REMEDIATION OF INDUSTRY WASTEWATER EFFLUENT BY USING KENAF AS WAXES ABSORBENT

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Abstract. Batik industry is one of the industries that produce high amount of waxes in their wastewater. Natural fiber has become apparently important as a source of absorbent. Kenaf (*Hibiscus cannabinus*) core is one of the good absorbent to absorb the waxes due to its characteristic. The contact time, weight of kenaf and the different form of kenaf can affect its absorbency. The powder form of kenaf has been proven to have better performance in term of wax absorption. The most suitable contact time is 15 minutes in which it has the highest wax absorption. Moreover, 1.2g of fibrous kenaf and 0.8g till 1.2g of kenaf powder showed high wax absorption capacity.

Introduction

In Malaysia, textile industry is very famous especially in east Coast of Peninsular Malaysia which it's known as Batik Industries which is inherited in numbers of families in Malaysia. However, this industry produces wastewater which contributes to water pollution because there are a lot of chemicals involved in the process. In this industry, more concern has been focus on the wastewater produced from the industry itself. Textile processes produce multi component wastewater which can be difficult to treat. [1].

The chemical reagents used are very diverse in chemical composition, ranging from inorganic compounds to polymers and organic products. Generally, the wastewater from textile industry is characterized by high value of BOD, COD, pH, and color [2]. High value in BOD of untreated textile water can cause rapid depletion of dissolved oxygen if it is directly discharged into the surface water sources. Therefore the effluents with high COD level are toxic to biological life [3].

There are many alternatives used by textile industry, such as biological, coagulation and oxidation methods. However, these methods are not efficient in removing contaminants. For an example, biological processes are not effective for

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treating dyestuff wastewater because many commercial dyestuffs are toxic to organisms. So, the textile industry is trying to use adsorbent such as activated carbon because of its high efficiency in removing contaminants. But, the disadvantage of activated carbon is that it is very expensive [4].

Natural sorbents are suitable absorbent due to the presence of surface waxes and can be used for both water and land oil spill cleanup. All these natural products had shown better performance or greater absorption and adsorption capacity than synthetic products such as polypropylene [5]. It has also been shown that it is possible for some natural sorbents to absorb significantly more oil than even polypropylene materials that are normally used commercially [6]. Natural sorbent material can be used as a substituent to commercial synthetic oil sorbent as it has higher efficiency in cleaning up oil spill and by incorporating other advantages such as biodegradability [7]. The example of natural sorbent are rice ash, wheat straw, kenaf and many more.

Kenaf is one of the members of hibiscus family (*Hibiscus cannabinus L.*). The composition of kenaf is 40% bast fiber and 60% core fiber, the later being processed to become absorbent. However, the product made from core fiber is non-reusable after it is used to absorb oil [8]. Kenaf core has shorter fiber length and higher lignin content than the bast portion. Kenaf has become the choice in industry because this material is easily stored and stable in most condition. After spent kenaf fiber is being used in treatment of contaminants, it can be degraded on-site to eliminate all the contaminants. Thus, it is an effective way to reduce contaminants to the environment [9].

The main problem of batik industrial is wax effluent and associated water pollution. The purpose of this research was to study and analyzed the use of kenaf as waxes absorbent for industries wastewater effluent. Moreover, the properties of the absorbent were analyzed to help the industries in treating the wastewater effluent. The industry that was chosen was textile industry as it contains all kind of waxes. Furthermore, there should be more focus on the method to treat wastewater for this industry.

The objectives of this study are to determined the absorbency of kenaf by using different form of kenaf, to determine the highest absorbency of kenaf by using different contact time of kenaf on wastewater and to determine the highest wax absorption by using different quantity of kenaf.

1. Experimental

1.1 Preparation of adsorbent. Kenaf was obtained from Lembaga Kenaf Negeri Kelantan, Malaysia. There are two types of kenaf used: powder (10 mesh) and fibrous kenaf (3mm).

1.2 Preparations of wax effluent. A stock solution of wax will be taken directly from the source.

1.3 Wax absorption test. 100 ml of wastewater from the batik industry was prepared in a 250ml beaker. Kenaf was weighed and was packed into the muslin cloth and it was put into the wastewater. Shaking was carried out by water bath at 140 rpm at 85° C. It was kept in the oven overnight at 50° C until the weight became constant. The amount of wax absorbed by the absorbent was determined by subtracting initial absorbent weight from the total weight of the wetted absorbent. The wax absorb can be calculate by equations 2.1:

Wax absorbed, g (E) = Weight of kenaf after drying, g (D)- weight of petri dish, g (C)- weight of magnet, g (B)-weight of kenaf, g (A)

2. Results and Discussion

2.1 Powder kenaf and fibrous kenaf. Figure 1 had shown that the highest wax adsorbent is powder kenaf. The kenaf core powder was proven to have the best performance in term of absorption if it was compared with different size of kenaf The efficiency of adsorbent depends on the surface area of adsorbent. The increases in the surface area of powder kenaf lead to increases in the efficiency of wax adsorption process. Then decreases in particle size of powder kenaf leads to pores being ruptured and some pores opening and breaking apart [10]. So, the van der Waals bonds between kenaf and wax were extremely soft in powder form. In addition, porosity of the fibrous bed decreases when it is subjected to comprehensive loads. The higher the porosity of absorbent materials, the higher the amount of wax can be absorbed on a sorbent material [11]. So, the porosity of powder kenaf also increased in comparison to the fibrous kenaf, leading to increased amount of effluent wax flow and trapped inside the porous structure of powder kenaf due to its arrangement.

Natural product, a kenaf is composed of linked glucose residues and is highly hydrophilic in nature and permeable in water. Thus, generally increases the rates of wax sorption capacity by forming hyrogen bonding between wax and the hyroxyl group of cellulose, hemicellulose in the cell wall. In their native form, there are two intramolecular hydrogen bonds between the glucose residues, the intramolecular hydrogen bond need to be broken before the wax form chemical bonding with kenaf [12]. That explain the powder kenaf has a good absorbent than fibrous kenaf.

The availibilty of free hyrogen bond on powder kenaf than fibrous kenaf. As availibility of free –OH groups on the surface of the kenaf, the number of hyrogen bonds between organic components and wax molecules also increased.,. Higher filler content resulted in higher voids entrapped leading higher wax accumulating at the interface between the kenaf. The –OH group on surface of kenaf will attact the wax effluent by attraction forces and trap the wax on the porous of the kenaf. Absorption happened in which the wax was permeates from wastewater to the kenaf. Increased in the wax absorbed might due to the transport of wax into the kenaf [13].

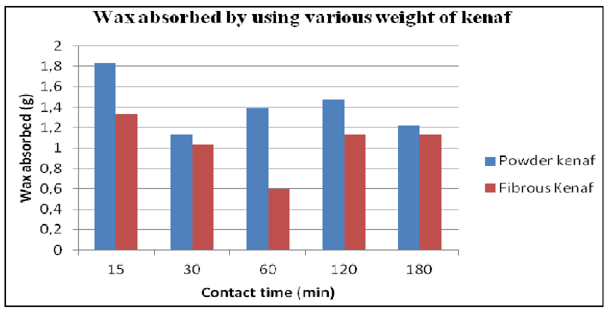

Fig. 1: The graph shown the wax absorbed by using various of contact time and different types forms of kenaf

Figure 1 also shown that the increases wax absorbed of kenaf which powder kenaf and fibrous kenaf, increases the contact time between wax effluent and absorbent. According the Figure 1, at the time of 15 minutes, large amount of wax might able to flow into pores of kenaf due to the first contact of wax with the surface of kenaf. After 15 minutes, the wax absorption were decreased.This might due to the lost of wax when the sample was taken out from the wastewater. A kenaf can release wax that was trapped in its pores when it was lifted out from the wastewater. The wax easily escapes from the pores of kenaf because the wax did not solidified at the temperature of higher than 75° C. The temperature still remained at approximately 70° C when the kenaf sample was taken out [14].

Increases contact time absorption process, the kenaf powder absorbed wax more than the fibrous kenaf. Because, micro-porous absorption in kenaf powder in which the tiny micro-pores in kenaf serve as trap zones for wax. As fibrous kenaf , the curve was looked like v-shaped.

2.2 Effect of weight of kenaf. Figure 2 shown that the increases weight of adsorbent (powder kenaf) from 0.2 g to 1.0 g, increases the wax absorption due to the increased the amount –OH group on surface of kenaf.The wax absorbed is affected by the hydroxyl (OH) groups. natural fiber contains three hydroxyl (OH) groups. These hydroxyl groups can form hydrogen bonds inside the macromolecule itself (intramolecular) and between other cellulose macromolecule (intermolecular) which is why all natural fibers are hydrophilic in nature. However, the kenaf has high oleophilicity in which it has strong affinity for wax. It absorbed the wax in the presence of water. Then, high porosity in the kenaf structure also contributes to higher initial uptake of wax [15]. A kenaf powder forms has short length and lignin higher than fibrous kenaf [9]. Thus, the amount of negative hyroxyl ion also increases, the wax absorption process also increases.

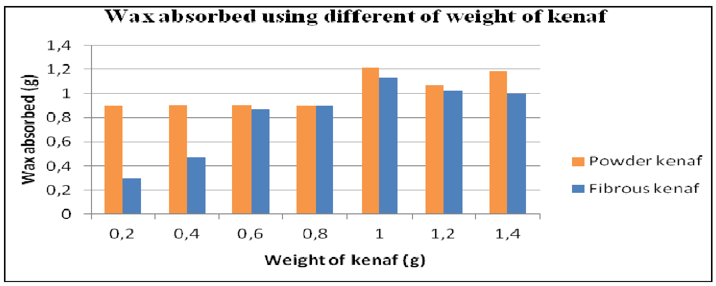

Figure 2: The graph shown the wax absorbed using different weight of absorbent(kenaf).

According the Figure 2, the wax absorption decreases from 1 g to 1.2 g due to the kenaf had poor retention capacity thus the wax easily flow out from surface of kenaf absorbent.Figure 2 also shown that the good absorbent types of kenaf is a powder forms which powder forms, 1 g.The properties of powder kenaf are higher porosity on surface, the higher surface area contact between wax molecules and absorbent(kenaf) due to the smallest the size of particles, the increases amount of hyroxyl group from hemicellulose, lignin and cellulose of kenaf.Moreover, the increases the attraction forces between –OH free ion and wax effluent, hyrogen bonding and van de waals forces leading increasing the wax absorption process.

Conclusion

The powdered form kenaf (10 mesh) had better performances than the fibrous form in term of its wax absorbed capacity. The high performance of kenaf plant as absorbent makes it ideal to absorb the waxes and it is one of the alternative way to reduce environmental pollution. Higher porosity surface and smaller particle size of powdered kenaf directly increase its surface area and its contact area between the waxes and its inner pores which leads to the increment of the waxes absorbed capacity.

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