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OIL REMOVAL USING DURIAN PEEL WASTES: EFFECT OF ADSORBENT CONDITION

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ABSTRACT: In the previous research it only investigate the feasibility of durian peel wastes in removing heavy metal from wastewater but none of them had investigated in removing of oil by using durian peel wastes. This shows that durian peel also able to remove and clean up oil spill. In this study we focus on the effect of adsorbent conditions on the adsorption of oil waste by using different conditions which are natural durian peel powder and treated durian peel powder as an adsorbent. Based on the result, the highest percentage of oil removal for a fixed 1.0 gram adsorbent dosage is on used vegetable oil, meanwhile, the lowest percentage is of removing lubricant oil, both using the natural durian peel powder. Compared to 2.0 gram adsorbent dosage, it is vice versa from natural which is the highest percentage is removing of lubricant oil and the lowest is removing used vegetable oil both using treated durian peel powder.

Keywords: Durian, Oil removal, adsorbent, lubricant oil, used vegetable oil

I. INTRODUCTION

Oil is defined as any neutral, non-polar chemical substance also known as viscous liquid at ambient temperature. Its application had been widely used in various sectors such as cooking, cosmetics, religion, painting, lubrication, fuel and last but not least chemical feedstock (Oxford, n.d). However, this precious commodity for industries if any spillage happened implies economic loss and in some cases, environmental issues such as oil spill or oil pollution on both land and seas (Wahi et al., 2013). Over the recent years, oil spill contamination or oil pollution has drawn extensive attention to the researchers because of the severe problem that put both the marine life and ecosystem at dire risk. (Srinivisan and Viraraghavan, 2010, Abdul et al., 2012).

a. Effect of oil to ecosystem and method to treat it

Large amount of emulsified oil in wastewater stream is a real concern as it could give adverse effect to environment; human economy, tourism activity and unpleasant odour and view (Santander et al., 2011) and aquatic life (Srinivisan and Viraraghavan, 2010). The consequences of these effects are transferred directly or indirectly to human as well by food chain ecosystem (Alade et al., 2011). Thus, an efficient system is very important for the recovery of the spilled oil. Oil removal methods have been classified into several categories which are physical, mechanical, biological and photochemical, filtration, screening, coagulation and adsorption. Each treatment method has their own advantages and limitations (Wahi et al., 2013; Angelova et al., 2011, Nurul et al., 2011). However, among the various existing techniques used for oil treatment, adsorption process is the most popular, effective and economically techniques (El-Nafaty et al., 2013 and Nurul et al., 2011).

b. Adsorption Process Description.

Adsorption process is the attraction between the outer surface of a sorbent and a sorbate without penetrating into the sorbent. Meanwhile, adsorption of oil occurs in three steps which are diffusion of oil molecules into sorbent surface, entrapment of oil into sorbent structure and finally agglomeration oil droplets in porous and

rough sorbent structure. Previous research showed that adsorption process seems to be most effective and attractive method due to its cheapness, simplicity and feasibility (El-Nafaty et al., 2013, Nurul et al., 2011, Wahi et al., 2013, Wang et al., 2013).

II. METHODOLOGY

Durian peel waste was collected as solid waste from dumping area of local supermarket. The peel was washed several times under running tap water to remove any physical impurities. The peels were cut into small pieces approximately 1 to 2 cm and dried under sunlight for 48 hours. Subsequently, the sample was dried again in hot air oven at 70 C for 4 hours. The dried sample was ground and sieved to get a powder form. The effect of adsorbent conditions on the adsorption of oil was investigated using different conditions

III. RESULTS

Adsorbent condition also is the important parameter that compares and contrasts the efficiency in adsorption of oil. In order to study the effect of this parameter, different kind of adsorbent conditions are used which are natural Durian Peel Powder (NDPP) and treated Durian Peel Powder (TDPP). Effect of adsorbent conditions on percentage oil removal.

Table I.1 and I.2 show the quantitative result of the effect of adsorbent condition on percentage of oil removal. Meanwhile, Figure II.1 and II.2 illustrate the percentage of oil removal by using natural DPP and treated DPP respectively.

Table I.1 Percentage of oil removal by using natural Durian Peel Powder adsorbent. [Condition : Adsorbent dosage 1.0 g]

Types of oil	Mass of durian peel powder adsorbent after, W_i (g)				Percentage of oil removal (%)
	R_1	R_2	R_3	R_{avg}	
Used Vegetable Oil (UVO)	1.7836	1.8161	1.8022	1.8006	**80.0630**
Lubricant Oil (LO)	1.7664	1.7795	1.7071	1.7710	**77.1000**
Kerosene (K)	1.7471	1.7834	1.7899	1.7734	**77.3460**

Table I.2 Percentage of oil removal by using natural Durian Peel Powder adsorbent. [Condition : Adsorbent dosage 2.0 g]

Types of oil	Mass of durian peel powder adsorbent after, W_i (g)				Percentage of oil removal (%)
	R_1	R_2	R_3	R_{avg}	
Used Vegetable Oil (UVO)	1.7836	1.8161	1.8022	1.8006	**80.0630**
Lubricant Oil (LO)	1.7664	1.7795	1.7071	1.7710	**77.1000**
Kerosene (K)	1.7471	1.7834	1.7899	1.7734	**77.3460**

From Table II.1 above, the highest percentage of oil removal for NDPP adsorbent is the removal of used vegetable oil for both 1.0 g and 2.0 g of adsorbent dosage are 80.0630% and 41.0335% respectively. The lowest percentage for NDPP adsorbent is lubricant oil

which is 38.4735%. The pattern can be seen in Figure II.1 below.

However, as compared to treated DPP adsorbent from Table II.2, the adsorbent produce two different types of oil that has the highest percentage removal which are used vegetable oil (81.7330%) and lubricant oil (42.8235%) for both 1.0 and 2.0 g respectively. From these result, it can be concluded that used vegetable oil can be removed by both adsorbent condition as it produce the highest percentage of oil removal compared to others oil. However, between natural and treated DPP, it can be concluded that treated DPP is better and a bit more effective compared to natural DPP adsorbent but still depend on types of oil to be removed. The pattern can be seen in Figure II.2 below.

b. Comparison on adsorption capacity between natural durian peels powder and treated durian peel powder

From Figure II.1, it shows that the highest percentage of oil removal for a fixed 1.0 gram adsorbent dosage is on used vegetable oil meanwhile, the lowest percentage is of removing lubricant oil, both using the natural durian peel powder. Compared to 2.0 gram adsorbent dosage, it is vice versa from natural which is the highest percentage is removing of lubricant oil and the lowest is removing used vegetable oil both using treated durian peel powder.

Previous researches proved that natural adsorbent do have both lower hydrophobicity and buoyancy that could lead to low oil removal efficiency and oil sorption capacity (Wahi et al., 2013). However, this can be improved by physical treatments such as grinding and sieving. These actions do not give effect on the hydrophobicity characteristics but it affects the oil removal efficiency of natural sorbent. This is due to the increase in surface area and the fact that there are many available binding sites (active sites) on finer sorbent particles size (Wang et al., 2006). This leads to the increase in oil sorption capacity and oil removal efficiency.

Nevertheless, this differs from adsorbent that is chemically modified with either acid or alkali. Among the approaches, there are variety kind of treatment such as acid (Sayed and Zayed, 2006), alkali (Abdullah et al., 2010), salt, surfactant, esterification and acetylation treatment and many more. Among all treatments used, acid and alkali are the most treatment used in modification of treated adsorbent. For acid treatment, the example of chemicals used are hydrochloric acid (HCl) used in kapok fibre (Wang et al., 2012), dodecyl benzene sulphonic acid to treat garlic and onion peels (Sayed and Zayed, 2006) and etc. It is used because of the tendency to disperse on oil surface, to remove of wax content and increase in cellulose hydroxyl groups respectively. Meanwhile, alkali treatment initially used to remove lignin, wax, pectin, coatings and exposes the inner surface of natural fibre which enhance in oil adsorption (Wahi et al., 2013, Abdullah et al., 2010). Besides, modified (treated) adsorbents increase in the cellulose content which is the main role in enhancing adsorption of oil.

However in this experiment, for treated adsorbent, it is treated by using both acid and alkali. This is done by soaking the chopped durian peel wastes in both chemicals simultaneously. The alkali treatment is used to increase the rough surface morphology and exposure inner surface which enhance in adsorption of oil. Meanwhile, the half an hour of acid treatment is to stop the exposure and increase the cellulose hydroxyl groups of durian peel fibre wall. (Wahi et al., 2013). Therefore, it can be conclude that, the efficiency of adsorption of oil is depends on structure of oil.

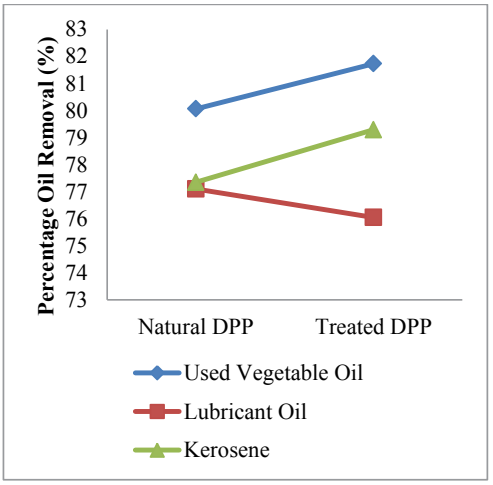

Figure II.1 Graph comparison of the effect of adsorbent condition on percentage of oil removal of different type of oils for 1.0 gram adsorbent dosage

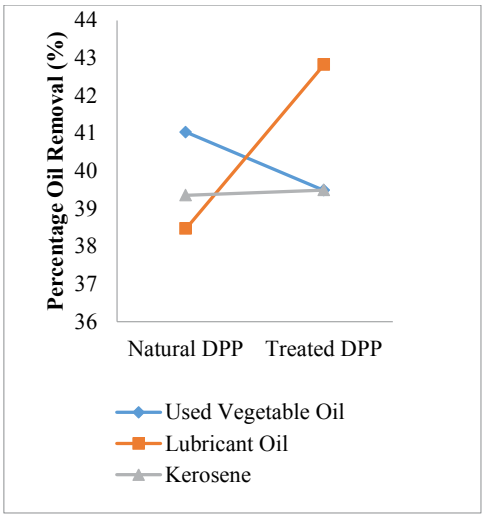

Figure II.2 Graph comparison of the effect of adsorbent condition on percentage of oil removal of different type of oils for 2.0 gram adsorbent dosage.

c. FTIR spectra

In order to determine which functional group were responsible for oil uptake, an FTIR analysis in solid phase was performed. FTIR spectrums were obtained for adsorbent solid samples before and after adsorption process. The results show in Figure II.3 and II.4 as the highest percentage of oil removal obtained is for used vegetable oil by using NDPP for 2.0 gram and TDPP for 1.0 gram adsorbent dosage.

The graphs produce almost likelihood patterns for each different adsorbent condition. Before adsorption, FTIR spectrum of NDPP observes two strong peaks that appeared at wave number 3293.63 cm-1 which indicate hydrogen-bonded stretch of hydroxyl (O-H) group like alcohol, phenols, and carboxylic acids. The other strong peaks was observed to be appeared at wave number 1018.76 cm-1 represents coupled C=O stretching and O-H deformation. Other peaks that present in raw durian include C-C=C symmetric stretch which indicates alkenes at wave number 1606.49 cm-1 and 2923.64 cm-1 corresponds to alkane group which is C-H sp3 stretching. These results are consistent with the composition of durian shell which mainly consists of 15.45% lignin, 73.54% holocellulose, 60.45% ά-cellulose and 23.09% hemi-cellulose (Jun et al., 2010).

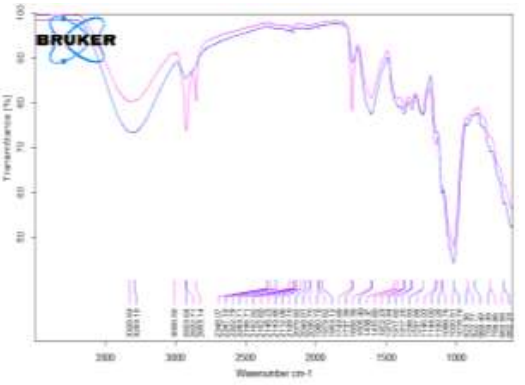

Figure II.3 Comparison of before and after adsorption of used vegetable oil by using NDPP for 2.0 gram adsorbent dosage

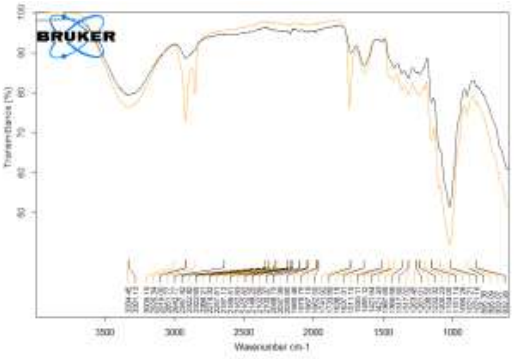

Figure II.4 Comparison of before and after adsorption of used vegetable oil by using TDPP for 1.0 gram adsorbent dosage

Meanwhile, the FTIR spectrum of TDPP adsorbent somehow shows the similar two strong peaks but at different wave number. For example, the hydroxyl group of O-H stretching was at 3334cm-1 wave number, C=O stretching at 1021.21 cm-1, alkane group at 2919.00 cm-1 and alkene group which at wave number 1637.31 cm-1. They show that when durian is treated with both alkali and acid, the intensity of functional group to be increases in wave number due to the alkali pre-treatment that exposes the inner surfaces of durian peel. This affect in the reduction of C=O and C-O functio Research and Innovation, UniKL MITEC, 2014nal group however, when it is neutralise with acid which is to stop the exposure of inner surface and increase cellulose hydroxyl group thus make TDPP to be more effective than NDPP adsorbent. This can be seen when hydroxyl group O-H stretch increase from 3293.63 cm-1 to 3334cm-1.

However, after adsorption of oil has occurred, additional 2 strong peaks to be appeared at wave number 2863.14 cm-1 to 2923.64 cm-1 and 1743.99 cm-1. This indicate the H-C-H asymmetric and symmetric stretch of alkane group as well as C=O stretch of ketones and ester in oil. This shows that oils used in this experiment contains ketones, alkane and ester functional group. Since, oil can be saturated and unsaturated fatty acid.

This finding result is supported by Tham et al. (2011), Saikaew and Kawewsarn (2009) and Jun et al. (2010) in their experiments on removing oil and heavy metal respectively by using durian peel waste. The similar results had obtained by Tham et al. (2011) that there is an increase in wave number value when treated with acid chemical. It indicates and shows that, carboxyl, hydroxyl, lignin, cellulose and alkane group involved in the adsorption of oil that contain ester, alkene, alkane and ketones. It is verified that durian peel can be used as an adsorbent in removing oil too.

IV. CONCLUSION

The objective is to compare the adsorption capacity in terms of percentage oil removal between natural and treated durian peel powder on different type of oils. In previous study, it is stated that alkali treatment would reduce the oil sorption capacity. However, from the batch experiment, the results show that there is no absolute result to determine which condition of adsorbent is the most effective to remove oil. This is due to different types of oils have different abilities to be adsorbed by durian peel adsorbent. In fact, the results show that the treatment of both alkali (sodium hydroxide) and acid (hydrochloric acid) on durian peel causes the adsorption capacity for treated to be the highest compared to natural only on lubricant oil and used vegetable oil as well kerosene for 1.0 gram and 2.0 gram dosage respectively. However, it can be concluded that compared to lubricant and kerosene oil, used vegetable oil is the most suitable oil to be adsorbed by both natural and treated durian peel powder adsorbent since it shows the highest percentage of oil removal in both adsorbent conditions. Thus, it is successfully compared the adsorption capacity between natural and treated adsorbent on different types of oils.

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