The International Journal of Engineering and Information Technology

journal homepage:www.ijeit.misuratau.edu.ly

Effect of Olive Peat on the Density, Rheology, and Fluid Loss of Drilling Fluid

Moiud M. Elwish
Petroleum Engineering Dept. Collage of Engineering,
Misurata University

Majed A. Enfis
Petroleum Engineer
Al Waha Petroleum Co.
Tripoli- Libya

Abdunaser O. Susi
Petroleum Engineering Dept., HOD
Collage of Engineering,
Misurata University

Abstract— **As it is known, the drilling mud which is the main part of all drilling operations in oil and gas wells should be optimum designed for achieving the target without obstacles. So, the good design of drilling fluid depends on the control of its physical properties such as the density which can be controlled by either adding a desirable solid such as barite or removing undesirable solids such as cuttings. Also, fluid loss can be controlled using lost circulation materials.**

In this study, experimental work has been conducted to study the effect of a new material called Olive Peat on the rheological properties of drilling fluid by conducting routine tests.

The laboratory experiment is carried out firstly on row drilling mud without Olive Peat. Then, different percentages of Olive Peat have been added to the row mud and properties of these new mixtures were estimated.

Results presented that the Olive peat has an Inverse relationship with the density of the drilling fluid because of the oil inside the new material which leads to creating an emulsion.

Furthermore, results show that the new studied material can be used in the drilling circulation system as it reduces the volume of fluid loss in mud.

Index Terms: **drilling mud, Olive Peat, Density , Rehology, Fluid Loss.**

I. INTRODUCTION

It has been known that drilling muds are traditionally based on water, either freshwater, seawater, naturally occurring brines, or prepared brines (Water base mud or Oil base mud) (A. T. Bourgoyne, et al, 1991). Many muds are oil-based, using direct products of petroleum refining such as diesel oil or mineral oil as the fluid matrix. In addition, various so-called synthetic-based muds are prepared using highly refined fluid compounds that are made to more-exacting property specifications than traditional petroleum-based oils (R. F. Mitchell).

In general, water-based muds are satisfactory for the less-demanding drilling of conventional vertical wells at medium depths, whereas oil-based muds are better for greater depths or in directional or horizontal drilling, which place greater stress on the drilling apparatus (A. T. Bourgoyne, et al, 1991). Synthetic-based muds are being developed in response to environmental concerns over oil-based fluids, though all drilling muds are highly regulated in their composition, and in some cases, specific combinations are banned from use in certain environments (Awele, N. 2014).

A typical water-based drilling mud contains clay, usually bentonite, to give it enough viscosity to carry cutting chips to the surface, as well as a mineral such as a barite (barium sulfate) to increase the weight of the column enough to stabilize the borehole (Dhiman, S. 2012).

Smaller quantities of hundreds of other ingredients might be added, such as caustic soda (sodium hydroxide) to increase alkalinity and decrease corrosion, salts such as potassium chloride to reduce infiltration of water from the drilling fluid into the rock formation, and various petroleum-derived drilling lubricants (MAHMUD, K. 2010).

Oil- and synthetic-based muds contain water (usually brine), bentonite and barite for viscosity and weight, and various emulsifiers and detergents for lubricity. In this work, the effect of Olive Peat on the drilling mud has been experimentally studied. The Olive Peat has oil in its structure which is expected to have an opposite effect on the drilling fluid density. Furthermore, it should be working as a lost circulation material (LCM).

Experimental work has been investigated using the base fluid with and without Olive Peat. Also, routine mud test properties have been conducted in the laboratory.

Compressed air, foam, clear water, water-based mud, and oil-in-water emulsion or oil-based drilling fluid are considered the most significant classifications of the drilling fluids (Azar and Samuel 2007). Therefore, based on some specific requirements and functions special types of drilling fluids are made (M. E. Hossain et. al.,2015), which will be tackled in this study.

Also, the lower permeability leads to thinner filter cake and lowers the volume of filtrate from mud (Rabia 2002).

Received 16 Nov , 2021; revised 27 Nov, 2021; accepted 27 Nov, 2021.

Available online 5 Dec, 2021.

Thus, the main objectives of this study are to study the effect of the Olive Peat on the density of drilling fluid, study the reduction of the fluid loss that can be occurring due to adding Olive Peat and estimate the rheological properties of drilling fluid with and without Olive peat.

1.1 Olive Peat

It is a substance extracted from the olive stick to extract the oil present inside the bed as is shown in figure 1contains many chemicals and it is in the original what is organic Peat forms when plant material does not fully decay in acidic and anaerobic conditions. It is composed mainly of wetland vegetation: principally bog plants including mosses, sedges, and shrubs. As it accumulates, the peat holds oil. This slowly creates wetter conditions that allow the area of the wetland to expand. peatland features can include ponds, ridges, and raised bogs companies may use pressure to extract oil from the peat, which is soft and easily compressed, and once dry can be used as fuel. In many countries, including Ireland and Scotland, peat was traditionally stacked to dry in rural areas and used for cooking and domestic heating.

Peat can be a major fire hazard and is not extinguished by light rain. Peat fires may burn for great lengths of time, or smolder underground and reignite after winter if an oxygen source is present .

Figure 1. Olive Peat

1.1.1 Types of peat material

Peat material is either fibric, hemic, or sapric. Fibric peats are the least decomposed and consist of intact fibre. Hemic peats are partially decomposed and sapric are the most decomposed (britannica web), [13].

Phragmites peat are composed of reed grass, Phragmites australis, and other grasses. It is denser than many other types of peat. Engineers may describe soil as peat which has a relatively high percentage of organic material. This soil is problematic because it exhibits poor consolidation properties – it cannot be easily compacted to serve as a stable foundation to support loads, such as roads or buildings.

II. METHODOLOGY

2.1 Experimental Equipment and Procedures:

Since it is important to know the physical properties of the drilling fluids, in order to fully process them to start the drilling process.

Hence, the methodology that has been used here was to determine the physical properties of clay experimentally before and after the effect of peat of olive. The mixing method used has been adopted.

The different quantities of raw materials as shown in table 1 and (drillingformulas web.), [11], were measured using an electronic weight scale. After that, the raw material and additives as shown in figures 1.2, &3 ware poured, one by one into the steel cup for the single spindle mixer as appears in figure 4. figures 2 to 4 Show the materials that used to formulate the water base mud & Olive Peat.

To evaluate drilling mud, there are several different techniques used in the industry to measure different fluid properties (Baker, 2006). Therefore, some of the lab devices were used in this experiment to measure the physical properties of the drilling fluid in laboratory such as mud balance(mud density), rotational viscometer (rheology), and API filter press (mud filtration).

Figure 2. Bentonite

Figure 3. Barite

Figure 4. Water

The table below describes the materials types, concentrations, additives and the function of each additive that used to formulate the drilling mud.

Table 1. Types of materials used in WBM preparation

Additive	**Function (S)**
Water	Base fluid
Bentonite	Control of viscosity and filtration
Barite	Control of density
Peat	Lost circulation material
Caustic soda	

2.2 Drilling Mud Equipment Used:

2.2.1 Electronic Scale:

Figure 5 shows the electronic balance which is used to estimate the mass of the materials used in the laboratory.

Figure 5. Electronic scale

2.3 Hamilton Beach Mud Mixer

A single spindle Hamilton Beach Commercial mixer was utilized for preparing mud samples. Mixer used had 3 speed setting with an additional pulsating switch and as shown in figure 6.

Figure 6. Hamilton Beach Mud Mixer

2.3.1 Procedures:

1. The weights of the clay components were measured according to the required quantity (bentonite, barite) by the electronic scale.
2. A certain amount of water was prepared (250 ml).
3. Fill the water in cup Mud Mixer.
4. The amount of barite was added to the water and then the bentonite was added to the mixture
5. The first component is added and then three minutes later the second component is added. The entire duration of the mixture was 45 minutes.

2.4 Mud Balance:

The mud balance must be calibrated firstly before being used, as shown in figure 7.

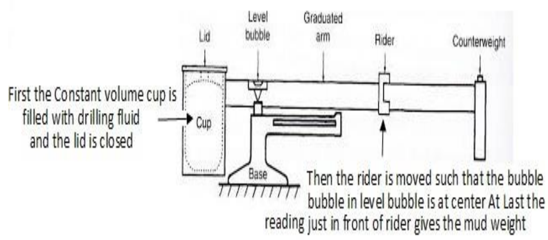

Figure7. Components Mud Balance

2.5 Fann Model 35 Viscometer

The instrument as shown in figure 8 (a,b&c) is prepared for 12-speed testing by setting the gearbox shift lever and selecting the proper speed range with the speed shift switch. hence, the shear stress values will appear on the dial.

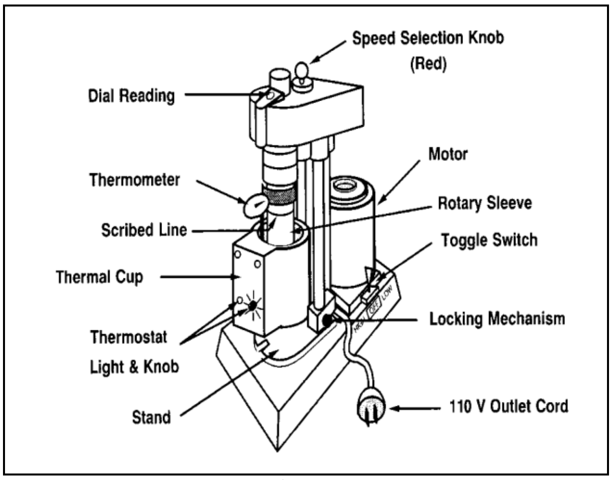

Figure 8, a. Speeds of Fann Model 35 Viscometers

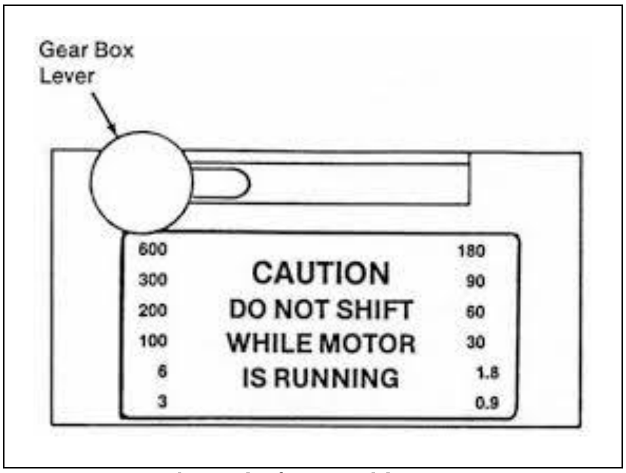

Figure 8, b. Speeds of Fann Model 35 Viscometers

2.5.1 Procedures

1. Measure and record the temperature of the mud sample.
2. Make sure the cup is clean and dry. Fill the cup about 2/3 of the with mud sample. Place the cup on the viscometer stand (the pins on the bottom of the cup fit into the holes in the base plate).
3. Turn the knurled knob between the rear support posts to raise or lower the rotor sleeve until it is immersed in the sample to the scribed line.
4. Toggle switch to (high) position on the right of the viscometer. Put the control speed in the lower position (600), and wait for the dial reading to stabilize.
5. Record the dial reading 600 rpm.
6. Change the switch on (low) position on the right of the viscometer. Put the control speed in the lower position (300), and wait for the dial reading to stabilize to take the reading.
7. Record the dial reading 300 rpm. The Plastic Viscosity is (reading 600rpm - reading 300rpm). The yield point is (reading 300rpm - Plastic Viscosity).

2.5.2.Procedures for measuring Gel Strength after 10 sec:

1. Change the switch on (high) position on the right of the viscometer. Put the control speed in the upper position (600) and switch on the device few minutes.
2. Switch off the device and start the timer to calculate the rest time (normally 10 seconds).
3. Put the control speed in the middle position (3).
4. After 10 seconds switch on the device on (low) position on the right of the viscometer, and record the maximum deflection of the dial before the Gel breaks, as the Gel strength in lb/100 ft2.
5. After the test, the sleeve was removed from the rotor, and cleaned all removed parts were.

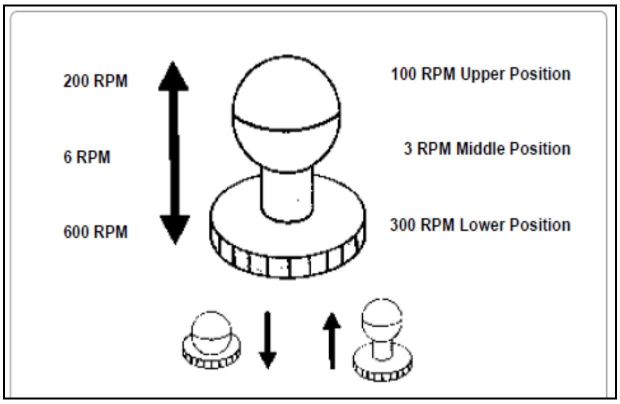

Figure 8, c. Speeds of Fann Model 35 Viscometers

2.5 Standard API Filter Press:

This device consists of a pressure cell, reservoir, frame, base cap, top cap, Weight, filter Paper, mesh screen, neoprene gasket, T-Screw and a graduated cylinder as shown in figure 9.

The test is conducted regularly based on the test steps that are exist in the laboratory manual (Amoco - Drilling Fluid Manual).

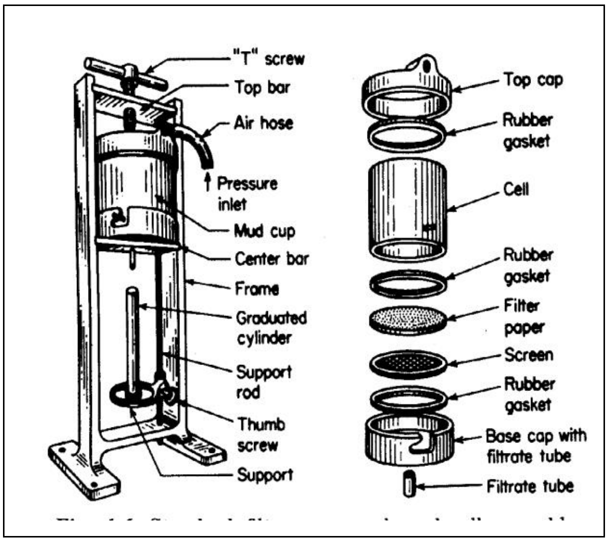

Figure 9. Standard API Filter Press

2. 6 Marsh Funnel Viscometer:

Funnel viscosity is the ratio of the speed of the slurry as it passes through the outlet tube (shear rate) to the force (weight of the slurry) causing the slurry to flow (shear stress). Funnel viscosity is reported as the seconds required for one quart of slurry to flow out a full funnel. Marsh Funnel Viscometer is shown in figure 10.

Equipments:

1. Measuring Cup (graduated).
2. Stopwatch.
3. Thermo meter.

Fresh slurry sample is collected, and then the experiment is conducted based on the steps that are exist in the laboratory manual.

Figure 10. Marsh Funnel Viscosity.

III. RESULTS AND DISCUSSION

Achieving the optimal specifications for any drilling fluid are considered the first guarantee of the safety for the rotary system and the formation zones layers during the well drilling operations.

The amount of ingredients that have been used in the lab tests are documented in table 2 below.

Table 2: The amount of ingredients that have been used in the lab tests

Component	Test 1	Test 2	Test 3	Test 4	Test 5
Water (ml)	350	350	350	350	350
Bentonite (g)	0.20	0.20	0.20	0.20	0.20
Barite (g)	20	20	20	20	20
Caustic soda (g)	0.50	0.50	0.50	0.50	0.50
Olive Peat (g)	0	5	10	15	20
Olive Peat %	0 %	1.33%	2.626 %	3.888 %	5.118 %

Five different tests have been applied to the original drilling fluid mixtures and some properties have been measured such as density, viscosity, rheological properties, and volume of fluid loss. The discussion of the obtained results for each test measured at room temperature of 25ºC and 14.5 psia as follows:

3.1. Density:

The density of the five tests with different percentages of Olive Peat is experimentally measured using mud balance. Results in the below figure presented that the density of the drilling fluid decreases with increasing of the Olive Peat.

Results indicate that the density id decreased from 8.6 ppg for the original mud to 6.1 ppg with adding about 5.1% of the Olive Peat.

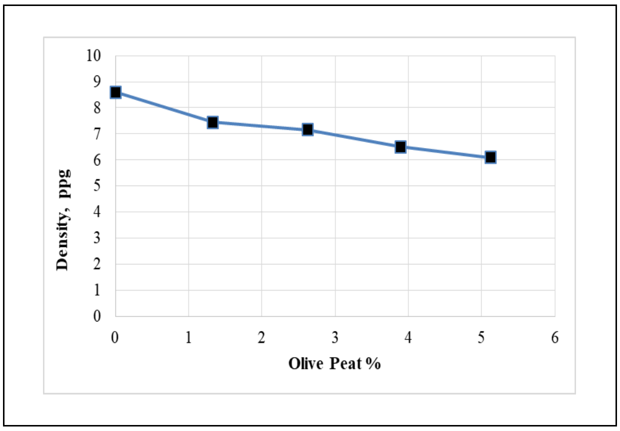

Figure 11. Density vs. Olive Peat%

3.2 Rheological data:

The rheological data of viscosity, yield shear stress and the type of the fluid model have been measured and recorded using the study of the relationship between the shear rate and shear stress using rotational viscometer for all tests.

3.2.1 Rheological properties for Test # 1:

The rheological results obtained from the viscometer have been converted to shear stress and shear rate that plotted together on linear scale. Results figure 12 presented that the shear stress has a linear relationship with the shear rate and indicate that the fluid follow the Bingham plastic model.

From the plot below, the plastic viscosity is 0.0052 Pa.S (5.2 CP) and the yield stress equals to 13 Pa (0.0019 psi).

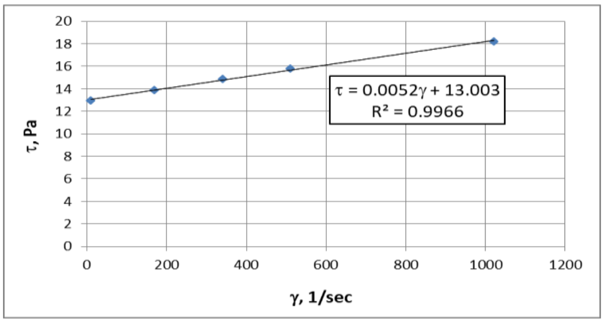

Figure 12. Shear stress vs. shear rate for Test # 1

3.2.2 Rheological properties for Test # 2:

The shear stress versus shear rate for test# 2 has been plotted; figure 13 and the results show that the fluid is follow the Bingham Plastic Model. Rheological properties have been obtained from the plot. From figure, viscosity is equal to 0.0085 Pa.S (8.5 CP) and yield stress is 4.747 Pa (0.00069 psia).

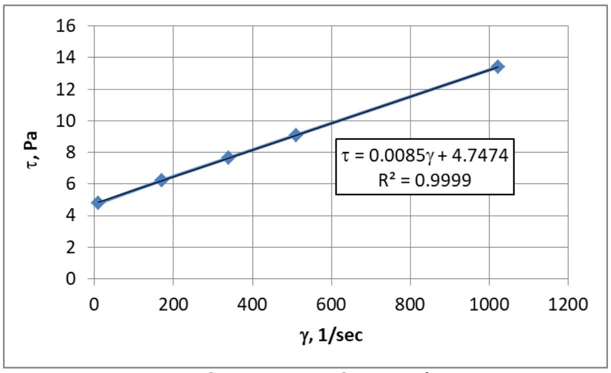

Figure 13. Shear stress vs. shear rate for Test # 2

3.2.3 Rheological properties for Test # 3:

The shear stress versus shear rate for test # 2 has been plotted; figure 14 and the results show that the fluid is follow the Bingham Plastic Model. Rheological properties have been obtained from the plot. From figure, viscosity is equal to 0.009 Pa.S (9 CP) and yield stress is 6.2633 Pa (0.00091 psia).

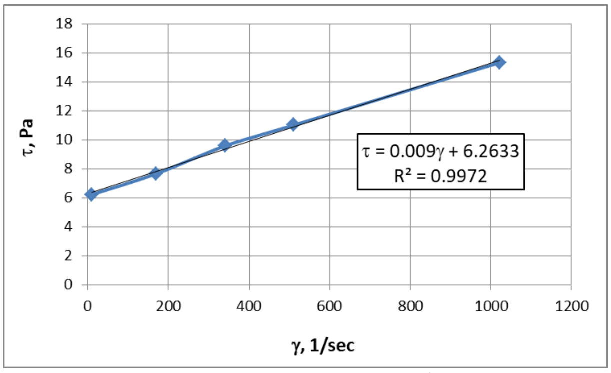

Figure 14. Shear stress vs. shear rate for Test # 3

3.2.4 Rheological properties for Test # 4:

For test # 4, the shear stress has been plotted versus shear rate and Bingham Plastic Model was investigated. From the figure 15 below, results presented that plastic viscosity is 0.008 Pa.S (8.0 CP) and yield stress is 4.371 Pa (0.0006 psia).

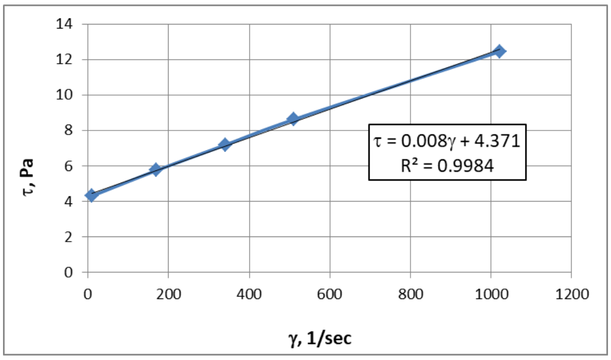

Figure 15. Shear stress vs. shear for Test # 4

3.2.5 Rheological properties for Test # 5:

The shear stress versus shear rate for test # 5 has been plotted; figure 16 and the results show that the fluid is follow the Bingham Plastic Model. Rheological properties have been obtained from the plot. From figure, viscosity is equal to 0.008 Pa.S (8 CP) and yield stress is 4.8489 Pa (0.0007 psia).

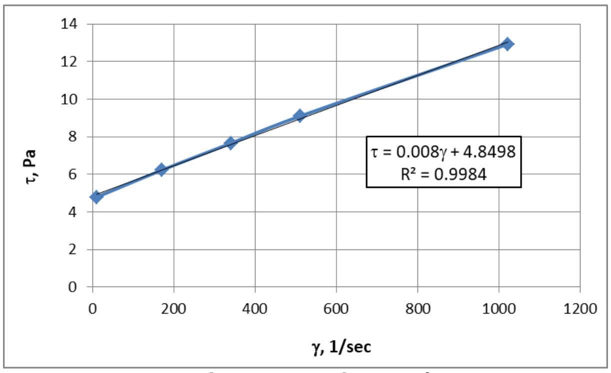

Figure 16. Shear stress vs. shear rate for Test # 5

3.3. Gel Strength:

The gel strength in units of lbm/100ft2, is measured by taking the maximum dial deflection when the rotational viscometer is turned at low rotor speed (3 rpm) after the mud has been static for a period of time generally 10 seconds or 10 minutes (Dhiman 2012).

3.4. Gel Strength for 10 sec &10 min.

Gel strength has been measured for all tests throughout the history of application. The results show that the strength of the gel decreases approximately with the increase of the olive peat percentage.

For 10 seconds, results that gel strength decreased by a percentage of about 66% as the Olive Peat percentage increased from 0% to 3.88% as appears in the figure 17 below.

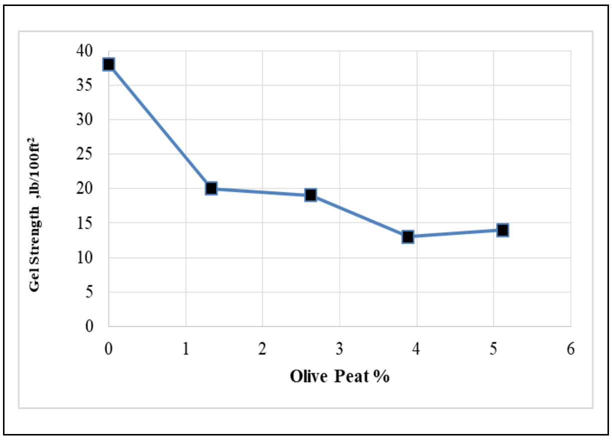

Figure17. Gel Strength vs. Olive Peat percentage at 10 sec

3.5 Fluid Loss:

The volume of the fluid loss at 30 minutes has been measured using API filter press. Results obtained show that the fluid loss decreases with increasing of Olive Peat as was expected where this material is working as Lost Circulation Material (LCM).

Figure 18 presented that the volume of fluid loss decrease with a percentage of 18% as the Olive Peat increased with 5.12%.

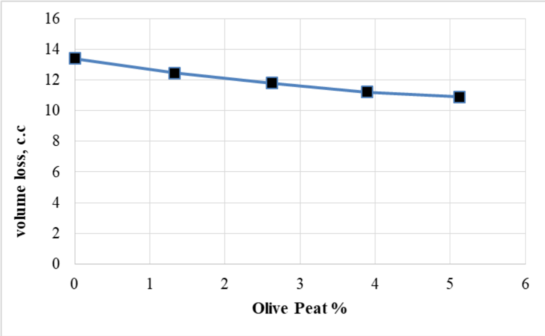

Figure 19. Volume of fluid loss vs. Olive Peat percentage

IV. CONCLUSION

From the results obtained during the experimental work done in this study, the following conclusion can be made:

1. The Olive peat works as a density reducer because of the oil inside of the peat. The oil worked as an emulsion.
2. All the rheological results indicate that the mud with the different percentages of Olive Peat follows the Bingham Plastic model.
3. Both viscosities and gel strengths for all tests presented that they have an opposite relation with the amount of Olive Peat.
4. As expected, the Olive Peat works as a lost circulating material and reduces the volume of the fluid lost.

Consequently, from the above conclusions, the study can recommend that :

The olive Peat can be used as a lost circulation material that has the ability to reduce the volume of fluid losses. Also, the effect of Olive Peat on the density can be controlled by properly removing all the oil from the material used.

REFERENCES

[1] A. T. Bourgoyne, et al, Applied Drilling Engineering. 2nd Edition Book, SPE, 1991.
[2] R. F. Mitchell, et al. fundamentals of drilling engineering, SPE textbook, 2011.
[3]Awele, N. "*Investigation of Additives on Drilling Mud Performance With* 'TØNDER GEOTHERMAL DRILLING'As A Case Study." Master. Aalborg University Esbjerg, 2014.
[4] Dhiman, S., "*Rheological properties & corrosion characteristics of drilling mud additives*."M. Sc, Dalhouse University, 2012.
[5] Mahmud, K. "*Effect of Contanmints on Water-Based Drilling Mud Properties*", 2010.
[6] Azar, J. J. and G. R. Samuel. Drilling engineering, PennWell book, 2007.
[7] Hossain M. E., Al-Majed, A.A. Fundamentals of Sustainable Drilling Engineering, 2015.
[8] Rabia, H., Well engineering & construction, Entrac Consulting Limited, 2002.
[9] Amoco, C. "*drilling fluids manual* ".
[10] Baker, H. D., Drillinq Fluids Reference Manual, Houston, 2006**.**
[11]www.drillingformulas.com/types-of-flow-and-rheology-models-of-drilling-mud.
[12] www.petrowiki.spe.org/Drilling_fluid_types.
[13] www.britannica.com/technology/peat.
[14] www.britannica.com/technology/drilling-mud.