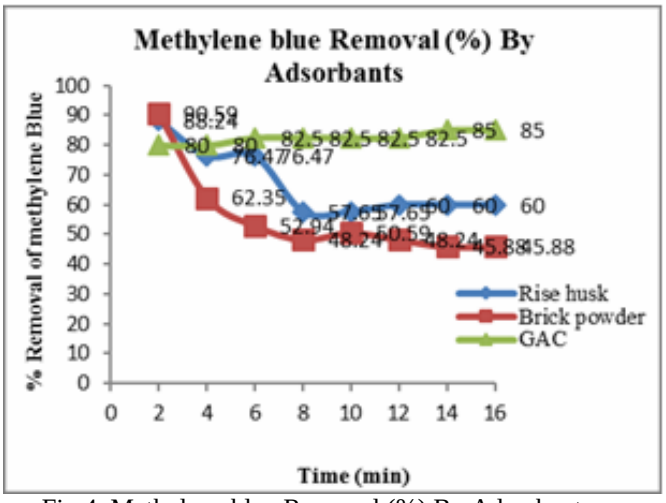

Fig.4. Methylene blue Removal (%) By Adsorbents

Fig.4. Effect of timedifference and concentration of Methylene Blue on removal: adsorbent dose: 85 gm of Rice Husk, 200gm of Brick powder, 160gm of GAC in column, dye concentration 25 mg/L, temperature, 31º C.

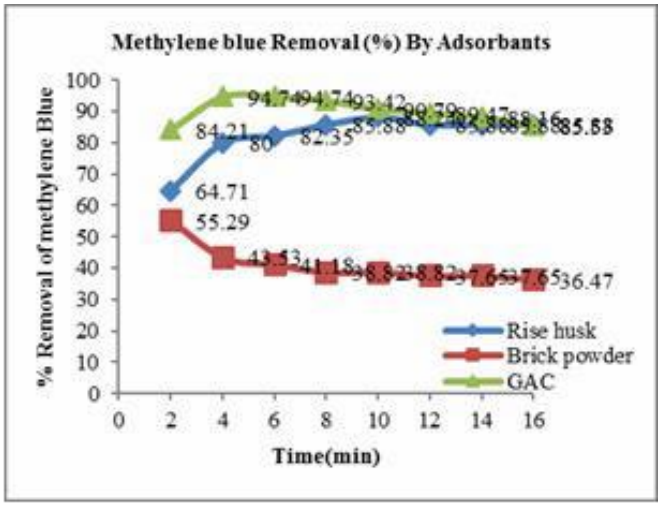

Fig.5. Methylene blue Removal (%) By Adsorbents

Fig.5. Effect of time difference and concentration of Methylene Blue on removal: adsorbent dose: 85 gm of Rice Husk, 200gm of Brick powder, 160gm of GAC in column, dye concentration 50 mg/L, temperature, 31º C.

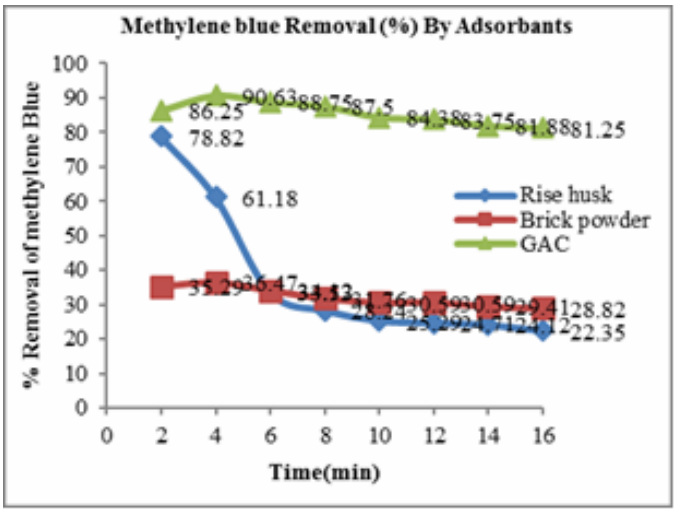

Fig.6. Methylene blue Removal (%) By Adsorbents

Figure.6. Effect of time difference and concentration of Methylene Blue on removal: adsorbent dose: 85 gm of Rice Husk, 200gm of Brick powder, 160gm of GAC in column, dye concentration 100 mg/L, temperature, 31º C

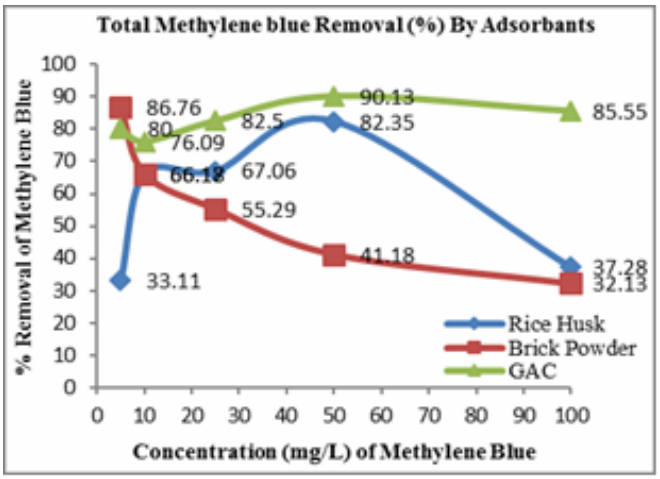

Fig.7. Methylene blue Removal (%) By Adsorbents

Figure.7. Effect of time difference and concentration of Methylene Blue on removal: adsorbent dose: 85 gm of Rice Husk, 200gm of Brick powder, 160gm of GAC in column, dye concentration was (5mg/l, 10mg/L, 25mg/L, 50mg/L, and 100 mg/L). Temperature, 31° C

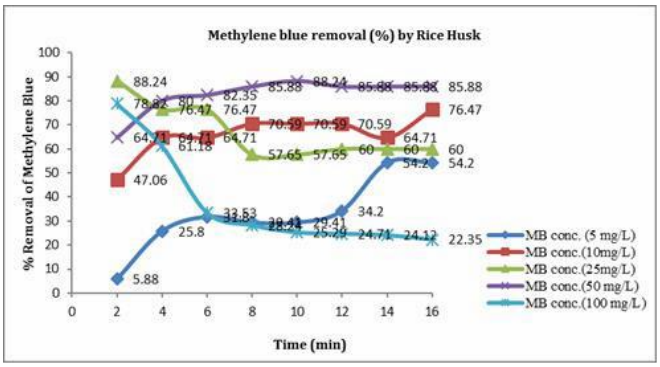

Fig.8. Methylene blue Removal (%) By Adsorbents

Figure.8. Effect of removal efficiency at 5 mg/L conc. It shows very low adsorption at the start from (5.88%), after 2 min its starts increasing up to 6 min andthen thesame adsorption iscarried out for 10 min,then again it increase till end it becomes(54.2%) thesecond observation with 10 mg/L conc. Shows (47.06 %) atthe starting pointthen suddenly increases to(64.71%), and then again increases up to (76.47%). In the third observationwith25 mg/L conc., at beginning was high (88.24) then gradually decreases up to (60%), concentration increases adsorption decrease. Same observation shows with 100 mg/L conc.

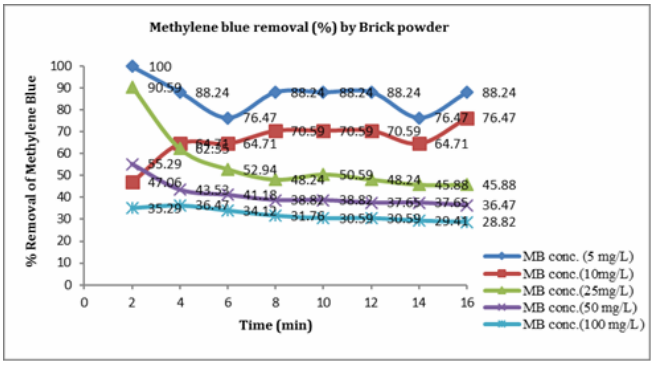

Fig.9. Methylene blue Removal (%) By Adsorbents

Figure.9. effect of methylene blue removal (%) by brick powder shows (100%) removal efficiency with 5 mg/L conc. It then gradually start decreasing up to 6 min,for 8 to 12 min it shows same adsorption capacity and then drops down at one point, then again increases at the end. Inthe second observation adsorption starts from (47.06%) and gradually increases up to (76.47%). For third observation initial adsorption is high then after 2 min starts decreases up to (45.88%). Same results were also observed with 50 mg/L conc. and 100 mg/L conc.

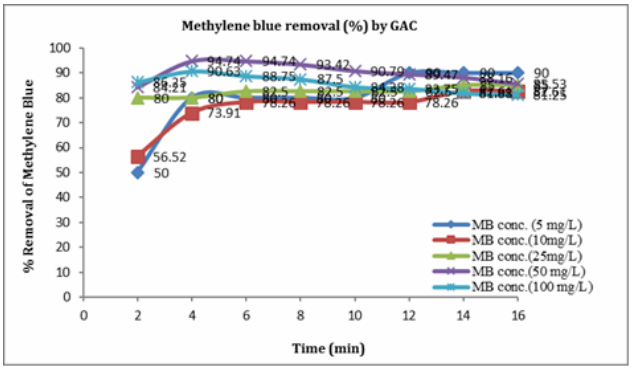

Fig.10. Methylene blue Removal (%) By Adsorbents

Figure.10 Effect of methylene blue removal (%) by (GAC) shows (50%) removal efficiency with 5 mg/L conc. Then observed that in each time difference adsorption increases till (90%). In thesecond observation removal of MBinitially to (56.52%), then starts increases till (85.53%).In this analysis same curves were observed i.e. whenconcentration increases theadsorption also increases.

A. Effect of dye concentration

The influence of the initial dye concentration of methylene blue (5 mg/L, 10mg/L, 25mg/L, 50mg/L and 100mg/L),on the adsorption rate using rice husk, brick power and GAC was studied. The experiments were carried out at fixed bed column study, at different concentrations and time. Dye removal by adsorbent material were about 60% was rice husk, 50% removal by brick powder and 85% of removal of methylene blue by Granular Activated Carbon (GAC) showed in figure 7.

CONCLUSION

Bio solid is a promising adsorbent for the removal of methylene blue from wastewater using rice husk and Brick powder. Rice husk, brick powder and GAC have been investigated under different experimental condition in Column study. Efficiency of Rice Husk achieved up to 82.32% at 50 mg/L concentration and GAC was 90.13%, with the difference of only 8% between the two adsorbent materials that is between Rice Husk and (GAC). Hence it is recommended that rice husk as a non conventional adsorbent material can be use to remove dye from the wastewater. There are many states producing large quantities of rice, so the raw material is largely available in India. This makes it cost effective compared to cost of GAC.

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