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Removal of methylene blue dye from simulated wastewater by cement kiln dust

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ABSTRACT

The purpose of this work is to test and discover the efficiency of CKD from Al-Muthanna city, Iraq. Removing the Methylene Blue Dye (MB) in simulated textile wastewater that was generated from the Al-Diwaniyah textile factory of Diwaniyah city in Iraq. The wastewater discharge from textile industries that contain methylene blue dye is removed by adsorption through cement kiln dust, therefore, was studied in this case. The best electrostatic action is the basic action between methylene blue and cement kiln dust. As cement kiln dust has especially nanostructure properties and the negative charge for his plane, the positive charge for methylene blue compound ability to simply adsorb above it. The optimum condition for gaining the best removal of dyes and reach to 99.57% is an initial concentration of 10 ppm, pH 9.0, temperature 30 C, dosage 1 gm, and rotary speed 150rpm. The reason for this may be due to the synergy effect of both the pH value of the media and the basic effect from the melting of the added adsorbent material in the media in addition to the presence of additional exchange sites when increasing the dose of adsorbent.

1. Introduction

Pollution in the water is different shape in normal. Pollution mainly forms from organic and inorganic materials. Mostly, inorganic dirtiness is explained by the high mass of the substance like colour, whereas organic pollutants expand from molecules smaller like chloroform to a macrocyclic or heterocyclic substance like colour. Dyes are cyclically organic compositions with a range of theist's higher weights for molecules [1]. Days are among the pollutants affecting the aquatic ecosystem being composed of a large group of Harmful Chemicals [2], [3]. What increases the environmental problem is that many industries, such as the textile industry, are depleting quantities of a large amount of water, as it is estimated the amount of water consumed to produce one kilogram of textiles is up to 200 litters and thus produces large amounts of wastewater contaminated with dyes different. In addition, organic days compounds its complex molecular structures and high molecular weight increase.

It is difficult to treat sewage contaminated with dyes [4]. Exposure to dyes in the textile industry It may cause major health problems to his health, ranging from Simple effects to carcinogenic and mutagenic effects It was found that dyes can cause significant damage to the skin lungs and skin, causing headaches and nausea, as well as Congenital malformations [5] added to Because the dyes have effects on the kidneys, liver and bladder Inflammation of the skin and asthma and cause problems in the nose and inflammation Nose for people working in the textile industry After prolonged exposure [6].

2. Material and method

Some of the series are tested with different variables to know cement kiln dust efficiency. Thus, basic methylene blue dye solutions (1000 ppm) were

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used (stock solutions) in the prepared laboratory by dissolving one gram from the required amount of dye in one liter from distilled water. Experimental solutions were prepared required to dilute basic dye solutions with water distilled to give the required dye concentrations for experiments adsorption.

Table 1. Material that used in experimental test

Materials	Purpose
Methylene blue	To prepare a stock solution.
Hydrochloric acid 35-38%	To treat pH value.
Sodium hydroxide	To treat pH value.
Buffer solution	To know the standard solution.

Table 2. Equipment useful in experimental

Equipment	Description	Origin
pH meter	pH 211	Romania
Stirrer	Model 1.613.01.001	Germany
COD test	0-1500 ppm	----------
Sensitive balance	----------	----------
Air dryer	----------	----------
Qualitative filter paper	Whatman No:42	---------

3. Adsorption experiment

The adsorption experiments were carried out to study the effects of important measures: quantitative Adsorbent material (cement kiln dust) and adsorbent concentration MB (methylene blue dye), pH value, temperature, contact time, and rotary per minute. Specific amounts of dust have been added to Cement kilns (adsorbent material) (0, 1, 2 g) in 250 ml beakers containing 100 ml of solutions of methylene blue dye (substance adsorbed) with different concentrations of dye (10, 55, and 100 mg/L) and pH values (3.0, 7.0 and 11.0), the temperature at (25, 35 and 45)C, contact time (1.0, 2.0 and 3.0 hr.) and rotary per minute (150, 250 and 350) rpm. The containers were placed in quantities of Specific adsorbent material and different concentrations of the material adsorbents with different pH values on the stirrer at a limited stirrer speed, limited temperature, and limited contact time. After the stirrer operations are completed, they are collected to get samples ready. After the experimental run, the solution is tested in a COD meter.

4. Results and Discussion

4.1 Effect of pH on the adsorption process

The pH value plays an important role In the entire process of adsorption, especially on capacity Adsorption due to its effect on providing concentrations of ions Hydrogen + H and hydroxyl - OH in which reaction system It appears from the results of Jain and [7]. From (figure 1) the dyes removal (% R) increased from 67.46 % to 88.31 % when PH meter increased from 3.0 to 11.0 at the same condition for others variables. The low percentage of dye removal from its solutions water when using a pH value (3.1 conditions acidic) may be due to the abundance of hydrogen ions + H gained from hydrochloric acid used in Adjusting the pH value of dye solutions water, which leads to competition between H + protons and cationic dye molecules (MB) on The exchange sites are available on the surfaces of the adsorbent and then Electrostatic attraction between protons available in the form of Large in the system and the surfaces of the adsorbent, accompanied by repulsion between The cationic dye molecules and the positive charges generated on the exchange surfaces, which causes a decrease in the rate of Removing the dye in the system [8]. At the basic conditions at 11.0 the presence of an abundance of hydroxyl ions in the system (aqueous solution of dye and adsorbent) enables it to Correlation with positive charges of methylene blue in its aqueous solutions, it can leave the medium to precipitate under basic conditions.

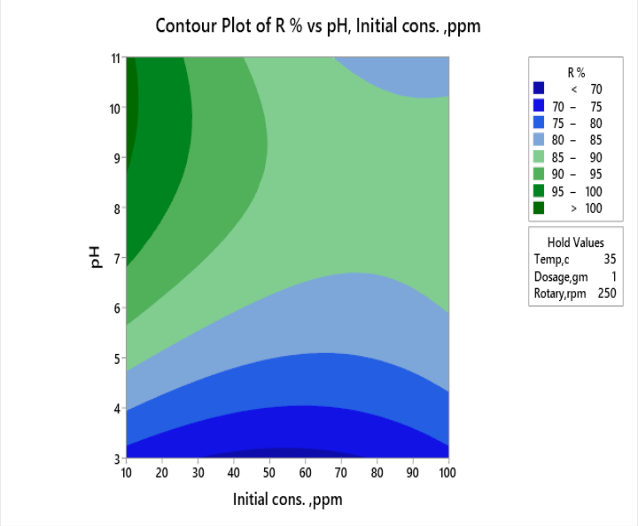

Figure 1. Effect pH value and initial concentration on dye removal

4.2 Effect of dye concentration on the adsorption process

The initial concentration of the dye has an important role in the capacity of Adsorption [9]. It is clear that Dye adsorption increases in line with increasing pH value. It was observed from the results of the study an increase in the percentage of dye removal from its aqueous solutions at the same condition for other variables, the initial concentration of the dye Provides an important driving force to overcome the resistance encountered The dye molecules as they move between the liquid phase and the solid phase [10]. From (figure 1) the dye removal (% R) increased from 89.02 % to 99.20 % when the initial concentration increased from 10 ppm to 100 ppm at the same condition for other variables. As it was observed at 1 g of the adsorbent material, the Relative decrease in the percentage of removal of the dye when its concentrations increase In the system it may be caused by the saturation of the exchange sites of one gram of a substance adsorbing cationic dye molecules at the equilibrium time depends on the concentrations used [11], sites available adsorption is relatively high at the concentration low of the dye, which facilitates the connection of shipments dye at exchange sites, and at high dye concentrations the sites available for exchange are few and therefore the ions The dye takes longer to reach the exchange sites [12] allowing Chance of repulsion between the charges of the dye molecules itself to remain in the solution away from the surfaces of the adsorbent material Which explains the low percentage of removal.

4.3 Effect of adsorbent dosage on the adsorption process

From Fig.2 the dye removal (% R) increased from 86.48 % to 92.11 % when the dosage increased from one gram to two grams at the same condition for other variables. The reason for the large increase despite the

use of conditions Acidic may be due to the use of an increased amount of dust base cement kilns that have a pH value of 12.4. And when soluble in aqueous solutions of the dye and with the help of stirrer operations (150, 250, and 350) provides hydroxyl ions negativity that may make the mean neutral tilted to the basal Which provides suitable conditions for removing the dye from its aqueous solutions, add to this that increasing the amount of the substance adsorption means an increase in the surface area of sites Adsorbents that increase the percentage of dye removal [13].

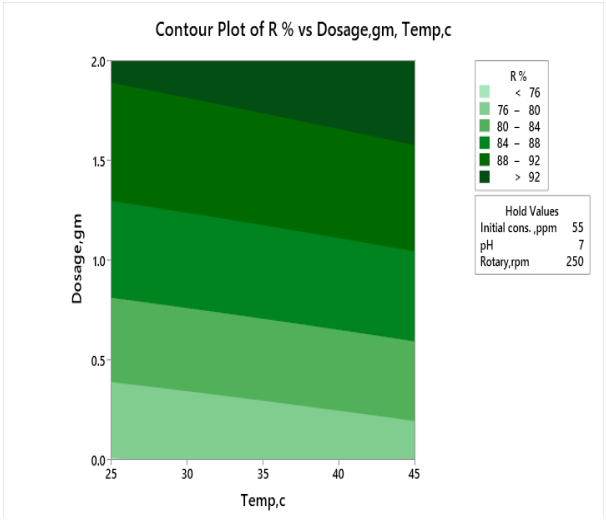

Figure 2. Effect dosage and temperature on dye removal

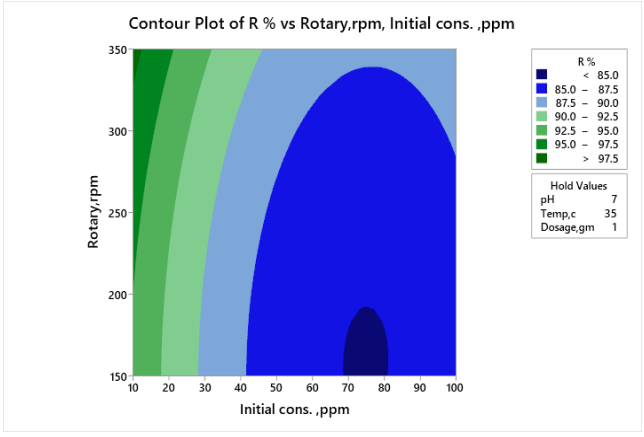

Figure 3. Effect rotary speed and initial concentration on dye removal

4.4 Effect of temperature on the adsorption process

The temperature has an important effect on the adsorption process. As the temperature increases, the rate of diffusion of adsorbate molecules across the external boundary layer and interval pores of the adsorbent particles increase [14]. Changing in temperature will change the equilibrium capacity of the adsorbent for adsorbates. From (figure 2) the dyes removal (% R) increased from 86.26 % to 89.52 % when the temperature increased from 25 C to 45 C at the same condition for others variables [14], [15].

4.5 Effect of rotary speed on the adsorption process

In the present study, mixing and aeration were provided by the rotation of the discs. Therefore, rotational speed was considered as an important parameter affecting the system performance. Decolorization efficiency increased with increasing rotational speed [16].
From (figure 3) the dye removal (% R) increased from 87.48 % to 89.52 % when the temperature increased from 150 rpm to 350 rpm at the same condition for other variables [14], [15].

5. Conclusion

In this study, the removal of Methylene blue (MB) dye from aqueous solutions using adsorbents as cement kiln dust was investigated. Optimization, parametric studies, adsorption isotherm, and kinetic studies were done. This work aimed to investigate the removal of Methylene blue (MB) dye from an aqueous solution by eco-friendly approaches, and adsorption methods processes.

REFERENCE

[1] L. Tinghul, T. Matsuura, and S. Sourirajan, 1983. Effect of Membrane Materials and Average Pore Sizes on Reverse Osmosis Separation of Dyes. *Ind. Eng. Chem. Prod. Res. Dev.*, vol. 22, no. 1, pp. 77–85, doi: 10.1021/i300009a018.
[2] N. Fathy, 2006. Removal of methylene blue by carbons derived from peach stones by H 3PO 4 activation : Batch and column studies. doi: 10.1016/j.dyepig..08.039.
[3] S. D. Khattri, 1998 . Colour removal from aqueous solutions by adsorption. no. July, pp. 230–234,.
[4] K. K. H. Choy, J. F. Porter, and G. Mckay, 2000. Langmuir Isotherm Models Applied to the Multicomponent Sorption of Acid Dyes from Effluent onto Activated Carbon. pp. 575–584,.
[5] J. F. Gonz and C. M. Gonz, 2004. Thermal regeneration of activated carbon saturated with p -nitrophenol. vol. 42, pp. 2285–2293, doi: 10.1016/j.carbon.2004.05.007.
[6] W. J. Ncz, 1987. THE REPEATED EXHAUSTION AND CHEMICAL. vol. 21, no. 8, pp. 961–965,.
[7] R. Jain and M. Shrivastava, 2008. Adsorptive studies of hazardous dye Tropaeoline 000 from an aqueous phase on to coconut-husk. vol. 158, pp. 549–556, doi: 10.1016/j.jhazmat..01.101.
[8] V. Vadivelan and K. V. Kumar, 2005. Equilibrium , kinetics , mechanism , and process design for the sorption of methylene blue onto rice husk. vol. 286, pp. 90–100, 2005, doi: 10.1016/j.jcis..01.007.
[9] S. Wang, Y. Boyjoo, and A. Choueib, 2005. A comparative study of dye removal using fly ash treated by different methods. vol. 60, pp. 1401–1407, doi: 10.1016/j.chemosphere.2005.01.091.
[10] S. V. U. C. O. 2006. Engineering and G. P. R. C. Engineering, The Removal of Composite Reactive Dye from Dyeing Unit Effluent. vol. 30, pp. 367–373,.
[11] J. Guthrie and A. Unyayar. The removal of colour from textile wastewater using whole bacterial cells : a review. doi: 10.1016/S0143-7208(03)00064-0.
[12] B. Benaouda, L. Duclaux, and L. Duclaux. Methylene blue and iodine adsorption onto an activated desert plant. doi: 10.1016/j.biortech.2008.02.053.
[13] L. Gong, W. Sun, and L. Kong, Adsorption of Methylene Blue by NaOH-modified Dead Leaves of Plane Trees. vol. 2013, no. April, pp. 13–19, 2013, doi: 10.4236/cweee.2013.22B003.
[14] P. Pokethitiyook,. Kinetics of basic dye (methylene blue) biosorption by giant duckweed (Spirodela polyrrhiza). doi: 10.1016/S0269-7491(03)00107-6.
[15] T. Shahwan and H. N. Erten, 2002 . Thermodynamic parameters of Cs + sorption on natural clays. vol. 253, no. 1, pp. 115–120,.
[16] Flavio Pavan, Ana Mazzocato, Yoshitaka Gushikem. Removal of methylene blue dye from aqueous solutions by adsorption using yellow passion fruit peel as adsorbent, Bioresoirce technology, 2008, v99-8, https://doi.org/10.1016/j.biortech.2007.05.067