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Application of Natural Zeolite in Methylene Blue Wastewater Treatment Process by Adsorption Method

Shinta Amelia✉, Maryudi

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Department of Chemical Engineering, Faculty of Industrial Technology, Universitas Ahmad Dahlan Campus IV, Tamanan, Banguntapan, Bantul, Yogyakarta, 55164

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Abstract

Textile industry waste contains dyes that are difficult to decompose naturally and cause disruption of ecosystems in water. The colorant that is often used in the textile industry is methylene blue which is a cationic heterocyclic aromatic compound. This compound is so stable that it is difficult to decompose naturally and is harmful to the environment in large concentrations. Therefore, we need a waste treatment technology that can reduce the concentration of dye waste in water. So far, the adsorption method remains the most efficient and effective technique in removing dyes because of its relatively large adsorption capacity. One method that can be used is the adsorption method using natural zeolite. Zeolite is one of the non-metal mineral commodities or multipurpose industrial minerals, one of which is as an adsorbent or adsorbent media. This study aims to determine the potential of natural zeolite in absorbing methylene blue with variations in the concentration of methylene blue and various sizes of natural zeolite mesh. The procedures in this experiment include, the preparation of natural zeolite with size variations of 20-60 mesh, 60-100 mesh and> 100 mesh and variations in the concentration of methylene blue used 15 ppm, 30 ppm and 45 ppm with contact time from 0 to 180 minutes. From the results of the study it was found that the smaller the size of natural zeolite used, the greater the percentage of dye removal that is at mesh size> 100 mesh the percentage of dye removal was 32.11%. As for the variation of the concentration of methylene blue, the smaller the concentration, the natural zeolite can work optimally ie at a concentration of 15 ppm at 180 minutes the remaining methylene blue concentration of 0.145 ppm.

INTRODUCTION

Dyestuffs produced from industry are generally non-biodegradable compounds, which cause environmental pollution, especially the aquatic environment. So far, the textile industry has the highest rank for the use of dyes. The coloring process in the textile industry uses dyes such as methylene blue in large enough quantities usually as synthetic dyes combined with other dyes (Khetaee, 2010). Methylene blue dyes are of great concern in the waste treatment process because they are difficult to decompose or degrade because they have benzene, are toxic, cause genetic mutations and have a negative effect on reproduction (Fayazi et al., 2016). Methylene blue is a basic dye that is important in the coloring process in the textile industry. However, the use of methylene blue dyes is very dangerous because it can irritates skin and eyes.

Waste management method that is often done is the adsorption method. Waste dye treatment by adsorption method has a high effectiveness in removing dyes in liquid waste (Wanchanthuek & Thapol, 2011). Adsorption is a purification method that is widely used in the oil industry and the textile industry because this method is considered effective in removing dyes

✉Corresponding author:
Department of Chemical Engineering, Faculty of Industrial Technology,
Universitas Ahmad Dahlan Campus IV, Tamanan, Banguntapan, Bantul, Yogyakarta
E-mail: shinta.amelia@che.uad.ac.id

(Tchobanoglous & Burton, 1991). This dye removal process is very dependent on the type of adsorbent used. Removal of dyes with various types of adsorbents, such as silica, chitosan, fuller earth, and peat have been carried out (McKay et al., 2001). Adsorption can be influenced by several factors, namely the surface area of the adsorbent, particle size, contact time, and pore size distribution. Another factor, namely pore distribution, pore distribution will affect the size distribution of the adsorbate molecules that enter the adsorbent particles.

In the last few years, a lot of research has been done to develop an efficient and effective adsorption method for treating dyestuffs. One of the adsorbents commonly used is zeolite because it has an open pore structure with a large surface area so that it allows the absorption of dyestuff molecules to increase (Suzuki & Okuhara, 2001). The zeolite structure which has porous properties can be utilized as an adsorbent material for pollutants released from an industry (Yamliha et al., 2013). In this research the methylene blue adsorption process was carried out with various concentrations using natural zeolite with various mesh sizes. The type of natural zeolite used is natural zeolite with micropore character.

MATERIALS AND METHODS

Materials

The materials used in this study are natural zeolite as adsorbent and methylene blue (95% analytic level, Sigma Aldrich) which is used as synthetic waste. Ultraviolet / visible (UV / Vis) spectrophotometer (Shimadzu Mini 1240) was used to analyze the concentration of methylene blue per unit time.

Adsorption Process

A total of 200 ml of methylene blue solution with various concentration variables was prepared in beaker glass. The solution is stirred with a magnetic stirrer at a constant speed of 450 rpm and a room temperature of 30^0C. Furthermore, 0.025 grams of natural zeolite with mesh size variables were each inserted into a beaker glass that already contained a solution of methylene blue. A total of 2 ml of the sample solution is taken every 5 minute for 3 hours. Furthermore, the concentration of methylene blue in solution (C) at any given time interval was analyzed with a UV-VIS spectrophotometer at a wavelength of 663 nm.

RESULTS AND DISCUSSION

Effect of Methylene Blue Concentration Variation on the Adsorption Process

Data from the study of adsorption of methylene blue dyes by natural zeolite with variable concentration can be seen in Figure 1. Based on these data it can be seen that in samples with a concentration of 15 ppm the adsorption process took place very quickly. It can be seen that at 180 minutes the remaining methylene blue concentration was 0.145 ppm. Whereas in the sample with a concentration of 30 ppm at 180 minutes the adsorption process the remaining concentration of methylene blue was 7.165 ppm. Furthermore, in the last sample with a concentration of 45 ppm at the same time of adsorption ie 180 minutes the remaining methylene blue concentration was 29.614 ppm.

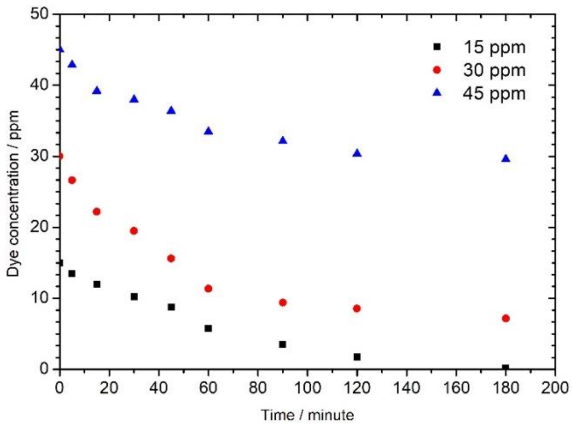

Figure 1. Effect of methylene blue concentration variations on adsorption capacity.

From Figure 1 it can be seen that the longer the entrapment time the greater the entrapment capacity will be. Good absorption results can be seen that there is a decrease in concentration where the final concentration will be smaller than the initial concentration. This happens because the longer the contact time between methylene blue with natural zeolite as an adsorbent, the greater the capacity of adsorption. In Figure 1 it can be seen that there is a correlation between contact time and adsorption capacity. The adsorption process takes place faster when the adsorption process is initiated (Khuluk *et al.*, 2019). Then after the adsorbate starts to accumulate in the adsorbent, the adsorption process becomes slower so that a greater concentration of methylene blue requires a longer contact time.

Effect of Natural Zeolite Mesh Size Variations on the Adsorption Process

In addition to variations in the concentration of methylene blue as synthetic waste, this study also uses variations in the size of the natural zeolite mesh. The size of natural zeolite used are 20-60 mesh, 60-100 mesh and> 100 mesh. The research data in Figure 2 shows that the percentage of dye removal for natural zeolite with a size of 20-60 mesh in 180 minutes is 14.988%. While the percentage of natural zeolite dye removal with a size of 60-100 mesh at the same time is 20.962%. And based on the results of the study the percentage of natural zeolite dye removal with size> 100 mesh is the largest percentage of 32.11%. Based on Figure 2 it can be seen that natural zeolite with particle size> 100 mesh has the largest adsorption capacity. This shows that the smaller the size of the adsorbent, the greater the adsorption capacity produced. This can occur because the smaller the size of the adsorbent, the resulting surface area to adsorb adsorbate is getting larger so the adsorption capacity is greater.

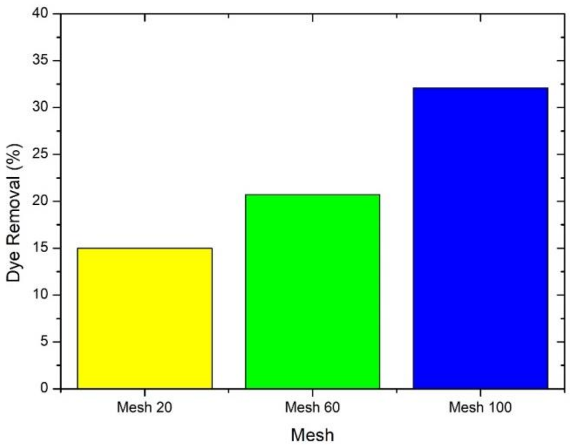

Figure 2. Effect of Natural Zeolite Size Variations on Adsorption Capacity.

CONCLUSION

Based on the results of the research discussed above, it can be concluded that the difference in the concentration of methylene blue waste affects the adsorption capacity. The highest adsorption capacity was achieved at 15 ppm blue methylene concentration in 180 minutes the remaining amount of methylene blue was 0.145 ppm. In addition, the contact time during the adsorption process also affects the adsorption results. The longer the contact time, the more adsorbate can be absorbed by the adsorbent. Another parameter that affects the adsorption capacity is the size of the adsorbent. Because the smaller the size of the adsorbent gives a larger surface area of the adsorption field so as to produce a higher adsorption capacity. The highest adsorption capacity is produced by natural zeolite with size <100 mesh.

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REFERENCES

Fayazi, M., Taher, M.A., Afzali,D., Mostafavi, A. 2016. Enhanced Fenton Like Degradation of Methylene Blue by Magnetically Activated Carbon/Hydrogen Peroxide with Hydroxylamine as Fenton Enhancer. Journal of Molecular Liquids. 216(April): 781-787.

Khetaee, A. R., Kasiri, M. B. 2010. Photocatalyst Degradation of Organik dyes in The Presence of Nano Structured Titanium Dioxide: Influence of The Chemical Structure of Dyes. Journal of Molecular Catalysis A: Chemical. 328(1-2): 8-26.

Khuluk, R.H., Rahmat, A., Buhani, B., Suharso, S. 2019. Removal of Methylene Blue by Adsorption onto Activated Carbon From Coconut Shell (*Cocous Nucifera L.*). Indonesian Journal of Science & Technology. 4(2): 229-240.

McKay, G., Choy, K. K. H., Potter, J. F. 2001. A Film-Pore-Surface Diffusion Model for the Adsorption of Acid Dyes on Activated Carbon. Adsorption. 7(October): 231-247.

Suzuki, T., Okuhara, T. 2001. Change in pore structure of MFI zeolite bytreatment with NaOH aqueous solution. Microporous and Mesoporous Materials. 43(1): 83-89.

Tchobanoglous, G., Burton, F. L. 1991. Wastewater Engineering Treatment, Disposal, reuse. Series Water Resource and environmental engineering 6^{th} ed. McGraw Hill Book Co., Singapore.

Wanchanthuek, R., Thapol, A. 2011. Kinetic Study of Methylene Blue Adsorption Over MgO from PVA Template Preparation. Journal of Environmental Science and Technology. 4(5): 552-559.

Yamliha, A., Argo, B. D., Nugroho, W. A. 2013. Effect of Zeolite Size on Carbon Dioxide Absorption (CO_2) On Biogas Flow. Jurnal Bioproses Komoditas Tropis. 1(2): 67–72.