Removal of Methylene Blue from Aqueous Solutions using Chemical Activated Carbon Prepared from Jackfruit (*Artocarpus heterophyllus*) Peel Waste

T.N.A.Tengku Hasbullah, O.S.Selaman and N.A.Rosli

***Abstract* — Dye wastewater generated is rated as the most polluting wastewater among all the industrial sectors. Adsorption using activated carbon (AC) has been proven to be effective to treat dye wastewater. In this study, jackfruit (*Artocarpus heterophyllus*) peel waste has been utilized for activated carbon (AC) preparation using chemical activation. This research attempts to study the factors affecting its adsorption performance. Series of experiments conducted consisted of the experiments studying the effect of initial dye concentration and also effect of adsorbent dosage. In the study, CAC showed adsorption capacity of 10.43 mg/g.**

***Keywords*:** dye wastewater, methylene blue, chemical activated carbon, jackfruit peel waste

I. Introduction

MALAYSIA is moving towards a developed nation in line with Vision 2020. In conjunction with that, Malaysia's rapid development also gives negative impact on the environment. In these recent years, water pollution has become a bad growing phenomenon. One of the major sources of this water pollution is wastewater. In Malaysia, textile industry contributes the most to the dye wastewater. Textile dye wastewater is wastewater produced during the dying process. The effluent from the textile dying process is commonly untreated and in a large quantity. Wastewater from textile industry contains high concentration of chemical and colour. The improper treatment of textile wastewater would cause environmental problems.

Several methods have been used for the removal of dyes from the environment including physical, chemical, and biological processes. Adsorption is a physcochemical wastewater treatment method [12]. If an AC for a specific purpose such as for wastewater treatment can be produced from low-cost or waste materials, then its use as an adsorbent should be economical [11]. Therefore, if an agro wasted can be used effectively to treat dye wastewater, it is not only solving the high cost problem but also manage our waste properly. The aim of this research is to remove Methylene Blue (a type of dye being used in textile industry) from aqueous solutions using Chemical Activated Carbon prepared from Jackfruit (*Artpcarpus heterophyllus*) peel waste.

There are basically two methods for preparing AC: physical and chemical activation. Physical activation consists of two steps: the carbonization of the starting material and the activation of the char by using carbon dioxide or steam. In chemical activation both the carbonization and the activation step proceed simultaneously [4].According to [2], activated carbon, also called activated charcoal or activated coal, is a general term that includes a carbon material mostly derived from charcoal. Adsorption is defined as mass transfer process by which a substance is transferred from the liquid phase to the surface of a solid, and becomes bound by physical or chemical interactions [10].

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The equilibrium data from a comparative study on the adsorption kinetics and thermodynamics of dyes onto acid activated low cost carbon of Congo red (CR), Malachite green (MG) and Rhodamine B (RDB) on the AC at various initial concentrations (5, 10, 15, 20, 25, 30 mg/L) with contact time reveal that the percent adsorption decreases with the increase in initial dye concentration. It means that the adsorption is highly dependent on the initial concentration of dyes [7].

A study on the removal of ammoniacal nitrogen (NH_3-N) from synthetic waste water using limestone (LS) and granular AC (GAC) shows that when the adsorbent dosage increased, the percentage removals of NH_3-N also increase. By varying the adsorbent dosage from 5 to 40 ml with LS:GAC or 25:15, the removal of NH3-N increases from 22 to 48%. This is due to the increase in adsorption site of the media. [3]

At greater contact time, removal efficiencies are greater. Longer solid-liquid contact had caused a better interaction between the media and the adsorbate. In this situation, more active surface media is exposed to the adsorbate by continuous shaking [8].

II. EXPERIMENTAL PROCEDURE

Jackfruit peel being used in this study undergone chemical activation process using phosphoric acid with 1:4 impregnation ratio. Series of experiments conducted in the study focus on factors affecting adsorption performance such as effect of initial dye concentration, effect of adsorbent dosage, and effect of contact time.

Effect of Initial Dye Concentration

In order to study the effects of initial dye concentration, experimental solutions of the desired initial concentration of 1.0, 1.5, and 2.0 mg/L were obtained by dilutions from stock solutions. The experiment to observe the effect of initial dye concentration was conducted by adding 0.4 gram of chemical activated carbon (CAC) into a series of 250 mL Erlenmeyer flask. Each Erlenmeyer flask was filled with experimental solution. The experimental solution consists of 100 mL of distilled water and 100 mL of initial dye (MB) concentration 1.0, 1.5, and 2.0 mg/L at 32 ±1 ºC. The temperature of the incubated refrigerated orbital shaker was set up. For the first 4 hours, 5 mL sample of the each solution was taken at 60, 120, 180, and 240, minutes. After 24 hours, 5 mL sample of each solution was taken.

Effect of Adsorbent Dosage

In order to study the effects of adsorbent dosage, chemical activated carbon (CAC) of the desired dose (0.5, 1.0, and 1.5 g) was used at 32 ±1 ºC. The experiment was conducted by adding chemical activated carbon (CAC) into a series of 250 mL Erlenmeyer flask. Each Erlenmeyer flask was filled with experimental solution. The experimental solution consists of 100 mL distilled water and 100 mL MB solution. The concentration of MB solution that was used in this experiment was 17 mg/L. The solutions of four different adsorbent dosages were formed. The next procedure was repeated from experiment of initial dye concentration after solution was formed.

Effect of Contact Time

In order to study the effect of contact time, the method and procedure were repeated from effect of adsorbent dosage experiment. The experiment was conducted by adding chemical activated carbon (CAC) into a series of 250 mL Erlenmeyer flask. Chemical activated carbon (CAC) of the desired dose (0.5, 1.0, and 1.5 g) was used at 32 ±1 ºC. Each Erlenmeyer flask was filled with experimental solution. The experimental solution consists of 100 mL distilled water and 100 mL MB solution. The concentration of MB solution that was used in this experiment was 17 mg/L.The next procedure was repeated from experiment of initial dye concentration after solution was formed.

III. RESULTS AND DISCUSSION

Effect of Initial Dye Concentration

Figure 1 shows, the percentage removal of MB with different initial concentration (mg/L). The highest percentage is 92 % at the concentration of 2 mg/L while the lowest percentage is at 1mg/L with 78 %. At a concentration of 1.5 mg/L, the percentage removal is 88 %. The result shows the percentage removal with the increasing pattern of percentage removal of dye with initial dye concentration.

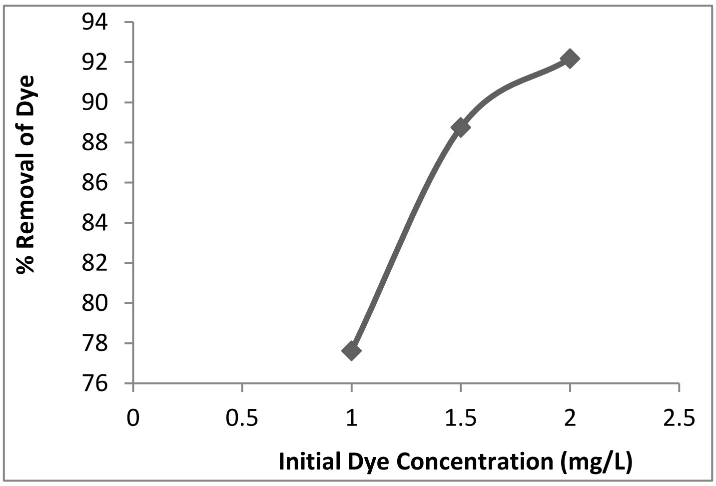

Figure 1: Effect of initial dye concentration

According to [6] in their study of the influence of the initial concentration of MB (5-25 mg/L) on the adsorption rate using untreated and treated rice hulls, the removal efficiency of the two adsorbents decreased with increasing initial dye concentration. Their result is vise versa with the result obtained in this study. In this study, adsorbent percentage removal increased with increase initial dye concentration. This is probably due the lower concentration of initial dyes that had been used which are 1.0, 1.5 and 2.0 mg/L

Effect of Adsorbent Dosage

Figure 2 shows, the percentage removal of MB with different adsorbent dosage (g/L). The highest percentage removal is at 7.5 g/L with 14 %. The lowest percentage removal is at 2.5 g/L with 4.2 %. While, for 5 g/L the percentage removal is 6 %. This result shows the increasing pattern of the percentage removal.

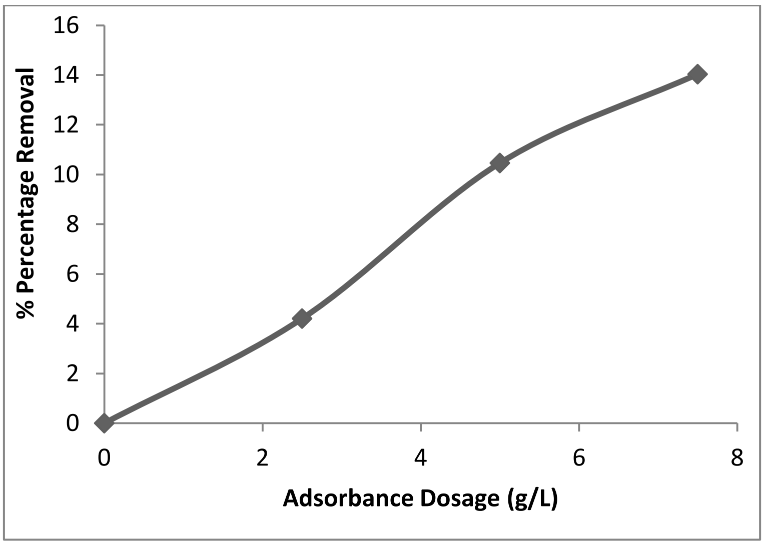

Figure 2: Effect of adsorbance dosage

With reference to [8], this is due the greater availability of the surface area. The 7.5g/l of adsorbent dosage have higher surface area compared to 2.5g/l. The reaction between adsorbate and adsorbent increase, due to the greater surface area of CAC react with MB.

Effect of Contact Time

Figure 3 shows the percentage removal of MB with different duration of time (h). From **Figure 3**, the result revealed that the percentage removal for 2.0 mg/L concentration is 92.17% at 24 hours compared to 84.03 % at 6 hours. The percentage removal for 1.5 mg/L concentration is 88 % at 24 hours compared to 84 % at 6 hours. The percentage removal for 1.0 mg/L concentration is 77.62% at 24 hours compared to 62 % at 6 hours. The highest percentage removal of MB is obtained from 2.0 mg/L concentration. For all these three concentrations, the plateau pattern was obtained after 5 hours with a little increase. The pattern shows the increasing of percentage of removal with the increase of contact time.

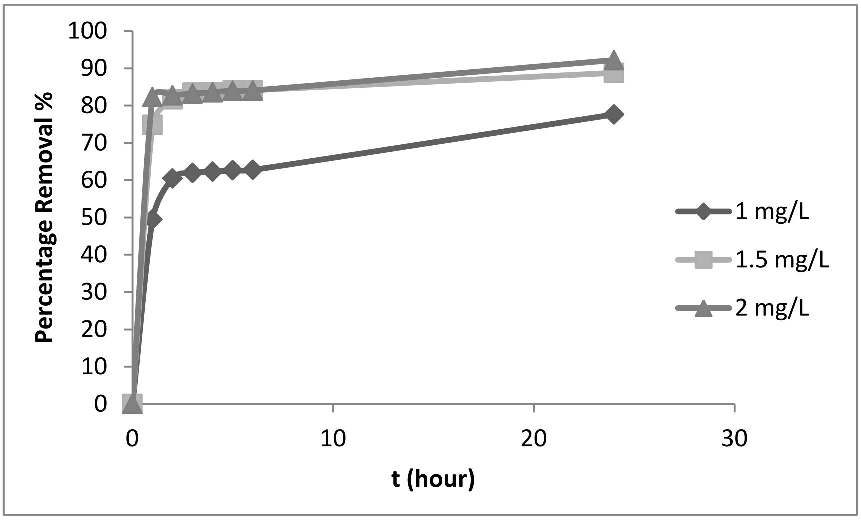

Figure 3: Effect of contact time

At the greater contact time, removal efficiencies are greater due to the longer solid-liquid contact caused of by interaction between the media and the adsorbate. In this situation, more active surface media is exposed to the adsorbate by continuous shaking [5].

IV. CONCLUSION

The study shows that initial concentration, adsorbent dose and contact time are factors indeed affect the performance of adsorbent. The percentage removal of MB increases with the increase of initial concentration, adsorbent dosage and contact time. Hence, CAC is a potential adsorbent that can treat dye wastewater by adsorption process. i.e. chemisorptions. Activated carbon production in this country should be extended to a variety of innovations such as from jackfruit peel waste.

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