Drilling Fluid Loss Control By Using Oil Palm Fibres

by

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
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Approved by,

(Ms. How Meng Git)

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

LEONG KHAI SIANG

ABSTRACT

The harsh environment in underground drilling operations encouraged the research and development of drilling fluids that can fill several crucial roles in the drilling process. One of the critical problems faced in well drilling operation is the loss of drilling fluid, namely lost circulation. A method for preventing loss of drilling fluid into fractures of rock formation includes using lost circulation material. In an attempt to solve moderate-to-severe lost circulation problems, operators have pumped a variety of substances down the wellbore to reduce the loss of drilling fluid to a thief zone. These involve the use of materials that swell in the presence of water and fill the thief zone area or plug the flow path from the wellbore so that fluid loss ceases.

This project is to study the alternative lost circulation material for drilling operation in oil and gas industry. The objective of the project is to propose oil palm fibres and its treatment method to be considered for the usage in loss circulation situation. The scopes of the study include the understanding of lost circulation and its classification for drilling operation and investigation on the lost circulation material which can provide improved fluid loss control. Besides that, the scope of study also includes the conduct of laboratory experiment on the samples of drilling mud in order to determine effectiveness for the proposed material and the results can be compared with the American Petroleum Institute (API) Standards.

The methodologies used can be grouped into five phases. Phase one is information gathering and literature review. Phase two is preparation of additive which is related to the oil palm fibres (proposed material). This is followed by conducting sample analysis on X-ray Powder Diffraction (XRD) and Scanning Electron Microscope (SEM). Next, preparation of mud samples will be conducted to show the influence of selected variables (different mixture of weighting agents and additive). Finally, the rheological experiments are done in laboratory. The anticipated results from the study are to prove the effectiveness of the use of oil palm fibres as a lost circulation material in reducing fluid loss.

ACKNOWLEDGEMENTS

The writer is delighted to have finally completed his Final Year Project which is entitled "Drilling Fluid Loss Control by Using Oil Palm Fibres". Nothing can be done without the God's blessing and will. Thus the writer owes the God so much for giving him the opportunity to finish this study successfully.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Drilling is an operation to access the underground deposits of liquids and gases, such as oil, water and natural gas. Wells are drilled through different formations in order to achieve optimum penetrations and stable borehole conditions. Reducing the friction and the heat produced by such friction is an important factor of any drilling operation, because most types of drilling is either reciprocal or involves rotational movement of the drilling apparatus within the borehole.

Drilling fluids are important for the drilling operation in oil and gas industry because they perform many functions. These include lubricating the drill and applying hydrostatic pressure in the well bore. The purpose is to ensure well safety and minimize fluid loss across permeable formations by forming a filter cake on the walls of the well bore. In the standard practice, the fluid is inserted into the borehole and act as a lubricant at the point where the well surface contact with the drilling pipe. Therefore, component and additives availability, temperature and contamination are just a few of the major factors that determine the design of a particular mud programme [1].

The loss of drilling fluid occurs when permeable or fractured rock formations are encountered. This happens whenever the hydrostatic pressure of the fluid column exceeds the pressure that exists within opening in the rock formation. When such condition happens, the drilling fluid will be forced into the openings. The losses of drilling fluid may cause the rock formation become unstable, resulting bad impact and damage to the well and equipment. Besides that, it may also cause injury to workers as well as greatly increase the cost for drilling operation.

In order to mitigate this problem, the drilling fluid must contain some type of element that can block the open holes in the rock. These elements of drilling fluid typically act as agent across the openings in the rock formation. This is to seal them into the hole and prevent more drilling fluid seeping in. These agents are termed as lost circulation material.

1.2 Problem Statement

When drilling in deep wells for oil, gas or geothermal reservoirs, high temperatures are usually encountered which adversely affect the performance of drilling fluids. One of the challenges in drilling is to keep the lubricating fluid from seeping out of the hole. High temperature will cause the hydrostatic pressure exceeds the pressure which exist within the openings of rock formation. This occurrence will cause the drilling fluid being forced in the openings, resulting in drilling fluid loss.

Table 1.1 shows the lost circulation cost impact. The occurrence of lost circulation will affect the process of drilling, cementing as well as the completion. Cementing production zones characterized by lost circulation will encounter problems which are not easily solved during and after the cementing operation. Besides that, extra cost and formation damage are some of the consequences of lost circulation, whereby the operators have to deal with during the construction and completion stages of the well. Therefore, the loss of drilling fluid is an expensive and pervasive problem faced by the well drilling industry.

Table 1.1: Lost Circulation Cost Impact

Lost Circulation Cost Impact		
Drilling	**Cementing**	**Completion/Work-over**
Loss of mud	Reduced annular coverage	Loss of completion fluid
Lost time	Casing corrosion	Lost time
Poor cement job	Poor zonal isolation	Formation damage
Reduced safety	Reduced safety	Reduced safety
Stuck in hole		Lost reserves
Wasted casing string		Loss of well
Failure to reach target TD		
Blow out and kill operations		
Downhole blowouts		
Environmental incident		

1.3 Significance of The Project

This project is to study the use of oil palm fibres as a lost circulation material, by adding to drilling fluid, in order to prevent or mitigate the loss of drilling fluid during the process of well drilling.

Agriculture is among the main activites in Malaysia. A number of wastes are produced from this industry. The trend to use waste materials has motivated the idea of using oil palm fibres instead of throwing or burning these wastes without any purposes. These waste materials will create environmental problem if left on the plantation. Therefore, it is beneficial if oil palm fibres can be utilised in oil and gas industry.

1.4 Objective and Scopes of Study

There is a variety of lost circulating materials, including hard rubber, plastic, paper and etc. The objective of the project is to propose an alternative lost circulation material that can effectively reduce loss of drilling fluid and has the characteristics that can meet the specifications in American Petroleum Institute (API) Standards.

In order to evaluate the potential of oil palm fibres for new application as lost circulation material, a detailed and comprehensive study is necessary. The scope of study is given as follows:

- Study of the drilling mud and its fundamental properties.
- Study of the lost circulation and its classifications.
- Conduct of laboratory experiment on samples of drilling fluid by measuring the rheological properties and filtration loss.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is to provide a better understanding about fluid loss and lost circulation material. There are several causes of lost circulations for drilling operation. This chapter provides the basic knowledge of how lost circulation takes place and causes bad impact to drilling operation, the roles of drilling mud and and the current research in drilling technology.

2.1 Mud Engineering

Prior to drilling, mud program will be worked out by engineers according to the expected geology. The drilling engineer is concerned with the selection and maintenance of the best mud for drilling process. More mud is required as the depth of the hole increases, and the mud engineer is responsible to ensure that the drilling mud used is able to meet the specification. The chemical composition of the mud will be designed so as not to destabilize the hole. It is sometimes necessary to completely change the mud to drill through particular subsurface layer. For example, high density mud is required when drill through oil, gas and salt water, whereas low density mud is advantageous for low pressure production zones.

As drilling proceeds, the mud engineer will get information from the mud logger about progress through the geology and will make regular physical and chemical checks on the drilling mud. Temperature survey and radioactive trace survey are those methods which used for this purpose to identify the specific location of lost circulation. For temperature survey as shown in Figure 2.1, the temperature recording device is used to run in hole on a wire line to provide a record of temperature against depth. The trend is recorded under static conditions to provide base log. The cool mud is then pumped in the hole in order to obtain the secondary log. After that, the lost circulation zone can be determined by referring to the temperature gradient. The similar procedure is applied to the radioactive tracer survey by using gamma-ray log. The mud engineer has to keep an eye on the equipment which is used to pump the mud and to remove particles if the geologists' predictions are not entirely correct, or if other problems arise.

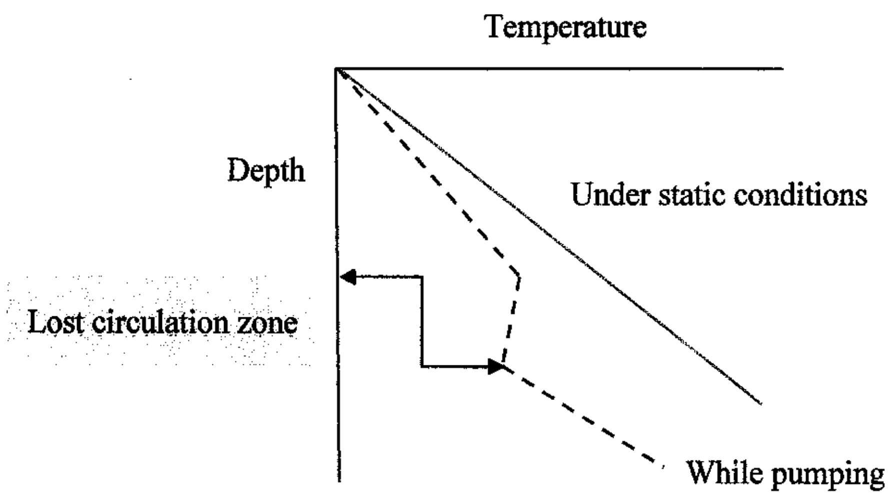


Figure 2.1: Principle of Temperature Survey

2.1.1 Functions of Drilling Mud

The harsh environment in underground drilling operations encouraged the research and development of drilling mud that can fill several crucial roles in the drilling process which include suspension, pressure control, buoyancy, lubrication, cooling and stabilization of formations [2].

The drilling mud is used to carry out many functions in well drilling operation. These include lubricating and cooling the drill string, to cool the drill bit and lubricate its teeth, carry out of the holes, stabilize the well bore to prevent from caving in and help in the evaluation and interpretation of well logs [3].

One of the primary functions of the drilling mud is to cool the drill bit and lubricate its teeth. As the drilling action requires mechanical and hydraulic energy, a large proportion of this energy is dissipated as heat. The drilling mud plays an important role to remove the heat and allow the drill bit to function properly. It also helps to remove drill cutting between the spaces and the teeth of the drill bit.

Besides that, the mud also provides lubrication by reducing the friction between the borehole walls and the drill string. This is normally achieved by the addition of oil, bentonite, graphite and etc. Drill string is the tubular and accessories on which the drill bit can run to the bottom of borehole. Figure 2.2 shows the use of drill string to suspend the drill bit and transmit rotary torque from the kelly to the bit. In general, the mud will absorb the heat generated by the string and release it by convection and radiation, to the air surrounding the surface pit tanks.

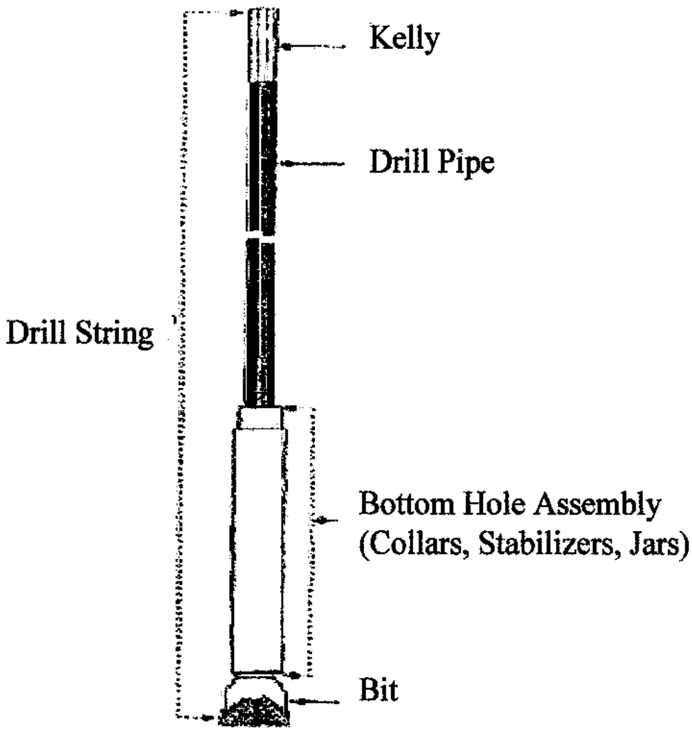


Figure 2.2: Typical Drill String Configuration [3]

From the safety perspective, the drilling mud can provide hydrostatic pressure which is greater than the formation pressure. This can prevent the damage to equipment or injury to personnel as the formation pressure contained within the hole is high. Mud is designed to prevent such accidents by counteracting the natural pressure of fluids in rock formation. A proper balance must be achieved in which the pressure of the drilling fluid against the walls of the borehole is enough to counter the pressure exerted by both rock formations and by oil or gas, but not so much that it damages the well [4].

Other than that, the drilling mud also can posses required properties that will aid the production of good logs. This is usually needed when wire line logs run in mud-filled holes or open-hole logs run to determine porosity and boundaries between formations and also to ascertain the existence and size of hydrocarbon zones.

2.1.2 Types of Drilling Mud

Generally, drilling mud can be defined as a suspension of solids in liquid phase. The liquid can be either water or oil. There are three types of drilling mud commonly used, which are water base mud, oil base mud and emulsion mud.

Figure 2.3 shows the composition of typical water base mud [6]. Water base mud consists of liquid water, reactive fraction, inert fraction and chemical additive. Reactive fraction is referred to the low specific gravity solids which react with the water phase and dissolved chemicals. It is used to provide viscosity and yield point, whereas inert fraction is high specific gravity solids to provide required mud weight and chemical additive to control mud properties. Besides that, the reactive fraction of a water base mud consists of clay such as bentonite and attapulgite. The inert solids include sand, barite, limestone and etc [3].

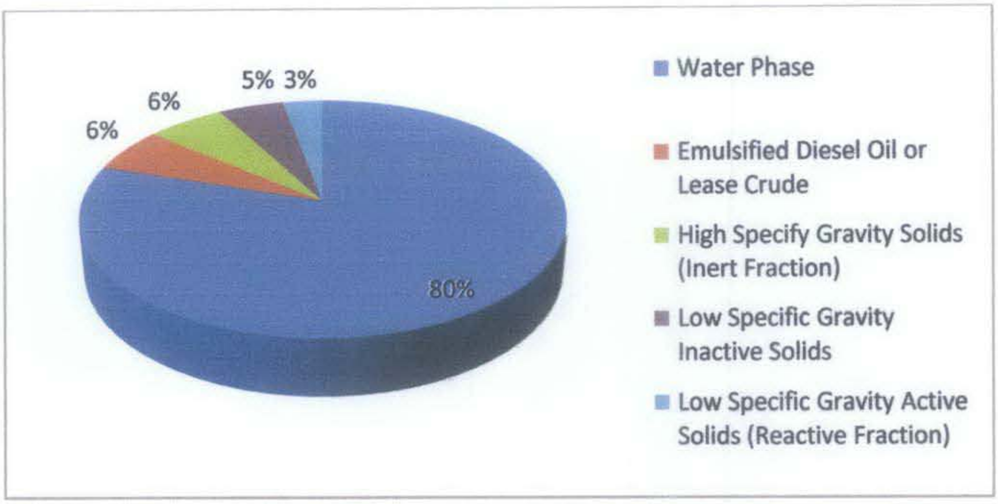


Figure 2.3: Composition of Typical Water Base Mud

Figure 2.4 shows the composition of a typical oil base mud [6]. It is similar to water base mud but oil base mud is emulsion of water in oil. The crude or diesel is the continuous phase and water is the dispersed phase for this type of drilling mud. Oil based mud is used to drill holes with severe shale problems and to reduce torque in well. It tends to be more stable at high temperature compared to the water based mud.

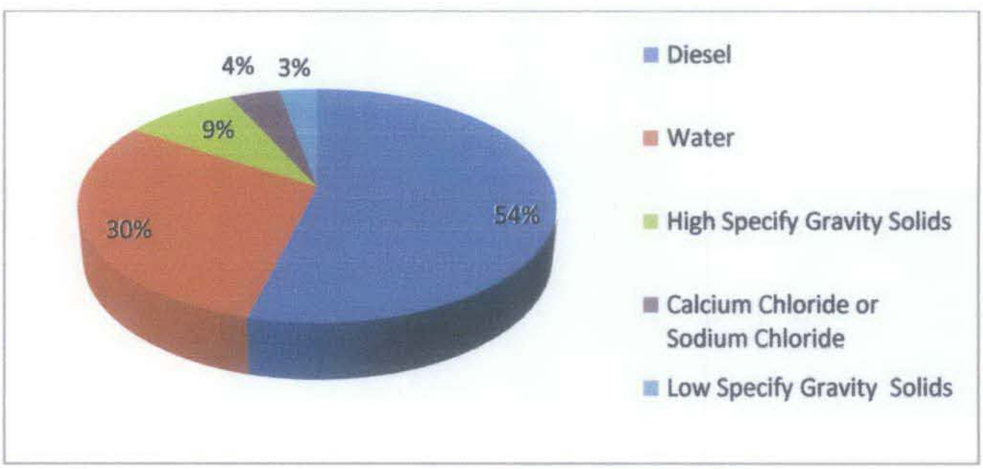


Figure 2.4: Composition of Typical Oil Base Mud

Emulsion mud is different with oil based mud, in which water is the continuous phase and oil is the dispersed phase. It can increase penetration rate, reduce filter loss, reduce chances of lost circulation and reduce drag and torque in well when the oil is added. An oil-emulsion mud normally contains 5-10% of oil by volume and the emulsion can be formulated by the use of sodium sap emulsifiers [3].

2.1.3 Fundamental Properties of Drilling Mud

The fundamental properties of mud include density, pH value, rheological properties and filtrate and filter cake. Mud density is defined by the mass of a given sample of mud divided by its volume. Mud weight is dependent on the quantity of solids in the liquid phase. The acidity or alkalinity of the mud is described by the use of pH value. The selection of mud weight is based on the wellbore pressure required to control the formation pressures encountered in the open hole without causing lost returns [7].

Figure 2.5 shows the formation of filtrate and filter cake. The fluid lost to the rock is described as 'filtrate' when a drilling mud comes into contact with porous rock. The rock will act as a screen to allow the fluid and small solids to pass through, retaining the larger solids. The layer of solid deposited on the rock surface is described as 'filter cake'. The quantity of mud is dependent on the volume of filtrate lost to the formation and the thickness of the filter cake. In other words, this volume is dependent on the magnitude of the differential pressure and mud characteristics of filter cake. Spurt loss is the condition where the initial volume of filtrate lost to the rock and forms the filter cake.

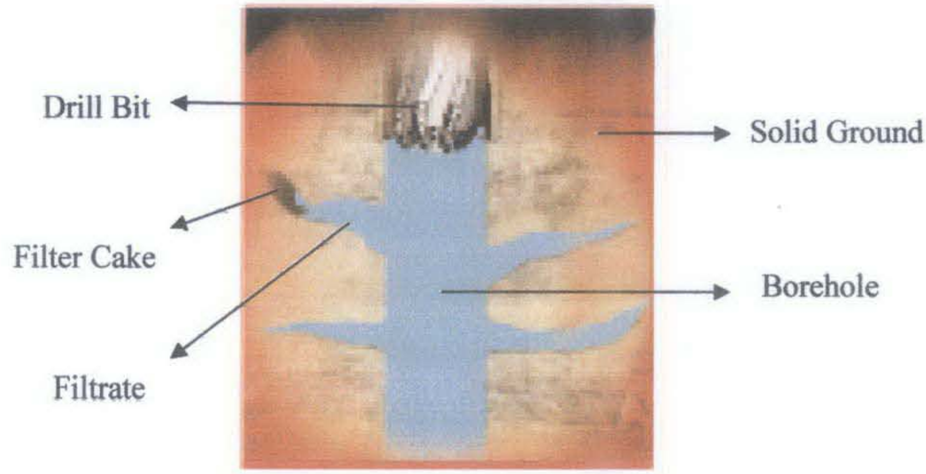


Figure 2.5: Formation of Filtrate and Filter Cake

The most important rheological properties of mud are density, plastic viscosity, yield point and gel strength. All these properties will be measured throughout this project for the proposed material. Plastic viscosity is a property to control the magnitude of shear stress which develops one layer of fluid over another. This property relates to the portion of flow resistance caused by mechanical friction. If the plastic viscosity is excessive, the equivalent circulating density will be excessive. This results in an increased risk of lost returns.

Yield point is a measure of the attractive forces between particles of mud resulting from the chargers on the surface of these particles and gel strength is the measure of minimum shearing stress to produce slip wise movement. If these properties are too high, the consequences will be the same as for high plastic viscosity. If they are too low, the result will be poor cuttings transport and an increased potential for weighting agents settling [7]. Figure 2.6 shows the typical marsh funnel used to measure plastic viscosity, yield point and gel strength. However, these properties also can be obtained by using rotational viscometer (Figure 2.7) which is able to produce results of higher accuracy.

Figure 2.6: Typical Marsh Funnel [8]

Figure 2.7: Rotational Viscometer [8]

2.2 Lost Circulation

If the mud weight exceeds the fracture pressure of the formation, the formation may rupture and large quantities of mud are lost inside it. This situation is referred as lost circulation. These cracks can also cause water seep into the well bore or into the hydrocarbon bearing zone, which would impede the ability of the formation to produce oil [5]. For lost circulation to occur, the size of the pore openings of the induced fractures must be larger than the size of the mud particles. In practice, the size of opening which can cause lost circulation is in the range 0.1 – 1.0 mm [3].

2.2.1 Lost Circulation Classification

Losses can simply be defined as the loss of drilling fluid (mud) to the formation. When losses occur, the dynamic or static pressure exerted by the total mud column exceeds the total formation pore pressure and fracture gradient. Additionally, the porosity and permeability of the formation is such that whole mud is lost to the formation thus preventing the sealing effect of the filter cake. Type of losses can generally be categorised as naturally occurring losses and mechanically induced losses. These rock formations contain the areas of high permeability that allow drilling fluid seep into the rock easily. Such rock formations may cause sudden loss of all or a significant part of the drilling fluid. These corresponding losses in well pressure will cause the rock formation to become unstable, and may cause a blowout, resulting in damage to the well and equipment and injury to the workers. Even if such damage does not occur, the loss of significant amounts of drilling fluid greatly increases the cost of drilling [9].

Naturally occurring losses are losses resulting from some aspect of the formation being drilled. Losses are common in various formations such as unconsolidated formations which include sand and gravel and cavernous formations which include gravel, limestone and dolomite. Besides that, permeable formations such as poorly cemented sandstone will also lead to the natural fractures or fissures which can occur at all depths in all formations.

Mechanically induced losses refer to the losses resulting from some aspect directly related to the drilling operation. Induced fractures are typically caused by large increases or spikes in the well pressure while drilling. The most common causes of mechanically induced losses are due to the high hydrostatic pressure resulting from an excessive mud weight or annular cutting load. Besides that, high surge pressure resulting from an excessive drill string or casing running speed also can cause the induced fractures.

2.2.2 Lost Circulation Material

Lost circulation material (LCM) is added to a mud to control the loss of mud into highly permeable sandstone, natural fractures, cavernous formations and induced fractures. Historically, lost circulation materials and chemical products designed to treat severe or massive fluid loss situations have included cellulose, almond hulls, black walnut hulls, dried tumbleweed, kenaf, paper, asphalt and both coarse and fine rice [10]. Before a mud filter cake can be deposited, lost circulation additive must bridge across the large openings and provide a base upon which the mud cake can be built.

The drilling industry for oil and gas field has studied various lost circulation materials (LCM) and has vast field experience using currently available products. They are generally divided into four categories, which are flake shaped materials, granular materials, fibre shaped materials and slurries.

Flake shaped materials include mica, cellulose, cottonseed hulls, wood chips, laminated plastic, graphite, calcium carbonate. These materials inhibit lost circulation by laying flat across the face of the leaking formation and seal it off. Granular materials include items such as nutshells, calcium carbonate, sized salt, hard rubber, asphalt and plastic. These materials have the characteristic of strength and rigidity. They can seal the leaking formation by wedging themselves inside the openings to reduce opening size, and enhancing the drilling fluid filtration control.

Cellulose fibre, saw dust, shredded paper, hay, rice husks and paper pulp are categorize as fibre shaped materials. These materials are being forced into openings and bridging them off which can allow the drilling fluid filtration control agents to become more effective. Slurries are mixtures to increase the strength of the material. These mixtures can be oil bentonite mud, hydraulic cement, or high filtrate loss drilling fluids.

2.3 Previous Research Done in Similar Field

Result from a similar study draws the comparison of performance between the corn cobs additive with the sugar cane additive by using two different sizes of additive, which are 125μm and 500 μm. Generally, the result focuses on four parameters, which include mud density, plastic viscosity, yield point and gel strength.

2.3.1 Mud Density

Figure 2.8 shows that as the amount of additives is increased, the mud density increased. It is the same trend for both sizes, which are 125 microns and 500 microns. Initially, both samples show the same density until the additive amount of 0.013 lb and further addition of additives would cause the curve to diverge. For the 500 microns of particle size, the density is higher due to the solid content of the particle size is larger compare with 125 microns.

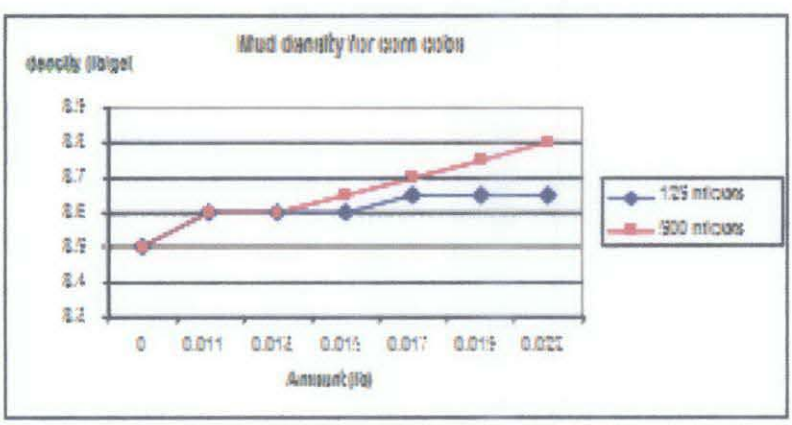


Figure 2.8: Mud Density of Corn Cobs Additive [11]

Figure 2.9 shows mud added with sugar cane has the same density trend as same added with corn cobs. The amount has a direct relationship with the density of the mud. However, the particle size has less effect and the density is almost similar throughout the addition of the additives.

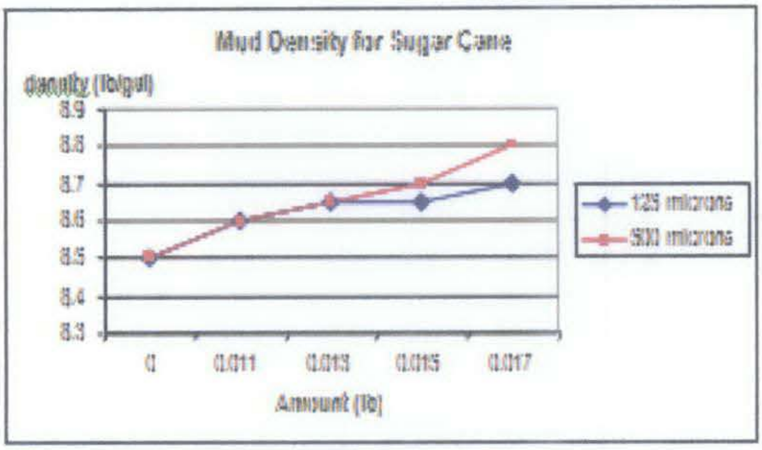


Figure 2.9: Mud Density of Sugar Cane Additive [11]

2.3.2 Plastic Viscosity

Figure 2.10 shows plastic viscosity of mud increases linearly with the amount of corn cobs added but further increment of corn cobs will decrease the value of the plastic viscosity. As expected, 500 microns shows a slightly higher value of plastic viscosity compared to 125 microns due to its particle size. The larger the particle size of additive used, the more viscous of the fluid will be.

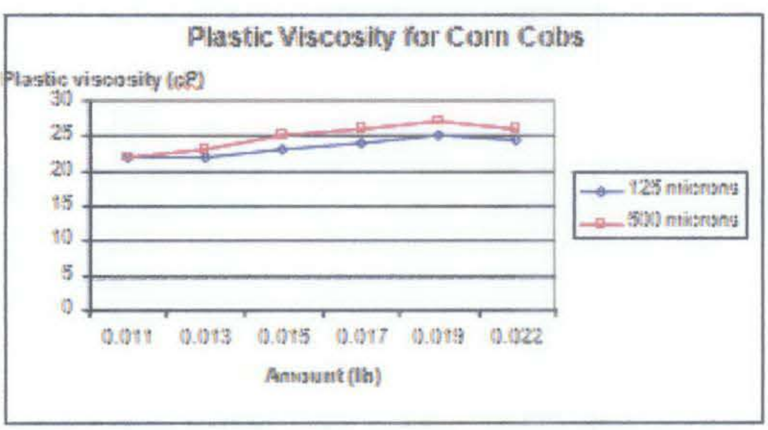


Figure 2.10: Plastic Viscosity for Sugar Cane Additive [11]

Figure 2.11 shows the trend of plastic viscosity for mud added sugar cane. Unlike corn cobs, sugar cane additives experience its optimum value in smaller amount of the addition. Based on the observation, there will be the optimum of plastic viscosity value for the formulation to work effectively. For the corn cobs, the optimum value is about 0.019 lb and for sugar cane is about 0.013 lb.

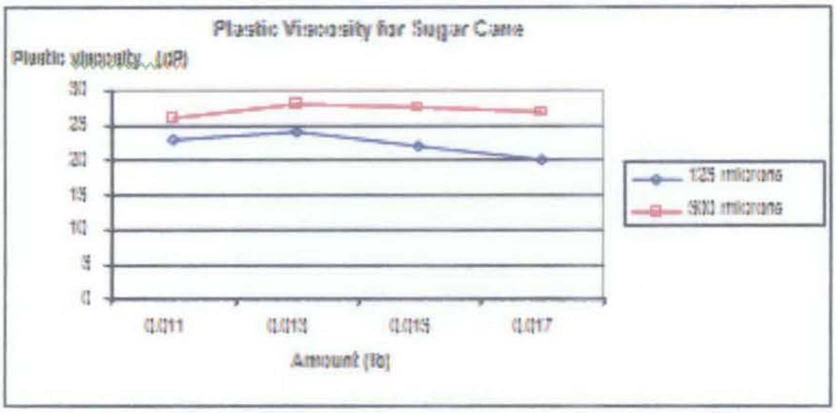


Figure 2.11: Plastic Viscosity for Sugar Cane Additive [11]

2.3.3 Yield Point

From Figure 2.12, the value of yield point for both sizes of corn cobs decreases as the amount of additive increases. For the 125 and 500 microns, the minimum reading is at 0.022. Based on the trend, further increment of the amount of additives will cause the curve to keep on decreasing.

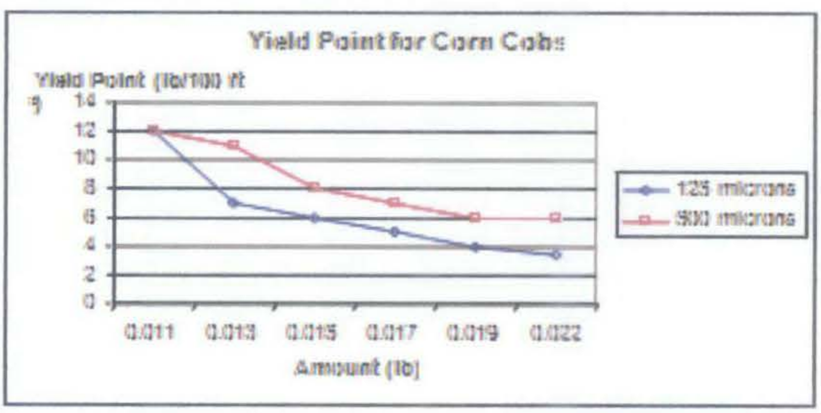


Figure 2.12: Yield Point for Corn Cobs Additive [11]

The trend of graph for sugar cane as shown in Figure 2.13 demonstrates better performance compared with corn cobs curves. The solid content in fluid sample of 125 microns is more compared with 500 microns causing the 500 microns having lower value compared to 125 microns. Further increment of amount would result in reduction of the value of yield point. Yield point is sensitive to the electrochemical environment indicates the need for chemical treatment. The yield point may be reduced by the addition of substances neutralizing the electric charges such as thinning agent and by addition of chemicals to precipitate the contaminants [11].

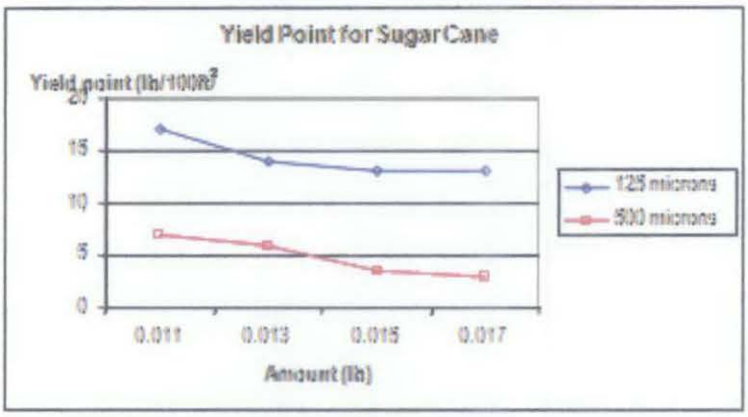


Figure 2.13: Yield Point for Sugar Cane Additive [11]

2.3.4 Gel Strength

Figure 2.14 shows the 10 second and 10 minutes gel strength for corn cobs additives. For 125 and 500 microns size corn cobs, the highest value is at the amount of 0.011 lb and the lowest value is at the amount of 0.022. For gel strength in both tests, 125 microns size corn cobs have a lower value compared to 500 microns size corn cobs.

Similar trend is obtained for sugar cane additives from Figure 2.15. However, the lower value for both tests is same and obtained at the amount of 0.017. For both additives, the particle size of 500 microns shows a higher value compare with 125 microns. The trends of the graph for gel strength for both additives are almost similar with the yield point graph. This could be due to the attractive forces in a mud system.

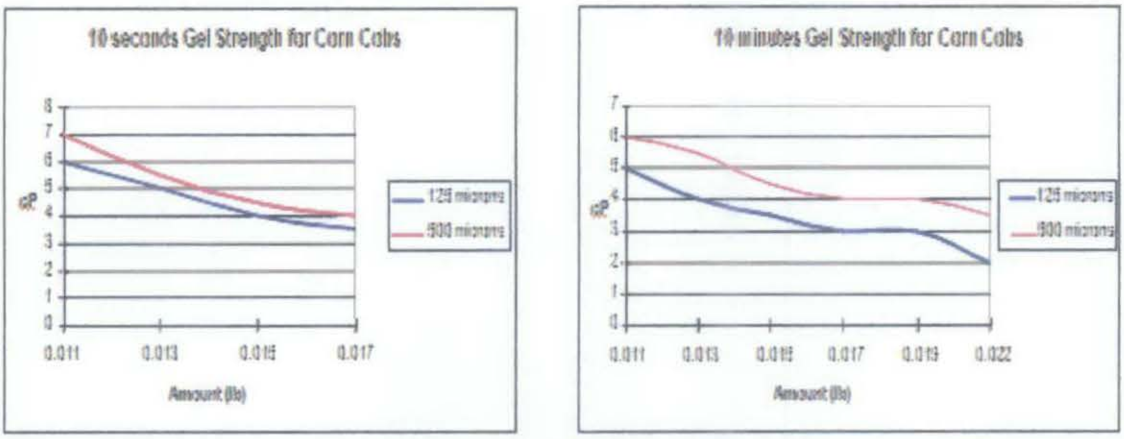


Figure 2.14: 10 Second and 10 Minutes Gel Strength for Corn Cobs Additives [11]

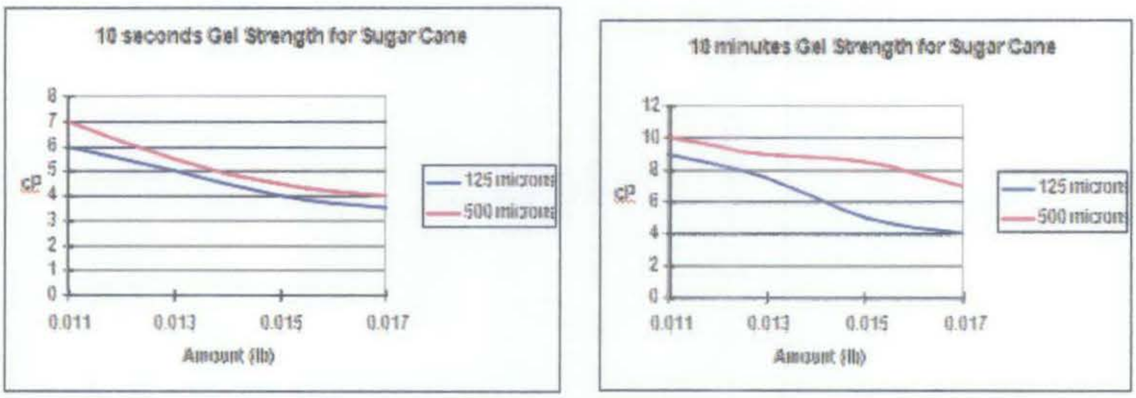


Figure 2.15: 10 Second and 10 Minutes Gel Strength for Sugar Cane Additives [11]

As overall, this study found that corn cobs could serve more as a viscosifier than as a fluid loss. Besides that, sugar cane could serve as a lost circulation material. The plastic viscosity has a direct relationship with the added amount while the yield point and gel strength shows a reverse relationship with the added amount.

CHAPTER 3

METHODOLOGY

The flow chart of the project is shown in Figure 3.1.

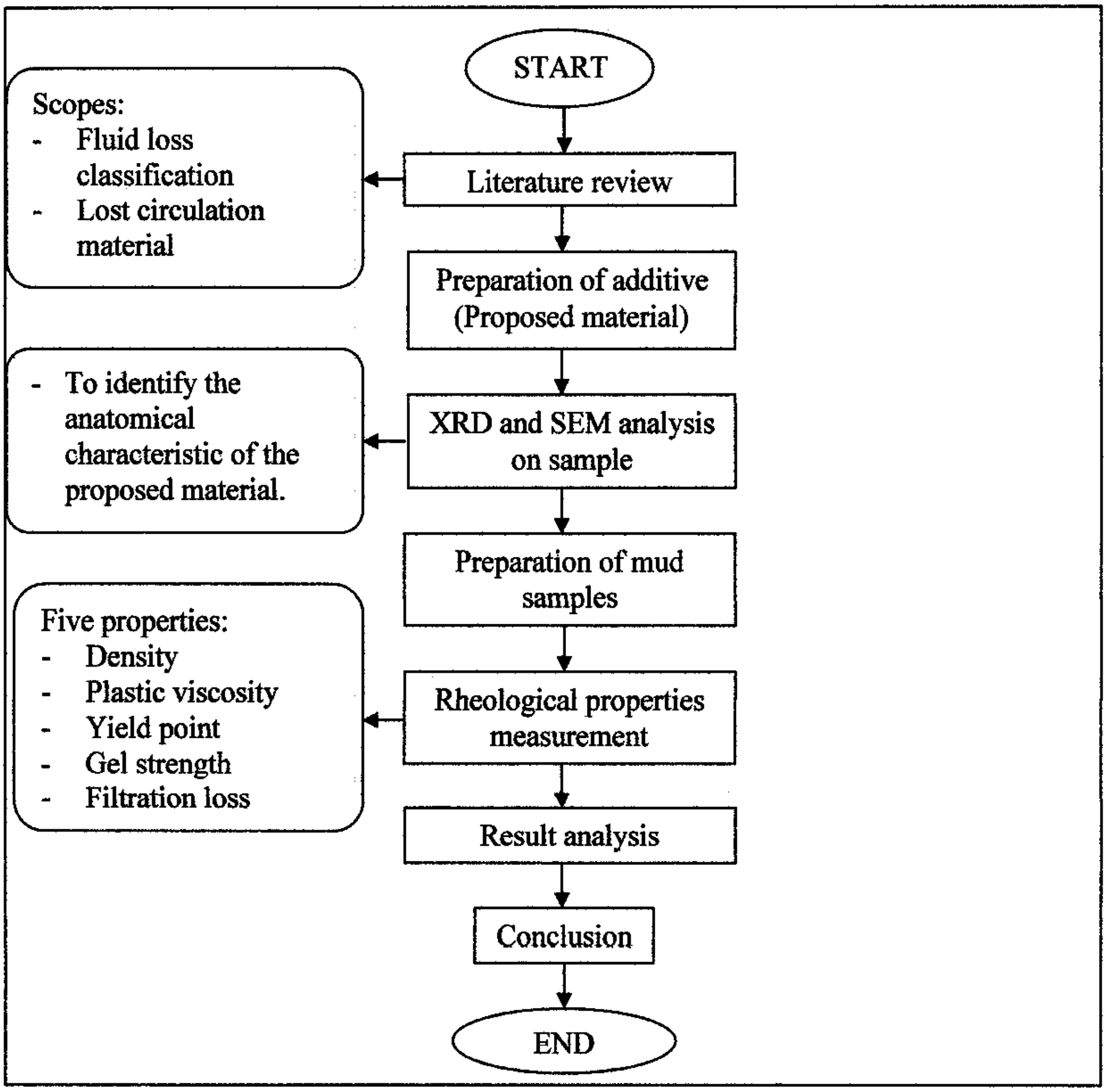


Figure 3.1: Flow diagram of the Overall Project Planned

3.1 Methodology and Procedure

The methodology and procedure to conduct the project is divided into five main parts. These include literature review and information gathering, preparation of additive, SEM and XRD analysis on sample, preparation of mud samples and measurement of rheological properties.

3.1.1 Literature Review and Information Gathering

The literature review provides an overview of the classifications of existing fluid loss and loss circulation material related to drilling operation in oil and gas industry. Besides that, the study on previous research done in similar field is also included. Information is gathered from resources such as books, journals and theses. All information is skimmed and selected based on importance and relevancy. The relevant information and data is studied thoroughly and extracted as the project's reference.

3.1.2 Preparation of Additive

The oil palm fibres additive was firstly cleaned and dried to remove other particles. Next, the additive was dehumidified for 24 hours at 70°C in an oven as shown in Figure 3.2 and Figure 3.3.

A laboratory blender was used to blend the additive into small pieces as shown in Figure 5. The oil palm fibres are placed in the glass and the power is turn on. The laboratory blender is controlled by a timer and the speed of cutter can be set. The fibres are blended until the powder form is obtained.

Technical Specification

Brand	Memmert
Dimensions (cm)	55 x 60 x 40 (w x h x d)
Voltage	20 – 200 °C
Temperature Range	240 Volts 50/60 Hz

Figure 3.2: Oven

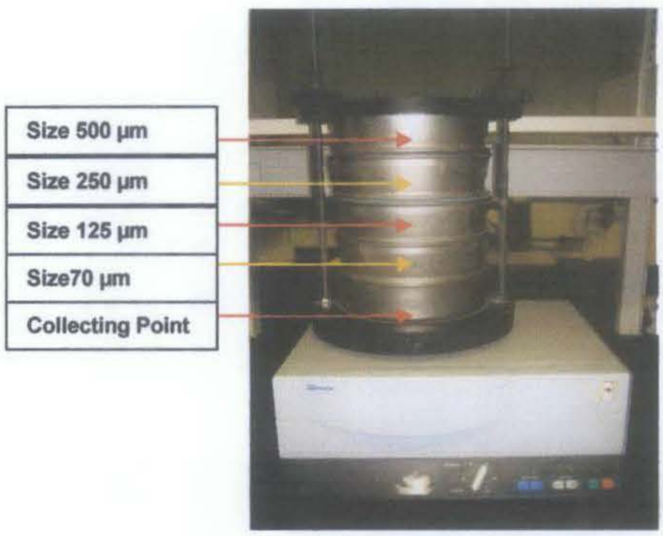
Figure 3.3: Oil Palm Fibres heated in Oven at 70°C for 24 hours

Technical Specification

Brand	Waring
Revolution	11000 – 22000 rpm
Power	300 W
Voltage	240 Volts 50 Hz
Mixing Vol.	1600 ml
Grinding Vol.	150 g

Figure 3.4: Laboratory Blender

Figure 3.5 shows the vibratory sieve shaker which is used to obtain the desired particle size through the segregation process. The oil palm fibres in powder form were sieved from the top stage until the bottom stage. Each stage has a container which is of different sieve's size. The desired particle size is set to below 70 micron meter. This container is placed at the second bottom and the sample can be collected at the bottom container. When the power is turned on, the sieve shaker will vibrate automatically within the time which is set by the user.



Technical Specification

Brand	Retsch
Max Feed Capacity	4 kg
Analysis Time	1 – 60 minutes
Measuring Range	63 - 500 µm

Figure 3.5: Vibratory Sieve Shaker

3.1.3 Chemical Analysis Using XRD and SEM

Two chemical analysis was conducted, namely X-ray Powder Diffraction (XRD) and Scanning Electron Microscope (SEM). The purpose of these sample analysis is to identify the chemical and mineral contaminants of the oil palm fibres. For SEM experiment, additional equipment, namely Energy Dispersive X-ray (EDX) is required. The sample to be measured in XRD must be dried and in powder form. The smaller of the particle size of the sample, the more accurate result can be obtained. By using x-ray diffractometer as shown in Figure 3.6, it provides a versatile non-destructive analytical technique for identification and quantitative determination of the various crystalline phases of compounds present in powdered or solid samples. Identification is achieved by comparing the x-ray diffraction pattern obtained from an unknown sample with an internationally recognized database containing more than 70,000 phases.

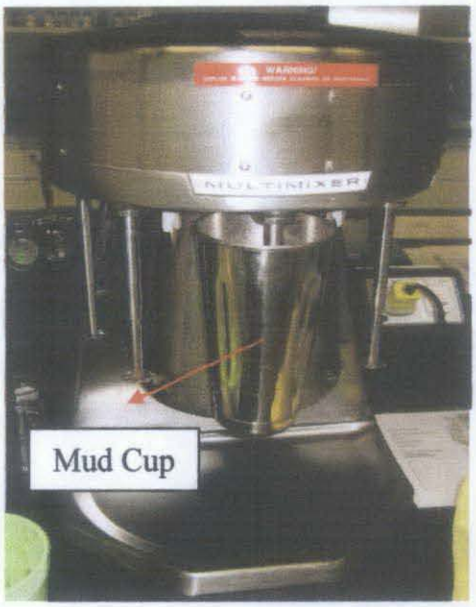
Figure 3.6: X-ray Diffractometer

SEM provides high resolution, three dimensional imaging of the pore system of the fibres. A specimen is placed into a high vacuum chamber and radiation from an electron beam is forced onto the sample. The interaction of the electron beam from the filament and the sample atoms generates a variety of signals. The secondary or backscattered electrons are detected and converted to an image. The device used for this experiment namely variable scanning electron microscope (VPSEM), model LEO VP 1430 is shown in Figure 3.7.

Figure 3.7: Variable Scanning Electron Microscope (VPSEM)

3.1.4 Preparation of Mud Samples

Hamilton Beach Multi mixer as shown in Figure 3.8 was used extensively to prepare mud samples. The mixer is used to stir the mixture for the drilling mud which is placed in the mud cup. This is to ensure the solid particles of additive can fully dilute into the mud. Otherwise, these solid particles will concentrate at the bottom of the mud cup.



Technical Specification

Brand	Hamilton Beach
No. of Spindle	5
Cup Capacity	30 Oz
Motor Max. Speed	11000 rpm
Motor Hp	1/3
Voltage	240 Volts 60 Hz

Figure 3.8: Hamilton Beach Multi Mixer

There are two types of mud samples to be prepared for the experiments, which are water base mud and oil base mud. The mixture for water base mud is only containing 350ml distilled water with 22.5g bentonite [12]. The composition of the mixture for water base mud is recommended by the API Standards 13B-1. Before adding the additive into it, the pure water base mud will be the control sample in the experiment. Table 3.1 shows the substance and quantity for the water base mud and named as Formulation A. Besides that, Formulation B contains the water base mud which mixed with chemical additives, such as barite and hematite. This is shown in Table 3.2, where barite and hematite act as the weighting agents.

Table 3.1: Substance and Quantity of Formulation A

Substance, quantity	Formulation A					
	1	2	3	4	5	6
Water ,ml	350.0	350.0	350.0	350.0	350.0	350.0
Bentonite (M4), g	22.5	22.5	22.5	22.5	22.5	22.5
Oil Palm Fibre, g	0.0	1.0	2.0	3.0	4.0	5.0

Table 3.2: Substance and Quantity of Formulation B

Substance, quantity	Formulation B					
	1	2	3	4	5	6
Water ,ml	350.0	350.0	350.0	350.0	350.0	350.0
Bentonite (M4), g	22.5	22.5	22.5	22.5	22.5	22.5
Barite , g.	45.0	45.0	45.0	45.0	45.0	45.0
Hematite, g.	15.0	15.0	15.0	15.0	15.0	15.0
Oil Palm Fibre, g	0.0	1.0	2.0	3.0	4.0	5.0

For oil base mud, the oil-water ratio was set at 70:30, as recommended by the API 13B-2 [13]. The required volume of Sarapar 147 was poured into the mixing container, followed by primary emulsifier and secondary emulsifier. Next, the required mass of lime was added followed by Brine (calcium chloride + water) and additives. Lastly, the required amount of bentonite was mixed and stirred. The flow chart of the oil base mud mixing process is shown in Figure 3.9. The substance and quantity of the mixture for oil base mud is described in Table 3.3 and named as Formulation C.

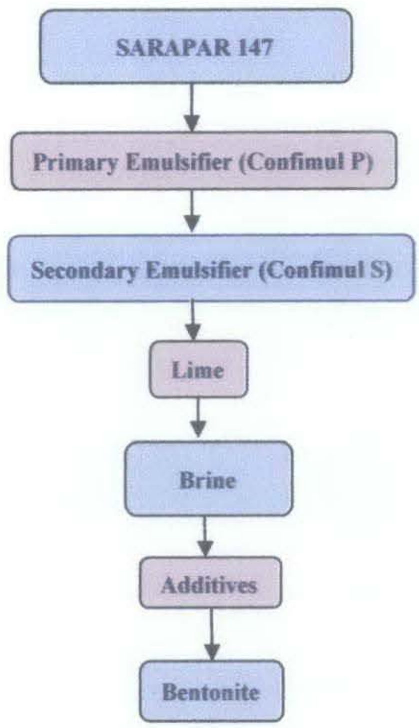


Figure 3.9: Flow Chart of Oil Base Mud Mixing Process

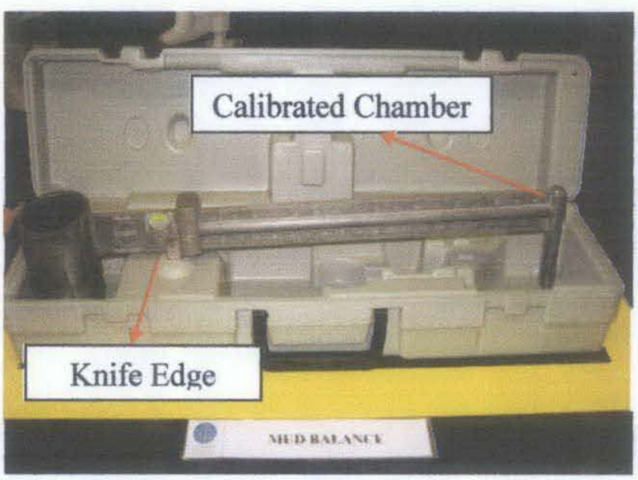
Table 3.3: Substance and Quantity of Formulation C

Substance, quantity	Formulation C					
	1	2	3	4	5	6
Sarapar 147 ,ml	245.0	245.0	245.0	245.0	245.0	245.0
Confimul P, g	20.0	20.0	20.0	20.0	20.0	20.0
Confimul S , g	20.0	20.0	20.0	20.0	20.0	20.0
Lime, g.	15.0	15.0	15.0	15.0	15.0	15.0
Brine, ml	105.0	105.0	105.0	105.0	105.0	105.0
Oil Palm Fibre, g	0.0	1.0	2.0	3.0	4.0	5.0
Bentonite (M4), g	22.5	22.5	22.5	22.5	22.5	22.5

3.1.5 Rheological Properties Measurement

Rheological tests conducted in this study are based on the procedures recommended by the American Petroleum Institute (API) Standards. Five parameters were measured to assess the rheological performance of the prepared mud samples. They are density (lb/gal), plastic viscosity (cP), yield point (lb), gel strength (cP) and filtration over time (ml). These tests include density measurement from mud balance, gel strength and apparent viscosity from rotational viscometer and fluid loss and mud cake measurement from API high-temperature filter press.

The Mud Balance as shown in Figure 3.10 is the device used to determine the density of drilling fluid. It has the range of 7 to 24 pounds per gallon or specific gravity of 0.84 to 2.88. A rider is moved along the balance arm to indicate the scale readings. There is a knife edge attached to the arm near the balance cup, and a bubble level built into the knife edge to indicate level of the arm. The drilling fluid density measurement test involves filling the cup with a mud sample and determining the rider position required for balance. The balance is calibrated by the chamber in the end of the scale. Water is usually used as the calibration fluid. In order to ensure an accurate measurement, the drilling fluid should be degassed before being placed in the mud balance.



Measuring Range	
7 - 24	lb/gal
310 -1250	lb/sq in/100ft of depth
45 -180	lb/cu ft
0.84 -2.88	gms/cm^3 Specific Gravity

Figure 3.10: Mud Balance

The device used is FANN Model 35SA viscometer as shown in Figure 3.11. Viscometer model was used for the rheological test to obtain the characteristic of plastic viscosity (PV) and yield point (YP). Temperature of the mud sample is within 120°F ± 2°F (≈50°C) throughout the tests. The thermal cup was filled 2/3 full with the mud sample. The thermal cup was placed on the viscometer stand and the rotary sleeve was immersed into the thermal cup. The dial reading was taken when the viscometer was run at 600 rpm. The speed was then changed to 300 rpm and the dial reading was taken. The dial reading was also taken for 200 rpm, 100 rpm, 6 rpm and 3 rpm.

Another rheological test on gel strength is obtained by noting the maximum dial deflection when the rotational viscometer is turned at a low rotor speed after the mud has remained static for some period of time. For 10-second gel strength measurement, the viscometer was turned to 600 rpm for 10 seconds and the toggle was switched off to allow the mud to stand for 10 seconds. After 10 seconds, the viscometer was run at 3 rpm and the maximum dial reflection was recorded. For the 10- minute gel strength reading, the same procedures were applied but it was allowed to operate for 10 minutes [12] [13].

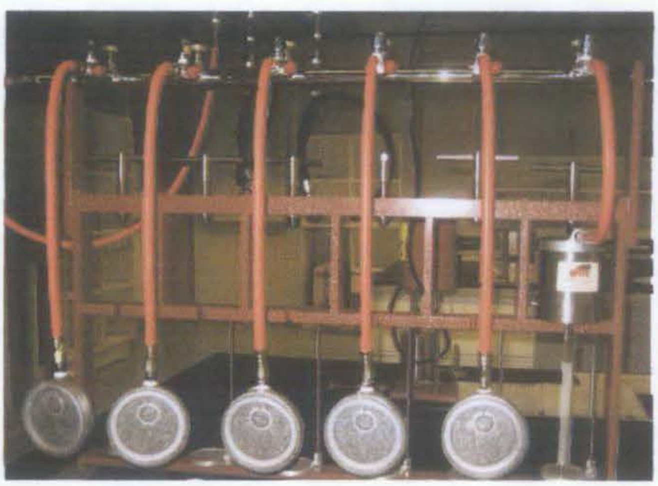
Technical Specification

Model No.	100 PSIG
# of Speed	6
Voltage	115 Volts 50 Hz
Speeds (rpm)	600, 500, 300, 100, 6, 3

Figure 3.11: FANN Model 35SA Viscometer

The Filter press for LPLT test is shown in Figure 3.12. It consists mainly of the cylindrical drilling fluid cells. These cells are made of materials resistant to strongly alkaline solutions which are so fitted. This is to ensure the applied pressure medium can be conveniently admitted into or bleed from the top. Besides that, it shall also be fitted with a sheet of filter paper that can be placed in the bottom of the cell just above a suitable support. The purpose of the filter paper is to collect the mud cake that has built up.

Measurement of the filtration behaviour and filter cake thickness characteristics of a drilling fluid is fundamental to drilling fluid control and treatment. Generally, the test will be done in 30 minutes by applying the appropriate pressure or temperature. The characteristics of the filtrate include oil, water or emulsion content. These characteristics are affected by temperature, pressure, the types and quantities of solids in the fluid and their physical and chemical interactions. Therefore, tests are run at both low pressure low temperature (LPLT) and high pressure high temperature (HPHT), and each requires different equipment and techniques.



Technical Specification

Rated working pressure	100 PSIG
115/230 VAC	50/60 Hz
Sample Volume	350 ml
Filtering Area	7.0 in²

Figure 3.12: LPLT Filter Press

HPHT filter press as shown in Figure 3.13 consists of a controlled pressure source (CO_2 or nitrogen), regulators, a drilling fluid cell able to contain working pressures, a system for heating the cell, a pressurized collection cell to maintain proper back-pressure (Table 3.4). The purpose of back pressure settling mainly is to prevent flashing or evaporation of the filtrate. Besides that, the drilling fluid cell has a thermometer well, oil resistant gaskets, a support for the filter medium and a valve on the filtrate delivery tube to control flow from the cell.

Technical Specification

Rated working pressure	1800 PSIG
Maximum temperature	350°F
115/230 VAC	50/60 Hz
Sample Volume	173 ml
Power Required	400 watts
Filtering Area	3.5 in²
Back Pressure Receiver Volume	15 ml

Figure 3.13: HPHT Filter Press

Table 3.4: Recommended Minimum Back Pressure [13]

Test temperature		Vapour pressure		Minimum back pressure	
°C	°F	kPa	psi	kPa	psi
100	212	101	14,7	690	100
120	250	207	30	690	100
150	300	462	67	690	100
Limit of "normal" field testing					
175	350	932	135	1 104	160
200	400	1 704	247	1 898	275
230	450	2 912	422	3 105	450

3.2 Tools and Equipment Required

Suitable tools, equipment and selected materials are needed to conduct the experiments and preparation of additive and mud samples. In the preparation of additive, the equipments needed include laboratory blender, vibratory sieve shaker and the experimental setup to conduct the XRD and SEM. Besides that, the equipments used in the rheological tests include mud balance, mixer, API filter press and viscometer. The summary of the required tools and equipment in listed in Table 3.5.

Table 3.5: Tools and Equipment Required

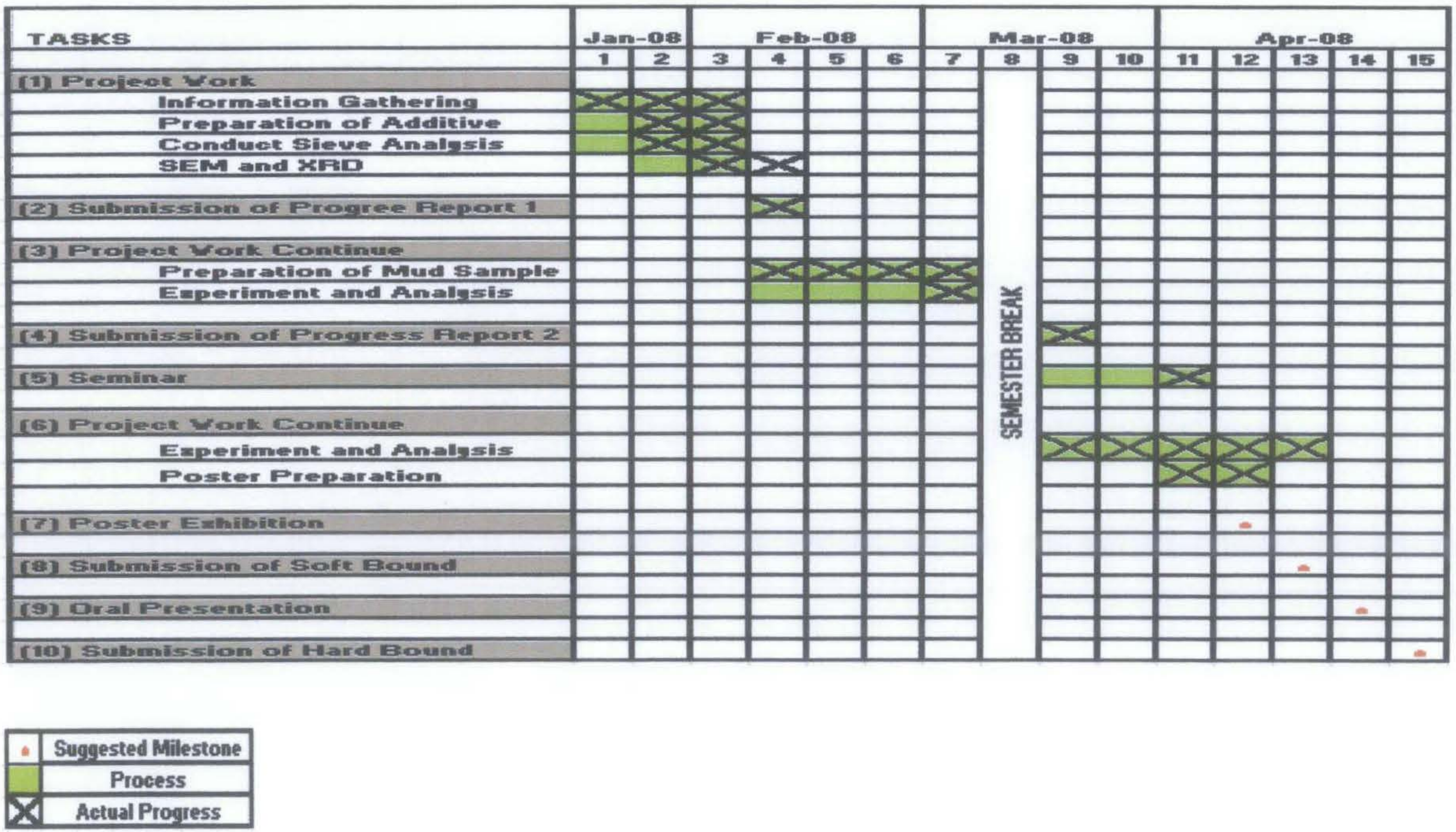
Task	Tools and Equipments	Availability
Preparation of additive	Oven	**UTP Building 5** (Chemical Engineering Block)
	Laboratory Blender	
	Vibratory Sieve Shaker	
Chemical Analysis	X-ray Diffractometer	**UTP Building 17** (Mechanical Engineering Block)
	Scanning Electron Microscope	
Preparation of mud samples	Hamilton Beach Multi Mixer	**UTP Building 15** (Petroleum & Geoscience Block)
Rheological Properties Measurement	Mud Balance	
	Viscometer	
	Filter Press (LPLT and HPHT)	

3.3 Gantt Chart for Final Year Project I

TASKS	Jul-07		Aug-07				Sep-07				Oct-07				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(1) Selection of Project Title	X	X											SEMESTER & HARI RAYA BREAK		
(2) Preliminary Research Work			X	X											
(3) Submission of Preliminary Report				X											
(4) Literature Review								X	X	Process					
(5) Consulting Experts from related fields															
Current research on this area				Process	Process	Process	Process	X	X						
(6) Submission of Progress Report									X						
(7) Laboratory Work															
Familiarization of Equipment									Process	X	X	X			
(8) Analysis & Planning for future works												X		Process	Process
(9) Submission of Interim Report First Draft														X	
(10) Oral Presentation															X

Process (green)	Process
X	Actual Progress

3.4 Gantt Chart for Final Year Project II



CHAPTER 4
RESULT AND DISCUSSION

The main discussion of this chapter is the comparison of performance before and after adding oil palm fibres as additive. Five parameters are being considered in the experiments, which are mud density, plastic viscosity, yield point, gel strength and filtration loss. Focus is given to filtration loss for the mud samples added with the appropriate amount of proposed material (oil palm fibres). Besides that, the sample analysis on scanning electron microscope (SEM), electron dispersive x-ray (EDX) and x-ray diffractometer are used for additional info to cross check if the mud samples show any abnormality.

4.1 SEM and EDX Analysis

Figure 4.1 shows the SEM image of the anatomical characteristic of the oil palm fibres. Oil palm fibres contain various sizes of vascular bundles. The vascular bundles were imbedded into a thin wall, namely parenchyma. Each bundle was made up of fibrous sheath, vessels, phloem and parenchymatous tissues [14]. Pholem was divided into two separate areas in each bundle and metaxylem vessels are separated by at least one layer of live parenchyma cells, which form a living barrier to possible transfer of gas bubbles.

Figure 4.2 shows the EDX result of oil palm fibre, revealing atomic percentage of 59.56% of carbon, 40.22% of oxygen and 0.22% of Silicon. The composition of carbon and oxygen indicates oil palm fibres are categorized as holocellulose material. Holocellulose consists of long chain carbohydrate molecules and it is the tough stuff that strengthens the structure of material [15]. In general, oil palm fibre contains the highest percent of homocellulose compared to other plant's fibre, such as coconut coir and banana stem. Besides that, the element of silicon is effective in oil spill absorbent and suitable to be used as lost circulation material.

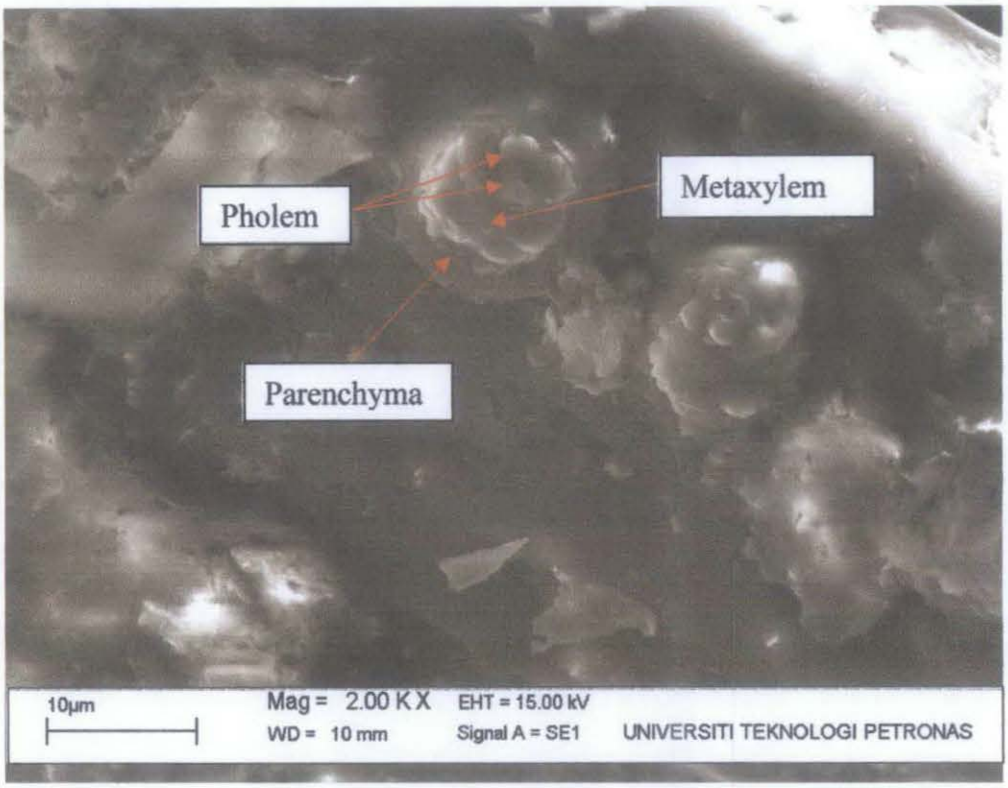
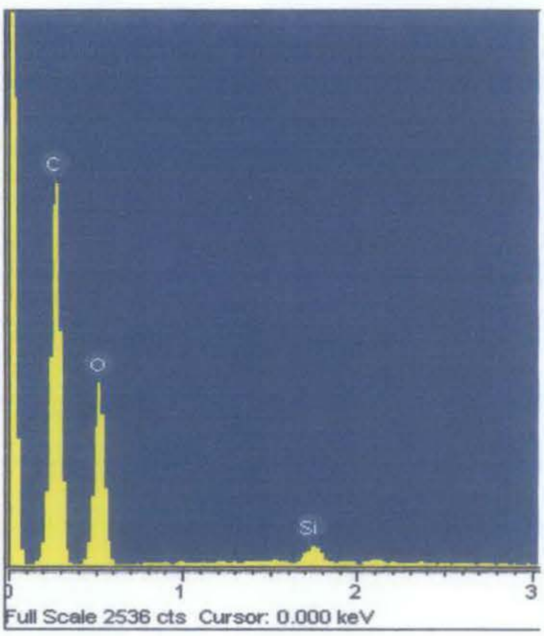


Figure 4.1: Anatomic Characteristic of Oil Palm Fiber



Processing option : All elements analyzed (Normalised)
Number of iterations = 5

Standard :
C CaCO3 1-Jun-1999 12:00 AM
O SiO2 1-Jun-1999 12:00 AM
Si SiO2 1-Jun-1999 12:00 AM

Element	Weight%	Atomic%
C K	52.40	59.56
O K	47.14	40.22
Si K	0.46	0.22
Totals	100.00	

Figure 4.2 EDX Result of Oil Palm Fibre

4.2 XRD Analysis

Figure 4.3 shows the sample analysis for oil palm fibres by using x-ray diffractometer in room temperature (25°C) with peak positions are reproducible to 0.02 degrees. Based on the result, the oil palm fibres are distinguished as molecular structure of non-crystalline substances, namely amorphous. This is indicated by the graph which shows the characteristic of amorphous, whereby the fluctuation did not reach the peak of Y-axis.

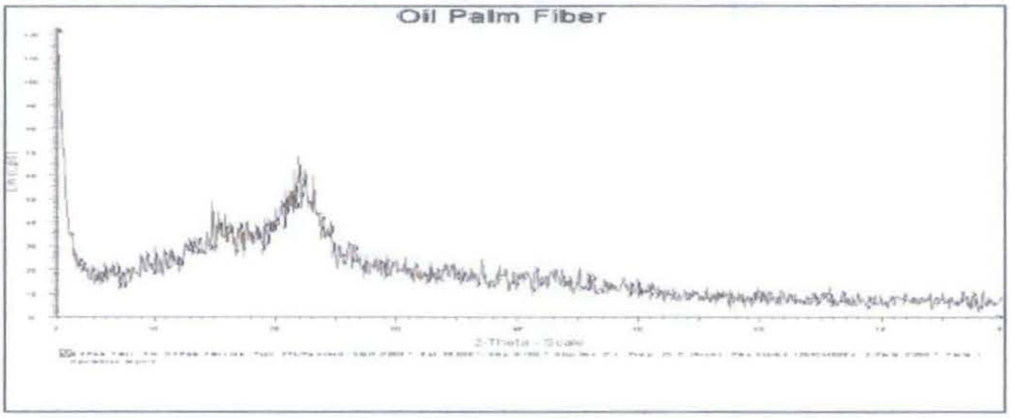


Figure 4.3: XRD Result of Oil Palm Fibre

4.3 Results for Formulation A, B and C

The results obtained from the rheological tests include mud density, plastic viscosity, yield point, gel strength and filtration loss. The substance of the formulation can be referred to Chapter 3.1.4. Analysis conducted are focused on plastic viscosity and yield point for the mud samples and compared with the standards in API 13A. The purpose is to determine whether the properties of the mud samples are able to meet the requirement and specification range. Besides that, the concern on filtration loss is to determine whether the mud samples added with proposed material (oil palm fibres) are able to reduce the filtration loss.

Table 4.1 shows the API 13A specification for mud properties, where the formula of standard ranges for plastic viscosity and yield point are shown. These formulas are applicable to drilling mud with density below 14 ppg.

Table 4.1: API 13A Specification for Mud Properties

Mud Density (ppg)	Plastic Viscosity (cp)		Yield Point ($lb/100ft^2$)	
	High Range	Low Range	High Range	Low Range
$\rho < 14$	$3.4\rho - 18.6$	$2.0\rho - 14$	$-4.0\rho + 66$	$0.4\rho - 0.6$

Based on the result obtained, the range of mud density is between 7.3 – 10 ppg. By substituting this range of mud density into formula, the acceptable plastic viscosity (PV) and yield point (YP) are calculated and tabulated in Table 4.2. All the results obtained through rheological tests will be compared with the values in Table 4.2, by referring to the corresponding mud density. The desire mud samples must fall within the values between the high range and low range in order to meet the specification. This is applied to both plastic viscosity and yield point properties.

Table 4.2: Acceptable Plastic Viscosity and Yield Point Ranges

Mud Density (ppg)	Plastic Viscosity (cp)		Yield Point ($lb/100ft^2$)	
	$3.4\rho - 18.6$	$2.0\rho - 14$	$-4.0\rho + 66$	$0.4\rho - 0.6$
	High Range	Low Range	High Range	Low Range
10.00	15.40	6.00	26.00	3.40
9.80	14.72	5.60	26.80	3.32
9.70	14.38	5.40	27.20	3.28
9.60	14.04	5.20	27.60	3.24
9.50	13.70	5.00	28.00	3.20
9.40	13.36	4.80	28.40	3.16
9.30	13.02	4.60	28.80	3.12
9.20	12.68	4.40	29.20	3.08
9.10	12.34	4.20	29.60	3.04
9.00	12.00	4.00	30.00	3.00
8.90	11.66	3.80	30.40	2.96
8.80	11.32	3.60	30.80	2.92
8.70	10.98	3.40	31.20	2.88
8.60	10.64	3.20	31.60	2.84
8.50	10.30	3.00	32.00	2.80
8.40	9.96	2.80	32.40	2.76
8.30	9.62	2.60	32.80	2.72
8.20	9.28	2.40	33.20	2.68
8.10	8.94	2.20	33.60	2.64
8.00	8.60	2.00	34.00	2.60
7.90	8.26	1.80	34.40	2.56
7.80	7.92	1.60	34.80	2.52
7.70	7.58	1.40	35.20	2.48
7.60	7.24	1.20	35.60	2.44
7.50	6.90	1.00	36.00	2.40
7.40	6.56	0.80	36.40	2.36

4.3.1 Rheological Test Results for Formulation A

Table 4.3 shows the results for formulation A throughout the rheological tests. By referring to API 13A with the mud density of 8.5 ppg, the ranges for plastic viscosity and yield point are 3 - 10.3 cP and 2.8 - 32 lb/100 ft^2 respectively. For mud density of 8.6 ppg, the ranges for plastic viscosity and yield point are 3.2 - 10.46 cP and 2.84 - 31.6 lb/100 ft^2. Based on the observations on plastic viscosity and yield point, all the mud samples from formulation A are able to meet the standards of API 13A as shown in Table 4.2. Additionally, the filtration loss of the mud samples can improve by adding the oil palm fibres.

Table 4.3: Results for Formulation A

Property, measuring unit	Sample A					
	1	2	3	4	5	6
Mud density, ppg.	8.5	8.5	8.5	8.6	8.6	8.6
600 rpm reading	34.0	32.0	32.0	28.0	24.0	22.0
300 rpm reading	28.0	27.0	26.0	22.0	20.0	17.0
Plastic viscosity, cP	6.0	5.0	6.0	6.0	4.0	5.0
Yield point, lb/100 ft^2	22.0	22.0	20.0	16.0	16.0	12.0
Gel 10 Sec	31.0	30.0	27.0	25.0	22.0	20.0
Gel 10 Min	36.0	36.0	34.0	32.0	26.0	25.0
Filtration Loss, ml/30min	23.8	23.2	21.7	21.2	20.4	19.2
Cake Thickness (mm)	3.27	3.33	4.2	4.51	92.8	79.2

Figure 4.4 shows the acceptable values of plastic viscosity for Formulation A. All the values obtained from rheological experiments are between the maximum range and minimum range for the mud which has density of 8.5 or 8.6 ppg. Without any additive, which is the base mud sample, it gives reading of 6 cP. The trend of the graph is fluctuating when the oil palm fibres are added. However, the optimum value is around 6 cP, where the mud samples are without additive and added 2g or 3g of oil palm additives.

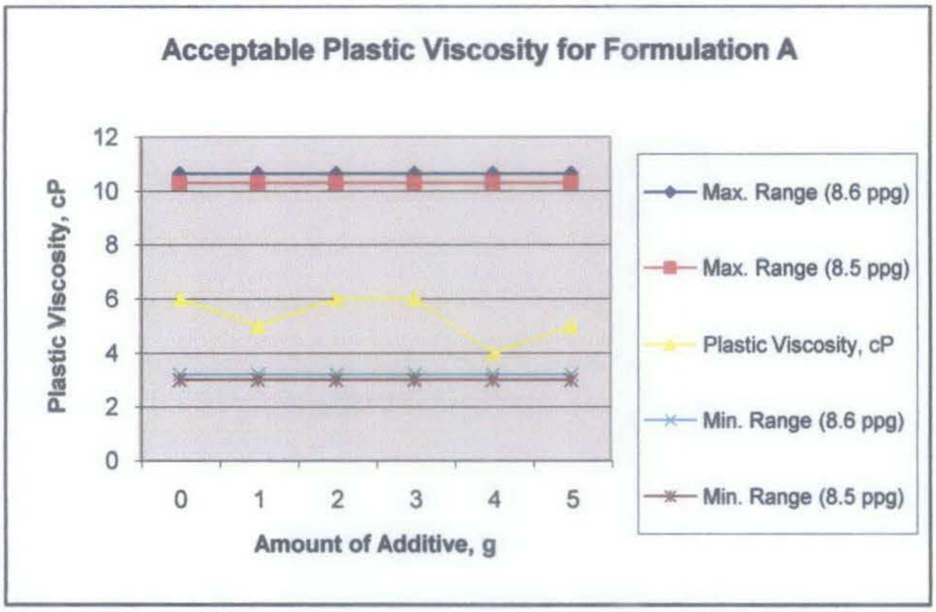


Figure 4.4: Acceptable Plastic Viscosity for Formulation A

Figure 4.5 shows the acceptable yield point for Formulation A. The desired results are shown, where all the values obtained from rheological experiments are between the maximum range and minimum range for the mud which has density of 8.5 or 8.6 ppg. The value of yield point decreases as the amount of additive increases. It is estimated the further increment of amount would also result the value of yield point to decrease.

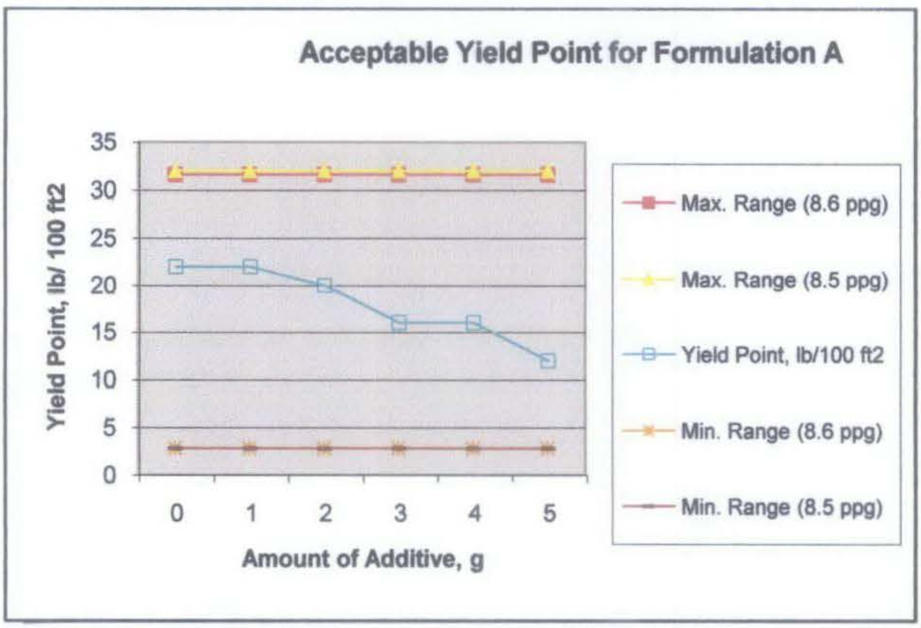


Figure 4.5: Acceptable Yield Point for Formulation A

The results of filtrate loss can be shown in Figure 4.6. It is obvious that the filtration volume is directly proportional with the added amount of additive. The filtrate loss is being improved by adding the amount of additive (oil palm fibres) into the mud samples. The optimum result is obtained when the greatest amount of additive is added. The percent of reduction for filtration loss is approximately 19.3% when 5g of additive is added. Therefore, oil palm fibres are feasible to be used in water base mud as lost circulation material to reduce the filtrate loss of drilling fluid.

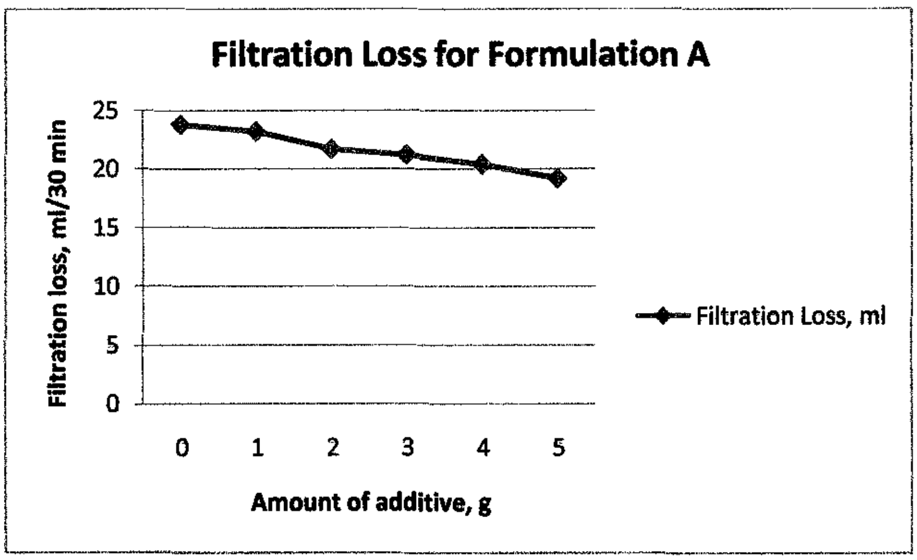


Figure 4.6: Filtration Loss for Formulation A

4.3.2 Rheological Test Results for Formulation B

Table 4.4 shows the results for formulation B throughout the rheological tests. Generally, there are six different mud density values have been obtained. Notice that, further increment of the amount of additives, will cause the mud density to keep on decreasing. This might due to the absorbent characteristic of oil palm fibres has react with the weighting additive (barite and hematite) which added in the mud sample. However, majority mud samples from formulation B also able to meet the standards of API 13A as Formulation A. Besides that, the filtration loss of the mud samples also can be improved by adding the oil palm fibres.

Table 4.4: Results for Formulation B

Property, measuring unit	Sample B					
	1	2	3	4	5	6
Mud density, ppg.	10.0	9.5	9.1	8.8	8.6	8.5
600 rpm reading	44.0	43.0	41.0	41.0	38.0	34.0
300 rpm reading	37.0	35.0	34.0	33.0	30.0	28.0
Plastic viscosity, cP	7.0	8.0	7.0	8.0	8.0	6.0
Yield point, lb/100 ft^2	30.0	27.0	27.0	25.0	22.0	22.0
Gel 10 Sec	43.0	41.0	40.0	38.0	36.0	33.0
Gel 10 Min	50.0	42.0	38.0	33.0	31.0	30.0
Filtration Loss, ml/30min	21.2	20.6	19.2	18.8	18.5	17.0
Cake Thickness (mm)	3.3	3.3	4.9	5.5	6.0	6.8

Figure 4.7 shows the acceptable plastic viscosity for Formulation B. The maximum range and minimum range for the respective mud densities is 10.3 cP and 6 cP. All the mud samples present the values within the range, proving the properties are able to meet the standard of API 13A. The trend of graph is similar with Formulation A, where the values of plastic viscosity obtained is fluctuating.

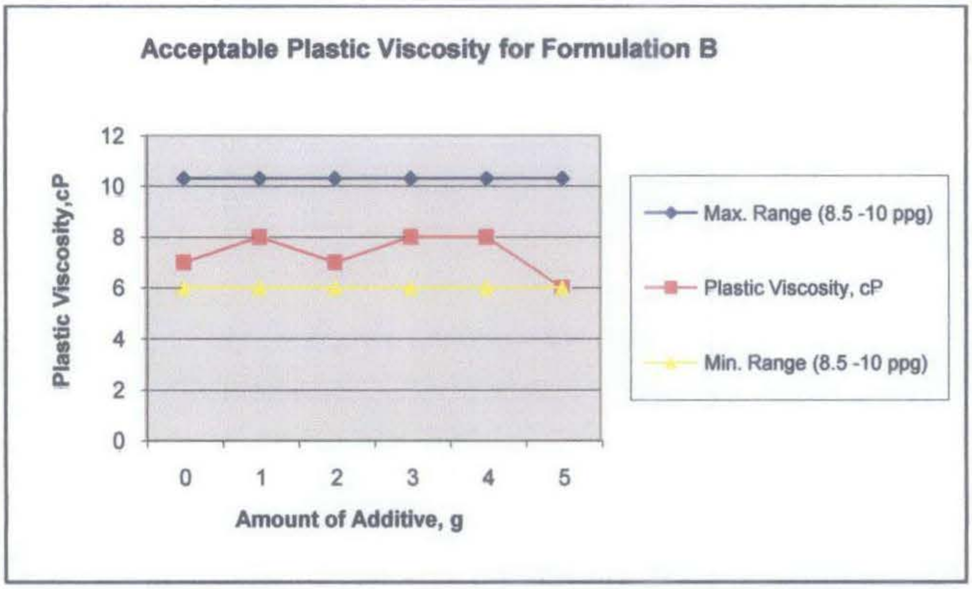


Figure 4.7: Acceptable Plastic Viscosity for Formulation B

Figure 4.8 shows the acceptable yield point for formulation B which has the mud samples with the density between 8.5 – 10 ppg. Based on the figure shown, the yield point obtained could not achieve the standard range of API 13A. The values of plastic viscosity only present the acceptable when 3g of additives have been added in the mud. Further increment of the amount of additive would result the value of yield point to decrease and become more desirable.

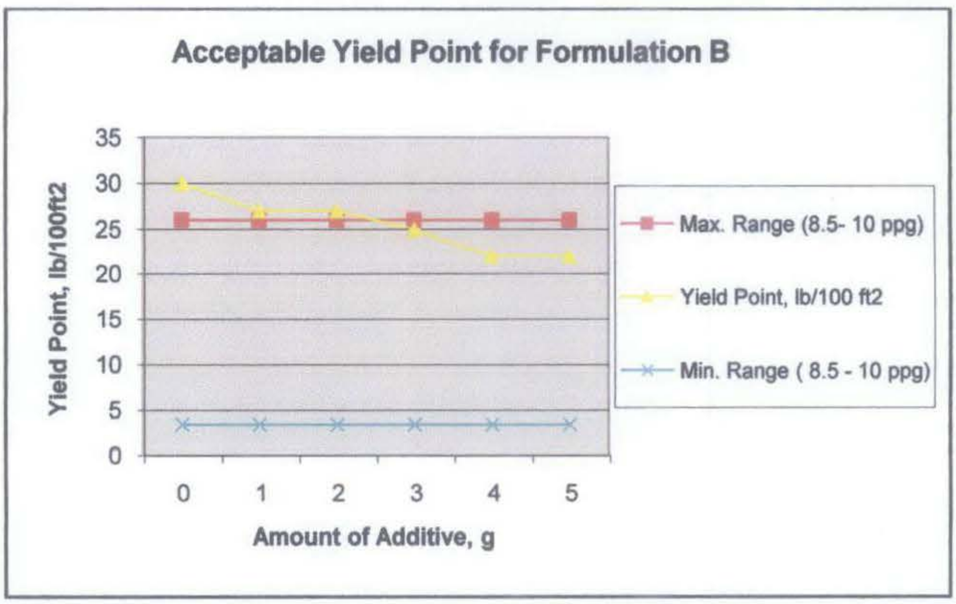


Figure 4.8: Acceptable Yield Point for Formulation B

The results of filtrate loss for Formulation B can be shown in Figure 4.9. It is obvious that the filtration volume is decreasing by adding the amount of additive (oil palm fibres) into the mud samples. This is similar with the trend which obtained from Formulation A, whereby Formulation A also substances of water base mud. However, the filtration loss for Formulation B with the same densities (8.5 and 8.6 ppg) is lesser compared to Formulation A. This is due to the mixture of weighting agents, such as barite and hematite which also can reduce the filtration volume. Besides that, the percent of reduction for filtration loss is up to 20% when 5g of additive is added. Therefore, oil palm fibres are still feasible to be used in water base mud which has added the weighting agents. Additionally, the performance as lost circulation material to reduce the filtrate loss of drilling fluid is greater.

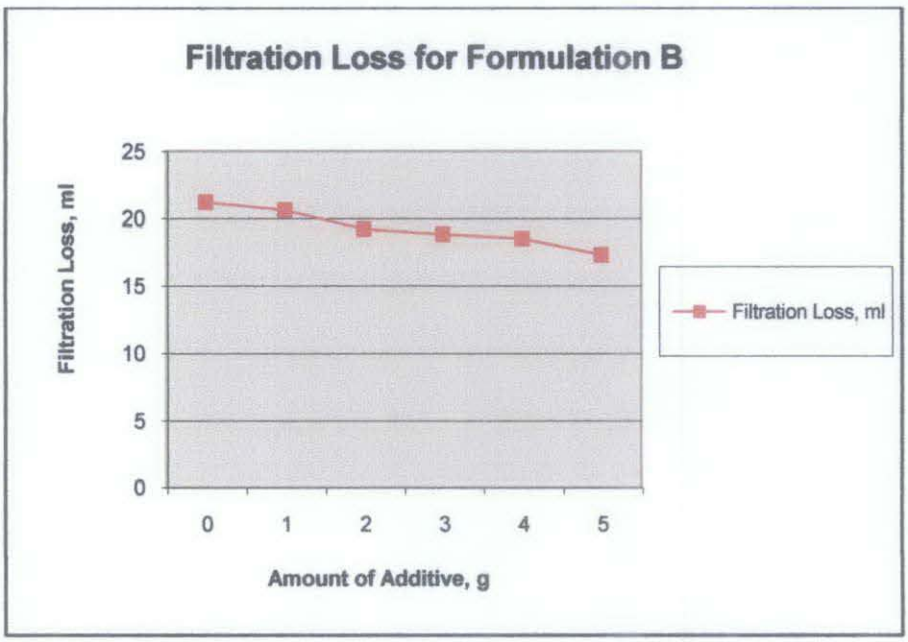


Figure 4.9: Filtration Loss for Formulation B

4.3.3 Rheological Test Results for Formulation C

Table 4.5 shows the results for formulation C throughout the rheological tests. Basically, there are only three different mud densities have been obtained from the tested oil base mud samples. The increment of the amount of additives will cause the mud density to have a minor decrement. This might due to the oil spill absorbent characteristic of oil palm fibres. Formulation C has the similarity with Formulation A, whereby all the mud samples able to meet the standards of API 13A. Besides that, the reduction of filtration loss for these oil base mud samples are more significant compared to the water base mud in Formulation B and C.

Table 4.5: Results for Formulation C

Property, measuring unit	Sample C					
	1	2	3	4	5	6
Mud density, ppg.	7.6	7.5	7.5	7.5	7.4	7.4
600 rpm reading	37.0	36.0	35.0	35.0	32.0	28.0
300 rpm reading	32.0	32.0	31.0	30.0	26.0	23.0
Plastic viscosity, cP	5.0	4.0	4.0	5.0	6.0	5.0
Yield point, lb/100 ft^2	27.0	28.0	27.0	25.0	20.0	18.0
Gel 10 Sec	30.0	29.0	28.0	28.0	26.0	26.0
Gel 10 Min	32.0	31.0	29.0	29.0	28.0	27.0
Filtration Loss, ml/30min	15.6	14.6	13.8	12.7	11.5	10.4

Figure 4.10 shows the acceptable plastic viscosity for Formulation C. There are three different ranges of plastic viscosity correspond to the mud density of 7.4, 7.5 and 7.6 ppg. All the mud samples present the desired values which are within the respective ranges. Based on the graph, the optimum value for the plastic viscosity is 6 cP. This value can be obtained when 4g of additive is added.

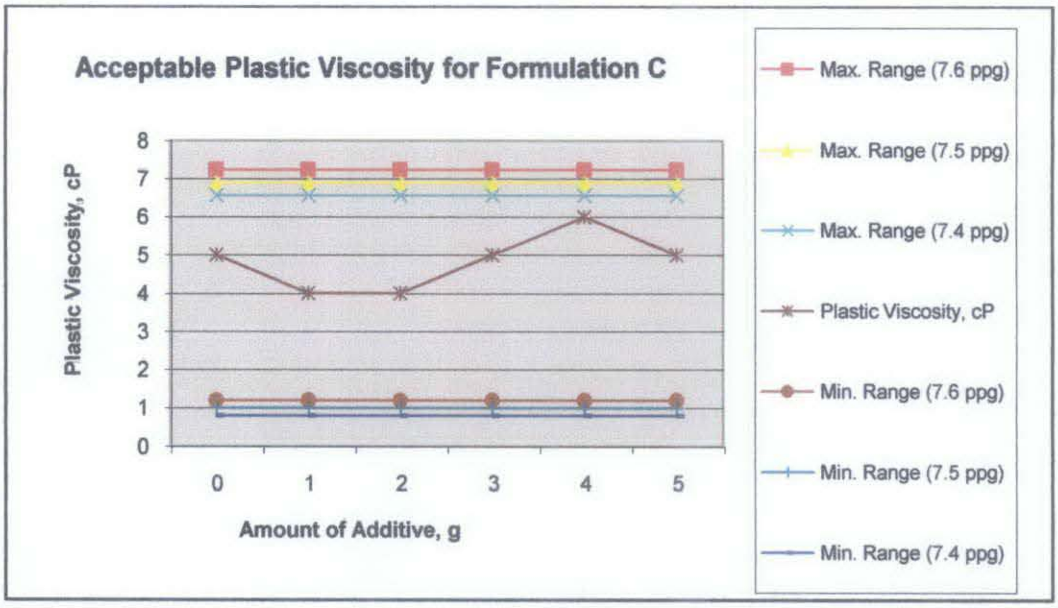


Figure 4.10: Acceptable Plastic Viscosity for Formulation C

Figure 4.11 shows the acceptable yield point for Formulation C. The desired results are shown, where all the values obtained from rheological experiments are between the maximum range and minimum range for the mud with density from 7.4 to 7.5 ppg. The optimum value is 28 lb/100 ft^2 when 1g of additive is added. Further on, the value of yield point decreases as the amount of additive increases. It is estimated the further increment of amount would also result the value of yield point to decrease.

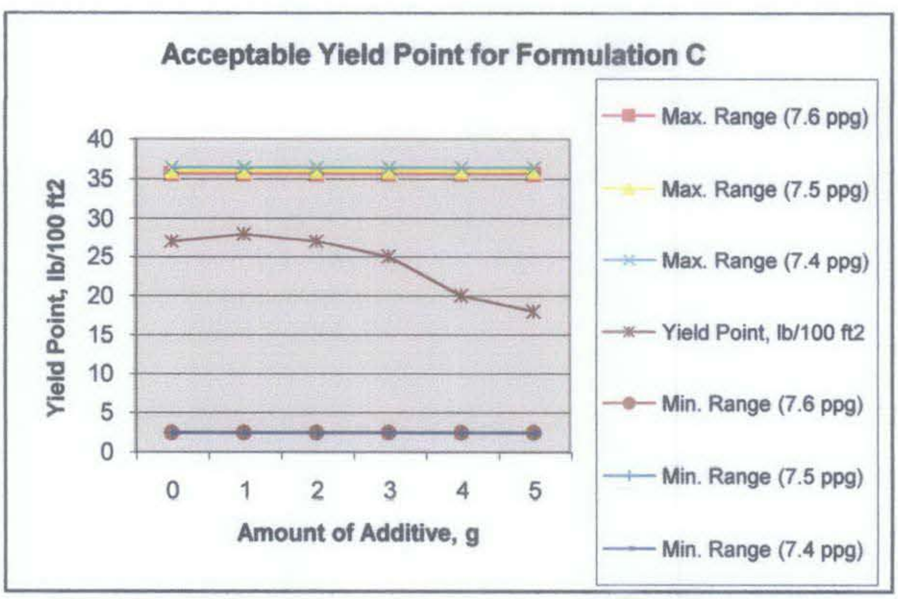


Figure 4.11: Acceptable Yield Point for Formulation C

The results of filtrate loss for Formulation C can be shown in Figure 4.12. It is obvious that the filtration volume is decreasing significantly by adding the amount of additive (oil palm fibres) into the mud samples. The filtration loss for Formulation C is better than Formulation A and B due to the type of sample mud. This is because the surface tension and compressibility of water base is greater than oil base. Thus, oil base mud is easier to be compressed and formed the filter cake which is thicker, results in less filtration loss. The percent of reduction for filtration loss in Formulation C is greater than 33% when 5g of additive is added. From the results obtained, oil palm fibres are feasible to be used in both water base mud and oil base mud.

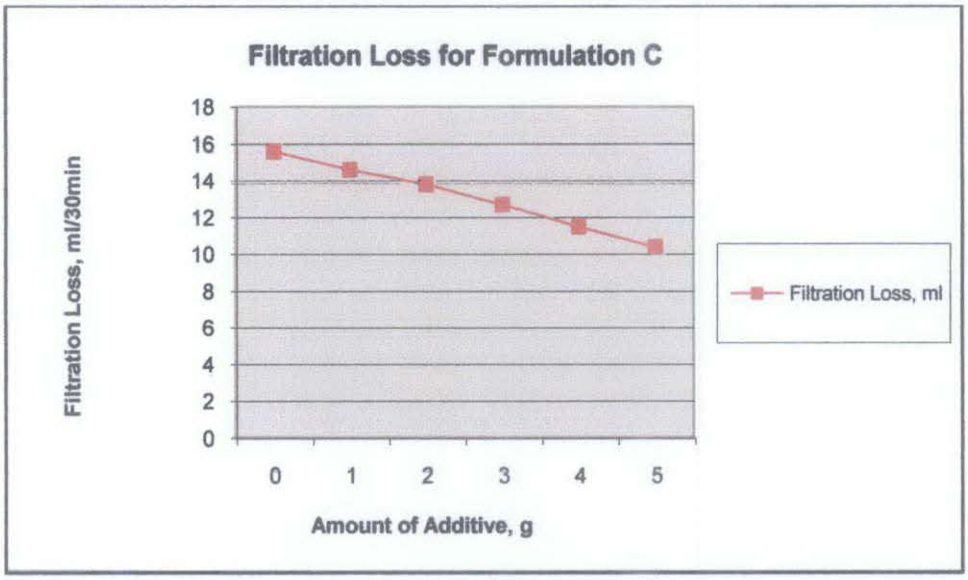


Figure 4.12: Filtration Loss for Formulation C

CHAPTER 5
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In drilling operation, the fractured rock formations provide areas of high permeability that allow drilling fluid to seep into the openings. In order to inhibit this loss, the drilling mud used must contain lost circulation material which act as sealing agent. One problem with conventional lost circulation material is they are not completely effective in closing the openings and preventing the loss of drilling fluid. The objective of the project is to propose a new lost circulation material that can mix into the drilling mud and effective in reducing the filtration loss. Besides that, it is also tend to fulfil the requirement of American Petroleum Institute (API) Standards.

Based on the obtained results, the present study found that the proposed material (oil palm fibres) are feasible to be used as lost circulation material in both water base mud and oil base mud. The oil palm fibres not only can reduce the filtration loss, but also can act as viscosifier agent to reduce the viscosity of the mud. Moreover, the prepared mud samples with oil palm fibres are able to meet the standards of American Petroleum Institute (API) Standards.

5.2 Recommendation

Careful drilling practices used in conjunction with the drilling mud which is most suitable can optimise drilling progress and minimise sample disturbance. As with all other aspects of planning and executing a quality drilling and sampling programme, there are certain facets of the selected drilling mud should be considered.

Formation Damage System (FDS) is the damage test system designed for formation damage testing of core samples. Test can be performed with before and after permeability measurement in both forward and reverse direction. It can simulate the flow in both directions between the formation and the borehole. The sample analysis on formation damage system can use to check the changes of permeability by injecting the sample mud mixed with oil palm fibres. If the reduction of permeability is significant, indicates that oil palm fibres are feasible as lost circulation material.

Besides that, there is a need to conduct detailed study on maximum percentage of oil palm fibre to be added without affecting its function in improving lost circulation material. Moreover, laboratory experiments on rheological tests by using different particle size of oil palm fibres can be considered to determine the suitable size of oil palm fibres which can provide optimum performance.

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