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Removal of dyes from textile waste water using adsorption by activated carbon of rice husk

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ABSTRACT: Results of removal of dyes from textile waste water using adsorption by activated carbon of rice husk are being presented. This research work is based on case study of waste water treatment plant of koh-e-noor textile industry located in Pakistan. Dyes used in research were Congo red and Magenta. Two parameters (agitation time and adsorbent dose) were selected to investigate the % age removal of dyes. Both of the dyes selected are hygienic, cause skin irritation and allergic dermatitis. It was found that the %age removal of both dyes increased as agitation time and adsorbent dose increased. The %age removal of Congo red was 88% and magenta was 85% by different agitation time, while in case of different adsorbent dose, the % age removal of Congo-red was 69.3% and magenta was 95.3%. It was observed that both of these dyes can be removed by activated carbon of rice husk. These results showed that adsorption by activated carbon of rice husk is a good economical method for the removal of dyes.

KEYWORDS: Textile waste water, dyes, Congo red, magenta, activated carbon, rice husk, removal of dyes, adsorption method, agitation time.

1 INTRODUCTION

Textile waste water contains caustic soda, starch, detergents, wax, pigments, and dyes. Presence of these pollutants increases Biochemical oxygen demand (BOD), chemical oxygen demand (COD), solid contents and toxicity of textile waste water. This untreated waste water is discharged by textile mills into municipal or industrial sewers as well as nearby drains and stagnant ponds. Environmental Protection Agency (EPA) has become effective in Pakistan. Textile waste water should be discharged after proper treatment and in compliance with National Environmental Quality Standards (NEQS). Textile industries in Pakistan are trying to find economical and best possible methods of waste water treatment.

2 TREATMENT METHODS FOR REMOVAL OF DYES

Main Methods/technologies for color removal can be divided into three categories, provided below. All of them have advantages and drawbacks. These methods of color removing are as under;

1. Biological treatment
2. Chemical treatment
3. Physical treatment

A lot of research work has been done on textile waste water treatment. Marrot and Roche [1] have given more than hundred references on textile waste water treatment. Pala and Tokat [2] studied the adsorption processes (on activated carbon, Biological sludges). Malik and Sanyal [3] described the methods like chemical coagulation, air floatation and adsorption for the removal of dyes. Basibuyuk and Forster [4] studied that AZo dyes are not prone to biodegradation under aerobic conditions. Halliday and Beszedits [5] treated textile mill waste water by adding PAC (Powder Activated Carbon) to activated sludge. Brower and Reed [6] showed that color of industrial origin cannot be removed by using municipal biological treatment processes. Balarubramanya [7] used anaerobic, batch fermentation method to treat willow dust residue, a solid cellulose textile waste. Panswad and Wong chaisuwan [8] showed that magnesium carbonate hydrated basis was better than alum and quick lime for removing reactive dye because of synergistic sorbing capacity of Mg (OH) 2 and CaCO3. Kannan and Sundaram [9] studied the adsorption of canto red on various activated carbons. P.K Malik [10] used activated carbons prepared from sawdust and rice-husk for adsorption of acid dye, acid yellow 36 and concluded that their adsorption capacity was reasonable good. He used adsorbent dose, pH and contact time as the basis. Namasivayam and Kavitha [11] studied the removal of Congo red from water by adsorption onto activated carbon prepared from coir pith, an agricultural solid waste. Gregorio Crini has done a lot of work on adsorption for the removal of dyes from waste water in the last decade. He Studied adsorption of dyes on betacyclodextrin polymer [12], non-conventional Low cost adsorbents for dye removal [13], Application of chitosan, a natural amino polysaccharide, for dye removal from aqueous solutions by adsorption processes using batch studies [14], Flour of Corn for dye removal from pulp and paper effluents [15], Preparation, characterization and sorption properties of cross-linked starch-based exchangers [16], the adsorption of several types of dyes on Cross-linked polysaccharides derivatives [17], starch-based modified filters used for the removal of Dyes from waste water [18].

3 EXPERIMENTAL

First of all I prepared the stock solutions (1000 mg per liter) of dyes (Congo-red and magenta). Then prepared the standard solution from the stock solution (10 to 100 mg/ liter) and measured absorbance using visible spectrophotometer. From the data obtained drew the calibration curves (between concentrations versus absorbance) at the wavelength for maximum absorbance (max = 497, 510 nm for Congo red and magenta). Took 30 ppm concentrated solution of Congo red dye and added activated carbon 0.1 gram into the solution. Transferred the solution into the magnetic shaker and observed the change in concentration from the absorbance of the solution with respect to time (interval 5 minute).Drew the graph between agitation times versus percentage removal of dye. Noted down the qt which is the amount of dye absorbed at any time t. Also drew the graph between logs (qeqt) versus time and find out the date of absorption. Took 65 ppm concentrated solution of magenta dye from the stock solution. Added Activated carbon from 0.1 gram to 1.0 gram into the solution. Put the solution into magnetic shaker and shake the solution for 5minutes. Found out the concentration with the help of absorbance. Drew the graph between percentage removal of dye and adsorbent dose and noted down the qt which is the amount of dye absorbed at any time t? Also drew the graph between log (qe-qt) versus time and determined the date of absorption.

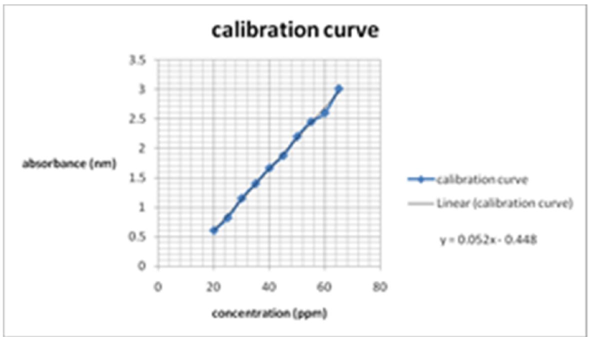

Figure 1 calibration curve

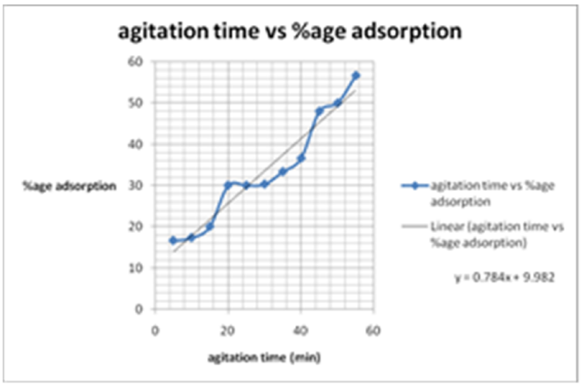

Figure 2 effect of agitation time on %age adsorption for congo red

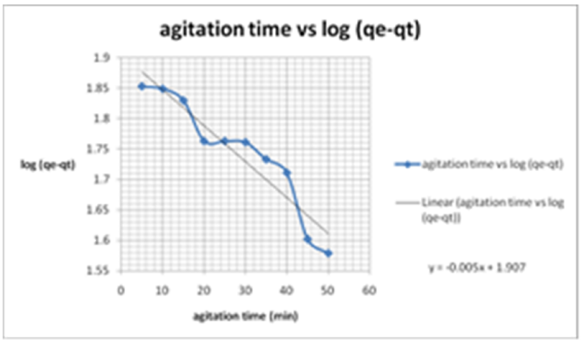

Figure 3 residual concentration of dyes as a function of time

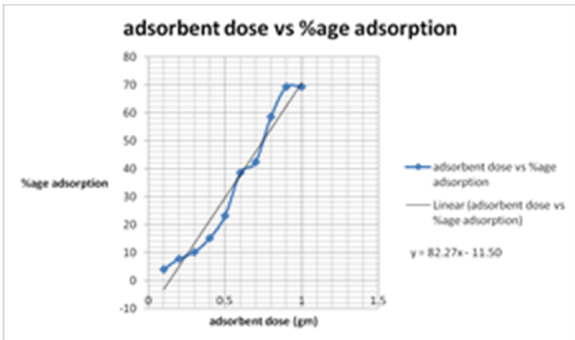

Figure 4 effect of adsorbent dose on %age adsorption for congo red

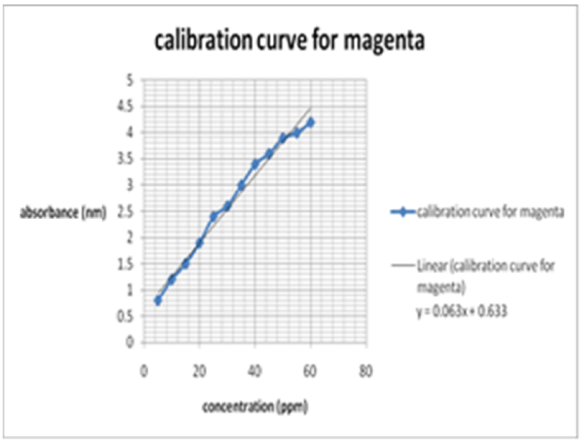

Figure 5   Calibration curve for magenta

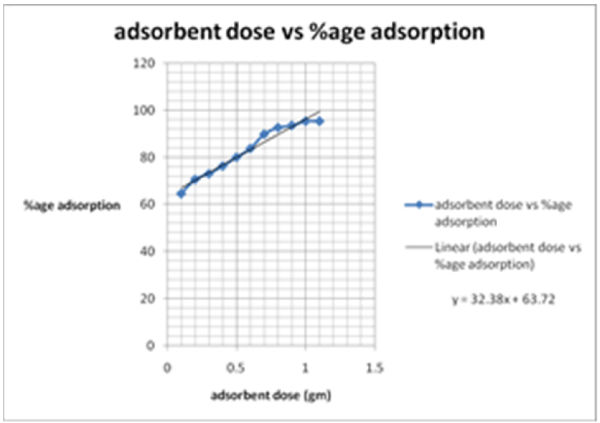

Figure 6   effect of agitation time on %age adsorption for magenta

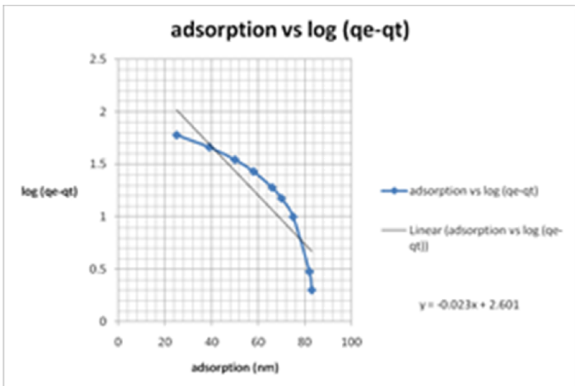

Figure 7   Kinetic model of absorption

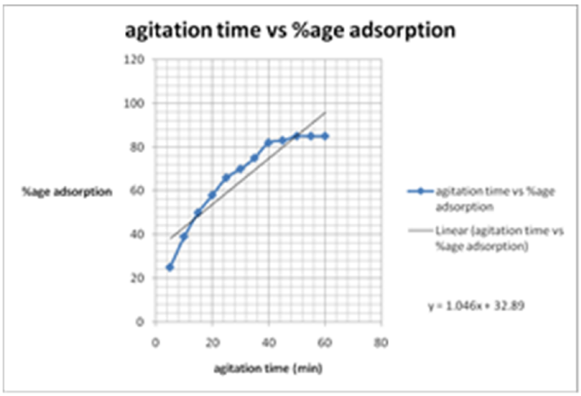

Figure 8 effect of adsorbent dose on %age adsorption for magenta

4 RESULTS AND DISCUSSION

The adsorption of dyes was investigated by using the two parameters.

1. Agitation time
2. Adsorbent dose

4.1 CALIBRATION

Calibration curve data (figure-1) shows that as the concentration of Congo red dye is increased the absorbance is also increased. Curve b/w concentration of Congo red and absorbance is a straight line, which shows the maximum absorbance against Congo red solution. The calibration curve shows beers law is obeyed in concentration range (0.5 65 mg). Figure-5 shows that Calibration curve of magenta dye is straight line. The calibration curve shows that as the concentration of solution increased absorbance is also increased.

4.2 EFFECT OF AGITATION TIME

The samples of Congo red and magenta of initial concentrations 30mg/l were taken in flask and treated with 0.1 gm. of adsorbent dose. Effect of contact time and initial dye concentration on adsorption of Congo red is shown in figure-2. It shows that the graph b/w agitation time and %age adsorption is straight line which shows that as the agitation time increased % age adsorption is also increased. Data shows that the increase in %age adsorption is slow in start but as time passed increase in % age adsorption is also increased the variation in % age adsorption of dye occurring due to the elapse time is shown. it is evident from the graph that activated carbon of rice husk treatment result in 50% removal of Congo red in 55 min which increased up to 88% in the 70 min while the figure-6 shows that removal of magenta is 75% in 35 min which increased up to 85% in 65 min. It is due to the formation of monolayer coverage on the outer surface of the adsorbent [9]. The increase in the rate of color removal with agitation time may be attributed to a decrease in the diffusion layer thickness surrounding the adsorbent particles.

4.3 ADSORPTION DYNAMIC

Adsorption dynamics were studied using various concepts of rate controlling step. Figure-3 shows that the rate of adsorption of Congo red solution is 0.00187307, the equilibrium time is determined by series of measurements. The curve shows the residual concentration of dyes as a function of time. Results show that within one hour, adsorption reaches complete equilibrium. Figure-7 shows that rate of adsorption of Magenta is 0.02329min^{-1} **For Congo red kad =** min^{-1}**is 0.008173007**

For magenta red kad = min^{-1}**is 0.02329**

4.4 EFFECT OF ADSORBENT DOSE

The effect of adsorbent dose is also investigated for the removal of dyes from the aqueous solution. Take Congo red and magenta of initial concentration 65 mg/l and treat with different adsorbent dose from 0.1 gm. to 1.1 gm. with keeping other parameters constant. Figure-4 and figure-8 show that %age adsorption is increased as adsorbent dose increases. Data and graph describes that the increase in %age adsorption is linear. It shows that 1 gm. of activated carbon of rice husk is required to remove the 65ppm solution of Congo red dye. It is observed that after some time adsorption of dyes become constant; the % age adsorption of Congo red is 69.3% at 0.9 g dosage % age adsorption of magenta is 95.3% at 1 g dosage. Graphs show that the % age adsorption of dyes increase due to the adsorbent dose because it is known as fact that more adsorbent dose is more helpful to absorb the dyes from its solution and at last a point reaches where the maximum adsorption is done at specific dose. This dose is considered as constant parameter.

5 CONCLUSIONS

I adopted the adsorption method by using activated carbon of agricultural waste (i.e. rice husk) and found that it is the best economical method for the removal of dyes. Efficiency can certainly be improved and more research is recommended in this area. During the performance, I selected only two dyes (Congo red, magenta). Research on other dyes using the same method can help in analyzing the effectiveness of the process still further. Agitation time and adsorbent dose were the parameters I worked on and found that %age adsorption is directly proportional to both of them. There are various other parameters whose effect should be investigated and results analyzed to make an even better assessment.

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