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I hereby declare that I have read this thesis and in my opinion this thesis has fulfilled the qualities and requirements for the award of Degree of Bachelor of Chemical Engineering (Chemical).

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SEPARATION OF OIL AND WATER USING SUGARCANE BAGASSE

NOOR ATIKAH BINTI MOHD BADRUDDIN

A thesis submitted in fulfilment
of the requirements for the award of the Degree of
Bachelor of Chemical Engineering

Faculty of Chemical & Natural Resources Engineering
Universiti Malaysia Pahang

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STUDENT'S DECLARATION

I declare that this thesis entitled "Separation of oil and water using sugarcane bagasse" is the result of my own research except as cited in references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature:
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In the Name of Allah, The Most Gracious and The Most Merciful

I humbly dedicated this thesis to…

my beloved parents, Hj. Mohd Badruddin bin Ibrahim

and Rokiah binti Abdullah

my family members

my friends

my supervisor and all faculty members

for all your care, support and believe in me .

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ABSTRACT

Sugarcane bagasse is one of the agricultural residues from sugar making industry. The usage of this organic waste has not been widely discovered here in Malaysia. In Malaysia sugar industry, estimated one tons of sugarcane generates 280 kg of bagasse. Sugarcane bagasse is a very good fibrous organic waste beside have a very high content of carbon. This research will be investigate the effectiveness of sugarcane bagasse as a material to adsorp oil and water. Other than that, the study is to increase the usage of sugarcane bagasse and reduce the number of organic waste produce by the industry. Raw bagasse and bagasse that is modified using sulphuric acid is used to determined the effectiveness of sugarcane bagasse as material to separate oil, which is in this research, crude palm oil is used. The research are done with different weight of bagasse for each bagasse sample and different size of bagasse. As a result, sugarcane bagasse can adsorp oil from the oil sample because of the high carbon content and adsorption is one of method for separation. The particle size are one of the factors effecting the adsorption capacity. The smaller particle size have greater surface area have higher adsorption capacity. Raw bagasse can adsorp more compare to that is modified using sulphuric acid. Chemical modification by using only sulphuric acid is not signifacantly increasing the adsorption capacity of the bagasse. Sugarcane bagasse can be one of the material to separate oil and water as an alternative method of separation. This alternative method can be used as one of the method to separate oil from water for cleaning the waste oil from oil spills as well as a method to separate oil from palm oil industrial waste.

ABSTRAK

Hampas tebu adalah salah satu daripada sisa pertanian daripada industri pembuatan gula. Sisa organik ini tidak digunakan secara meluas di Malaysia. Dalam industri gula di Malaysia, dianggarkan satu tan daripada tebu menghasilkan 280 kg hampas. Hampas tebu adalah sangat baik kerana sisa organik ini bergentian dan mempunyai kandungan karbon yang sangat tinggi. Kajian ini akan menyiasat keberkesanan hampas tebu sebagai bahan untuk menyerap minyak dan air. Selain daripada itu, kajian ini adalah untuk meningkatkan penggunaan hampas tebu dan mengurangkan bilangan hasil sisa organik oleh industri. Hampas tebu yang mentah dan hampas yang diubah suai secara kimia dengan menggunakan asid sulfurik digunakan untuk menentukan keberkesanan hampas tebu sebagai bahan untuk menyerap medium yang berasingan, dimana dalam penyelidikan ini, minyak sawit mentah digunakan. Penyelidikan dilakukan dengan mengkaji berat yang berbeza untuk setiap sampel hampas dan juga hampas yang berlainan saiz. Hasilnya, hampas tebu boleh menyerap minyak dari sampel minyak kerana kandungan karbon yang tinggi dan penyerapan merupakan salah satu kaedah untuk memisahkan dua medium berbeza. Hampas yang tidak diubah suai boleh menyerap lebih banyak minyak berbanding dengan hampas yang diubah suai secara kimia dengan menggunakan asid sulfurik. Pengubahsuaian kimia hampas tebu dengan hanya menggunakan sulfurik asid sahaja tidak mampu untuk meningkatkan keupayaan serapan hampas tebu dengan ketara. Hampas tebu boleh dijadikan salah satu bahan untuk mengasingkan minyak dan air. Kaedah alternatif ini boleh dijadikan sebagai salah satu kaedah untuk mengasingkan minyak dari air untuk tujuan membersihkan sisa minyak dari tumpahan minyak dan juga sebagai kaedah untuk mengasingkan minyak dari sisa industri minyak sawit.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Recently, agricultural products have been rapidly increasing with the number of consumer demand. The increases of the usage of the raw material for production, the number of by-product are also increasing. In Malaysia, the amount of organic waste such as sugarcane bagasse, rice straw and rice husk are a lot. Usually these types of by-product are used as animal feed or mostly used as a fuel to generate the boiler mill (D. Kalderis et al., 2008).

Sugarcane or its scientific name *Saccharum officinarum* is a by-product in large industries which is sugar industries. The abundant amount of sugarcane bagasse from the extraction of juice for the productions of juice are ready for utilize but it's very limited. Reported that one tons of sugarcane generates 280 kg of bagasse, which is the fibrous by-product remain after the extraction of juice for the production of sugar. Mostly, by-product are just used as burned source for sugar mill to generate energy or being burned down (Suhardy et al., 2007) and that cause air pollution.

Oil pollution, usually occur in the sea, rivers or any navigable waters, has became a serious issue in the world. Oil pollution in the sea steadily increased with the increase of oil consumption (M. Hussien, 2008). Usually in the wide ocean, crude petroleum oil becoming the major issues of oil spilling. The wastewater release from palm oil company also becoming major issue as the content of oil in the wastewater can affect the waste drainage system and the environment.

As oil pollution became a serious concern, the issues of cleaning the environment arise. To come out with the way in cleaning the oil, it doesn't only concern about the effectiveness of the method also the cost of it. Hence, by using this type of material (agriculture residue), it not only cost effective, and it also are able to release the oil effectively. Current studies show that not only oil adsorbing properties of material but also the recycle of these materials is important (Deschamps et al, 2003).

1.2 Problem Statement

There are huge amount of sugarcane bagasse obtain from sugar production but the utilization of it's still limited. As sugarcane bagasse is one of the raw materials that have high carbon content, it should be used as a more useful raw material in other type of field or industries. Oil spills have been deteriorating land and decreasing the groundwater quality. When oil spills happens, the water system is affected. Oil pollution remains a serious concern. It leads to oil waste contamination in the water. With the structure of sugarcane bagasse which contains of fibre and high carbon content, it can become an adsorbent to adsorb the oil from water.

The same problem occur at the palm oil mill where the wastewater must be release with the content of oil in it at effecting the quality of wastewater can be release. Wastewater treatment needs to improve in order to make the oil separated with the water and the wastewater can be treated normally. The cost would be high if other method used for example skimming the oil from water and so on. By using agricultural waste, the cost is lower and the sources are easy to get. The methods commonly used to remove oil involve oil booms, dispersants, skimmers, sorbents etc. The main limitations of some of these techniques are their high cost and inefficient trace level adsorption (Wardley-Smith, 1983).

1.3 Research Objective

The objectives of this research are

i. To increase the usage of by-product of sugar, the sugarcane bagasse as one of the way to reduce the organic waste.

ii. To investigate the effectiveness of sugarcane bagasse to adsorb oil from water.

1.4 Scope of Study

In this research, the parameters that will be measure are the particle size, which is the size of the sugarcane bagasse. The size of sugarcane bagasse will be manipulated and the effect of the particle size towards the effectiveness of the sugarcane bagasse as oil adsorbent will be measure. Next is to manipulate the weight of the bagasse. There will be 3g and 5g of bagasse to be tested and the effect of weight towards the adsorption rate will be measure. Finally, the bagasse will be divided into raw bagasse and modified bagasse. Modified bagasse is consists of raw bagasse that is modified using the sulphuric acid.

1.5 Rationale and Significance of Study

The abundant amount of organic waste should be utilize more wisely because organic waste are obviously a cheaper residue compare to others which involve chemical used, and also the cost of production. By using sugarcane bagasse for example, organic waste could be used more widely as an adsorbent to adsorb oil, in the oil industry whether petroleum industry or palm oil industry. To make the environmental issues better in the future, this study will help to widen the usage range of agricultural residue and also pollution problem. People are usually not interested in making organic waste as an alternative to reduce the pollution or make it a product to minimize the cost of production.

Besides that, this research also determines the best condition of sugarcane bagasse as an adsorbent. It is based on the scope of study where the size of the sugarcane bagasse gives an important effect towards the adsorptivity of the bagasse. The sugarcane bagasse also chemically modified with sulphuric acid to determine the effectiveness of the sugarcane bagasse as an adsorbent.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Agricultural industries are rapidly increases in Malaysia, but the waste of this industry are not well managed. The huge numbers of organic waste have not been fully utilize (Suhardy et al., 2007). Organic waste have a high potential as an alternative way of producing many thing for example paper, separation material and also filter. This is because the chemical compositions of this organic waste are not being discovered. There are organic waste such as rice husk, coconut husk, rice straw and sugarcane bagasse that have high adsorption capacity. This is due to the existence of activated carbon in the composition of the agricultural by-product (D.Kalderis et al., 2008).

Figure 2.1 - Sugarcane Plant that used in production of Sugar

2.2 Sugarcane Bagasse

Sugarcane bagasse is an agricultural residue of sugar production in industry scale also the by-product of cane juice. Sugarcane bagasse is usually being used as combustion material in the industry for the boiler (L.Sene et al., 2002). Currently, sugarcane bagasse are being utilize because it is inexpensive raw material. This material has many advantages. The advantages are, because of the rapid growth of the sugar-cane plant, widespread cultivation, lower energy and bleaching chemical requirements for bagasse refining. From the production itself, raw bagasse is very easy to obtain as for one tonne of refined sugar results in two tonnes of bagasse.

2.2.1 Chemical composition

The chemical composition of sugarcane bagasse is the reason of its usage as alternative materials for various industries (Pandey et al., 2000). Sugarcane bagasse contains 50% cellulose, 25% hemicelluloses, and 25% lignin (Zandersons et al., 1999). This composition is relatively resistant to biodegradation. Besides that, sugarcane bagasse is well-known for the high activated carbon content which is the main reasons for being a good adsorbent. Sugarcane bagasse also has 9.78% content of silica and 90.22% content of carbon (Suhardy et al., 2007). This is the reason of sugarcane bagasse have high activated carbon.

Content of Silica	Content of Carbon
9.78%	90.22%

Table 2.1 - Analysis of chemical content of sugarcane bagasse

retrieve from *School of Materials, Bioprocess and Environmental Engineering, Universiti Malaysia Perlis(UniMAP)*

Table 3
Chemical composition of sugarcane bagasse ash

Component	Indian SBA (wt.%)	SBA (Gupta and Imran, 2004) (wt.%)	SBA (Srivastava et al.,2006) (wt.%)	SBA (Payá et al., 2002) (wt.%)
SiO_2	45.34	60.5	51.5	59.87
CaO	2.73	3.0	6.0	3.36
Fe_2O_3	1.20	4.90	3.5	5.76
Al_2O_3	0.98	15.4	10.8	20.69
K_2O	6.27	nr	nr	1.37
MgO	2.51	0.81	1.10	1.87
P_2O_5	2.27	nr	nr	nr
SO_3	1.28	nr	nr	nr
Cl	0.43	nr	nr	nr
Na_2O	0.20	nr	nr	1.11
Rest[a]	<0.2	nr	nr	nr
Br	0.004	nr	nr	nr
LOI (1100 °C)	36.6	18.0	nr	0.63

nr = Not reported.
[a] Cr_2O_3, MnO, NiO, ZnO, SrO and Br.

Figure 2.2 - Chemical Composition of Sugarcane Bagasse

2.2.2 Application of sugarcane bagasse

The cellulose content in sugarcane bagasse is useful in paper making industry. As another usage of agricultural residue, sugarcane bagasse is used as an alternative raw material in making paper. The Sugar Cane Paper Company located in San Francisco has commercially used bagasse in making paper and also tableware product. This is because of other than cellulose content, the fibrous content of sugarcane bagasse can make the paper made of bagasse as good as paper made from tree. (thesugarcanepapercompany.com)

Figure 2.3 – Sugarcane

Sugarcane bagasse was used as a biofilters for the treatment of benzene-contaminated airstreams. The sugarcane bagasse act as filtration agent to treat contaminates benzene in an air streams. The sugarcane bagasse as a biofilter has been discovered and the percentage of removal of contaminated benzene in air stream is 52% for raw sugarcane bagasse and 53% for sieve sugarcane bagasse (M.Zilli, 2004). Besides benzene contaminated air streams, sugarcane as biofiltration is used in removal of BTEX in volatile organic compounds (VOCs) which is the major group of pollutant. BTEX which contains of benzene, toluene, ethyl benzene and o-xylene from VOCs can be removed by using biofilter. It was nearly 100% removal of BTEX achieve as the sugarcane bagasse is used as biofilter (A. K. Mathur, 2006).

Before new technologies of using sugarcane bagasse as air filter or used in paper making, sugarcane bagasse usually used as raw material in production process or as fuel. Bagasse is usually used as boiler fuel at sugar factory. The combustion of bagasse provides enough heat and this could avoid the usage of fossil fuel. The ash from combustion of bagasse is also used as fertilizer or production of construction material. (P. A. O. George, 2010)

Figure 2.4 - Fresh sugarcane bagasse

2.3 Activated Carbon (AC)

Activated carbon is a material commonly used in increasing number of environmental applications, in environment protection, in water and wastewater treatment and also air filter (D.Kalderis et al., 2008). It can be produce with any material that has rich carbonaceous such as rice husk and sugarcane bagasse. AC can be a great adsorbent if being treat towards some chemical or physical process. It is called the activation process through the pyrolysis and chemical impregnation with chemical solution (D.Kalderis et al., 2008).

Activated carbon that prepared from sugarcane bagasse is used in sugar industries for the removal of colorants from sugar liquor. It is found out that the bagasse from the sugar industry have been used to prepared an activated carbon and used again in the industry. Besides that, it has been used for treatment water and industrial wastewater as an adsorbent of polluted substances (Khadija Qureshi, 2008). Activated

carbon from sugarcane bagasse has high adsorptive capacity compare to other. (Khadija Qureshi, 2008).

There are other agricultural residues that have been used to make an activated carbon. Besides sugarcane bagasse, rice husk, nut shells, peat, wood and many more (D. Kalderis, 2008). Comparing between activated carbon made from rice husk with sugarcane bagasse, activated carbon from sugarcane bagasse have the best adsorption behaviour towards the adsorption of polluting substances which is landfill leachated (D. Kalderis, 2008)

2.4 Adsorption process

Adsorption is one of the separation processes. There are many type of separation process which includes;

- Adsorption
- Centrifugation and cyclonic separation
- Chromatography
- Crystallization
- Distillation
- Drying
- Evaporation
- Extraction

Adsorption process define as one or more components of a gas or liquid stream are adsorbed on the surface of a solid adsorbent and a separation is accomplished (Geankoplis, 2003). It is different from absorption, in which a substance diffuses into a liquid or solid to form a solution. Other than that, the term sorption encompasses both processes, while desorption is the reverse process. Adsorption is operative in most natural physical, biological, and chemical systems, and is widely used in industrial applications such as activated charcoal, synthetic resins and water purification.

There are many type of adsorbents have been developed for a wide range of separation. The physical properties of adsorbents are usually has a very porous structure, with many fine pores. The adsorption usually occurs as a monolayer on the surface of the fine pores, although several layers sometime occur. (Geankoplis, 2003)

Adsorptions are divided into physical adsorption and chemical adsorption. Physical adsorption occurs in which the adsorbent adheres to the surface only with weak intermolecular interaction. Chemical adsorption on the other hand, occurs as a molecule adheres to a surface through the formation of the chemical bond.

2.5 Conclusion

Sugarcane bagasse residues of sugar industry are great alternative way as an air filter because of the content of carbon. It can help to reduce the hazardous gas release in the air and also an inexpensive material of producing air filter. Other than that, the major by-product of agricultural residue can be reduced and the usage can be more utilize in larger industrial scale.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter, the detail materials used and experimental procedure will be explain. Started with where the raw material is collected, the preparation of the sample, the method of research and finally the data collection method for the research.

3.2 Materials

The raw material used in this experiment is sugarcane bagasse with various weights and size to be tested the absorptivity rate of the bagasse. The bagasse is obtained from small sugarcane vendor near Gambang. The weight and size are varies in order to compare the optimum condition of absorptivity of the bagasse. To test the absorptivity of the bagasse towards oil, crude palm oil is used. Crude palm oil is one type of heavy oil and important in the palm industry. The crude palm oil is obtained from Kilang Sawit Bukit Sagu.

3.3 Apparatus

3.3.1 Industrial Grinder

Figure 3.1 – Industrial grinder

Grinder is used to grind the sugarcane bagasse into smaller size. The size of the sugarcane bagasse before grind is too big and the fiber is very long. It is very hard to measure such condition of sugarcane bagasse.

3.3.2 Oven

Figure 3.2 – Oven

Oven is used to dry the raw bagasse. At the first place, the sugarcane bagasse is wet due to the water content of the bagasse. To obtain dry bagasse, it needs to be dry in

the oven for about few hours (if the temperature is high within 100ºC – 150ºC) or for a day (if the temperature is within 60ºC - 80ºC).

3.3.3 Sieve shaker

Figure 3.3 – Laboratory sieve shaker

Sieve shaker is used to sieve the raw bagasse into different size. There is 2mm - 45µm of tray size of the sieve shaker. The raw bagasse is separated into the desired size and be tested with the oil.

3.3.4 Electronic weight scale

Figure 3.4 – Analytical weight

Electronic weight scale is used to weight the bagasse. Two different weight needed in the research are 3g and 5g of bagasse. It is more accurate to used electronic weight scale.

3.4 Experimental Procedures

3.4.1 Preparation of the sample

The fresh sugarcane bagasse is grind first using industrial grinder. Then the bagasse is dried in an oven for one day at the temperature of 60ºC - 80ºC. For modified bagasse, the dry bagasse have been treated with the chemical agents in order to activate the surface functional groups, decrease cristalinity of cellulose, and reduce lignin. The raw bagasse is treated with 1M sulphuric acid. The raw bagasse is soak in the 1M sulphuric acid for 5 minutes. Then, the modified bagasse is washed with distilled water and dried in the oven for a few hours with temperature 100ºC.

The bagasse is sieve using sieve shaker. The desired sizes are 2mm, 630µm and 160µm. For every size, different weight of bagasse need to prepared which are 3g and 5g. The bagasse is weigh using analytical weight scale for accurate reading. The reason of using different weight for the bagasse sample is to observe the effect of weight towards adsorption capacity. Even though the weight different is only 2g, but the bagasse physically have a lot of different.

The bagasse then put in a dry cloth (the cloth must be weight first and the value are recorded). The entire sample is put in 100ml of crude palm oil for 10minutes. The reason of choosing crude palm oil as tested oil because crude palm oil is type of heavy oil and previous research have already done with light oil like crude petroleum oil. The volume for all tested sample are constant which is 100ml. the volume of 100ml is so that the bagasse sample completely immerse in the oil for the test to avoid any error. The error may occur if the bagasse is not completely immerse because there will be some of the bagasse are not in contact with the oil.

After 10 minutes, the sample bagasse is taken out and drained for 15minutes. The sample must be completely drained. The sample can be drained at room temperature at open space. The bagasse then re-weighs and the value is recorded. The procedure is repeated for all sample bagasse and repeated twice.

The percentage of adsorptivity and the sorption capacity of the bagasse is calculated from the result obtain from the test. The percentage of adsorptivity and sorption capacity is calculated using equation below;

$$Adsorptivity = \frac{Weig\,ht\ of\ sorbent\ \ containing\ \ \ fluid}{Initial\ \ weig\,ht\ of\ \ sorbent} \times 100 \qquad (1)$$

$$Sorption\ Capacity = \frac{Weig\,ht\ of\ \ sorbent\ \ containing\ \ \ fluid - initial\ \ weig\,ht\ of\ \ sorbent}{Initial\ \ weig\,ht\ of\ \ sorbent} \qquad (2)$$

3.4.2 Data Collection

OIL								
	Initial weight	**Size**	**Weight (g)**			**Final weight**	**% Adsorption**	**Sorption Capacity**
			1	**2**	**Average**			
Raw bagasse	3g	2mm						
		630µm						
		160µm						
	5g	2mm						
		630µm						
		160µm						

Table 3.1 – Data collection table for adsorption of oil using raw bagasse.

OIL								
	Initial weight	**Size**	**Weight (g)**			**Final weight**	**% Adsorption**	**Sorption Capacity**
			1	**2**	**Average**			
Modified bagasse	3g	2mm						
		630µm						
		160µm						
	5g	2mm						
		630µm						
		160µm						

Table 3.2 – Data collection table for adsorption of oil using modified bagasse.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This research is to determine the effectiveness the sugarcane bagasse to separate oil and water. To determine the effectiveness, the weight, particle size and chemical modification of the bagasse have been manipulated. This chapter will be discussing the result from the research and to accomplished the objective of the research

4.2 Result

4.2.1 Adsorption of crude palm oil using raw bagasse

OIL								
Raw bagasse	Initial weight	Size	Weight (g)			Final weight	% Adsorption	Sorption Capacity
			1	2	Average			
	3g	2mm	17	17.8	17.4	14.4	480	3.8
		630µm	16.8	17.5	17.15	14.15	472	3.72
		160µm	15.4	16.7	16.05	13.05	435	3.35
	5g	2mm	30.3	30	30.15	25.15	503	4.03
		630µm	31.2	33.4	32.3	27.3	546	4.46
		160µm	29.8	32.5	31.15	26.15	523	4.23

Table 4.1 – Adsorption of oil using raw bagasse.

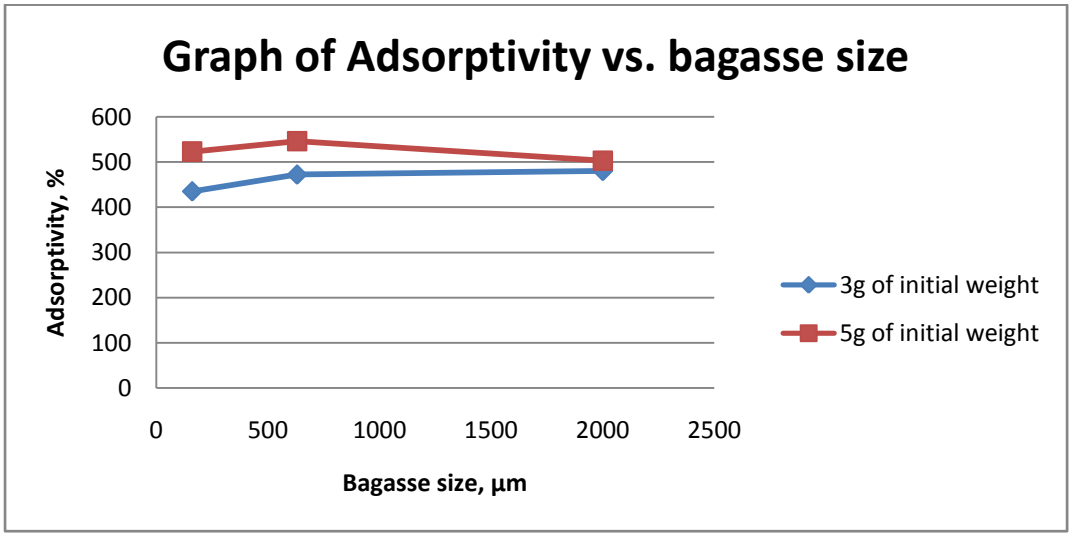

Figure 4.1 – Effect size of raw bagasse on the adsorptivity

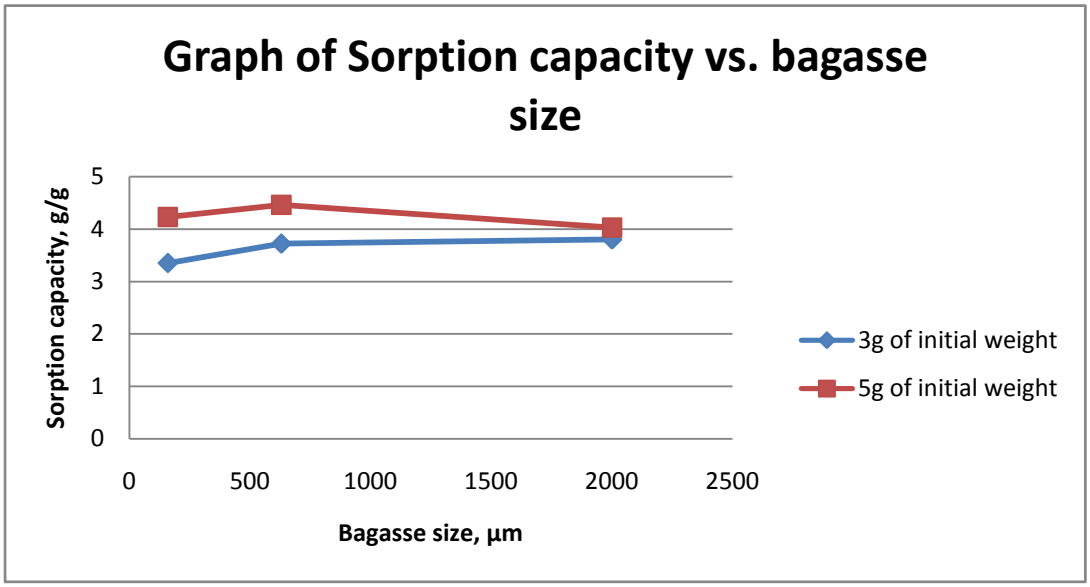

Figure 4.2 – Effect size of raw bagasse on the sorption capacity

From the result obtain, the weight of the bagasse affect the adsorptivity and the sorption capacity. 5g of raw bagasse has higher adsorptivity and sorption capacity compare to 3g of raw bagasse. This is because there is more bagasse to adsorb the oil in terms of quantity. Even the time for the bagasse to adsorb is the same, all of the bagasse able to adsorb oil. Based on size of the bagasse, the size of 630µm has the highest adsorptivity rate and sorption capacity. Compare to the other sizes, the 2mm size has the lowest adsorptivity rate and sorption capacity. This is due to the surface area of the bagasse. The effectiveness of the bagasse depends on the surface area.

4.2.2 Adsorption of crude palm oil using modified bagasse

OIL								
Modified bagasse	Initial weight	Size	Weight (g)			Final weight	% Adsorption	Sorption Capacity
			1	2	Average			
	3g	2mm	8.3	9.4	8.85	5.85	195	0.95
		630µm	10.6	10.1	10.35	7.35	245	1.45
		160µm	9.6	10	9.8	6.8	227	1.27
	5g	2mm	11.6	12	11.8	6.8	136	0.36
		630µm	15.8	15.5	15.65	10.65	213	1.13
		160µm	14.7	15	14.85	9.85	197	0.97

Table 4.2 – Adsorption of oil using modified bagasse.

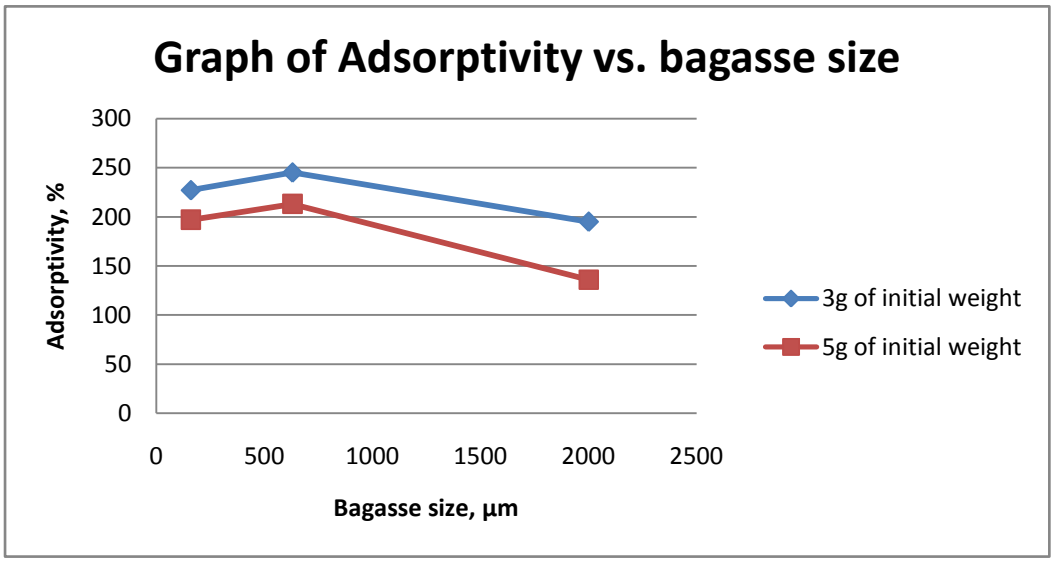

Figure 4.3 – Effect size of modified bagasse on the adsorptivity

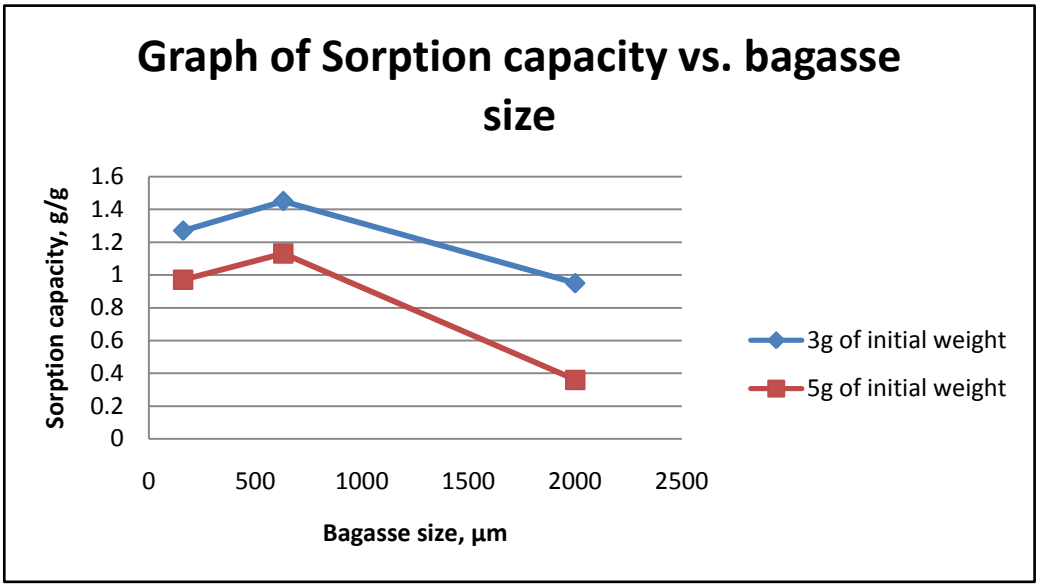

Figure 4.4 – Effect size of modified bagasse on the sorption capacity

For modified bagasse, the result obtain is vice versa with the raw bagasse. It is because the 3g weight of modified bagasse able to have higher adsorption rate and sorption capacity compare to 5g of modified bagasse. Based on the size, the result is the same with raw bagasse which is the size of 630µm has the highest adsorptivity and sorption capacity. The bagasse with the size 2mm surprisingly has the lowest adsorptivity and sorption capacity.

4.2.3 Comparison of adsorptivity and sorption capacity between raw bagasse and modified bagasse

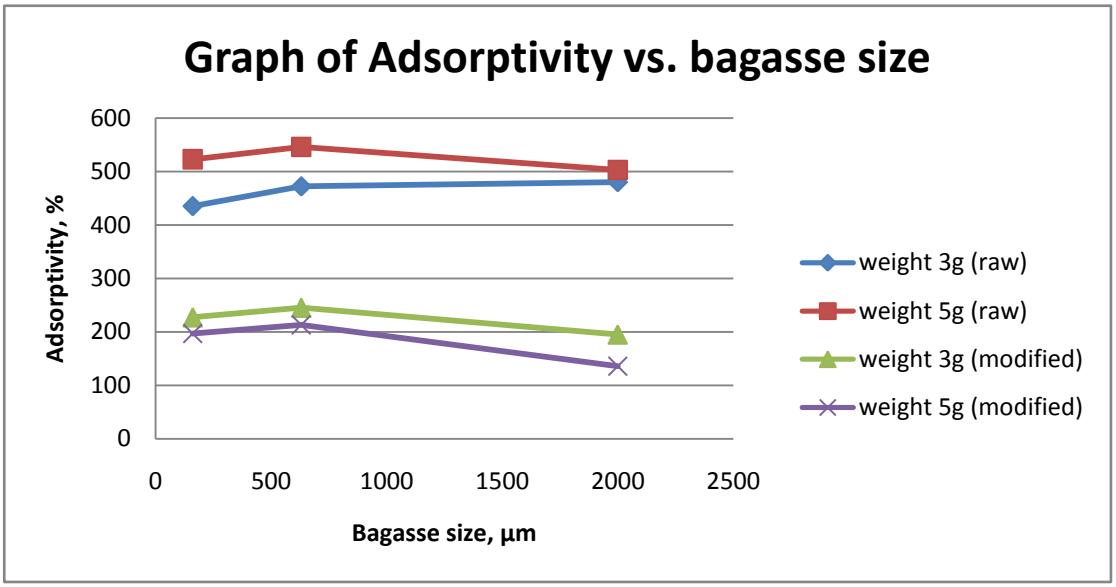

Figure 4.5 – Comparison of adsorptivity for both raw bagasse and modified bagasse

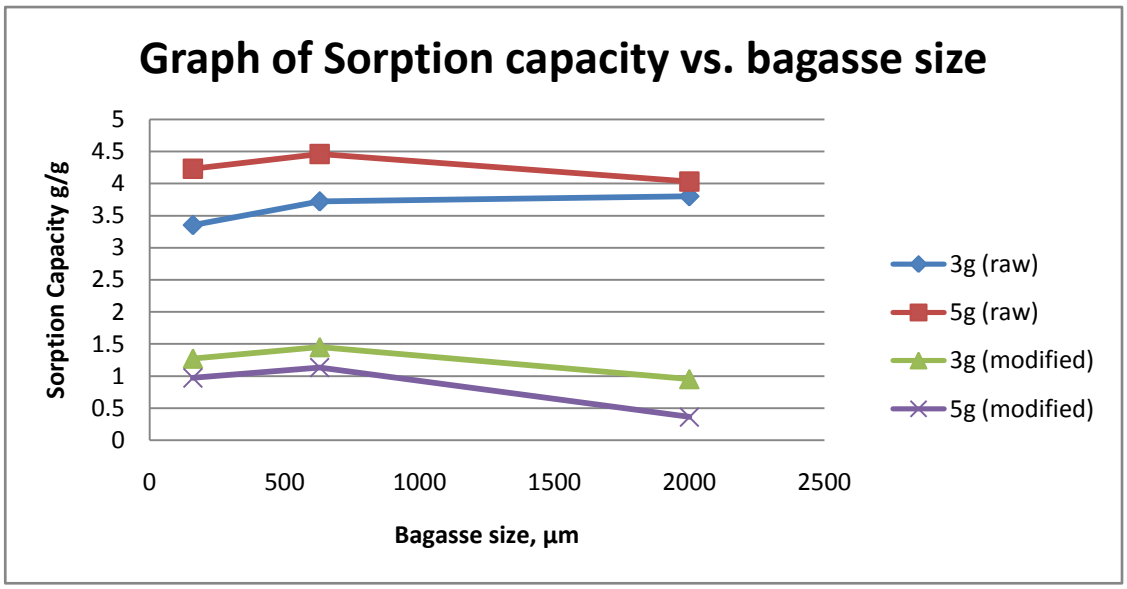

Figure 4.6 – Comparison of sorption capacity for both raw bagasse and modified bagasse

Based on the graph, it clearly shows the effectiveness of raw bagasse compare to modified bagasse. The rate is higher compare to modified bagasse for both weight and sizes. The trends for all sample bagasse are the same which is the size of 630µm has better adsorptivity compare to the other size. This is means that the good size of adsorption of should not be too big neither too small. The trend repeats for the sorption capacity. The figure shows that decreasing the average particle size increase the sorption capacity and adsorptivity, where the optimum size is obtained at average particle size of 630µm and then the sorption capacity and adsorptivity started to decrease.

4.3 Discussion

Adsorption is a process that occurs when a gas or liquid solute accumulates on the surface of a solid. The characteristics of carbon that affect the adsorption process are the pore texture, surface chemistry and mineral matter content. The adsorption capacity of carbon materials is not related in a simple form with their surface area and porosity. The adsorption capacity will depend on the accessibility of the organic molecules to the inner surface of the adsorbent, which depends on their size (C. Moreno-Castilla, 2004).

The research is basically to determine the effectiveness of sugarcane bagasse by manipulating the weight, the size and type of bagasse. The different weight of the bagasse which is 3g and 5g happens to give different result for raw bagasse and modified bagasse. For raw bagasse, as stated in the section 4.1.1, the bagasse with 5g of initial weight give higher adsorption capacity compare to bagasse with weight of 3g. The amount of sorbed oil is increase as the amount of sorbent increase. This is because the sorbent surface area contact to oil was maximum so the oil sorbed was maximum.

On the other hand, the result for modified bagasse is vice versa. The bagasse with 3g weight has higher adsorption capacity compare to 5g. The bagasse is chemically modified with sulphuric acid; the structure of the bagasse is changing. As mention earlier, one of the characteristic of carbon that affects the adsorption process is pore texture. When the bagasse is modified with 1M of sulphuric acid, the bagasse pore is filled in with the molecule from sulphuric acid. When weighing the bagasse, the quantity is less compare to raw bagasse but the weight is the same. As the sulphuric acid fill in the pore, there is minimum contact area between the oil and the bagasse. The decrease of sorption capacity also because of the chemical alteration or destruction of important functional groups in cellulose, lignin or other materials in the bagasse (Yeneneh et al, 2010).

In a research of modified lignocellulosic wastes such as rice husk, sugarcane bagasse and coconut husk conducted by Chemical Engineering Department, Universiti Teknologi PETRONAS (UTP), a chemically modified bagasse could increase the adsorption performance of the bagasse. By modified the bagasse using sulphuric acid, sodium methylate and citric acid. So, that must be one of the reason the result of modified bagasse is not as expected from the literature. This can be used to improve the research in the future. The chemically modified bagasse can have a good adsorption performance may be due to formation of new functional groups and increase in the number of binding sites and better ion exchange achieved after modification (Yeneneh et al, 2010).

The size of bagasse also been manipulated to determine the effectiveness of the bagasse as an oil adsorbent. From the result from section 4.1.5, the comparison of all different sample of bagasse gives the same trends about the particle size of the bagasse. The adsorption capacity is increase at the size of 160µm to 630µm and then started to decrease at the size of 2mm. Adsorption is a surface phenomenon that is directly related to surface area (Hussein et.al, 2009). The smaller particles size, have a greater surface area. This leads to the increasing of adsorption capacity of the bagasse. With the increasing surface area, the capillaries formed are also increase and increase the adsorption capacity. Bagasse is the type of adsorbent that hold oil between the particles. This is called capillary adsorption because of the formation of capillaries (Hussein et.al, 2009).

Bagasse is a great material to adsorb oil, heavy metal, gas or dye because of the carbon content. It can be converted into activated carbon that works as the most effective materials of adsorbent. As to separate oil and water, method of adsorption is applied in the research. Bagasse is a combination of cellulose, hemicelluloses and lignin. It is the material that can adsorb hydrophilic and hydrophobic materials (A.E.-A.A. Said et al, 2009). Bagasse can attract both of the materials because of the structure of it. The different is that bagasse adsorbs more of the hydrophobic material which is oil. Bagasse can adsorb water as well but the adsorption capacity is very low.

By using sugarcane bagasse as oil separator with the method of adsorption is very effective. From the result obtained, the sugarcane bagasse has the ability to adsorb oil at certain condition. The bagasse also can be chemically modified to increase the adsorption performance. Bagasse can be fully utilized even after using it as adsorbent; it still can be used as combustion for furnace or boiler in the industry. Sugarcane bagasse cannot directly to separate water and oil when it mix together. It can adsorb oil and water when it separate. Oil and water will separate because of the different density and viscosity.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research is done to increase the usage of by-product of sugar, the sugarcane bagasse as one of the way to reduce the organic waste. Instead of being used as a combustion raw material for boiler and furnaces at the mill. With high carbon content and have a strong fibrous component in the structure of sugarcane bagasse, it is a waste to just used it as combustion raw material and been used as animal feed. The carbon content and fibrous component of sugarcane bagasse can be used in many fields. It can be used as raw material to adsorb oil from oil spill or waste. This research is also done to investigate the effectiveness of sugarcane bagasse to adsorb oil from water. From the result obtained from the research, sugarcane bagasse is very effective in adsorbing oil. The good condition of sugarcane bagasse to adsorb oil is the particle size. The small particle size has a greater surface area that increases the adsorption capacity of the bagasse. The comparison between the raw bagasse and modified bagasse from this research show that raw bagasse has higher adsorption capacity. Both of the objective are achieve.

5.2 Recommendation

From this research a lot of aspect can be approve to have more improve result. From the previous research, the modified bagasse should have higher adsorption capacity compare to raw bagasse. As a recommendation, the bagasse can be modified not only sulphuric acid but also can be mixed with sodium methylate and citric acid. This research also can be tested using many type of different chemical. Other than that, the modified bagasse can be chemically modified using alkali solution instead of acid. The result from the manipulation of size can be varies with a lot more size to be tested. This research also can be improved by using the carbonized sugarcane bagasse. The concentration of the chemical used also can be varies like using 0.5M, 0.8M and so on to get a better result.

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APPENDIX A

Operating grinder machine

Putting the bagasse one by
one in the grinder

Grinding machine

Cleaning grinding machine

Raw sugarcane bagasse

Modified bagasse

Bagasse are completely
immersed in the oil

After 10minutes, the bagasse
is take out from oil

Raw bagasse after take out
from oil

SEPARATION OF OIL AND WATER USING SUGARCANE BAGASSE

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