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ASSESSING THE METHYLENE BLUE ADSORPTION CAPACITY ON RICE HUSK ASH

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Abstract

The work to find the compounds which can adsorb methylene blue (MB) for the treatment of textile wastewater, that is essential in the current period. In this study, rice husk ash was used for MB adsorption under conditions of pH ranging from 6-7-8-9, the mass of rice husk ash ranging from 0.05-0.1-0.25-0.5-0.75-1.0g and stirring time ranging from 20-40-60-80-100 minutes. The concentration of MB solution is fixed at 50 ppm, the volume of the used solution was 25ml at the room temperature. The results showed that when adding 0.1g of rice husk ash with a volume of porous hole of 0.005 cc/g, diameter of porous hole = 2.320e + 01 Å into the solution of MB of 50ppm for 60 minutes at pH of 8, the maximum adsorption capacity of rice husk ash reached 11.1mg/g. This shows the ability to utilize rice husk ash, an agricultural waste, to treat wastewater.

Keywords: rice husk ash, adsorb, methylene blue.

Introduction

Producing handmade tiles are a traditional craft in Vietnam; this village has been creating jobs for many workers in rural areas. However, this village has caused severe environmental pollution to the air (by HF, dust ...), water and land resource depletion. In particular, the contamination by rice husk ash (the origin of dust and pH changes in water) generated from the brick firing process is also an exciting problem (especially in the dry season). Currently, in Vietnam, there are almost no effective measures to deal with as well as make use of this waste [1].

Besides, the environmental pollution caused by wastewater in general and textile wastewater in particular is an issue of concern in the current period. The textile wastewater is often polluted by the presence of the high concentration of the dyes For example; MB is a dye that is used quite commonly in the textile industry, often used directly for dyeing cloth, cotton yarn or for dyeing paper or products from bamboo and ink. MB can cause diseases of the eyes, skin, respiratory, gastrointestinal, and even cause cancer.

Excessive MB concentrations in water will hinder the adsorption of oxygen into the water from the air, thus hindering the growth of plants and animals, causing the disturbance of microbial activity and the self-cleaning process of the water. The treatment of textile dye wastes is often difficult due to Due to the durability of dyes, complex structures result in very high processing costs [2].

In a water environment, an interaction between adsorbents and substances adsorbed were far more complex because there are at least three components that cause interactions: water, adsorbent and substance adsorbed. Due to the presence of the solvent, there is a competitive adsorption process between adsorbent and solvent on the adsorbent surface. The pair has strong interaction, so adsorption happens to that pair. The selectivity of the interaction depends on the elements: the solubility of substances in water adsorption device, the hydrophilic or hydrophobic of adsorbent, the hydrophobic level of substances absorbed in water environment. Compared to adsorption in the gas phase, adsorption in the water environment is usually much slower speed. This is due to the interaction between the adsorbed substance and the water solvent and the adsorbent surface making the diffusion process of the soluble molecules slowdown. The adsorption of water environment is influenced by the pH of the environment. The change of pH not only leads to the change in the nature of the adsorbent (the weak acidic substance, the weak base substance or the neutral substance have different separations at different pH values) but also affect the functional groups on the surface of the adsorbent. Besides, the adsorption process is also affected by the concentration of adsorbent [3] [4] [5].

Therefore, the choice of materials and methods for the treatment the textile wastewater both cheap and easy to perform is essential. Currently, there are many inexpensive materials, easy to find (such as bagasse, peanut shells, corncobs, coconut shells, straw, water hyacinth, banana fiber, rice hulls, and rice husk ash), that are used to remove the toxic substances in the water environment. Husk ash, a by-product of tile manufacturing industry, is being evaluated as the potential for the fabrication of the adsorbent to make adsorbent materials for the treat of environmental pollution.

Materials and methods

Materials

Chemicals:

The MB solution of 1000mg/l, the disodium hydrogen solution of 1/15M, the solution of potassium dehydrogenate phosphate of 1/15M, 0.05M of the Borax solution, 0.1N HCl, NaOH 0.1N prepared from chemicals of Merck manufacturer

Rice husk ash

Rice husk ash retrieved from brick kilns in MangThit district - VinhLong province of Vietnam

Methodology

Analysis method of MB

Method to build the standard curve: From the equation $A = k.(Cx)^b$. In principle to build the standard solution series using for quantifying a substance, the standard solution series with the light adsorber concentrations in the linear region ($b = 1$) must be concocted. Then, the measurement of the optical absorption of A from the standard solution series. From the optical absorption values of A, the equation of $A = f(C)$ was built. After obtaining the standard curve, dispensing the solution samples which needed to determine the MB concentrations under the

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conditions like building the standard curve. Then, measuring optical adsorbance of them with conditions such as the standard curve (with similar solutions, the cuvette, the same wavelength) is the value Ax. Ax pressure values measured on a standard road find the concentration value Cx respectively [6].

Method of data analysis:

The method was used to choice the optimal parameter by the ANOVA variance analysis method followed by Turkey's test (p-value < 0.05) using the statistics software STATGRAPHICS Centurion XV.

Experimental design method:

The experimental process was done according to diagrams 1

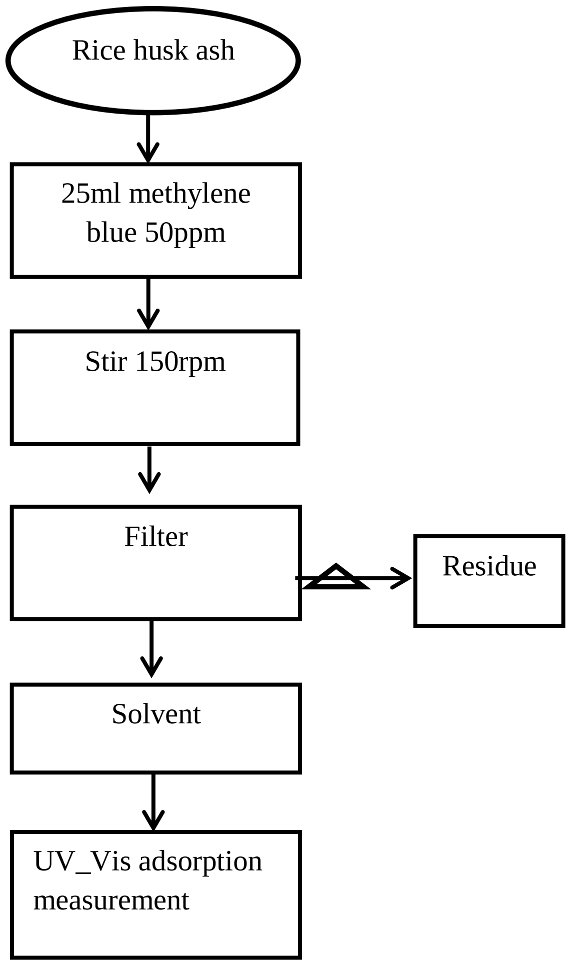

Diagram 1. The experimental procedure to investigate the influence of pH, rice husk ash mass and adsorption time to the MB adsorption capacity of rice husk ash

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Experiment 1: Investigating the effect of pH on the MB adsorption capacity of rice husk ash. The ranges of PH: 6-7-8-9.

The evaluation criteria of the experiment: the MB adsorption capacity of rice husk ash.

Experiment 2: Investigating the influence of husk ash mass and stirring time to the MB adsorption capacity of rice husk ash.

The ranges of rice husk ash: 0.05-0.1-0.25-0.5-0.75-1.0g.

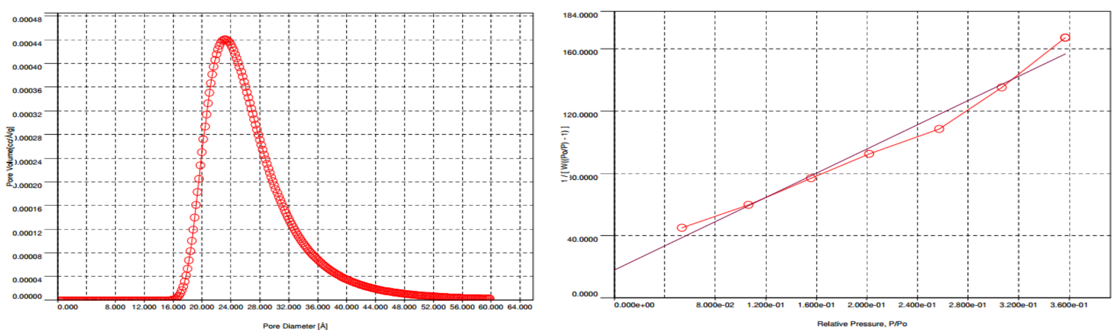
The stirring times: 20-40-60-80-100 minutes.

The evaluation criteria of the experiment: the MB adsorption capacity of rice husk ash.

Results and discussion

The influence of pH on the MB adsorption capacity of rice husk ash

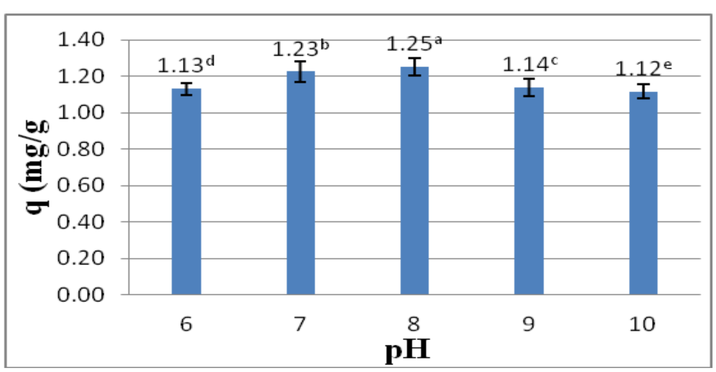
The MB adsorption on rice husk ash was due to the micropores below the surface of rice husk ash with very small diameter 2.320e + 1 Å, thereby creating a certain volume of porous holes in the adsorbent as shown in Figure 1, thus promoting the absorption of MB on rice husk ash.



Volume of porous hole = 0.005 cc/g
Porous hole diameter = 2.320e+01 Å

the surface area of husk ash = 8.564 m²/g

Figure 1. Volume, Diameter and the surface area of Porous hole of the rice husk ash.



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Notes: [a]The highest adsorption capacity value and the difference was statistically significant compared to other values. [b], [c], [d] and [e]the lower values.

Figure 2: Effect of pH on the MB adsorption capacity of rice husk ash.

The results presented in Figure 1 show that the adsorption capacity of rice husk ash increased from pH 6 to 8 (from 1.13mg/g to 1.25mg/g) and decreased at pH 9 and 10 (from 1.25 to 1.12mg/g). This results are in good agreement with the earlier report Jyoti Rana *et al.*, (2014) [7]. That could be explaind high pH levels leaded to the surface of the adsorbent affected by OH^- groups in the solution. As a result, the surface of the adsorbent became negative, that increased the electrostatic interaction between the adsorbent and MB. The result was an increase in the MB adsorption capacity of adsorbent. Also at pH 9 and 10, there were a slight decrease in the MB adsorption capacity. This could be due to chloride ions in the solution effecting on the surface of adsorbant [8]. Thus pH 8 was chosen to conduct the next experiment.

Effect of rice husk ash content and stirring time on the adsorption capacity of MB

Table 1. Influence of interaction between mass and stiring time on the MB adsorption capacity of rice husk ash.

Mass of rice husk ash (g/25ml)	**Adsorption time (minutes)**					**Average**
	20	40	60	80	100	
	adsorption capacity **(mg/g)**					
0.05	7.01	8.46	8.96	8.16	9.20	8.36[b]
0.1	9.58	10.32	**11.10**	10.34	11.14	10.33[a]
0.25	4.80	4.48	5.13	4.65	4.76	4.76[c]
0.5	2.20	2.42	2.34	2.26	2.37	2.32[d]
0.75	1.72	1.72	1.72	1.72	1.71	1.72[e]
1.0	1.31	1.30	1.31	1.30	1.31	1.30[f]
Average	4.43[c]	4.78[b]	5.09[a]	4.74[b]	5.08[a]	

Notes: [a]The highest adsorption capacity value and the difference was statistically significant compared to other values. [b], [c], [d] , [e] and [f]the lower values.

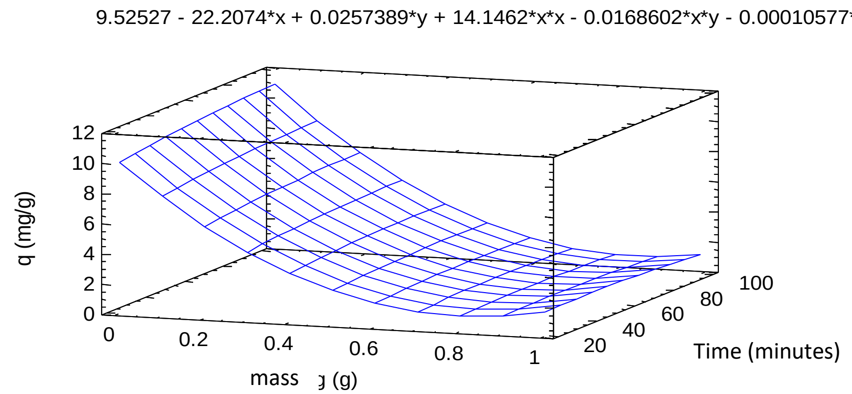

Figure 3. The interaction effect between mass of the adsorbent and adsorption time to the MB adsorption capacity of rice husk ash.

From the experimental results shown in Table 1, the regression equation was set using software Stat graphics Centurion XV.

$$z = 9.52527 - 22.2074x + 0.0257389y + 14.1462x^2 - 0.0168602xy - 0.00010577y^2 \quad (1)$$

Where: x is the mass, time is y, and z is the adsorption capacity.

From the equation (1), it is possible to calculate the adsorption capacity as changing the time or the mass of the adsorbent

The Experimental results from table 1 showed that the adsorption trend increased as the time from 20 to 60 minutes. That reached the corresponding adsorption capacity from 4.43 to 5.09mg/g. T then; the adsorption capacity was relatively stable as increasing adsorption time from 60 to 100 minutes. Accoding to the statistics, the best time for the process was chosen of 60 minutes.

Considering the mass of the rice husk ash, the adsorption trend increased from 0.05g to 0.1g (corresponding to the adsorption capacity of 8.36mg/g to 10.3mg/g). When the mass of rice husk ash continued increasing from 0.1g to 1.0g, the adsorption capacity decreased from 10.33mg/g to 1.3mg/g. It could be explain that when increasing the mass of the adsorbant to a certain limit in a fixed mass of MB, the saturated state of the adsorption would be breaked. Therefore the amount of MB adsorbed on a unit of the adsorbent would decrease due to the amount of the adsorbent in the solution more than the amount of the adsorbent needed to adsorp MB, so the residual amount of adsorbent would be a cause of adsorbant waste. Therefore the optimal conditions the mass of rice husk ash of 0.1g and the time of 60 minutes were used for the MB adsorption process reaches. At this condition, the maximum MB adsorption capacity of rice husk ash reached 11.1mg/g. This adsorption capacity was approximately 38.7% in compared to the MB adsorption

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capacity of the activated carbon from rice husk ash (achieving the adsorption capacity of 28.7mg/g) as reported in the previous research [9].

Conclusions

When changing the pH values, it will lead to changes in the MB adsorption capacity of rice husk ash. Besides, the concentration of the adsorbent also significantly affect to the MB adsorption capacity. The optimal condition of the adsorption process included the mass of rice husk ash of 0.1g, the concentration of MB solution of 50ppm during 60 minutes at pH 8. At the condition, the MB adsorption capacity of rice husk ash reached 11.1mg/g. The important point of this study was the determination the dependent relationship of factors of the adsorbent mass (x) and adsorption time (y) on the MB adsorption capacity of rice husk ash (z) by the equation $z = 9.52527 - 22.2074x + 0.0257389y + 14.1462x^2 - 0.0168602xy - 0.00010577y^2$. From this equation, it is possible to predict the MB adsorption capacity at a concentration of rice husk ash and a determined time. Thereby, it is possible to utilize this abundant and low-value raw material source to research and apply in textile and wastewater treatment and the ability to handle other wastewate

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REFERENCES

Nguyen Trung Thanh, "Research and application of rice husk ash from incinerators handmade brick to adsorp methyl orange," University of An Giang, 2016.

Duong Ngoc Bich et al "Research adsorption capacity of methylene blue dye adsorption materials made from corncobs and corn husks," Journal of science and forestry technology, vol. 2, pp. 77-81, 2013.

Tran Van Nhan, Ho Thi Nga, wastewater treatment technologies, Hanoi: Scientific and Technical Publisher, 2005.

Van Cat, adsorption and ion exchange processing in technology of water and wastewater treatment, Hanoi: Statistics, 2002.

Tran Van Nhan, Nguyen Thac Suu, Nguyen Van Tue, Physiochemistry II, Hanoi: Educational Publisher, 1998.

Tran Tu Hieu, Analysis of UV-Vis absorption spectra, Hanoi: Hanoi National University Publisher, 2003.

Jyoti Rana, Lakshman Singh, "A Comparitive Adsorption Studies on Rice Husk Ash, Activated Rice Husk and Neem Leaves by Using Methylene Blue as Dye, "Journal of Chemistry and Materials Research, vol. 1, pp. 60-64, 2014.

Pankaj Sharma et al., "Removal of methylene blue from aqueous waste rice husk and rice husk using ash," Desalination, vol. 259, pp. 249-257, 2010.

Hoa thai Ma et al, "Effect of the carbonization and activation processes on the adsorption capacity of rice husk activated carbon," Vietnam Journal of Science and Technology, vol.55, no. 4, pp. 485-493, 2017.