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Study of Sawdust as Natural Oil Sorbent for Oil Spill Comparative Study: Albayda, Libya

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Abstract

Oil pollution has become one of the most serious threats to the water ecosystem over the past 30 years due to the widespread development of the offshore petroleum industry, increased oil runoff, increased accidental spills, and fuel discharges from the ground - oil drilling accidents and the increase in offshore oil transportation. Despite the presence of many techniques to clean up oil spills, sorbents are considered as one of the most attractive techniques due to the high rate of absorption or adsorption and ease of application. Organic-based sorbents have become the best type to use based on their abundance of resources and its biodegradability. Among the many natural organic sorbents available, sawdust has big potential to be used as oil absorbent due to its advantages of being low-cost source, low density and exhibiting hydrophobic- oleophillic characteristics. In this study, the utilization of sawdust as sorbent material some types of oil was investigated (crude oil, oil 40 and oil 20W50). The effects of process with two parameters such as weight of sorbents and contact time on the extent of oil sorption were investigated.

Keywords: oil spill; sorbents; sawdust; crude oil; oil 40; oil 20W50; adsorption.

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الملخص

أصبح التلوث النفطي أحد أخطر التهديدات للنظام البيئي المائي على مدى الثلاثين عامًا الماضية بسبب التطور الواسع النطاق لصناعة البترول البحرية ، وزيادة تسرب النفط ، وزيادة الانسكابات العرضية ، وتصريف الوقود من الأرض – حوادث التنقيب عن النفط وزيادة في نقل النفط البحري. وعلى الرغم من وجود العديد من التقنيات لتنظيف الانسكابات النفطية ، إلا أن المواد الماصة تعتبر من أكثر التقنيات المفضلة نظرًا لارتفاع معدل الامتصاص وسهولة التطبيق. أصبحت المواد الماصة ذات الأساس العضوي أفضل نوع للاستخدام بناءً على وفرة مواردها وقابليتها للتحلل البيولوجي. من بين العديد من المواد الماصة العضوية الطبيعية المتاحة ، تتمتع نشارة الخشب بإمكانية كبيرة لاستخدامها كممتص للزيت نظرًا لمزاياها المتمثلة في كونها مصدرًا منخفض التكلفة ، وكثافة منخفضة ، وخصائص كارهة للماء. في هذه الدراسة تم دراسة استخدام نشارة الخشب كمادة ماصة لبعض أنواع النفط (زيت خام, زيت 40 وزيت 50/20) تم دراسة تأثير العملية مع متغيرين مثل وزن المواد الماصة ووقت التلامس على مدى امتصاص الزيت.

الكلمات الرئيسية: انسكاب نفطي، مواد ماصة، نشارة الخشب، زيت خام، زيت 40، زيت 50W20 ؛ الامتزاز.

1. Introduction

An oil spill is a release of a liquid petroleum hydrocarbon into the environment due to human activity and is a form of pollution. The term often refers to marine oil spills, where oil is released into the ocean or coastal waters. Oil spills include spills of crude oil from tankers, sea platforms, drilling rigs and wells, as well as spills of refined petroleum products and their by-products, heavy fuels used by large ships such as bunker fuel, or any spillage of any white oily waste or waste oil. Cleaning up spills can take many years (G. M. Dunnet, 1982).

Major sources of waste oil include petroleum refining, petrochemical plants, vehicle repair garages, metal and steel manufacturing industries, vegetable and animal oils in household's wastes and abattoir wastes. one of the main sources of water pollution is crude oil spill. Oil and petroleum products can pollute sources of water such as seas, oceans, rivers, or underground waters. Oil spill over the oceans and seas requires prompt attentions due to their environmental and economic impacts.

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On April 20, 2010, the Deepwater Horizon oil rig, an ultra-deep water offshore drilling rig, exploded in the Gulf of Mexico about 41 miles off the Louisiana coast, this was due to the explosion that occurred under the waters of the Gulf of Mexico. The fire burned for 36 hours, and the 4.1 million barrels of oil recovered in Gulf of Mexico, eleven crew members died, and others were seriously injured, as fire engulfed and ultimately destroyed the rig. Where this is considered an accident the largest marine oil spill in the history of the petroleum industry. (J. Stephen Dorrler, 1972 and G.J.H. Goossens).

In general, wherever oil is produced, transported, stored, and used, there will be a risk of spillage. Spilled oil has an undesirable taste and odor, affects tourism and economy, and causes severe environmental damages (Hussein et al., 2008; Sayed and Zayed, 2006).

To overcome the environmental challenge, novel synthetic organic sorbents with high oil absorption capacities, high porosity, large surface area and high degradability rate were developed, e.g., cellulose aerogels. Inorganic sorbents such as manganese oxide, bentonite, have high oil absorption capacities. Natural organic sorbents such as peat and cotton grass fiber, rice husk and carbonized rice husk, butyl rubber, coconut husk, sawdust, Kapok fiber, sugar cane bagasse, chitosan barley straw and other natural fibrous sorbent have also been used for removal of oils from contaminated waters.

Oil sorbents can be classified into three basic categories, including inorganic mineral products, organic synthetic products, and organic vegetable products (Adebajio et al., 2003; She et al., 2010). Inorganic sorbents include zeolites, silica, perlite, graphite, vermiculites, sorbent clay, diatomite, glass, wool, sand, and volcanic ash; materials such as polypropylene and polyurethane are organic synthetic products. Natural organic sorbents include peat moss, wood fiber, cotton fiber, cellulosic kapok fiber, kenaf, milkweed floss straw, hay, sawdust, ground corncobs, feathers, and other carbon-based products (Annunciado et al., 2005; She et al., 2010).

Several methods have been developed to eliminate oil from polluted water. The oil spill on water is usually classified as large or small scale. At large scale, cleaning up of the spill is limited by using booms followed by skimmers. Mechanical techniques by using shovels are commonly employed for oil spills that are landed on shore (Abdullah et al.,2010).

Further treatment by in- situ burning, bioremediation (Zahed et al.,2010), and using chemical agents, such as dispersants (Lessard and DeMarco,2000) have

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been used. An illustration of the fate of oil spills in the marine environment (weathering process) (Karana et al., 2011), Even though several studies have been performed in this area, more research is still required. The most commonly used shoreline cleanup options are listed in Table 1.1:

Table 1.1: The most commonly used shoreline cleanup options

Category of Response Option	Example Technology
Natural method	Natural attenuation
Physical method	Booming and skimming
	Wiping with absorbent materials
	Mechanical removal
	Low pressure flushing
	Washing
	Cutting vegetation
	Stripping
Chemical methods	Dispersants
	Demulsifiers
	Gelling agents (solidifiers)
	Surface film chemicals
	In situ burning
Biological methods	Bioremediation
	Phytoremediation

Source: (Zahed et al., 2005; Zhu et al., 2001; Alade, 2011).

This paper was designed to examine the utilization of Sawdust in the removal of oil spills from contaminated waters as a means of physical treatment to replace the conventional synthetic adsorbents that are currently used.

Problem Statement

In the process to clarify the purpose of the paper was being carried out, the problem statement is divided into two sections:

Significant of the Project

This paper is carried out with the aim to study on natural organic that can be used to replace synthetic absorbents.

Objectives

The objectives of my paper are:

- To increase the usage of by-product of the Sawdust as one of the ways to reduce the organic waste.
- To investigate the effectiveness of Sawdust to adsorb oil from water.

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Scope of Study

materials had been chosen from organic materials products to be the test materials. They are Sawdust. The scope of study will be on the rate of oil absorption of the materials on crude oil.

2. METHODOLOGY

INTRODUCTION

In this part, the detail materials used, and experimental procedure will be explained. 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**.**

MATERIAL PREPARATION

The material proposed is sawdust this the natural sorbent evaluated during the experiments.

1.Preparation of the sawdust

The sawdust was obtained from a carpentry workshop located near the in the industrial district in Albayda city, then the sawdust was soaked in water for 12 hours, and after, the samples were dried under sunlight for three days, then the samples were dried in the oven at 105° C, for a p 24hour, then measuring the moister in the sawdust after drying. After that, the samples were placed in boxes and stored in a controlled laboratory environment until use, as shown in the figures bellow.

Figure 2.1 The sawdust before preparation

Figure 2.2: Dry the sawdust at temperature about 105 C°

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Figure 2.3 The sawdust after preparation

Figure 2.4 Measuring the moister in the sawdust after drying

2. Crude oil, Oil 20W50, oil 40

Crude oil sample was obtained from Arab Gulf Oil Company (AGOCO) Tobruk - Refinery Libya (95% pure). Biodiesel sample was obtained from experimental study, oil (40- 20W50) were buy from market.

Figure 2.5 sample of Crude oil, Oil 20W50, oil 40

3. Apparatus and Experimental tools

1. Electric Oven
2. Electronic Balance
3. Mixer
4. Beakers, with different sizes (500ml_1000ml).
5. Conical Flasks, with different sizes (50ml_250ml_1000ml).
6. Glass pan
7. Metal net.

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4. EXPERIMENTAL PROCEDURE

1. Oil absorption

The objective of this test is to determine the optimum absorbent capacity without competing presence of water. This test is performed at room temperature.

The type of absorbent material used sawdust; The sawdust categorized as absorbent since the materials are unconsolidated.

2. Sawdust experiment

Step (1): at constant volume of oil, constant absorption material and the change in time

Figure 2.6 shown the weigh 10g of sawdust

1. Weigh 10g of sawdust and is known as m_1 in unit gram.
2. 200 ml of seawater is poured on the 1-liter beaker.
3. Add about (20 mL) of crude oil into (200 mL) Sea Water and put them in beaker at room temperature.
4. Measuring 10 gram of sawdust and put it in the beaker which has a sample of crude oil and sea water and mixing them.

Figure 2.7 shown supply the material

Figure 2.8 shown Add of crude oil into Sea Water

Figure 2.9 shown add of oil40 into Sea Water

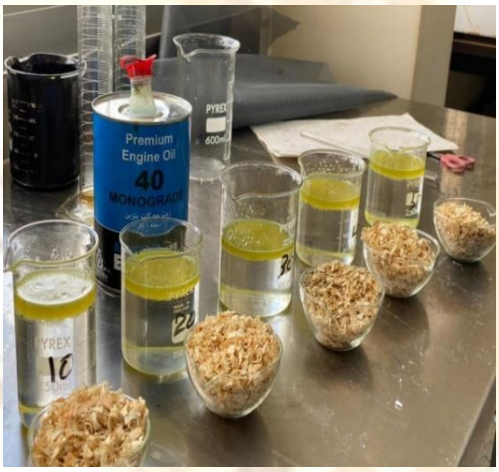

Figure 2.10 shown add of oil20w50 into Sea Water

Figure 2.11 shown the mixing of material by mixer

5. It is left for 10 minutes to absorbed.
6. Observe the effect of sawdust on crude oil.

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7. Separate the mixing on metal net
8. Strain the contents of the beaker using a mesh to catch the sawdust
9. Record the weight of absorbent material at each time test. (20, 30, 40,50 minutes) (after the absorbent)
10. Calculate the percentage of oil absorption using eq (1).

$$\boldsymbol{Percentage\ of\ \ oil\ \ absorbency = \frac{m_2 - m_1}{m_1} * 100 \ldots . 1}$$

***Where*:**

Q: Represents the oil absorption %.

$m_{1:}$ The weights of the oil-absorbent before oil absorption, g

m2: The weights of the oil-absorbent after oil absorption, g. (Lei Ding, et al 2010).

11. Apply the experiment for three types of oil

3. RESULT AND DESCUSSION

OIL ABSORBENCY TEST:

The oil absorbency test is conducted based on procedures discuss in, the types of oil were used in this experiment is crude oil, oil 40 and oil 20w50.

Step 1: at constant volume and with changing time

Table 3.1: Shown the result of oil absorbency for sawdust

Time (minuet)	Sorption weight (kg)		
	crude oil	oil 40	oil 20w50
10	77.85	79.14	77.33
20	76.56	78.54	77.48
30	77.84	76.46	77.99
40	77.19	75.85	80.26
50	78.96	78.62	78.6

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From table 3.1 and as shown in the figure 3.1: shown that the mount oil absorbency of sawdust was for crude oil, where reach to **77.85 kg** at 10 minutes, but decreases the weight of the absorbent material to **76.56 kg** at 20 minutes., then increases the absorbency will be **78.96 kg** at 50 minute to becomes the best absorbency at this time.

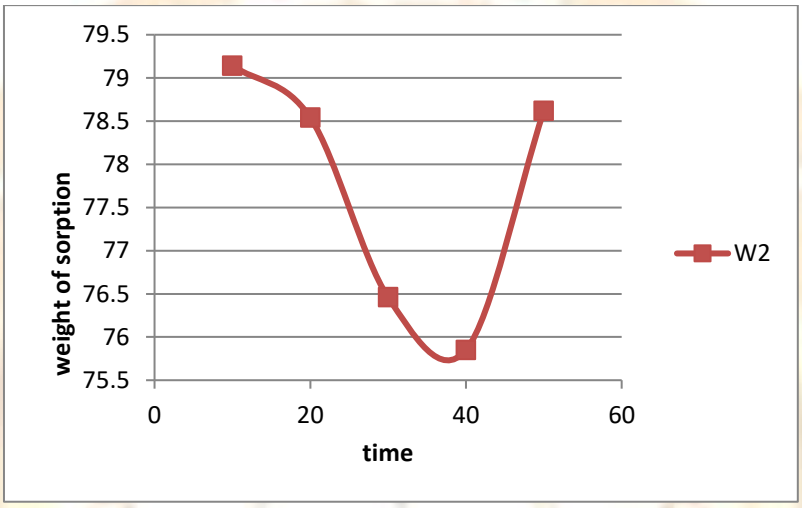

Figure (3.1) Shown the result of use the sawdust with crude oil

From table 3.1 and as shown in the figure 3.2: shown that the mount oil absorbency of sawdust was for oil40, where reach to **79.14 kg** at 10 minutes, but decreases the weight of the absorbent material to **78.54 kg** at 20 minutes., then increases the absorbency will be **78.62 kg** at 50 minute to becomes the best absorbency at 10 minute

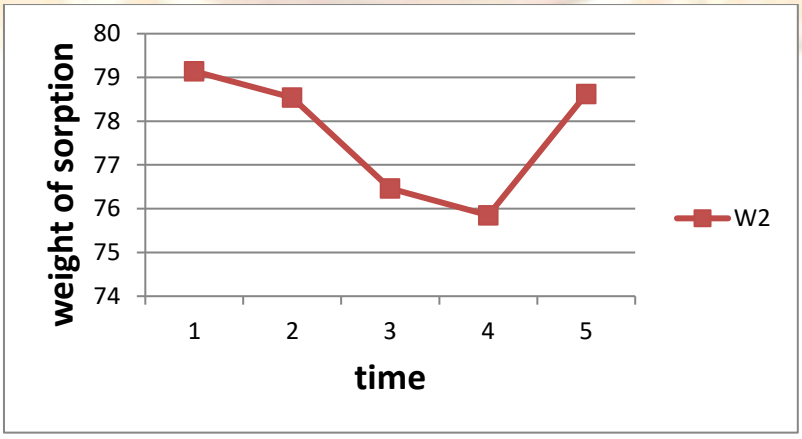

Figure (3.2): Shown the result of use the sawdust with oil (20w40)

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From table 3.1 and as shown in the figure 3.3: shown that the mount oil absorbency of sawdust was for oil (20w50), where reach to **77.33 kg** at 10 minutes, then increases the weight of the absorbent material to **80.26 kg** at 40 minutes. but decreases the absorbency will be **78.6 kg** at 50 minute to becomes the best absorbency at 40 minutes.

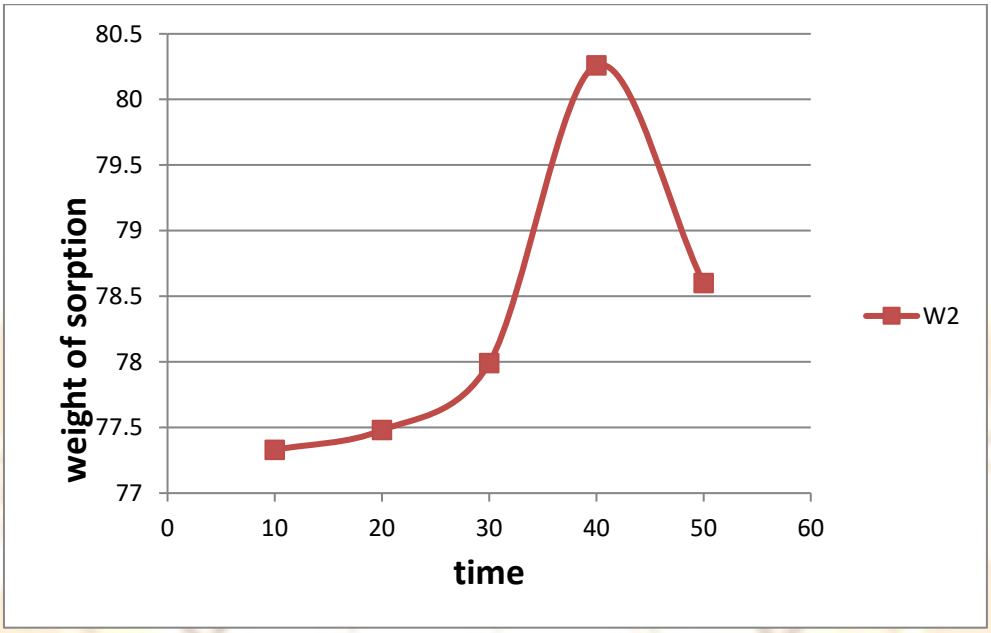

Figure (3.3): Shown the result of use the sawdust with oil (20w50)

From table 3.1: and with comparing between crude oil, oil 40 and oil 20w50, the figure 3.4: shown that the mount oil absorbency of sawdust for oil 20w50 higher than crude oil, oil 40, where reach to 80.26 kg at 40 minutes. but for oil 20w50 the weight of the absorbent material reaches to 79.14 kg at 10 minutes. From the results, we note that the rate of absorption of the oil 20 W 50 is the best and the reason is the process became regular, while in other oils there was a disturbance in absorption during the specified times.

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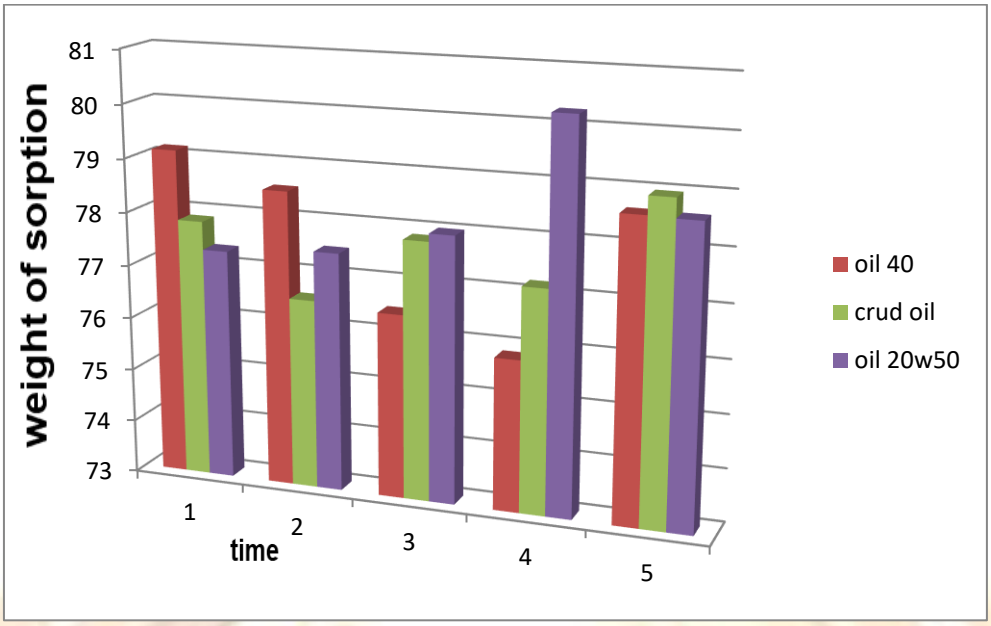

Figure (3.4): shown the comparing between three types of oil with change the time from (10 to 50 minutes) for five times as in

Step (2): at constant with changing weight of adsorption substance (sawdust) After the calculation of bellow equation with constant time at 30 minutes and different weights of (5 ,10 ,15, 20,25) to Calculate the percentage of oil absorption using, as shown in the table 3.2.

$$Q = \frac{m_2 - m_1}{m_1} * 100$$

From the results and comparison as shown in table 3.2 & figure 3.5. and when taking into account that the absorption time and the volume of the contaminated oil are fixed, while we changed the weight of the absorbent material, it was noted that when the weight of the absorbent material was five grams, the absorption rate was the best for these oils, as it was for 40 oil the highest for crude oil and 20w50 oil.

Table 3.2: Shown the Weight of Material, g M1 (V) Oil Absorbency, g/g C%

Weight of Material, g M1	The weights of material with the oil-absorbent after oil absorption, g M2			Oil Absorbency, g/g C%		
	crude oil	oil 40	oil 20w50	*c% oil 40*	*c% oil 20w50*	*c% crude oil*
5	81.24	66.01	65.68	93.85	92.39	92.43
7.5	90.04	75	72.26	91.67	89.62	90
10	93.54	79	78.36	89.31	87.24	87.34
12.5	98.83	82.25	57.4	87.35	78.23	84.8
15	112.26	85.9	65.9	86.63	77.24	82.54

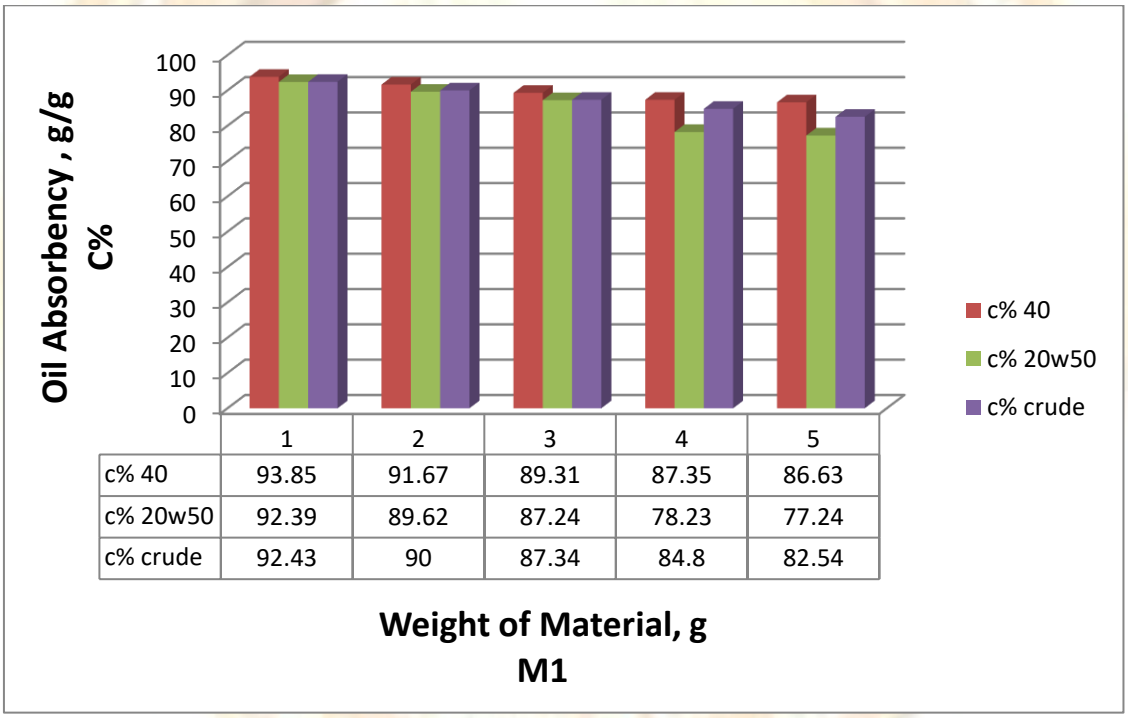

Figure (3.5): shown the comparing between three types of oil with change the absorbent material.

4. CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION:

In the present study the oil sorption capacity of sawdust was then used in different particle sizes to remove a crude oil layer dispersed seawater.

The following conclusions can be drawn from the results obtained:

1. The results had shown that sawdust have the highest oil absorbency rate and lowest water absorbency rate. This is the characteristics of an excellent absorbent which has low hydrophobic and high oleophilic characters.
2. Using this absorbent will not bring more damage to the environment the sawdust as from the best material
3. The result of experiment indicated that at change the time of absorbent, absorbency of sawdust for oil 20w50 higher than crude oil, oil 40, where reach to 80.26 kg at 40 minutes
4. we note that the rate of absorption of the oil 20 W 50 is the best and the reason is because the process became regular, while in other oils there was a disturbance in absorption during the specified times.
5. when we changed the weight of the absorbent material, it was noted that when the weight of the absorbent material was five grams5, the absorption rate was the best for these oils, as it was for 40 oil the highest for crude oil and 20w50 oil.

4.2 RECOMMENDATIONS:

1. During the experiments with removal of the oils from sea water, it is recommended that it is applied this in column experiment.
2. This experiment should be conducted on other labs to simulate the offshore waves which will affect the oil absorbency rate in real situation.
3. recommended to be used the sawdust as alternative oil spill absorbent due to their highest oil absorbency and lowest water absorbency.

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