Removal of Methylene Blue from aqueous solution using spent bleaching earth

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Abstract. The waste from industrial textile waste is one of the environmental problems, it is required effective and efficient processing. In this study spent bleaching earth was used as absorbent. It was found that the absorbent was effective to remove methylene blue from aqueous solution with removal efficiency 99.97 % in 120 min. Several parameters such as pH, amount of absorbent loading, stirring speed are found as key factor influencing removal of methylene blue. The mechanism of adsorption was also studied, and it was found that Langmuir isotherm fitted to data of experiment with adsorption capacity 0.5 mg/g.

1. Introduction

Industrial wastes are increasing with the rapid development of industry, i.e. volume and type. One of the most disturbing problems of industrial waste is the dye content [1]. The textile industry is one of the industries that produces colored liquid waste, the dye in the textile industry is one of the main raw materials, about 10-15% of the dye has been used, unfortunately it cannot be reused and must be disposed [2]. In the textile industry, methylene blue is one of the most commonly used thiazine dyes, because it is economical and also easy to obtain. The use of methylene blue may cause some effects, such as gastrointestinal irritation if swallowed, causing cyanosis if inhaled, and irritation of the skin if touched by the skin [3].

Many dye removal processing methods have been tried to deal with this problem, but only the adsorption method is superior to other methods [4]. Because adsorption is a simple, easy to operate, flexible, affordable method of separation, and does not produce toxic products [5]. The first step to get an effective adsorption process is by selecting adsorbents with high selectivity, capacity and recyclable. Spent bleaching earth (SBE) is using of absorbent generated from CPO refining process.

In this research, spent bleaching earth (SBE) will be used as adsorbent to adsorb the methylene blue dye with variation of pH 6, 8, and 10, variation of adsorbent mass 1, 1.5, and 2 g and 60 minute stirring time, 90 minutes and 120 minutes.

2. Experimental

The activation was done to process of spent bleaching earth was done by heating using furnace at 500 °C for 7 hours, then sieved using 200 mesh sieves. The preparation of the liquor was carried out by dissolving 1 gram of methylene blue into a 1 litter flask, and added aquadest to the threshold. Standard methylene blue solution with 1 ppm concentration of 10 mL was measured using UV-VIS spectrophotometer to obtain the maximum wavelength. Methylene blue solution with a concentration of 20 ppm with variation of pH 6, 8, 10 and 12 taken 200 mL and fed into a beaker. Then added adsorbents with the variation as much as 1, 1.5, and 2 grams. For then, stirred with a magnetic stirrer with a speed of 205 rpm varied for 60, 90, and 120 minutes. Subsequently the solution was filtered using filter paper, deposited on the sample bottle for analysis.
From the analysis with the adsorption method, the colour testing of the sample before and after added adsorbent spent bleaching earth is by calculating the efficiency of decreasing concentration. The adsorption capacity is calculated from the Langmuir equation or Freundlich equation [6].

3. Result and discussions

Effect of pH variation on reduced methylene blue substance concentration is presented in Figure 1. Base on the figure, it is seen that the efficiency of decreasing concentration of the highest methylene blue dye at pH 8. It was possible that the isoelectronic point of methylene blue lies at pH 8 and the functional group present in the adsorbent could bind the dye to its maximum. At lower pH, H⁺ in the solution will further disrupt the bonding between the adsorbent and methylene blue, as more carboxyl and siloxane groups in the adsorbent bind the H⁺ and become positively charged, resulting in the adsorbsents becoming more difficult to bind to the methylene blue dye ions. At pH 10 there was a decrease, because of OH⁻ in the solution could not be captured by the dye, so there werefree OH in the solution. The carboxyl group present in the adsorbent was a positive partially charged active group, so that at the time of addition of the colour base tends to be partially negative. This led to competition between the dye and the free OH-ion to occupy the surface of the adsorbent which will decrease the dye adsorption power by adsorbent

![Figure 1](image.png)

**Figure 1.** Effect of pH variation on decreasing methylene blue colour substance concentrations.

The use of an appropriate amount of adsorbent mass will affect to the efficiency of decreasing of the concentration of the methylene blue dye. It can be seen in the following picture that there is an increase in stress on the methylene blue dye in each adsorbent mass increase. 2 gr of adsorbent mass always has the highest decreasing efficiency. This is directly proportional to the theory put forward by Wambu [7] that the more adsorbent mass used the higher the efficiency level. The results of this study indicate that the more mass of the adsorbent undergoing 200 mL of methylene blue dye solution, the more the dye adsorbed by the adsorbent.

The agitation time used has an effect on the efficiency of decreasing concentration of methylene blue dye. It can be seen in Figure 1 and Figure 2 that there is always an increase in the efficiency of decreasing the concentration of the methylene blue dye in each increase in aggregation time. The stirring time of 120 minutes always has the highest decreasing efficiency for each pH and the adsorbent mass has been varied. The results obtained in accordance with the theory proposed [8] that the longer time of stirring it will get the results of high concentration reduction efficiency. The small particle size has a greater molecular interaction power so that its absorption becomes better.
To know the adsorption capacity of pH variation, adsorbent mass and stirring speed at adsorption of methylene blue dye by spent bleaching earth then used two isotherm models namely Langmuir and Freundlich isotherms. The determination of isotherm signifies a relationship with the adsorption capacity, therefore the Ce Versus Ce / qe curve was made according to the Langmuir isotherm model in Figure (a) and the Ce versus log qe log curve according to the Freundlich isotherm model in Figure (b) By comparing the coefficient of determination (r²), an appropriate adsorption isotherm model will be selected.

From Figure 4 (a) and Figure (b) it can be seen that the isotherms suitable for methylene blue adsorption by spent bleaching earth on variarian pH is Langmuir isotherm because it has a higher coefficient of determination (r²) that is 1 whereas for isotherms Freundlich coefficient of determination is only 0.947, the isotherm used is Langmuir isotherms with adsorption capacity (Qo) of 0.5035 mg / g. This result is in line with what was stated by [9], that the adsorption of methylene blue dye follows Langmuir isotherms. These results suggest that the possibility of the adsorption process occurring involves the formation of a strong enough bond (chemisorpsi) greater than in fisisorpsi so that it is difficult to be released again.
4. Conclusions

Efficiency of decreasing concentration in methylene blue dye was highest when pH 8, 2 gram adsorbent mass and stirring time 120 minutes with efficiency decreasing concentration of 99.973%. Adsorption of methylene blue dye by spent bleaching earth on pH variation follows Langmuir isotherm with determination coefficient ($r^2$) is 1, adsorption capacity of 0.5035 mg / g. Adsorption of methylene blue dye by spent bleaching earth on variation of adsorbent mass following Langmuir isotherm with determination coefficient ($r^2$) is 0.843, adsorption capacity of 0.3816 mg / g. Adsorption of methylene blue dye by spent bleaching earth on variation of stirring time following Langmuir isotherm with determination coefficient ($r^2$) is 1, the adsorption capacity is 0.5012 mg / g.

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