The Comparison of Different Types of Chemicals as Fluid Loss Control Additives in Synthetic Base Mud

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11561
Petroleum Engineering

Dissertation submitted in partial fulfillment of
the requirements for the
Bachelor of Engineering (Hons)
(Petroleum Engineering)

APRIL 2012

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Petroleum Engineering Programme
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
BACHELOR OF ENGINEERING (Hons)
(PETROLEUM ENGINEERING)

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APRIL 2012

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.

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(MUHAMMAD LUQMAN BIN HASAN)

ABSTRACT

In drilling fluids, there are a few components that need to be taken care of in order to produce desired drilling fluids. One of the main components in the drilling fluids is fluid loss control additives. This additives help in reducing and controlling fluid loss from the drilling fluids. It can be severe if the fluid loss is not being controlled. There are many types of chemicals that can be used in order to help in fluid loss control. In this project, four (4) fluid loss additives that will be tested are gilsonite, sodium asphalt sulfonate, sulphonated asphalt and organophilic lignite. All of these chemicals have different ability in order to control fluid loss. Some of them also have different ability and usage in drilling fluids. For instance, sodium asphalt sulfonate can be used as shale control inhibitor in the drilling fluids system. Above-mentioned chemicals are widely used and known. Most of them are compatible with the synthetic base muds system. Therefore, in this project, all of the chemicals will be tested in synthetic base mud system. Since all of the chemicals have different ability, therefore the mud properties will be specified and tested as follows condition: 10 lb/gal mud weight, 75:25 oil water ratio and 25% Wt $CaCl_2$. In order to make the data more relevant, there will be two conditions whereas the chemicals will be tested which is in contaminated muds and also in non-contaminated muds. Contaminated muds means that the muds will be added with some solids and cuttings and the non-contaminated muds are fresh muds which it will not be added with solids. All of the conditions also will be tested using three different types of base oil which are SARALINE 185V, SARAPAR 147 and ESCAID 110. This is to ensure the data is valid and the comparison can be done. At the end of the experiment, gilsonite tend to be the most efficient fluid loss reducer agent based on the initial condition of the test. The SARALINE 185V base oil also gives the best result while compared to SARAPAR 147 and ESCAID 110 as base oil in this test.

ACKNOWLEDGEMENTS

Thank you to Allah the Almighty for the opportunity to live and opportunity to explore your priceless knowledge.

My heartiest gratitude goes to my beloved family for being very supportive throughout five-year period of my tertiary study. I also would like to thank you the lecturers in Petroleum and Geosciences Department of Universiti Teknologi PETRONAS (UTP) and lab personnel for their help and guidance.

My grateful thanks also go to Mr Jasmi B Ab Talib, my project supervisor for his endlessly support and guidance and also for making my duration of final year project filled with knowledge and experience. Thank you once again for supporting and assisting me in completing this project.

Special thanks also go to all staff of Scomi Oiltools Sdn. Bhd. – Global Research and Technology Centre (GRTC), Shah Alam especially Mr Erwin Ariyanto, the Manager – Technical Laboratory for giving me a chance to conduct my test at GRTC. I also would like to thank Mrs Fardelen Mohd Naimi (Team Leader of Technical Service), Mrs Haryani Omar (QMS & HSE) and Compliance Department staffs, Mr Aziz (Team Leader) and Mr Nadiem Suhairi for helping me out during my test at GRTC. A priceless contribution and hard work from all of you was very much appreciated.

Last but not least, I would like to express my heartfelt gratitude to all my friends especially UTP students and course mate for sharing knowledge and helping me out for this project.

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1.0 INTRODUCTION

1.1 BACKGROUND OF STUDY

Drilling fluid is basically a fluid that helps in operation to drill boreholes into the earth. It has many functions and characteristics and it can be distinguished by its properties. This fluid used in the rotary drilling process primarily to clean the rock fragments from beneath the bit and carry them to the surface. Besides that, it also exerts sufficient hydrostatic pressure against subsurface formations to prevent formation fluids from flowing into the well.

In general, drilling fluids can be classified into three types which are the liquids, gases and mixture of both. However, in current drilling process, most of the operation is using the liquids form of drilling fluids. There are three types of liquid drilling fluids which are water-base muds, oil-based muds and synthetic-base muds. In order to prepare the drilling fluids, a few things need to be considered especially the composition of the mud. The composition of the mud consists of base fluid, weighting agent, fluid loss control agent, inhibitor, bridging agent, viscosifier and a few more addictives. Different chemicals used in the drilling fluids give different impact and function.

In drilling fluids, the function of fluid loss control agent is to reduce the fluid loss from the drilling fluid and also improve the mud cake formation. Several types of materials are used to reduce filtration rate and improve mud cake characteristics (Bourgoyne Jr., Chenevert, Millheim, & Young Jr., 1986). In this project, there are four different types of chemicals used as a fluid loss control agent. The chemicals are natural occurring gilsonite, sodium asphalt sulfonate, sulphonated asphalt and organophilic lignite. All of these chemicals have different ability as fluid loss controlling agent. Some of them also have other functions in drilling fluids. For instance, sodium asphalt sulfonate can also be used as shale control inhibitors but at the same time it is also helps in controlling fluid loss.

In general, gilsonite is a unique natural hydrocarbon high in asphaltenes and nitrogen compounds, is a granular solid that is fully compatible with bitumen (Gilsonite). The main function of gilsonite is to be used for high temperature and high pressure (HTHP) filtration control in invert oil / synthetic base systems over a wide range of temperatures. On the other hand, sodium asphalt sulfonate is a complex and modified hydrocarbon compound. It is chemically formed by the sulfonation process. This chemical is widely used in the industry because of its ability to help in shale control inhibitor. Besides that, it is also helps in fluid loss control.

The sulphonated asphalt is basically has the same functions as sodium asphalt sulfonate. It is a modified chemical from sodium asphalt sulfonate. It is compatible with both water base and also synthetic base mud systems. It also can be used as shale control inhibitors agent. It is also environmentally friendly and accepted to be used on land or offshore drilling. The organophilic lignite or organolig is one of the chemicals that also widely used as fluid loss controlling agents. It is lignite that actually has been coated with a chemical that renders it dispersible in oil. Basically, it is used in synthetic base mud systems.

This project is done basically to compare these various types of chemicals that can be used as fluid loss control additives in synthetic-based mud. The end result of this project is to see the ability of all chemicals in terms of controlling fluid loss. All of these chemicals have the ability to control fluid loss but the comparison of the data will be done. All chemicals will be tested at 10 lb/gal of mud weight, at 75:25 oil water ratio, 25% Wt $CaCl_2$. In order to get better result, all of the chemicals will be tested by using three (3) different types of base oil (e.g. SARAPAR 147, SARALINE 185 V and ESCAID 110). It is also will be tested at two different conditions. The first condition is a clean, non-contaminated mud and the other condition is contaminated mud.

Therefore this project is developed to compare four (4) different types of chemicals that can be used as fluid loss control additives. The title of this project is 'The Comparison of Different Types of Chemicals as Fluid Loss Control Additives.'

1.2 PROBLEM STATEMENT

1.2.1 Problem Identification

In drilling fluids activities, there are a few chemicals that can be used in the synthetic based systems as additives. For example, there a lot of chemicals that can be used as fluid loss control additives. However, some chemicals give different result according to different condition and mud specifications. Some chemicals do not give same result if certain condition is applied even though they have same functions. Therefore the determination on which one is giving the best result should be done in order to minimize the operation cost.

Therefore for this project, there are four (4) different types of chemicals will be tested and compared in terms of the fluid loss collection. There are a few mud conditions that have been set up which are: 10 lb/gal mud weight, 75:25 oil water ratio (OWR), and 25% Wt $CaCl_2$. From these conditions, the fluid loss controlling agents will be tested and compared the result in terms of fluid loss collection.

Besides that, there are a few types of base oil that will be used which are SARALINE 185 V, SARAPAR 147 and also ESCAID 110. There are of course other base oils available in the market, however between this three base oil, which one will give the best result in term of fluid loss control additives performance need to be determined. Besides that, fresh mud and contamite mud sometimes have different characteristics. Therefore, the test will be done to see whether both fresh mud and contaminated mud have same result or not.

1.2.2 Significant of the Project

As mentioned above, one of the end result that is in favor is whether this project can benefit to the industry. Of all these four (4) chemicals, which chemicals give the best result with the specific condition needs to be determined. If we know which one is the most efficient, we can minimize the operation cost. At the end, it can benefit the industry.

1.3 OBJECTIVE AND SCOPE OF PROJECT

The scope of the project is mainly on the drilling fluids and its functions. The evalution is based on the fluid loss control agent.

The objectives of this project are as follows:

1) To compare the result of fluid loss control additives in terms of the amount of filtrate collection based on the condition: 10 lb/gal mud weight, 75:25 OWR and 25% Wt $CaCl_2$.

2) To determine which base oil gives the best result in terms of fluid loss control additives performance.

3) To compare the fresh mud and also contaminated mud (contaminated mud means the mud will be added with some solids such as cuttings from the rig).

1.4 RELEVANCY OF THE PROJECT

This project is relevant since it has a significant value to the operating companies which deals with drilling fluids. The data of the project can be used to help the industry on which chemicals that can be used effectively with certain condition as mentioned above. Therefore, it will help the industry or the companies to save time and cut cost of the operation.

1.5 FEASIBILITY OF THE PROJECT

Below is the Gantt Chart that shows how the project can be done within the scope and time frame:

Activities	Week						
	1 until 7	8	9	10	11	12	13	14
Project Continues (from FYP 1)								
Submission of Progress Report		X						
Project Work Continues								
Pre - EDX					X			
Submission of Draft Report						X		
Submission of Dissertation (soft bound)							X	
Submission of Technical Paper							X	
Oral Presentation (Viva)								X
Submission of Dissertation (hard bound)								X

Figure 1: Gantt Chart of the Project

Below is the Key Milestone of the project:

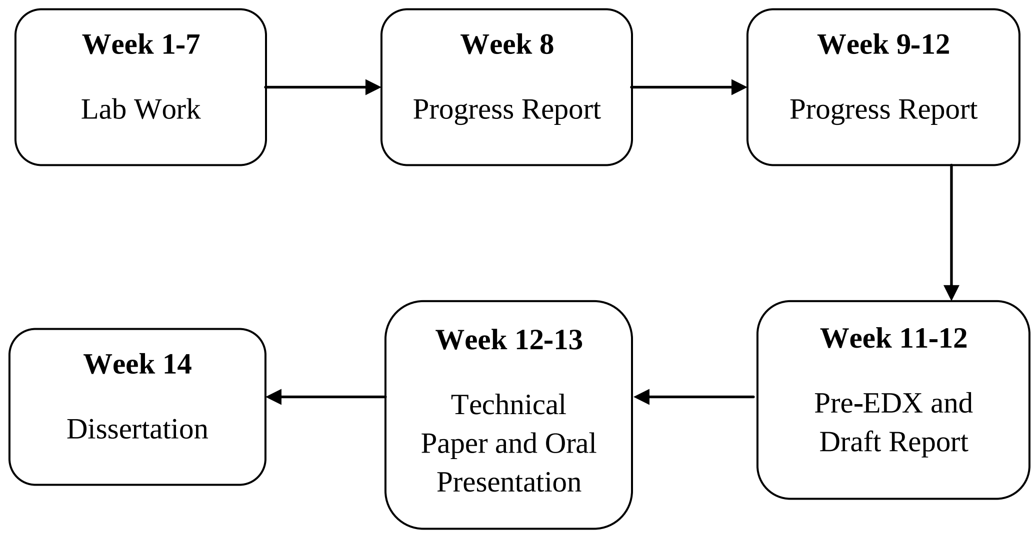


Figure 2: Key Milestone of Project

2.0 LITERATURE REVIEW AND THEORY

2.1 DRILLING FLUID

The drilling fluid is very much related to most of the drilling problems. In petroleum engineering term, drilling fluid is better known as a fluid used to aid the drilling of boreholes into the earth. It is often used while drilling oil and natural gas wells. Besides that, drilling fluids are also used for much simpler boreholes, such as water wells on exploration drilling rigs. In oil and gas industry, liquid drilling fluid is often called drilling mud. The three main common categories or types of drilling fluids are water-based mud (WBM), which can be dispersed and non-dispersed, non-aqueous mud (NAF), usually called oil-based mud (OBM), and gaseous drilling fluid, in which a wide range of gases can be used. Below is the simplified version of types of drilling fluids.

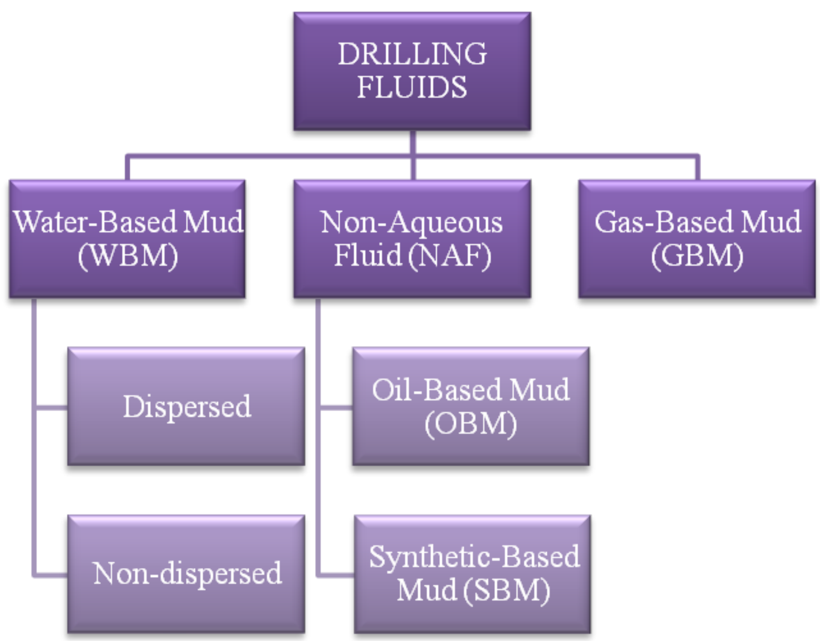


Figure 3: Types of Drilling Fluids.

Based on the figure above, below is the details explanation about commonly used mud which is Water-Based Mud (WBM), Oil-Based Mud (OBM), and Synthetic-Based Mud (SBM).

1) Water-Based Mud (WBM): Water is the basic component in the drilling fluids and WBM is the drilling fluid that consists mainly of water with no oil inside it. The most basic water-based mud system starts with water, clays and other chemicals are incorporated into the water to create and produce a homogenous blend resembling something between chocolate milk and malt.

2) Oil-Based Mud (OBM): Oil-based mud is one of the examples of Non-Aqueous Fluid (NAF). It is a mud where the base fluid is a petroleum product such as diesel fuel. Oil-based muds are used for many reasons, for example, some being increased lubricity, enhanced shale inhibition, and greater cleaning abilities with less viscosity. The advantages and disadvantages of using oil mud can be found as such:

No.	Advantages	Disadvantages
1	Good rheological properties at temperatures as high as 500^oF.	Higher initial cost.
2	More inhibitive than inhibitive water base muds.	Requires more stringent pollution-control procedures.
3	Effective against all types of corrosion.	Reduced effectiveness of some logging tools.

Table 1: Advantages and Disadvantages of using Oil-Base Mud.[1]

[1] Bourgoyne Jr., A. T., Chenevert, M. E., Millheim, K. K., & Young Jr., F. (1986). Applied Drilling Engineering. In A. T. Bourgoyne Jr., M. E. Chenevert, K. K. Millheim, & F. Young Jr., *Applied Drilling Engineering* (pp. 41-84). Texas: SPE Foundation.

3) Synthetic-Based Mud (SBM): Synthetic-based mud is a mud or drilling fluid where the base fluid is synthetic oil. This type of mud is most often used on offshore rigs because it has the properties of an oil-based mud. If we want to compare, the toxicity of the fluid fumes are much less than an oil-based fluid

2.1.1 Functions of Drilling Fluids

The objective of a drilling operation is to drill, evaluate and complete a well that will produce oil and/or gas efficiently. Drilling fluids perform numerous essential functions that help make this possible (Styles, et al., 2006). There are primary functions and secondary functions. The primary functions are as follows:

1) Control formation pressure

Usually, if formation pressure increases, mud density should also be increased, often with barite (or other weighting materials) to balance pressure and keep the wellbore stable. If the formation pressures is unbalanced, it will cause an unexpected influx of pressure in the wellbore possibly leading to a blowout from pressured formation fluids.

2) Transport cuttings from the well

Drilling fluids must suspend drill cuttings, weight materials and additives under a wide range of conditions. Drill cuttings that settle can causes bridges and fill, which can cause stuck-pipe and lost circulation which later will break the formation. Weight material that settles is basically referred to as sag. Sagging can cause a wide variation in the density of well fluid, this more frequently occurs in high angle and hot wells.

3) Maintain stable wellbore

Chemical composition and mud properties must combine to provide a stable wellbore. Weight of the mud must be within the necessary range to balance the mechanical forces. Wellbore stability = hole maintains size and cylindrical shape. If the hole is enlarged, it becomes weak and difficult to stabilize, resulting in problems such as low annular velocities, poor hole cleaning, solids loading and poor formation evaluation.

There are also secondary functions of the drilling fluids. The functions can be summarized as follows:

Functions	Explanation
Support weight of tubular.	Drilling fluid buoyancy supports part of the weight of the drill string or casing.[2]
Cool and lubricate bit and drilling strings.	The drilling fluid will lubricate the bit tooth penetration through rock and serves as a lubricant between the wellbore and drill string thus reducing torque and drag.
Transmit hydraulic horsepower to bit.	The hydraulic horsepower will generate at the bit is actually the result of flow volume and pressure drop through the bit nozzles. This energy will then be converted into mechanical energy which removes cuttings from the bottom of the hole and improves the rate of penetration.

[2] Styles, S., Ledgister, H., Singh, A. K., Meads, K., Schlemmer, R., Tipton, P., et al. (2006). *Drilling Fluid Engineering Manual.* Kuala Lumpur: Scomi Group.

Provide medium for wireline logging	The drilling fluid will help and provide medium for wireline logging. However, different types of fluids will give different result of logging due to the differing physical characteristics.

Table 2: Secondary Functions of Drilling Fluids

2.1.2 Composition of Drilling Fluids

Theoretically, mud is consisted of the mixture between fluids and solids. Usually, water-based drilling mud will commonly consists of bentonite clay (gel) with additives such as barite, calcium carbonate (chalk) or hematite. Various thickeners are also used to influence the viscosity of the fluid. For example, xanthan gum, guar gum, glycol, carboxymethylcellulose, polyanionic cellulose (PAC), or starch.

Besides that, deflocculants are used to reduce viscosity of clay-based muds; anionic polyelectrolytes (e.g. acrylates, polyphosphates, lignosulfonates (Lig) or tannic acid derivates such as Quebracho) are frequently used. People always call red mud as the Quebracho-based mixture, named after the color of the red tannic acid salts.

In the mud, other components are also added to provide various specific functional characteristics. There are also some other common additives include lubricants, shale inhibitors, and fluid loss additives (to control loss of drilling fluids into permeable formations).

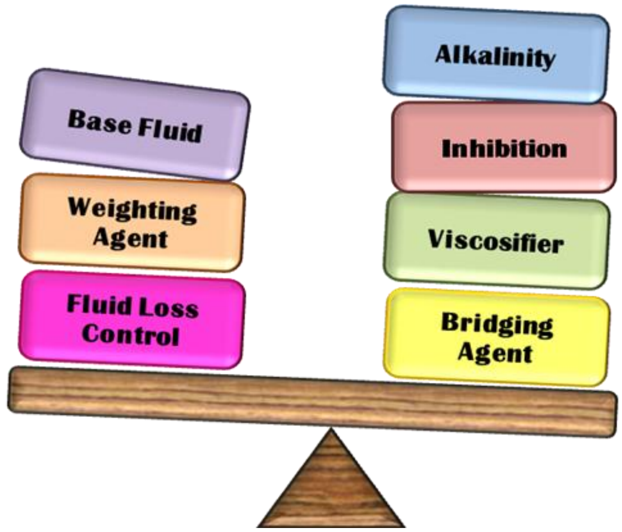


Figure 4: The composition of Drilling Fluids.

2.2 GILSONITE

Gilsonite actually has been made commercially and uses as the additives in the drilling fluid. Different companies of drilling fluids have different names for gilsonite. For example, Scomi Oiltools named gilsonite as CONFI-TROL and MI SWACO named it as VERSA-TROL and Baker Hughes named it as CARBO-TROL. There is also a specially-designed gilsonite for high temperature uses, however the cost of it is a lot higher than normal gilsonite.

Gilsonite, or often called as North American Asphaltum is a natural, resinous hydrocarbon found in the Uintah Basin in northeastern Utah. This natural asphalt can be considered similar to hard petroleum asphalt and is often called a natural asphalt, asphaltite, uintaite, or asphaltum. Usually, gilsonite is soluble in aromatic and aliphatic solvents, as well as petroleum asphalt. Due to its unique compatibility, this gilsonite is frequently used to harden softer petroleum products in manufacturing activity. Gilsonite in mass is a shiny, black substance similar in appearance to the mineral obsidian and it is brittle and can be easily crushed into a dark brown powder.

Gilsonite is first found below the earth's surface in vertical veins or seams that are generally between two and six feet in width, but can be as wide as 28 feet. The veins are closely parallel to each other and are oriented in a northwest to southeast direction. They broaden many miles in length and as deep as 1500 feet. The layer will show up on the surface as a thin outcropping and steadily widen as it goes deeper. Due to the narrow mining face situation, Gilsonite is mined today, much like it was 50 or 100 years ago. The main difference is that modern miners use pneumatic chipping hammers and mechanical hoists.

In terms of the function in drilling fluids, it is actually used for high temperature and high pressure (HTHP) filtration control in invert oil / synthetic base systems over a wide range of temperatures. It is often used to seal low pressure and also depleted formations. This gilsonite is compatible to all invert oil / synthetic base systems and can be used both in the initial formulation and also for treatment while drilling.

Usually, the appearance of this gilsonite is black powder and it can disperse well in water at 20^{o}C. The melting point of gilsonite is between (166^{o}C – 177^{o}C) and the specific gravity is 1.06. The advantages of using gilsonite are as follows:

1. It enhances emulsion stability.
2. It has minimal rheological impact.
3. It is effective over a wide range of temperatures.

There are also recommended treatments for using this gilsonite. The recommended treatments are such as: Initial treatment in the range of 2 - 10 lb/bbl (5.71 - 8.53 kg/m3) is recommended, although higher concentrations may be necessary in extreme cases. Pilot testing should be conducted to determine actual concentration needed in each case. If gilsonite is to be added to a newly mixed mud prior to displacement, the addition should be made after all other components have been mixed thoroughly. [3]

2.3 SODIUM ASPHALT SULFONATE

Sodium Asphalt Sulfonate is basically a chemically modified hydrocarbon compound. It is made water soluble due to the unique sulfonation process to form it. In drilling fluids aspect, sodium asphalt sulfonate is better known for its ability as versatile, total mud conditioner that aids in stabilizing shale formations. Besides that it is significantly increases lubricity and also reduces high temperature - high pressure filtration. Due to this, it also enhances filter cake properties at the same time. It is suitable to be used in both water base and oil base systems.

Basically, this sodium asphalt sulfonate is consumed on the drilled solids and on the well bore. It has a few advantages such as follows:

1. Controlled water and oil solubility to effect best chemical and physical performance.
2. Minimizes damage to productive formations.
3. Reacts with shale to prevent or stop sloughing and swelling.
4. Significantly increases lubricity; either alone or synergistically with small amounts of oils and synthetics.
5. Environmentally acceptable - is used on land and offshore.

[3] *Product Information.* (n.d.). Retrieved June 20, 2011, from Scomi Group Bhd Web Site: http://www.scomigroup.com.my/core/oilfield_intro.asp

6. Extremely temperature stable - does not have the softening point typically associated with unreacted asphaltic additives.
7. Inhibits dispersion of drilled solids.
8. Minimal and easily distinguishable fluorescence - does not hamper well logging or core analysis.
9. Will not leave oil slick, sheen or rainbow on water at offshore locations
10. No emulsifiers needed to ensure proper mixing.

2.4 SULPHONATED ASPHALT

This chemical actually is an asphaltic mud additive that has been reacted with sulfite to add anionic sulfonate groups to the complex molecular structure. Sulfonate groups have a few advantages such as it makes the additive water dispersible, and usually depending on the extent of sulfonation process. This chemical also has same functions as sodium asphalt sulfonate which is stabilize the wellbore and as a filter cake additive for both water-base and oil-base systems.

It is also performs a wide variety of functions in a drilling fluid. It acts as a high temperature fluid loss control agent and gives thin tough filter cakes. One of the thing about this chemical is it reduces torque and drag, inhibits the sloughing and dispersion of shales and aids in the emulsification of oil.

Physically this chemical looks as black powder. Below are some of the advantages of sulphonated asphalt:

1. Controlled water and oil solubility to effect best chemical and physical performance.
2. Reacts with shale to prevent or stop sloughing and swelling.

3. Significantly increases lubricity; either alone or synergistically with small amounts of oils and synthetics.
4. Environmentally acceptable - is used on land and offshore.
5. Extremely temperature stable Inhibits dispersion of drilled solids.
6. Minimal and easily distinguishable fluorescence - does not hamper well logging or core analysis.
7. Will not leave oil slick, sheen or rainbow on water at offshore locations.

2.5 ORGANOPHILIC LIGNITE

Organophilic Lignite is basically amine-treated lignite used for filtration control in oil base muds and synthetic base muds. Basically it is used to control filtration rates in oil based drilling fluids, including synthetic oil based drilling fluids. This chemical of filtration control agent is stable at high temperatures and can be used to control filtration rates in deep, hot wells.

It also can be used to improve the emulsification of water in oil based drilling fluids and to promote drilling fluids stability. It is proven that this chemical meet the environmental specification in most countries. This chemical also has a few advantages such as follows:

1. Mixes easily.
2. Controls HTHP filtrate.
3. Works in all types of Oil Base Muds and Synthetic Base Muds at varying concentrations.
4. Increases the stability of fluids to temperatures above 400° F.
5. Provides supplemental emulsion stability in oil emulsions at high temperatures.

2.6 BASE OIL

In this project, all samples are tested in three different base oils which are SARALINE 185 V, SARAPAR 147 and ESCAID 110. Below are the properties of each base oils:

Properties / Base oil	SARALINE 185 V	SARAPAR 147	ESCAID 110
Physical State	Liquid at ambient temperature	Liquid at ambient temperature	Liquid at ambient temperature
Colour	Colourless	Colourless	Colourless
Odour	Odourless	Odourless	Mild petroleum / Solvent
Boiling Point	200^oC – 320^oC	255^oC – 295^oC	200^oC – 250^oC
Vapor Pressure	<0.1 kPa at 40^oC	<0.1 kPa at 40^oC	0.023 kPa at 20^oC
Density	776 – 779 kg/m^3 at 15^oC	774 kg/m^3 at 15^oC	798 kg/m^3
Vapour Density	>5	>5	6.2 at 101 kPa
Pour Point	-27^oC	0^oC – 10^oC	-39^oC
Flash Point	$>85^oC$	$>120^oC$	77^oC
Flammable Limits	1% - 6%	0.4% - 4.3%	0.6% - 5.0%
Solubility in H_2O	Insoluble	Insoluble	Insoluble

Table 3: Characteristics of Base Oils.

2.7 THEORY

2.7.1 Basic Mud Testing

Basic mud testing is the fundamental steps to evaluate and conduct the test on the drilling fluid for this project. Basic mud testing includes the step by step procedures that need to be taken and to be followed. It includes the first step which is the preparing the chemicals which the weighting of the chemicals must be accurate. After that, the testing should include the mixing of the chemicals which need specific sequence. Then, the rheological test before and after hot-rolling should be done. Other than that, fluid loss test also should be done.

2.7.2 Yield Point

$$\tau_y = \theta_{300} - \mu_p$$

In non-Newtonian fluid, a few characteristics of the fluids are needed to be determined. One of them is yield point. Yield Point is a function of the concentration of mud solids and their surface charges and potentials which affect inter particle forces. Dispersants and deflocculants are believed to adsorb on the mud particles. This action changes the chemical nature of the surfaces and likewise affects the inter particle forces, resulting in viscosity and YP reductions.

2.7.3 Plastic Viscosity

$$\mu_p = \theta_{600} - \theta_{300}$$

Plastic Viscosity, μ_p is basically the proportional to rate of shear, thus largely reflects the resistance to flow. This situation is due to mechanical friction of the particles. The formula to calculate the plastic viscosity as stated above. Plastic viscosity is a function of solids' concentration and shape. It will be expected to increase with decreasing particle size with the same volume of solids.

In oil muds, the plastic viscosity decreases with an increase in temperature or oil content.[4] Besides that, we also can calculate the apparent viscosity from the data that will be obtained from viscometer. The formula to calculate apparent viscosity is as follow:

$$\mu_a = \frac{300\ \theta_N}{N}$$

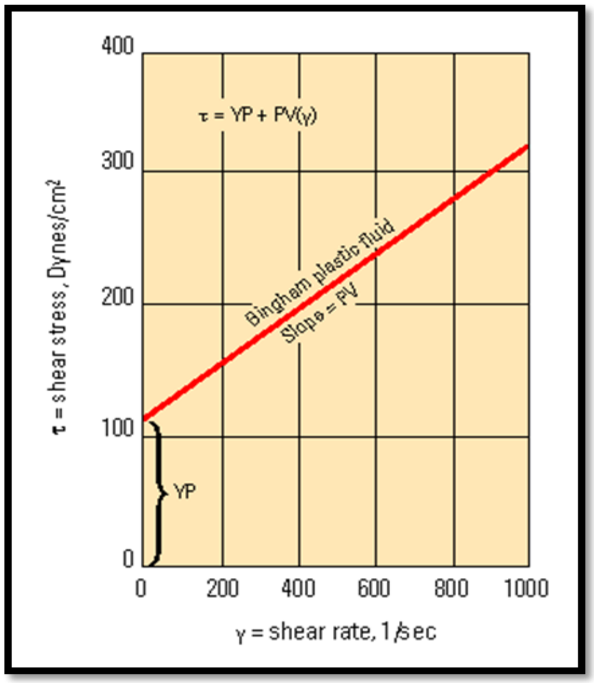


Figure 5: Plastic viscosity (PV) and yield point (YP) on X-Y plot of Bingham plastic model.

[4] Styles, S., Ledgister, H., Singh, A. K., Meads, K., Schlemmer, R., Tipton, P., et al. (2006). *Drilling Fluid Engineering Manual.* Kuala Lumpur: Scomi Group.

2.7.4 Gel Strength

The gel strength is one of the non-Newtonian rheological parameters. The unit of the gel strength is lbf/100 sq ft. gelling characteristics of the fluid can be determined from taking a 10 second and a 10 minute gel reading. Consequently there is no requirement to take a 30 minute gel under normal circumstances. However if increasing rheology is becoming a problem, a 30 minute gel should also be taken in order to determine the effectiveness of the treatment program.

2.7.5 HTHP Filtrate Analysis

Generally, the results from the filtrate analysis will confirm the departure from normal of the values of yield point and gel strengths from rheological tests. Increases in mud volume due to liquid or gas intrusions should also be noted. Salt water flows are almost always accompanied by methane gas. Methane gas does not affect the chemical properties of either oil or water-based muds. Hydrocarbon gases can thin an oil-based mud through becoming dissolved in the base oil.

3.0 <u>METHODOLOGY</u>

3.1 RESEARCH METHODOLOGY

3.1.1 General Procedure

This research is based on the general guideline on basic mud testing procedure. The formulation of the mud composition is based on the American Petroleum Institute (API) standard. The reference used is the API 13 which is based on the drilling fluids procedure. In general, below is the step by step procedure to conduct the experiment:

1) Preparing the mud by weighting the chemicals according to the formulation which has been prepared earlier.
2) Mixing the mud by adding the chemicals one by one according to the sequence and also time located.
3) Test the mud weight of the mud so that it is tally and accurate with the formulation.
4) Test the rheological properties of the mud at the specific temperature.
5) Test the pH of the mud.
6) Test the emulsion stability of the mud.
7) Hot-rolling the mud for certain period of time. The purpose of ho-rolling the mud is to simulate the condition in the wellbore.
8) Test the rheological properties of the mud after hot-rolling.
9) Conduct the filtration test by using high temperature and high pressure (HTHP) filter press.
10) Record all data.
11) Repeat step 1 until 10 for contaminated mud.

3.1.2 Detailed Procedure

Procedure for testing rheological properties of the mud using Fann 35 Viscometer:

1) Assemble the rotor and the bob at the right place.
2) Preheat the heating jacket at 120^{o}F.
3) Pour the mud sample into the sample cup.
4) Place the sample cup with the mud inside it onto the heating jacket.
5) Start the test by stirring the mud using 600 rpm speed.
6) Consistently, check the temperature of the mud until it reaches 120^{o}F.
7) Once it reached the temperature, the reading for 600 rpm is taken followed by 300 rpm, 200 rpm, 100 rpm, 6 rpm and 3 rpm.
8) The data is recorded.

Procedure for taking Emulsion Stability reading:

1) Right after the rheological properties test is done; maintain the mud in the heating jacket so that the temperature is 120^{o}F.
2) Insert the electrode probe into the mud. Hand-stir the mud for about ten (10) seconds. Press the button to start the voltage ramp.
3) Observe and jot down the value appeared on the readout.

Procedure for hot rolling the mud sample:

1) Preheat the oven at 250^{o}F.
2) Pour the mud samples into the aging cell. Ensure that it is about three quarter full only.
3) Close the aging cell tightly.

4) Pressurize the mud sample by inserting pressure for about 100 psi.
5) Ensure that the cell is not leaking.
6) Wait until the right time and ensure the temperature of the oven reached 250^{o}F, and then the aging cells are put into the oven.
7) After 16 hours of rolling, then stop the heating and cool the cells down. Water bath can be used to help cooling down the temperature of the cells.
8) After the cells are cooled down, then only open the cell carefully.
9) Take out the mud samples from the cell, pour it into the mud cup and then stir the mud for about 5 minutes.
10) Continue with the next test.

Procedure for High Temperature and High Pressure test:

1) Preheat the heating jacket of HTHP equipment and prepare the cells for the test.
2) Pour the mud into the cell and close it tightly. Ensure that the o-ring is placed and the filter paper is inserted as well. Once the heating jacket reached 250^{o}F, put the cells into the heating jacket.
3) Heat the mud until the temperature reached 250^{o}F. At the same time apply some pressure while heating.
4) Once the desired temperature is reached, increase the pressure at the top of the cell. In this test, 100 psi is applied at the bottom of the cell and 600 psi is applied at the top of the cell making the total pressure is 500 psi.
5) The time is set for 30 minutes and filtrate collection is done from time to time. The bottom valve stem is turned about half

to collect the filtrate.

6) After the test is done, open the receiver outlet valve to collect all filtrate in the graduated cylinder. Record the value for the filtrate collected.
7) Disassemble all equipments and carefully release all pressure. Cool down the cells in the water bath.
8) After that, with extra careful, collect and measure the mud cake formed at the bottom of the cell. Record the data.
9) Clean up the cells.

3.2 LIST OF CHEMICALS

Below is the list of chemicals that will be used and the function of the chemicals:

Products (Chemicals)	Function
SARALINE 185 V, SARAPAR 147, ESCAID 110	Base Oil
Gilsonite	Fluid loss controller
Sodium Asphalt Sulfonate	Fluid loss controller
Sulphonated Asphalt	Fluid loss controller
Organophilic Lignite	Fluid loss controller
Organophilic bentonite	Viscosifier
Fatty Acid	Emulsifier
Lime (Calcium Hydroxide)	Activate emulsifier
Fresh Water	Help to dissolve salt
Salt (Calcium Chloride)	Alkalinity
Barite	Weighting agent
Rev-Dust	Contaminate the mud

Table 4: List of Chemicals.

3.3 GANTT CHART AND KEY MILESTONE OF THE PROJECT

The overall Gantt Chart and Key Milestone can be found at page 5. However the project's flow for the test is as follows:

First Step : Mixing the muds.

Seond Step : Test rheological properties and ES value.

Third Step : Prepare for hot-rolling.

Fourth Step : Hot-roll the mud for 16 hours.

Fifth Step : Cool down the mud.

Sixth Step : Test rheological properties and ES value after hot-rolling.

Seventh Step : Do HTHP test.

Below is the flow of the tests (with picture):

1) Weighting the chemicals.

Figure 6: Weighting the chemicals.

2) Mixing the samples.

Figure 7: Mixing the samples.

3) Let sample mix evenly.

Figure 8: The sample while mixing using Hamilton Beach mixer.

4) Test the initial properties of the sample.

Figure 9: Rheology test using Fann 35 Viscometer.

5) The emulsion stability test.

Figure 10: The emulsion stability test using ES meter.

6) Hot roll the samples at specific temperature.

Figure 11: Samples being hot roll in the oven.

7) HTHP test after hot-rolling.

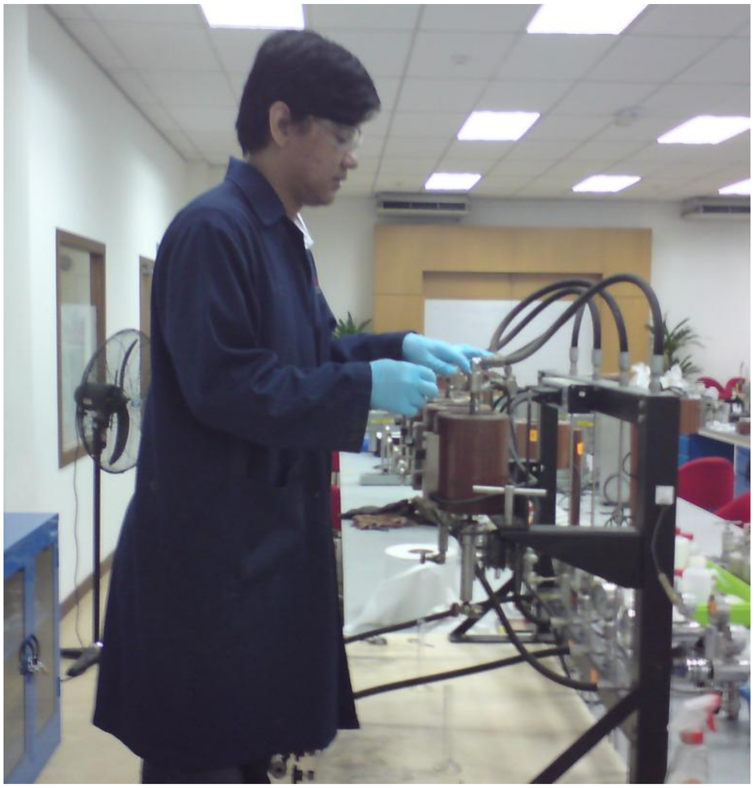
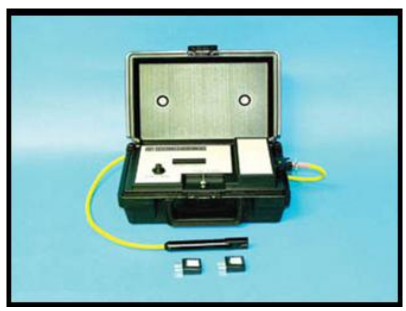


Figure 12: HTHP test using HTHP filter press.

3.4 LIST OF EQUIPMENTS

Below is the list of equipments that will be used in this project:

No.	Equipment	Picture	Function
1	Weighting Balance	 *Figure 13 : Weighting Balance*	This electronic device is used to measure and weigh the amount of the chemicals needed.
2	Hamilton Beach Mixer	 *Figure 14: Hamilton Beach Mixer*	This device is used to mix and stir the drilling muds. It has a solid agitator as the cutter.
3	Silverson Mixer	 *Figure 15: Silverson Mixer*	This is also one of the drilling muds mixers. It has different types of screen or heads to stir or mix the muds. Usually it is used for a larger amount of muds.

4	Fann 35 Viscometer	 *Figure 16: Fann 35 Viscometer*	This equipment is used to measure the rheological properties of the mud such as Plastic Viscosity (PV), Yield Point (YP) and Gel Strength.
5	Mud Balance	 *Figure 17: Mud Balance*	This mud balance is used to measure the mud weight or density.
6	Electrical Stability Meter	 *Figure 18: Electrical Stability Meter*	Emulsion Stability (ES) Meter can be used to measure the emulsion rate in the mud. This test is done only for oil-based mud or synthetic-based mud system.
7	Aging Cell	 *Figure 19: Aging Cell*	Apparatus that will be used to store drilling muds for hot-rolling.

8	Oven	 *Figure 20: Oven*	This rolling oven is used for hot-rolling the drilling muds. The hot rolling is the simulation of the condition at the wellbore.
9	Thermo Cup & Heating Jacket	 *Figure 21: Thermo Cup & Heating Jacket*	These apparatus is used in order to help in test the rheological properties of the muds. These equipments will be used along with the Fann 35 Viscometer.
10	Particle Size Analyzer	 *Figure 22: Particle Size Analyzer*	This electronic equipment is used to determine the particle size distribution of the chemicals.
11	High Temperature High Pressure Filter Press	 *Figure 23: HTHP Filter Press*	This filter press is used for filtration test and also to obtain mud cake. This test is done at high temperature and high pressure.

Table 5: List of Equipments

3.5 MUD FORMULATION

Below is the drilling fluid formulation for this project:

<table>
<tr><th>No.</th><th>Products</th><th>SG</th><th colspan="4">C</th><th colspan="4">NC</th><th colspan="4">C</th><th colspan="4">NC</th><th colspan="4">C</th><th colspan="4">NC</th></tr>
<tr><td rowspan="3">1</td><td>SARALINE 185</td><td>0.78</td><td colspan="4">163.56</td><td colspan="4">166.66</td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td></tr>
<tr><td>SARAPAR 147</td><td>0.77</td><td colspan="4"></td><td colspan="4"></td><td colspan="4">161.11</td><td colspan="4">164.11</td><td colspan="4"></td><td colspan="4"></td></tr>
<tr><td>ESCAID 110</td><td>0.8</td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4">167.74</td><td colspan="4">170.86</td></tr>
<tr><td rowspan="2">2</td><td>CONFI-MUL P</td><td>0.87</td><td colspan="4">3.0</td><td colspan="4">3.0</td><td colspan="4">3.0</td><td colspan="4">3.0</td><td colspan="4">3.0</td><td colspan="4">3.0</td></tr>
<tr><td>CONFI-MUL S</td><td>0.88</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td></tr>
<tr><td>3</td><td>CONFI GEL</td><td>1.7</td><td colspan="4">10.0</td><td colspan="4">10.0</td><td colspan="4">10.0</td><td colspan="4">10.0</td><td colspan="4">10.0</td><td colspan="4">10.0</td></tr>
<tr><td rowspan="5">4</td><td>WITHOUT FLC (BASE)</td><td></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td></tr>
<tr><td>GILSONITE</td><td>1.05</td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td></tr>
<tr><td>SAS</td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td></tr>
<tr><td>SA</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td></tr>
<tr><td>ORGANOLIG</td><td></td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td><td></td><td></td><td></td><td>6.0</td></tr>
<tr><td>5</td><td>LIME</td><td>2.3</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td><td colspan="4">9.0</td></tr>
<tr><td>6</td><td>Fresh Water</td><td rowspan="2">1.22</td><td colspan="4">69.9</td><td colspan="4">71.2</td><td colspan="4">69.75</td><td colspan="4">71.04</td><td colspan="4">70.15</td><td colspan="4">71.46</td></tr>
<tr><td>7</td><td>Calcium Chloride</td><td colspan="4">24.96</td><td colspan="4">25.43</td><td colspan="4">24.91</td><td colspan="4">25.37</td><td colspan="4">25.05</td><td colspan="4">25.52</td></tr>
<tr><td>8</td><td>DRILL BAR</td><td>4.28</td><td colspan="4">96.75</td><td colspan="4">119.94</td><td colspan="4">99.4</td><td colspan="4">122.64</td><td colspan="4">92.22</td><td colspan="4">115.33</td></tr>
<tr><td>9</td><td>REV DUST</td><td>2.6</td><td colspan="4">28.0</td><td colspan="4"></td><td colspan="4">28.0</td><td colspan="4"></td><td colspan="4">28.0</td><td colspan="4"></td></tr>
</table>

Table 6: Mud Formulation

Legend: 1) C – Contaminated Mud 2) NC – Non-Contaminated Mud 3) SA – Sulphonated Asphalt

4) SAS – Sosium Asphalt Sulfonate 5) ORGANOLIG – Organophilic Lignite

Note: This project was done at Scomi Oiltools – GRTC. Therefore all the chemicals' name is based on Scomi's name.

4.0 <u>RESULT AND DISCUSSION</u>

4.1 RESULT

Result for drilling fluids that had been tested using base oil SARALINE 185V:

TYPES OF MUD		BASE				GILSONITE				SAS				SA				ORGANOLIG			
Properties		C		NC		C		NC		C		NC		C		NC		C		NC	
		BHR	AHR	BHR	AHR	BHR	AHR	BHR	AHR	BHR	AHR	BHR	AHR	BHR	AHR	BHR	AHR	BHR	AHR	BHR	AHR
1	Mud weight	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
2	Rheology (^{O}F)	120	120	120	120	120 F	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
	600	69	66	67	63	72	67	65	63	71	66	62	61	69	64	58	57	69	63	58	57
	300	45	43	44	42	49	45	44	43	48	44	42	41	46	44	39	38	47	44	39	38
	200	36	34	35	33	38	36	36	35	37	34	32	32	39	38	31	26	38	37	31	25
	100	25	23	24	22	31	29	29	27	30	27	24	24	31	29	22	17	31	28	23	16
	6	11	10	11	9	15	13	14	12	15	14	13	12	14	13	10	7	14	12	11	7
	3	10	9	10	8	14	12	13	11	14	13	12	11	13	12	9	6	13	11	10	5
3	**PV**	24	23	23	21	23	22	21	20	23	22	20	20	23	20	19	19	22	19	19	19
4	**YP**	21	20	21	21	26	23	23	23	25	22	22	21	23	24	20	19	25	25	20	19
5	Gel 10 sec	14	11	12	10	18	15	17	15	68	57	65	63	62	55	58	54	61	47	48	44
6	Gel 10 min	22	22	20	18	24	19	21	20	77	69	75	74	71	62	63	59	71	51	54	51
7	ES	835	563	1003	911	968	754	1018	908	918	679	993	869	729	525	798	641	744	461	813	634
8	HTHP (500 psi, 250 F)	-	6	-	6.4	-	2	-	2.2	-	3.4	-	3.8	-	3.6	-	4	-	3.6	-	3.8

Table 7: Result using SARALINE 185V as Base Oil

Legend: 1) C – Contaminated Mud 2) NC – Non-Contaminated Mud 3) BHR – Before Hot-Roll 4) AHR – After Hot-Roll

5) SA – Sulphonated Asphalt 6) SAS – Sosium Asphalt Sulfonate 7) ORGANOLIG – Organophilic Lignite

Result for drilling fluids that had been tested using base oil SARAPAR 147:

TYPES OF MUD		BASE				GILSONITE				SAS				SA				ORGANOLIG			
Properties		CONTAMINATE		NON-CONTAMINATE		CONTAMINATE		NON-CONTAMINATE		CONTAMINATE		NON-CONTAMINATE		CONTAMINATE		NON-CONTAMINATE		CONTAMINATE		NON-CONTAMINATE	
		BHR	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**
1	Mud weight	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**
2	Rheology (^{O}F)	**120**	**120F**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**	**120**
	600	**64**	**61**	**62**	**58**	**67**	**62**	**60**	**58**	**66**	**61**	**58**	**56**	**64**	**59**	**53**	**52**	**64**	**58**	**53**	**52**
	300	**40**	**47**	**39**	**37**	**44**	**40**	**39**	**38**	**43**	**39**	**37**	**36**	**41**	**39**	**34**	**33**	**42**	**39**	**34**	**33**
	200	**31**	**29**	**30**	**28**	**33**	**31**	**31**	**30**	**32**	**29**	**24**	**27**	**34**	**33**	**26**	**21**	**33**	**32**	**26**	**20**
	100	**20**	**17**	**19**	**17**	**26**	**24**	**24**	**22**	**25**	**22**	**19**	**19**	**26**	**24**	**17**	**12**	**26**	**23**	**18**	**11**
	6	**9**	**8**	**9**	**7**	**13**	**11**	**12**	**10**	**13**	**12**	**12**	**10**	**12**	**11**	**8**	**6**	**12**	**10**	**9**	**6**
	3	**8**	**7**	**8**	**6**	**12**	**10**	**11**	**9**	**12**	**11**	**10**	**9**	**11**	**10**	**7**	**5**	**11**	**9**	**7**	**4**
3	**PV**	**24**	**14**	**23**	**21**	**23**	**22**	**21**	**20**	**23**	**22**	**21**	**20**	**23**	**20**	**19**	**19**	**22**	**19**	**19**	**19**
4	**YP**	**16**	**33**	**16**	**16**	**21**	**18**	**18**	**18**	**20**	**17**	**16**	**16**	**18**	**19**	**15**	**14**	**20**	**20**	**15**	**14**
5	Gel 10 sec	**13**	**10**	**11**	**9**	**17**	**14**	**16**	**14**	**67**	**56**	**64**	**62**	**61**	**54**	**57**	**53**	**60**	**46**	**47**	**43**
6	Gel 10 min	**21**	**21**	**19**	**17**	**23**	**18**	**20**	**19**	**76**	**68**	**74**	**73**	**70**	**61**	**62**	**58**	**70**	**50**	**53**	**50**
7	ES	**869**	**512**	**986**	**893**	**932**	**687**	**982**	**866**	**872**	**591**	**923**	**781**	**683**	**494**	**742**	**590**	**699**	**422**	**786**	**597**
8	HTHP (500 psi, 250 F)	**-**	**7**	**-**	**7.2**	**-**	**2.4**	**-**	**2.6**	**-**	**3.8**	**-**	**4**	**-**	**3.8**	**-**	**4.2**	**-**	**3.8**	**-**	**4.2**

Table 8: Result using SARAPAR 147 as Base Oil

Legend: 1) C – Contaminated Mud 2) NC – Non-Contaminated Mud 3) BHR – Before Hot-Roll 4) AHR – After Hot-Roll

5) SA – Sulphonated Asphalt 6) SAS – Sosium Asphalt Sulfonate 7) ORGANOLIG – Organophilic Lignite

Result for drilling fluids that had been tested using base oil ESCAID 110:

TYPES OF MUD		BASE				GILSONITE				SAS				SA				ORGANOLIG			
Properties		**CONTAMINATE**		**NON-CONTAMINATE**		**CONTAMINATE**		**NON-CONTAMINATE**		**CONTAMINATE**		**NON-CONTAMINATE**		**CONTAMINATE**		**NON-CONTAMINATE**		**CONTAMINATE**		**NON-CONTAMINATE**	
		BHR	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**	**BHR**	**AHR**
1	Mud weight	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
2	Rheology	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F	120 F
	600	58	55	55	53	64	61	62	59	63	60	60	58	61	58	59	57	61	58	59	57
	300	36	34	35	34	42	40	40	39	41	40	41	40	38	36	39	38	38	36	39	38
	200	25	21	23	19	37	31	32	29	33	31	33	29	31	32	32	31	31	25	32	31
	100	19	17	18	15	26	23	24	21	25	24	25	22	23	24	24	24	22	18	24	23
	6	8	7	8	6	14	11	12	10	13	12	13	10	12	10	10	8	12	9	10	8
	3	7	6	7	15	13	10	10	9	12	11	11	9	11	9	9	7	10	8	9	7
3	**PV**	22	21	20	19	22	21	22	20	22	20	19	18	23	22	20	19	23	22	20	19
4	**YP**	14	13	15	15	20	19	18	19	19	20	22	22	15	14	19	19	15	14	19	19
5	Gel 10 sec	10	9	10	7	16	14	14	12	65	53	64	51	54	49	53	46	54	49	52	43
6	Gel 10 min	21	19	20	16	23	19	20	18	71	65	70	63	69	59	67	56	69	59	67	55
7	ES	805	541	969	895	927	723	986	883	895	647	961	841	697	493	762	610	723	421	784	609
8	HTHP (500 psi, 250 F)	-	7.2	-	7.4	-	2.4	-	2.6	-	3.8	-	4	-	4	-	4.2	-	4	-	4.2

Table 9: Result using ESCAID 110 as Base Oil

Legend: 1) C – Contaminated Mud 2) NC – Non-Contaminated Mud 3) BHR – Before Hot-Roll 4) AHR – After Hot-Roll

5) SA – Sulphonated Asphalt 6) SAS – Sosium Asphalt Sulfonate 7) ORGANOLIG – Organophilic Lignite

4.2 DISCUSSION AND ANALYSIS

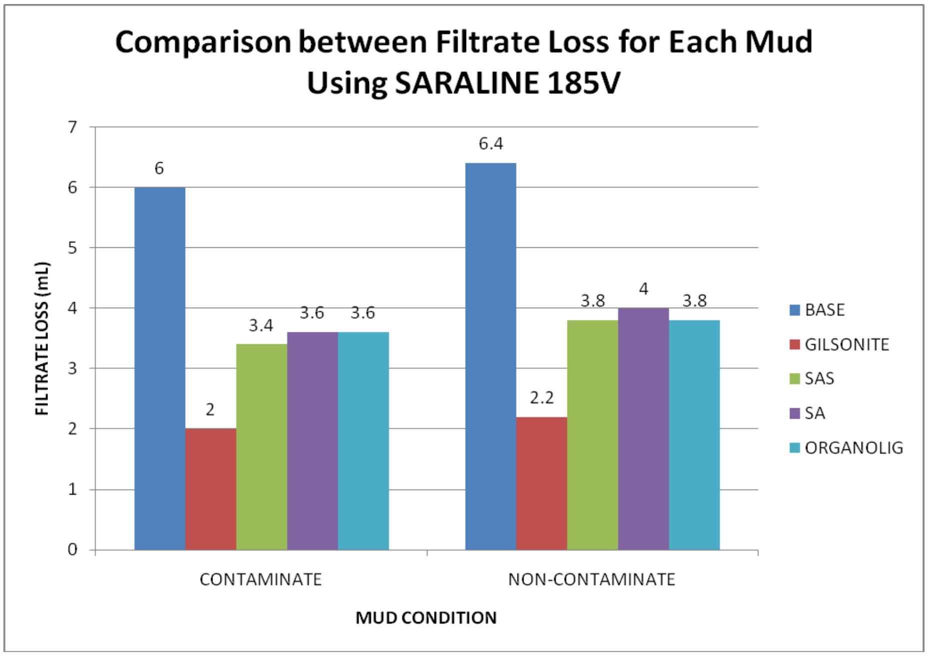


Figure 24: Comparison between Filtrate Loss for Each Mud Using SARALINE 185V

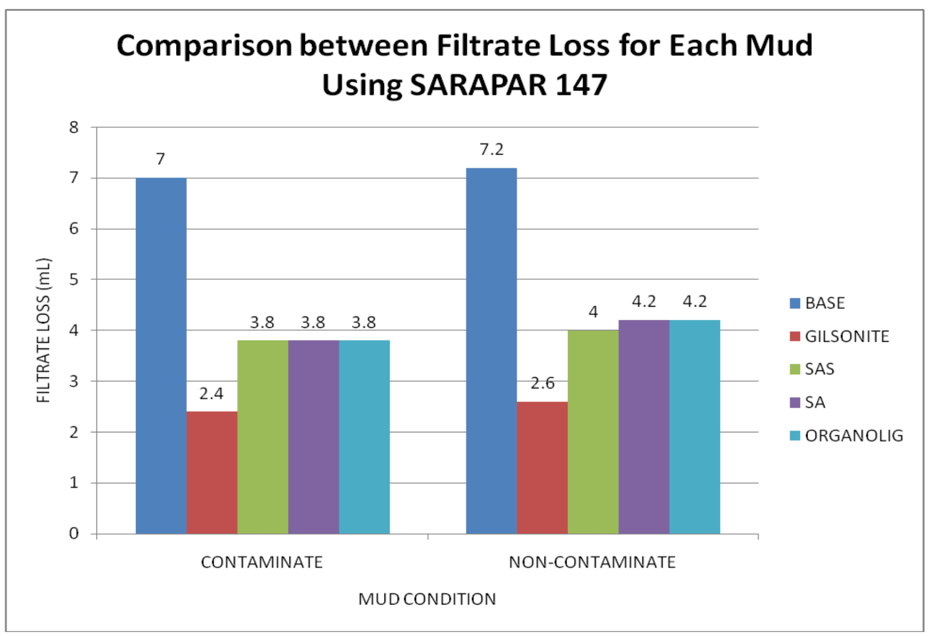


Figure 25: Comparison between Filtrate Loss for Each Mud Using SARAPAR 147

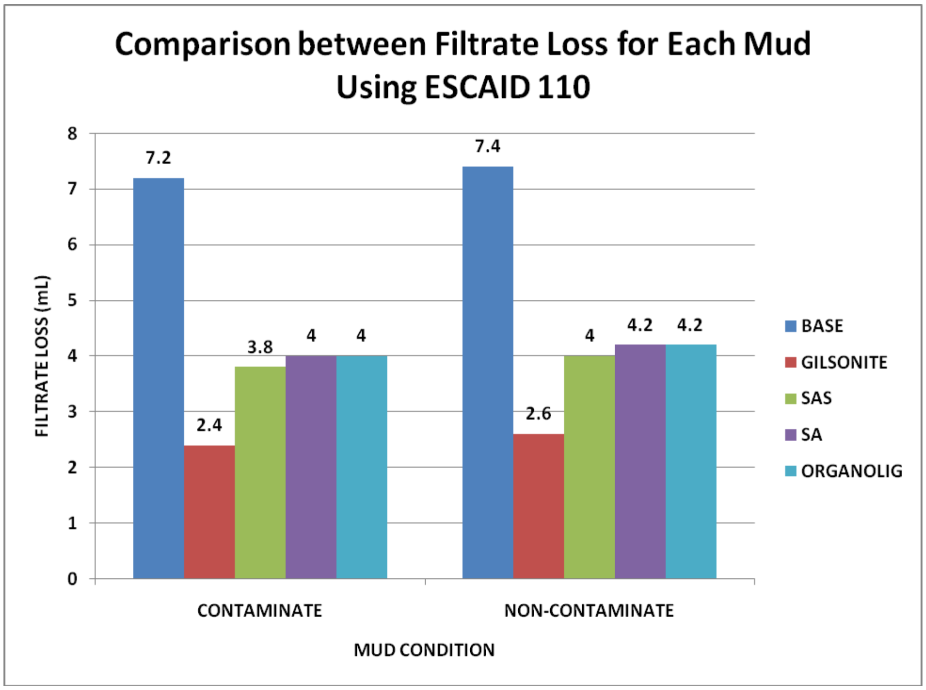


Figure 26: Comparison between Filtrate Loss for Each Mud Using ESCAID 110

1) From the above graphs, we can see that muds that do not have any fluid loss control additives give the highest value of filtrate loss collection. This is because in this base muds there is no chemicals that act as prevention chemicals to control the fluid loss and it is significantly that we need fluid loss control additives in drilling fluids.

2) We can also see that muds that are contaminated with some solids give the lower value than the one that are not contaminated with solids. This is because when the muds system has additional solids, it is actually helps to prevent the fluid loss.

3) Of all four (4) additives, gilsonite gives the best value in terms of fluid loss control. This is because gilsonite is proved to be one of the best chemicals in helping to reduce fluid loss.

4) The values for fluid loss collected for all four chemicals are quite good and not to high. It shows that all chemicals can be used as fluid loss control agent.

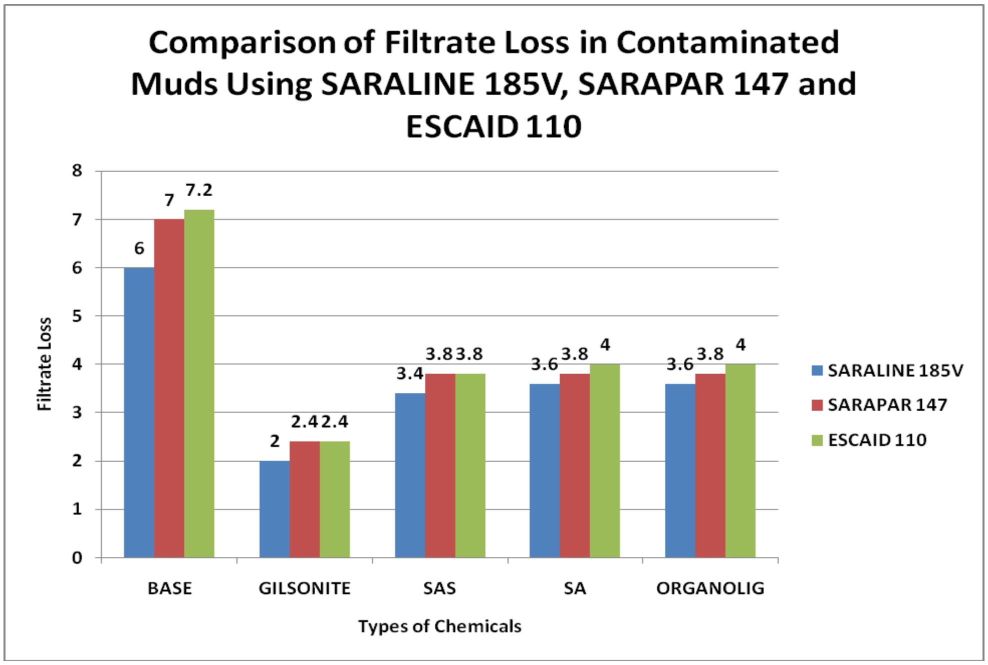


Figure 27: Comparison of Filtrate Loss in Contaminated Muds Using SARALINE 185V, SARAPAR 147 and ESCAID 110

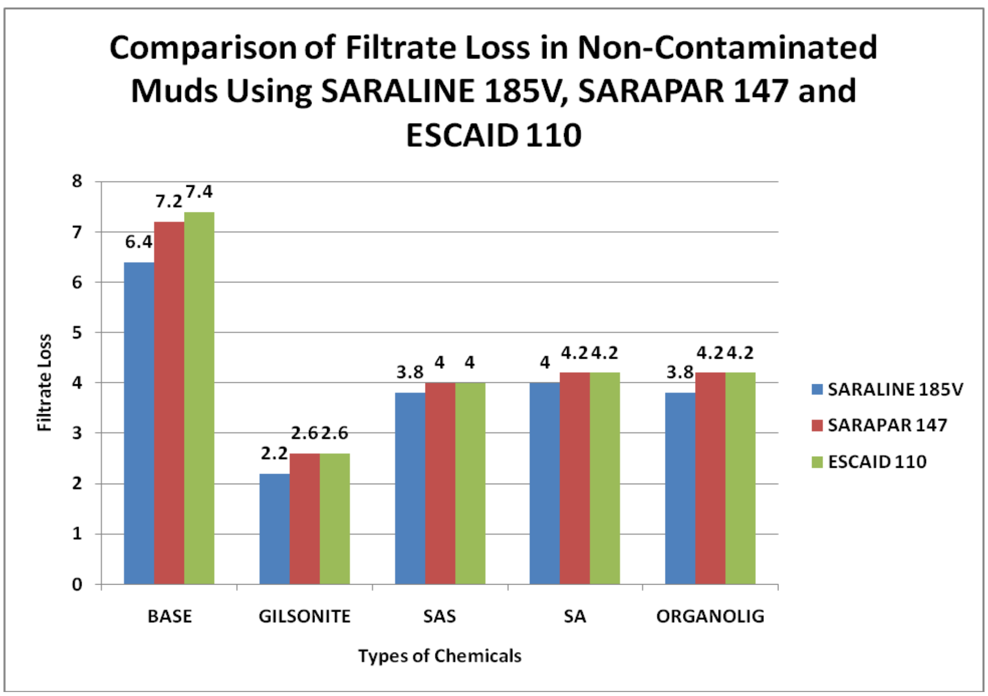


Figure 28: Comparison of Filtrate Loss in Non-Contaminated Muds Using SARALINE 185V and SARAPAR 147

5) From Figure 27 and Figure 28, we can see that for both contaminated and non-contaminated muds, muds that used SARALINE 185V as base oil gives the best result in terms of filtrate loss. This is probably because SARALINE 185V is cleaner than SARAPAR 147 and ESCAID 110. Besides that, research shows that SARALINE 185V have higher performance while compared to the other two base oils.

6) However, this is not proved that SARALINE 185V is always the best choice. In this case, SARALINE 185V is the best based on the initial mud condition which are: 10 lb/gal of mud weight, at 75:25 oil water ratio, 25% Wt $CaCl_2$.

7) As expected, the samples that do not have fluid loss control reducer in this case the base samples, gives the highest value of fluid loss collected.

8) The purpose of contaminate the samples with REV-DUST is to simulate the real condition at the wellbore. This is because when we drill and insert the mud into the wellbore, there will be some solids that will mix with mud. The solids will be brought to the surface.

9) Therefore, from the result that had been collected so far, we can see that the contaminated muds, gilsonite and SARALINE 185V gives the best result in terms of fluid loss collected.

4.2.1 Error Analysis

1) In this experiment, there are a few human errors. The first one may be the accuracy while weighting the chemicals. Sometimes the readings are not really accurate and it can be affected by the surrounding such as air flow.
2) The next error is parallax error while taken the measurement of rheological properties and also the fluid loss collected. While taking the rheological

values, the indicators sometimes move too fast and the measurement are based on assumptions.

3) The reading of fluid loss collected in the measurement cylinder can be fault due to the eyes condition. The eyes and the meniscus should be parallel in order to get accurate value.

4) Besides that, the mud itself sometimes is not mix properly. This is due to the mixing time. Sometimes the muds are mixed too long and sometimes too short in time.

5) Another error would be the machine error. For this experiment, there are a lot of equipments used such as Fann 35 Viscometer, HTHP Filter Press, ES meter and others equipment. Sometimes, the equipments itself are not working properly or perhaps it has not been calibrated yet before the testing. Due to this, the values obtained from the equipments can be not really accurate.

5.0 CONCLUSION

In conclusion, from the result that had been collected, we can see the differences between all four (4) chemicals that act as fluid loss additives in the drilling fluids. All of them give different values but very close to each other. All of the chemicals also proved to be good chemicals in helping to reduce fluid loss in the muds.

Besides that, we can also see that the base oil used gives some impact to the data collected. So far, SARALINE 185V gives the lowest value in terms of fluid loss given the specific conditions. We can also see that there are some differences in the values of the data between the contaminated muds and non-contaminated muds. It is proved that the contaminated muds give the lowest value in terms of fluid loss collection.

All in all, this project is done within the time frame and the progress is good. All of the objectives stated below have been achieved which are:

1) To compare the result of fluid loss control additives in terms of the amount of filtrate collection based on the condition: 10 lb/gal mud weight, 75:25 OWR and 25% Wt $CaCl_2$.

2) To determine which base oil gives the best result in terms of fluid loss control additives performance.

3) To compare the fresh mud and also contaminated mud (contaminated mud means the mud will be added with some solids such as cuttings from the rig).

5.1 Recommendation

1) Further testing and evaluation can be done to improve the data collection. To ensure that the data is accurate, the reading for each test should be done three times.

2) Besides that, to see the variation of the data, the oil water ratio can be changed. For example, use 80:20 OWR or 70:30 OWR.

3) The salinity for this test also can be changed for example use 20% Wt $CaCl_2$. This is to see the changes in the data. The tests that have been done before is only based on one condition. Thereofre, we can change the mud condition to prove that gilsonite and base oil SARALINE 185V are the best option.

6.0 REFERENCES

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7.0 APPENDICES

Figure 29: Picture of Sulphonated Asphalt

Figure 30: Picture of Organophilic Lignite

Figure 31: Picture of Sodium Asphalt Sulfonate

Figure 32: Picture of Gilsonite