

Utilization of Crude Oil as an Alternative Oil Base Mud Drilling Operation by “VICOIL” Standard Drilling Simulation Rig in MGTM Well UPN “Veteran” Yogyakarta Education Park Mineral Geotechnology Museum Field

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Manuscript received: May, 18th 2021; Revised: July, 9th 2021

Approved: August, 30th 2021; Available online: September, 2nd 2021

ABSTRACT - Shale is one of the rocks that often causes drilling problems because shale tends to swell or swell when in contact with mud filtrate, mainly Water-base Mud (WBM). This study aims to determine how the performance of Oil-base Mud (OBM) based on Crude Coconut Oil (CCO) in overcoming the swelling problem. The methodology used consists of drilling simulation and cutting analysis in the X-Ray Diffraction (XRD) laboratory. The series of activities in the study began with the preparation of rock layers, followed by testing the penetration rate using Water-base Mud as a comparison. After cutting analysis was carried out in the XRD laboratory of UPN “Veteran” Yogyakarta with the Rigaku tool, then replaced the type of drilling fluid Oil-base Mud with basic materials alternative to Crude Coconut Oil (CCO) and followed by a penetration test. Rate of Penetration (ROP) test results from WBM with Rheology 1 at interval A or a depth of 1.96 ft-4.92 ft is 442.8 ft/h, Rheology 2 at interval B or a depth of 4.92-10.5 ft is 118.5 ft/hr on the first day. Swelling occurred and resulted in pipe sticking at depth of 6.5 ft. Based on the Bulk Mineral analysis, clay mineral content is 23.84%. Based on the Clay Oriented, smectite dominates the clay by 29.09%. Based on MBT, shale belongs to class B (illite and mixed-layer montmorillonite illite), where this mineral can expand. Based on a Geonor As test, 5.18% of the cutting can develop when exposed to water. The drilling fluid was replaced with Oil-base Mud based on alternative Crude Coconut Oil (CCO), and obtained ROP Rheology 1 at Interval A of 492 ft/h and Rheology 2 at Interval B of 480 ft/h. The results of the Compressive Strength test interval A on the first, third, and fifth days were 31,699 psi, 42,265 psi, and 52,831 psi. The results of the Compressive Strength test interval B on the first, second, and third days were 31,496 psi, 41,517 psi, and 52,971 psi. Based on clay mineral analysis and magnitude of ROP value, is known that Crude Coconut Oil (CCO) based Oil-base Mud is effective because during the simulation, there are no drilling problems, and the resulting ROP value is greater than the first day Water-base Mud.

Keywords: Swelling, Minerals, Crude Coconut Oil, Oil Base Mud, Rate of Penetration

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How to cite this article:

KRT Nur Suhascaryo, Endah Wahyurini, and Yuan C. Guntoro, 2021, Utilization of Crude Oil as an Alternative Oil Base Mud Drilling Operation by “VICOIL” Standard Drilling Simulation Rig in MGTM Well UPN “Veteran” Yogyakarta Education Park Mineral Geotechnology Museum Field, Scientific Contributions Oil and Gas, 44 (2) pp., 123-139.

INTRODUCTION

Each type of drilling fluid has character, mainly in controlling hydrostatic pressure, which will affect the rate of penetration or Rate of Penetration (ROP) and its role in minimizing problems during drilling.

Two drilling mud systems, namely water-base mud and oil-base mud. Some of the categories include air, water, and oil. Drilling mud depends on its physical and chemical properties. Problems are often found in the water-base mud (WBM), mainly in the shale

zone. Drilling-grade bentonite is a naturally occurring clay containing the clay minerals of smectite. It can also contain accessory minerals, such as quartz, mica, feldspar and calcite. Shale layer swells or peels off when it comes into contact with water-based drilling mud. By definition, a high performance water-based system is supposed to emulate the performance of an invert fluid while eliminating most, if not all, of the risk and cost associated with managing wastes generated while drilling with invert emulsion systems.

Rate of penetration (ROP) is the volume of rock crushed per unit area (ft) per unit time (hours), or it can also be interpreted as the bit rate destroying the rock to be penetrated and in general ROP measures the speed or progress of the bit when drilling. The compressive strength is equal to the sum of the uniaxial compressive stresses, when the element under consideration is completely disconnected. Shale is a type of rock whose constituent minerals are mostly clay minerals. Swelling and sloughing are influenced by the mineral content in shale itself and the reactivity value of the clay. It is agreed on by many researchers that the methylene test is one of the most accurate and quickest methods in detecting clay minerals in aggregate fines. In drilling operation, there is direct contact between the circulating mud and the walls of the wellbore, resulting in a reaction that affects the properties of the mud, especially in drilling on shale or clay formation (argillaceous). The hydration phenomenon is caused by the interaction between drilling mud and argillaceous formation, which causes an increase in bulk volume of rock and expansion pressure. The conditions identified include the occurrence of sloughing, heaving, expansion (tight hole) and gradual hole enlargement and caving.

The use of oil-base mud has an unfavorable environmental impact, so that in several countries, regulations regarding its use have been enacted. Oil-base mud is more expensive than water-base mud. Coconut Crude Oil (CCO) or coconut oil is used as an alternative to mud oil-base hoping that the drilling operation process can be more effective. Coconut Oil or Crude coconut oil (CCO) is a processed product from coconut meat in the form of a clear liquid, tasteless liquid with a distinctive coconut odor. Crude coconut oil does not require expensive, because the raw materials are easy to obtain at low

prices and simple processing. Pure coconut oil has chemical-physical properties, including organoleptic (colorless and needle-like crystals) and odor (there is a slightly sour smell plus a caramel smell). The solubility of CCO is insoluble in water, but soluble in alcohol (1:1). The specific gravity is 0.883 at 20°C. The percentage of evaporation is that CCO does not evaporate at a temperature of 21°C (0%). The melting point is 20-25°C, boiling point: 225°C, and the density of air (Air=1): 6.91. Vapor pressure (mmHg) is one at 121°C. CCO processing methods include fermentation methods, gradual heating, centrifugation, acidification and inducement.

X-Ray Diffraction (XRD) is an analytical method that is effective in describing rocks and certain chemical compounds in solid form by using X-ray diffraction/reflection. The basic law of using X-ray diffraction refers to Bragg's Law which is written with the formula $n\lambda = 2d \sin \theta$ where n is the order of fraction (1,2,3,... n), λ is the wavelength (Å), d is the thickness of the unit cell, and θ is the diffraction angle.

This research aims to determine the performance of Crude Coconut Oil as an alternative material Oil-base Mud in overcoming swelling problems. The methodology used consists of drilling simulation and cutting analysis. The series of activities in the study began with the preparation of rock layers, penetration rate using Water-base Mud, cutting analysis was conducted in the X-Ray Diffraction Laboratory, Methylene Blue Test, and Geonor As analysis, then replaced the type of drilling fluid Oil-base Mud with alternative base material Crude Coconut Oil and continued with the penetration rate test.

A. Literature Review

1. Drilling Mud

Drilling mud or fluid is a fluid that circulates in rotary drilling, which has various functions required in drilling operations. The type of drilling mud that is in accordance with the characteristics of the well will support the success of the drilling operation, especially on the flow pattern and drilling speed and the successful removal of cuttings to the surface (Coussot *et al.*, 2004; Saasen *et al.*, 2002).

There are two drilling mud systems, namely water base mud and oil base mud. Zaba & Doherty (1970) classified drilling mud mainly based on the fluid phase: water (water base), oil (oil base) or gas.

2. X-Ray Diffraction (XRD) – Bulk Mineral

X-ray diffraction is a tool used to determine the mineralogy of sedimentary rocks. Monocromatic x-ray rays that penetrate the mineral grains, will be scattered by the atoms that make up the mineral. At a certain angle, the scattered x-ray beam will produce a secondary beam. This phenomenon is called diffraction. This relationship is written in the Bragg equation:

$$N\lambda = 2d \sin \theta$$

Description:

d = Basal spacing.

n = Fraction order (1, 2, 3,.....n)

λ = Wave length, Å

θ = Shooting angle, °

Furthermore, to calculate the percentage of minerals in the sample, the following equation is used:

$$A = \frac{I_A}{(I_A + I_B + \dots + I_n)} \times 100\% \quad (1)$$

Description:

A = Percent mineral (%)

I = Shooting intensity (cps)

3. Coconut Crude Oil (CCO)

Coconut Oil or Crude coconut oil (CCO) is a processed product from coconut meat in the form of a clear, tasteless liquid with a distinctive coconut odor. The manufacture of Crude coconut oil does not require expensive costs, because the raw materials are easy to obtain at low prices and simple processing. Pure coconut oil has chemical-physical properties, including organoleptic (colorless and needle-like crystals) and odor (there is a slight sour smell plus a caramel smell). The solubility of CCO is insoluble in water, but soluble in alcohol (1:1). The specific gravity is 0.883 at 20°C. The percentage of evaporation is that CCO does not evaporate at a temperature of 21°C (0%). The melting point is 20-25°C, boiling point: 225°C, and the density of air (Air=1): 6.91. Vapor pressure (mmHg) is 1 at 121°C.

4. "VICOIL" Standard Drilling Simulation Rig

The "VICOIL" standard drilling simulation rig consists of a power system using a Honda C70

engine and a Dexta Cam Starter generator type QS5-15P/3. The Honda C70 engine has 71.8 cc engine specifications, type OHC, 4 stroke air conditioning, performance 6 hp @ 9000 rpm (power), 0.53 kg.m @ 7000 rpm (torque). The generator has 500V and 15A specifications. The supporting structure made of steel construction with a height of 3 meters, an area of 4 m² (bottom) and 2 m² (top). The substructure is made of an arrangement of 24 iron pipes measuring 1.25 inches with an area of 16 m². The substructure is equipped with a cat walk with a height of 4 m and an iron construction ladder consisting of 15 steps. Rig floor has an area of 16 m² of iron plate. On the hoisting equipment there is a modified drawwork made of the Honda C70 frame with dimensions of 1,805 mm (length), 685 mm (width), 995 mm (height). Suspension in the form of swing arm, double shockbreaker (front), leading link, and 2.2 inch travel (rear). Drum type brakes to help control speed. Rear tire size 2.50 – 17 - 6 PR. The overhead tool consists of a 12 cm diameter crown block, a modified hook with a direct drilling line belay, a modified traveling block with a rectangular shape measuring 1 m long, 15 cm wide and 30 cm high. The drilling line consists of a fast line made of steel rope. The rotary assembly consists of a square turntable with a side length of 30 cm. The turntable is connected to the generator via a belt on a 15 in diameter gear. The master bushing is square with a side length of 16 cm. Kelly bushings are rectangular in shape with a side length of 4 cm. The drill pipe series consists of a rectangular Kelly with a length of 9.8 ft, a drill pipe in the form of a 1.25 inch steel pipe with a length of 5.58 ft, and a modified drill collar in the form of a steel pipe thread measuring 1.25 inch with a length of 8.2 ft. The chisel (bit) is a modified drag bit with a steel cutter bit type with a three-blade design with a diameter of 4 inches. The preparation area for the circulation system consists of a tandone brand mud tank with a capacity of 350 liters equipped with a dynamo-powered agitator to stir the drilling fluid in the mud tank. Modern brand dynamo with type JY09A-4 with specifications HP, 220V, 50 HZ, 2.36A, 1400 RPM. The circulation equipment consists of a Shimizu brand mud pump model PS-226 BIT in the form of a water pump with a specification rate of 0.069 bpm to 0.176 bpm. The conditioning area consists of a rectangular shale shaker with a double-layered iron wire filter measuring 30 cm wide and 40 cm long. There are setting tanks with a capacity of 70 liters used to accommodate mud during the conditioning area. The settling tanks are equipped with an International type DB-125 water pump with a specification rate of 0.176 bpm.

DATA AND METHODS

The method in this research is drilling simulation and laboratory test with the following steps:

1. Arrangement of rock layers

The preparation of this layer is intended to determine the effect of rock layer compactness on the penetration rate with drilling mud.

2. Preparation of WBM

Preparation of water-base mud (WBM) which will be used for drilling and acts as a comparison for OBM made from CCO.

3. Rate of penetration

This test was carried out using a standard drilling simulation rig, VICOIL, located at the Mineral

Geotechnology Museum Park, UPN “Veteran” Yogyakarta. The drilling simulation tower is equipped with four drilling systems with modifications.

4. Cutting analysis

Cutting analysis was carried out using the X-Ray Diffraction method with the Rigaku tool.

X-ray diffraction bulk mineral analysis

X-ray diffraction analysis using bulk minerals is used to see the mineral content contained in the sample. X-ray diffraction is a tool used to determine the mineralogy of sedimentary rocks. Monochromatic x-ray rays that penetrate the mineral, will be scattered by the atoms that make up the mineral. At a



Figure 1
“VICOIL” standard drilling simulation rig.

certain angle, the scattered x-ray will produce a secondary ray.

X-ray diffraction clay oriented

After the mineral content based on bulk minerals is known and if there is clay content, it must be continued with X-ray diffraction analysis using bulk minerals to see the clay content in bulk minerals.

Methylene blue test

The methylene blue (MBT) test was carried out to determine the cations that could be found and had indications of flake reactivity and

swelling tendency. Based on the MBT value, the value of the cation exchange capacity will be obtained, which will later be used to determine the appropriate type of shale.

Geonor As

The mechanism of this test is sedimentation to see the large percentage of clay to swell when in contact with water.

5. Analysis of drilling problems is carried out based on data obtained during cutting analysis in the laboratory.

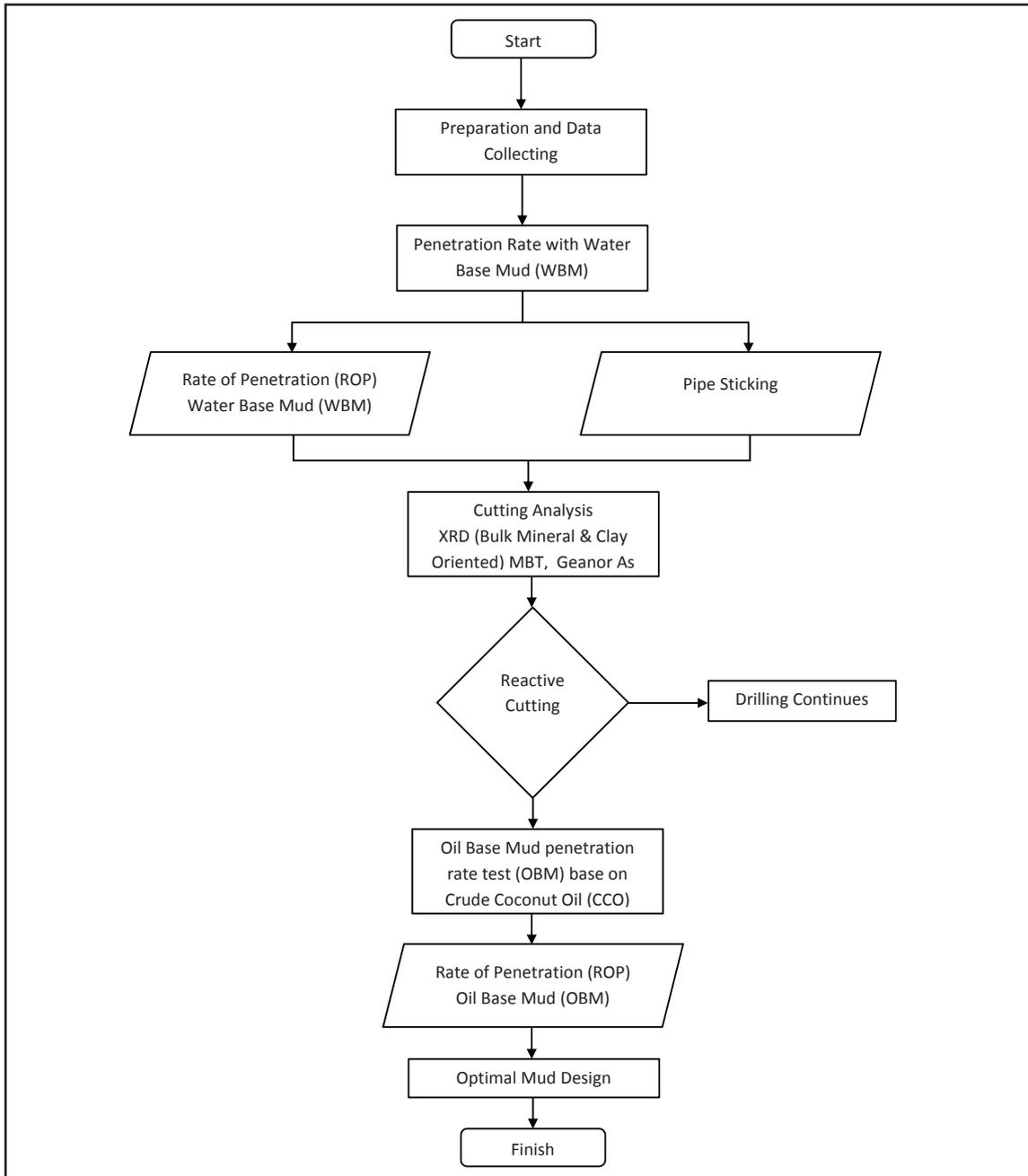


Figure 2
 Flow chart.

6. Change of oil-base mud drilling mud type and determination of drilling mud composition

Change a drilling mud and determine the composition of the drilling mud by identifying the potential problems seen from the XRD readings and also the target physical properties of the drilling mud to be achieved.

7. The physical properties of an effective Coconut Crude Oil-based oil-based mud can be determined based on the results of the penetration rate test with the “VICOIL” standard drilling simulation tower.

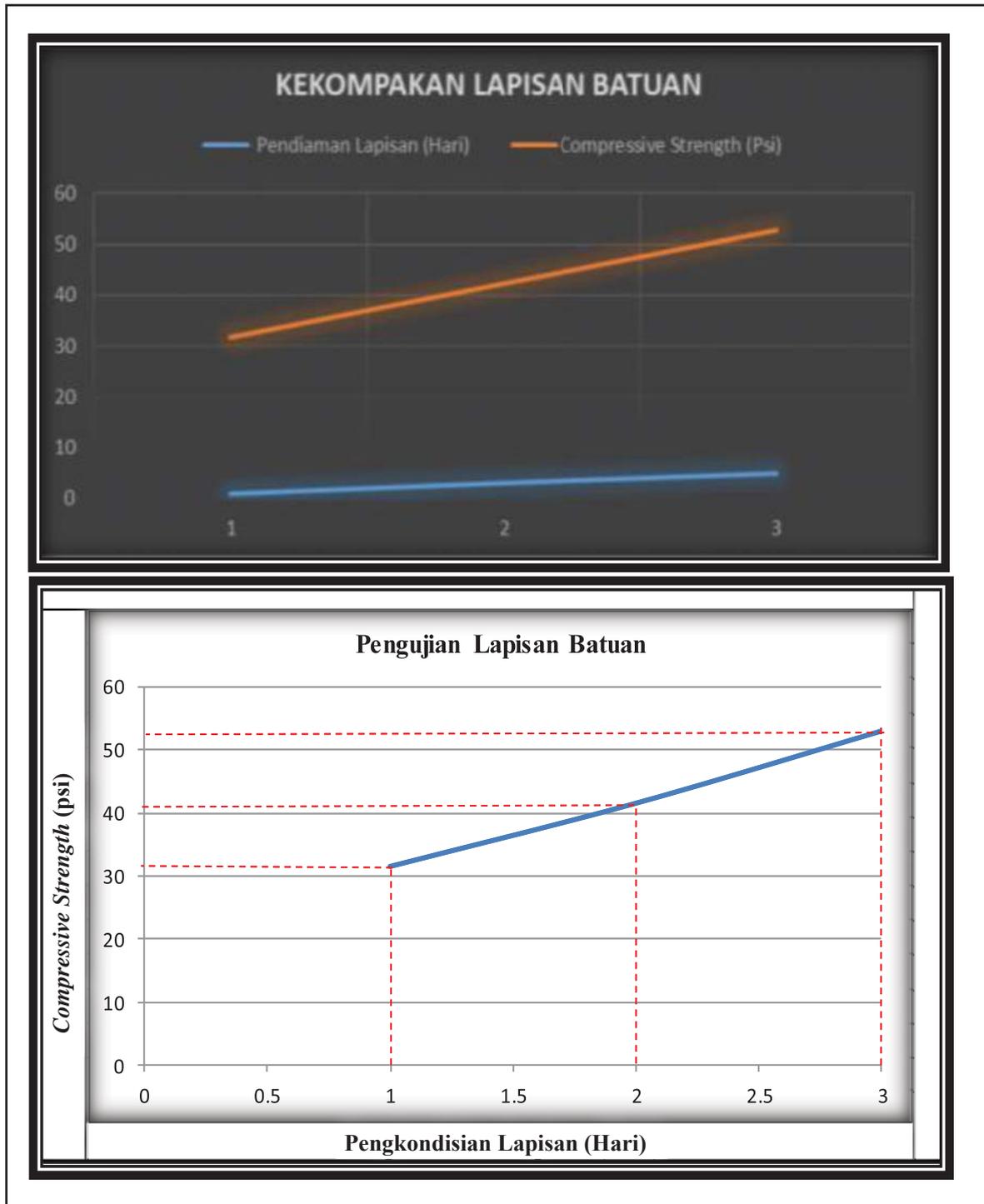


Figure 3
Comparison of compressive strength to well Layer A (left) and B (right) conditioning.

RESULTS AND DISCUSSION

A. Drilling Simulation by “VICOIL” Standard Drilling Simulation Rig

1. Arrangement of Rock Layer

In the simulation well, there are 2 rock layers were arranged in the form of shale and sandstone. First rock layers or interval A on depth 1.96-4.92 ft with a composition consisting of 6.6 kg or 37 % bentonite, 5.5 kg or 49 % sand, and 1.7 kg or 14 %. Second rock or interval B layer on depth 4.92-10.5 ft with a composition consisting of 23.1 kg or 41% bentonite, 27.5 kg or 42% sand, and 8.5 kg or 17% cement. This simulation are conducted 6 shale layers, where 2 insert shale lies at the middle and bottom of interval A and 4 layers of shale on interval B at of 6 ft - 6.6 ft, 6.8 ft - 7.5 ft, 7.7 ft - 8.3 ft, and 8.5 ft - 8.8

ft. The results of the Compressive Strength interval A testing on the first, third and fifth day is 31,699 psi, 42,265 psi, and 52,831 psi. The results of the CS interval B testing on the first, second and third day is 31,496 psi, 41,517 psi, and 52,971 psi. Composition WBM of A and B listed on Table 1.

2. Penetration Rate Testing with Water Base Mud (WBM)

The rock layer testing was carried out after the rock layers were arranged in the simulation well using “VICOIL” standard drilling simulation rig. The fixed WOB value used is 7.136 lb for interval A and 32.34 lb for interval B, the RPM fixed value is 147 rpm. The drilling pump used has a rate of 0.069 bpm. The volume of drilling mud used in this simulation is 17.85 liters interval A and 38.92 liters interval B. During testing with WBM, a pipe sticking problem

Table 1
 Composition of water base mud (WBM) simulation

Composition Of Water Base Mud A and B				
Interval A		Interval B		
Ingredients	Amount			
Water	17.85 liter	38.92		liter
Bentonite	1147.5 gram	2502		gram
KOH	25.5 gram	55.6		gram
PAC-L	127.5 gram	336.6		gram
PAC-R	127.5 gram	336.6		gram
KCL	255 gram	667.2		gram

Table 2
 Comparison of WBM rheology test results

Rheology Water Base Mud Comparison by “VICOIL” Drilling Simulation Rig					
No.	Properties	Rheology 1	Rheology 2	API Spec	Unit
1	<i>Mud Weight</i>	8.6	8.9	8.8 - 9.6	ppg
2	<i>Plastic Viscosity</i>	13	10	10-Aug	cp
3	<i>Yield Point</i>	12	14	< 24	lb/100 ft ²
4	<i>Gel Strength (10 sec/ 10 min)</i>	2-Jan	4-Feb	2-3/ 4-5	lb/100 ft ²
6	<i>Filtration loss</i>	6.8	6.2	< 15	ml/30 min
7	<i>Filter Cake Thickness</i>	0.285	0.22	< 4	mm
8	pH	9	10	9.5 - 11.5	

occurred in the bottom of interval A and at a depth of 7 ft and 8 ft from the surface. There are WBM rheology 1 for interval A and rheology 2 for interval B are shown on Table 2.

3. Cutting Sample Analysis

Cutting analysis is carried out to determine the type of rock layer that is penetrated. The cuttings tested in this simulation show an indication of swelling, this can be seen in Figure 4 which shows the reaction of swelling when the sample is dropped with water.

XRD Bulk Mineral Analysis

Cutting analysis was carried out using a Rigaku tool with a firing angle of 3°–90°. A figure 6 is obtained after shooting the cutting sample, where this figure is a comparison between the intensity and the angle of shooting.

From this figure, it is known that the peak of the cutting interval is at a shooting angle of 26.68° with an intensity of 192.647196 cps. Then the calculation is carried out using the Bragg equation as follows:

$$d = \frac{\lambda}{2 \sin\left[\frac{2\theta(deg)}{2}\right]}$$

$$d = \frac{1,5406 \text{ nm}}{2 \sin\left[\frac{26.68}{2}\right]}$$

$$d = 3.34 \text{ \AA}$$

It is known that the peak size indicates the percentage of minerals, it can be calculated by the following equation:

$$= \frac{\text{Quartz Intensity(cps)}}{\text{Total Intensity}} \times 100\%$$

$$= \frac{192.647196}{365.24989} \times 100\%$$

$$= 56.97 \%$$

Calculation from those above equation is tabulation, the presentation of table 5 various minerals in the analyzed cuttings were obtained. The mineral content of Clay in the cutting drilling by the “VICOIL” Drilling Simulation Rig is quite large, namely 23.84 %, Quartz mineral content is 56.97 %, Kaliophilite mineral content is 6.75 %, Pyrite mineral content is 6.69%, and Dolomite mineral content is 5.75 %. So we can take the conclusion the high clay minerals can be examination with Clay Orientation.

Table 3
Results of WBM rheology 1 and 2 penetration rate on the first daytable

Depth (ft)	ROP Day 1 by Rheology WBM 1 (ft/h)	Depth (ft)	ROP Day 1 by Rheology WBM 2 (ft/h)
2.94	944.64	7	1069.7
3.94	235.2	9	360
4.92	176.4	10.5	131.7

Table 4
WBM rheology 1 and 2 total of penetration rate results

WBM Testing			
Rheology	Day	Depth (ft)	ROP Total (ft/h)
1	1	4.92	442.8
2	1	5.58	295.4

XRD Bulk Mineral Analysis

Based on Clay Oriented, clay content dominated by smectite or montmorillonite 29.09 %. Cation Exchange Capacity from smectite is high, there are 80-120 meq/ 100 gr.

Methylene Blue Test (MBT)

From MBT analysis, titration every 2 ml of methylene blue to sampel of cutting. The result is 16 meq/ 100 gr so the shale include a B class (illite and mixed layer), from that, the shale can be swelling.

Geonor As

Based on the swelling test with the geonor as tool, then if the cutting sample is in contact with water it will produce a swelling percentage of 5.18%.

4. Testing the Penetration Rate Using OBM made from CCO

The penetration rate test uses Oil Base Mud (OBM) drilling fluid with alternative base materials of Crude Coconut Oil (CCO) or Coconut Oil. The volume of drilling mud used in this simulation is 38.92 bbl.

In testing the penetration of rock layers using Oil Base Mud based on alternative CCO, the results obtained are different Rate of Penetration (ROP). The longer the rock layer is left in place, the higher the

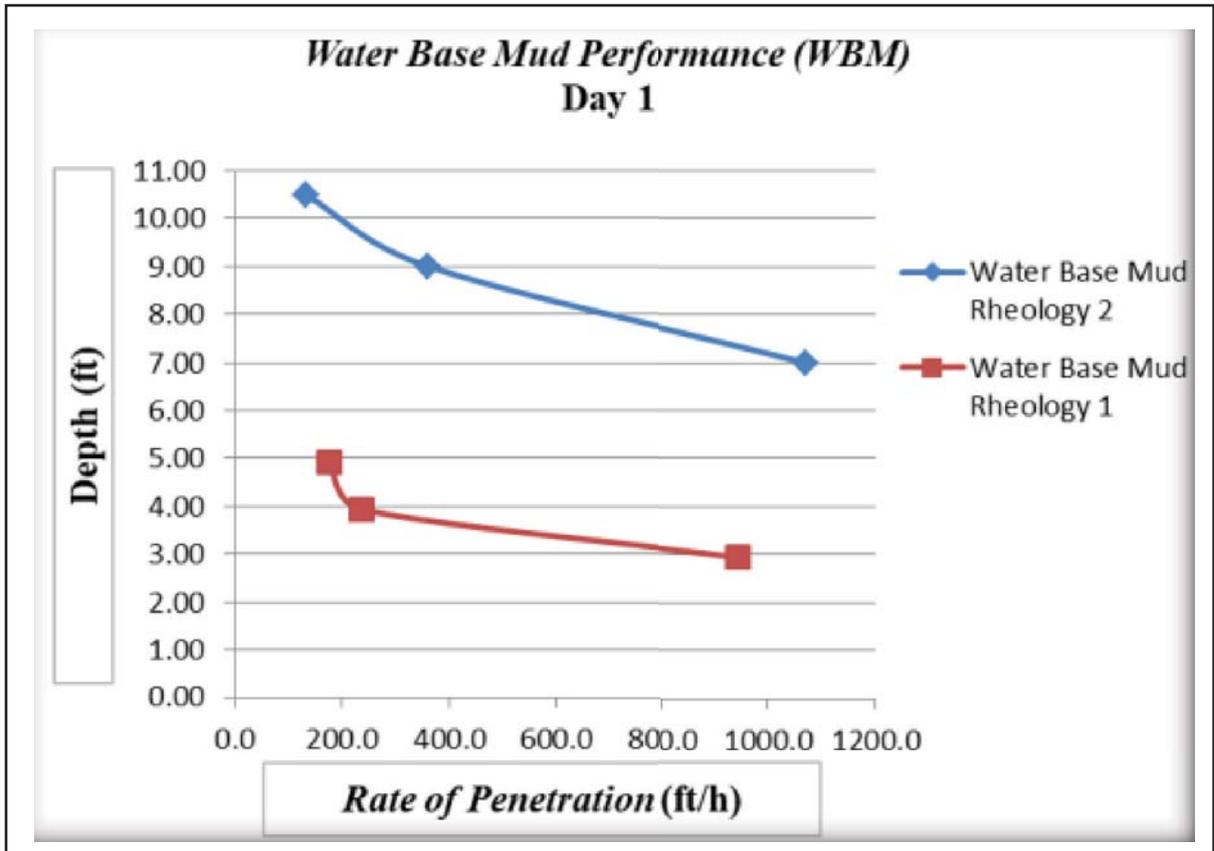


Figure 4
Comparison of depth with rate of penetration day 1 by rheology.



Figure 5
Sample of cutting dropped by water.

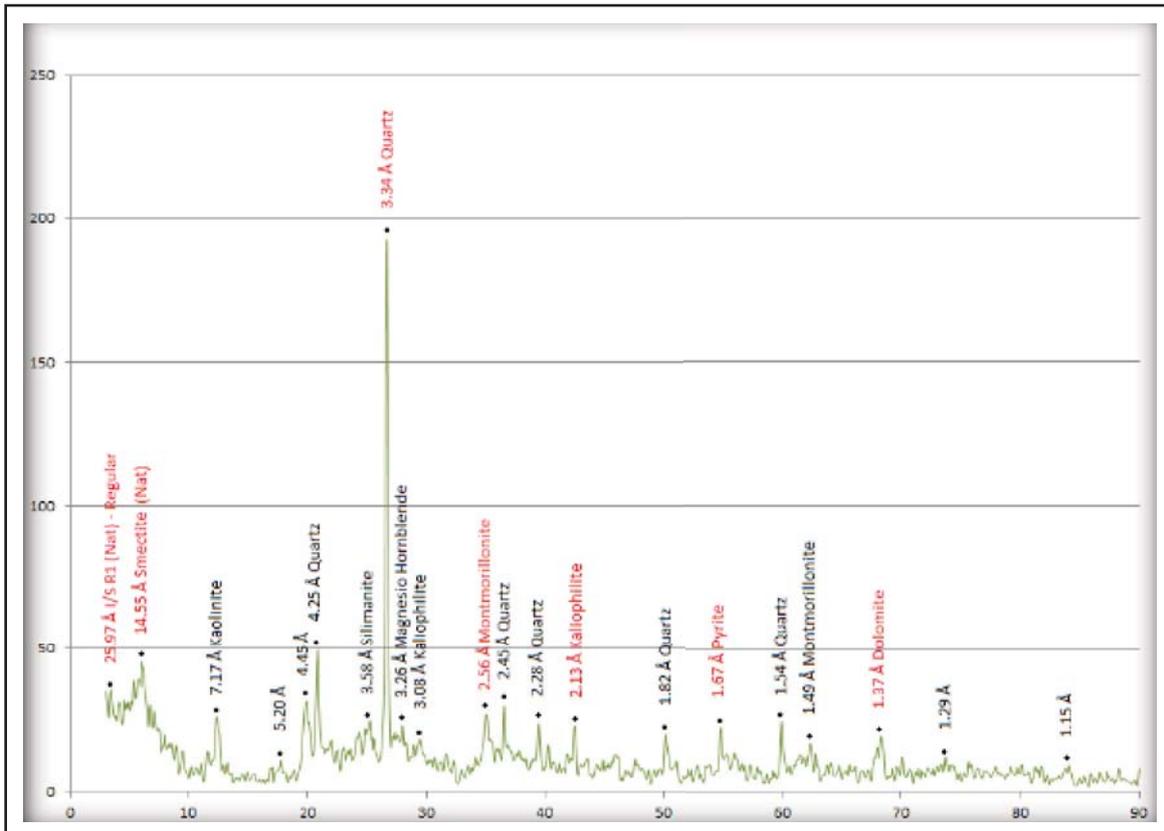


Figure 6
Results of bulk mineral analysis

Table 5
Cutting analysis results of bulk mineral XRD

2 θ (deg)	Intensity (cps)	2 θ/2	d	Mineral	Percent (%)
3.4	35.371654	1.7	25.97	<i>I/S R1 (Nat) - Regular</i>	10.46
6.07	45.259733	3.035	14.55	<i>Smectite/ Monmorillonite</i>	13.38
26.68	192.647196	13.34	3.34	<i>Quartz</i>	56.97
42.5	22.821814	21.25	2.13	<i>Kaliophilite</i>	6.75
54.89	22.620702	27.445	1.67	<i>Pyrite</i>	6.69
68.34	19.459853	34.17	1.37	<i>Dolomite</i>	5.75

Compressive Strength value is due to the influence of the cementation level of the rock and the load on the rock, so the rate of penetration will be smaller.

The total Rate of Penetration (ROP) value generated while using OBM Rheology 2 on the first day of

testing was 589.1 ft/h, the second day of testing was 164.7 ft/h, and the third day of testing was 71.7 ft/h. The rate of penetration produced by OBM on the first day is greater than the use of WBM Rheology 2. When the drilling simulation with OBM was carried

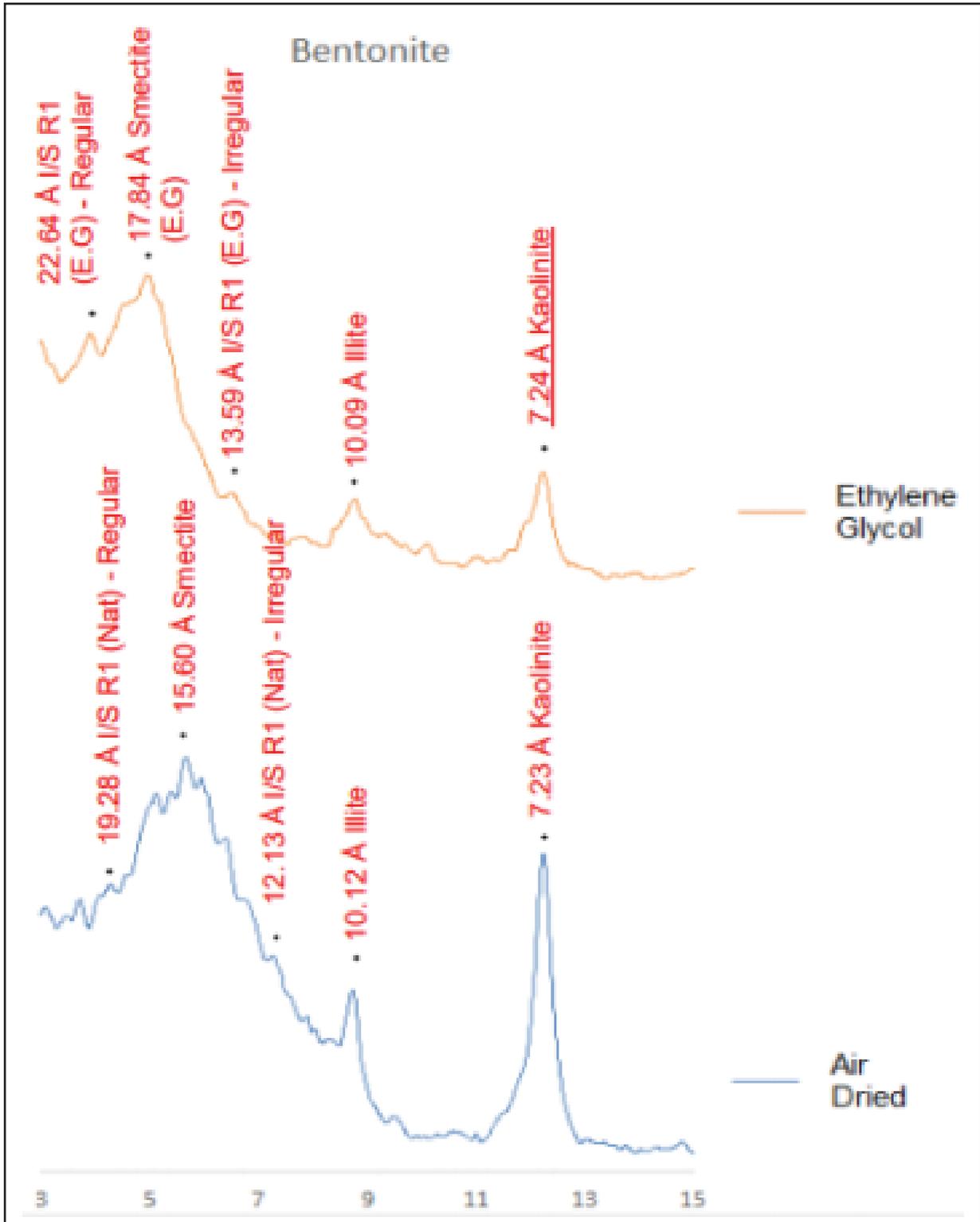


Figure 7
 Results of clay oriented analysis.

out, no problems were found. Based on the value of the penetration rate with OBM, it can be seen that the rate of penetration will decrease with increasing days which is in line with the increase in the compressive strength value of the rock layer.

CONCLUSIONS

First day ROP data obtained using WBM interval A with Rheology 1 is 442.8 ft/h, Rheology 2 is 295.4 ft/h and OBM Rheology 1 is 492 and Rheology 2

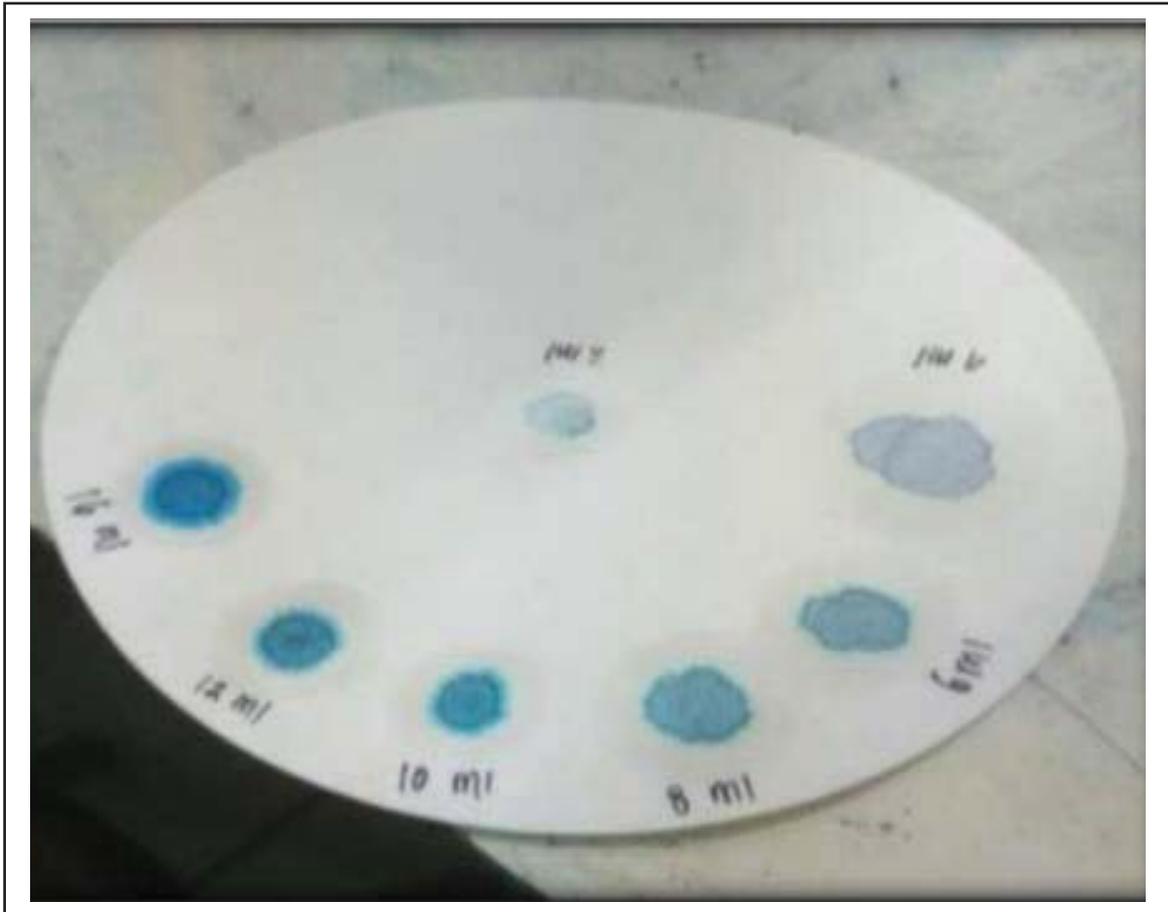


Figure 8
Results of MBT test.

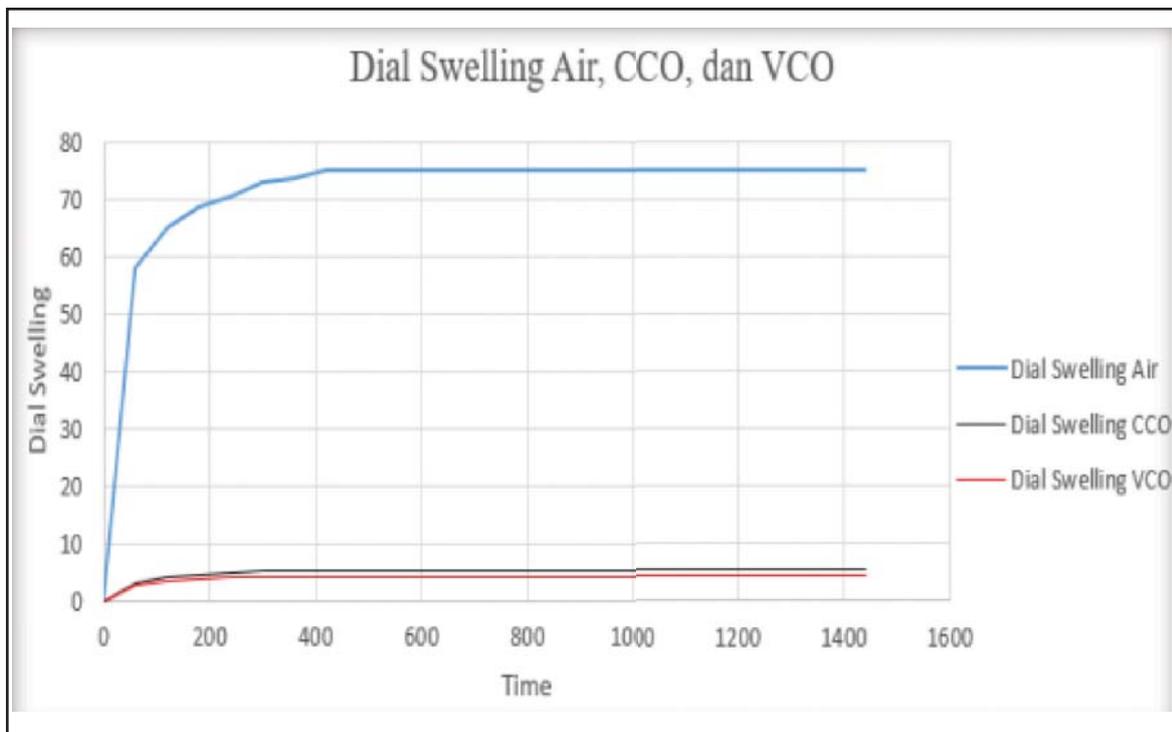


Figure 9
Dial swelling cutting.

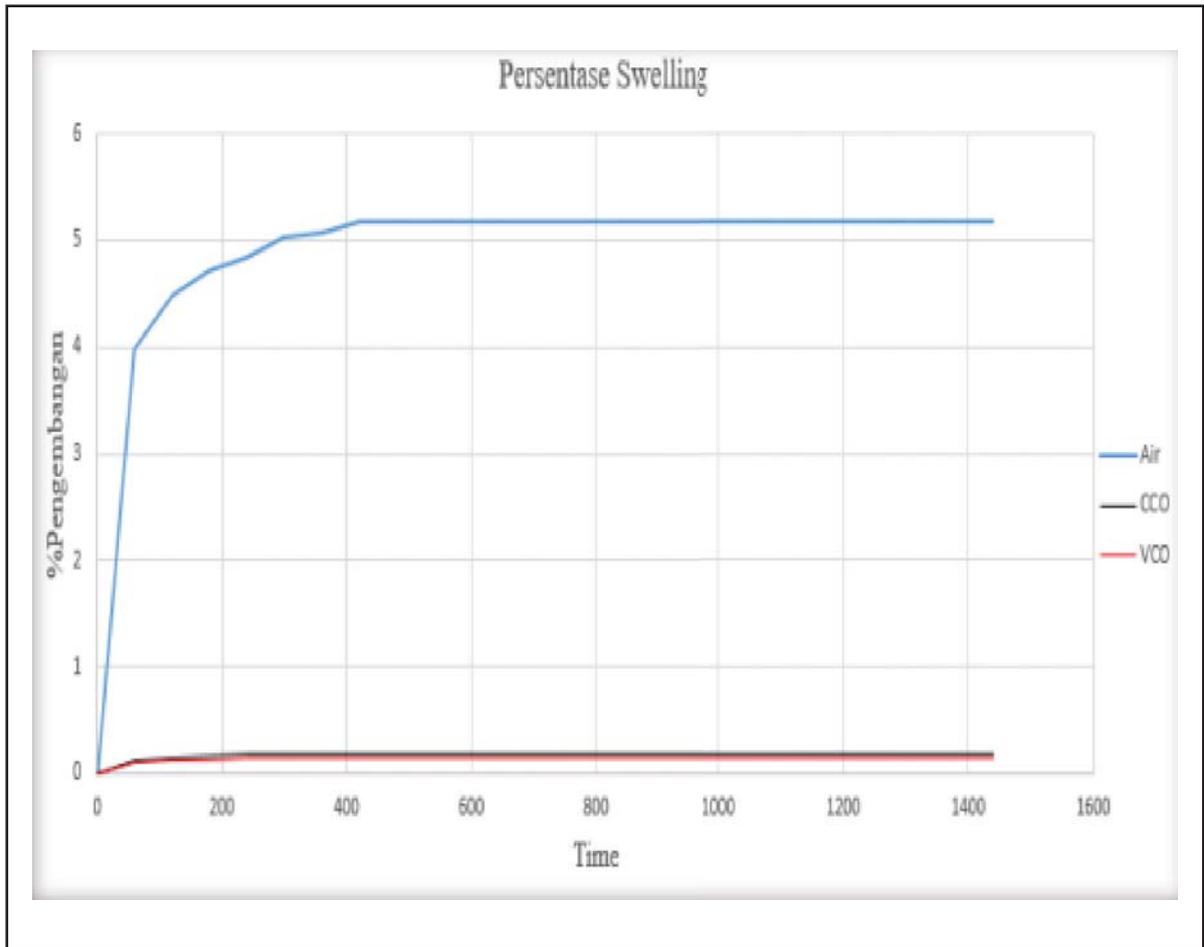


Figure 10
 Percentage swelling cutting.

Table 6
 Composition of oil base mud (OBM) simulation by "VICOIL" standard simulation rig

Composition of Oil Base Mud interval A and B			
	Interval A		Interval B
Ingredient	Amount		Amount
CCO	12.495 liter	31.136	liter
Water	5.355 liter	7.8	liter
CaCl ₂	1530 gram	3892	gram
H-Lime	255 gram	556	gram
Barite	5100 gram	11120	gram
Geltone	153 gram	333.6	gram
Carbotrol	255 gram	667.2	gram
Invermul	0.255 liter	0.6	liter
EZ Mul	0.102 liter	0.2	liter

Table 7
Comparison of rheology test results by "VICOIL" drilling standard simulation rig

Rheology Oil Base Mud					
No.	Properties	Rheology 1	Rheology 2	API SPEC	Unit
1	Mud Weight	10.3	10.1	11-Oct	ppg
2	Plastic Viscosity	19	18	< 35	cp
3	Yield Point	32	24	15 – 25	lb/100 ft2
4	Gel Strength (10 sec/ 10 min)	16-Dec	15-Aug	6-10/ 13-18	lb/100 ft2
6	Filtration loss	3	3.8	< 4	ml/30 min
7	Filter Cake Thickness	1.7	1.8	< 2	mm
8	pH	8	6	8.5 - 9.5	
9	MBT		12	≤ 12.5	meq/ ml of fluid

Table 8
First, second and third day penetration rate results with OBM rheology 1 and 2

Rheology	Depth (ft)	Day 1 ROP (ft/h)	Day 3 ROP (ft/h)
1	2.94	944.64	248.5
	3.94	271.3	160.3
	4.92	196	135.6
2	7	1152	195.8
	9	595	73.2
	10.5	348.4	37.6

Table 9
Total penetration rate results

Total Penetration Rate OBM by Rheology 2			
Rheology	Day	Depth (ft)	ROP (ft/h)
1	1	4.92	492
	3	4.92	264.3
2	1	5.58	589.1
	3	5.58	71.7

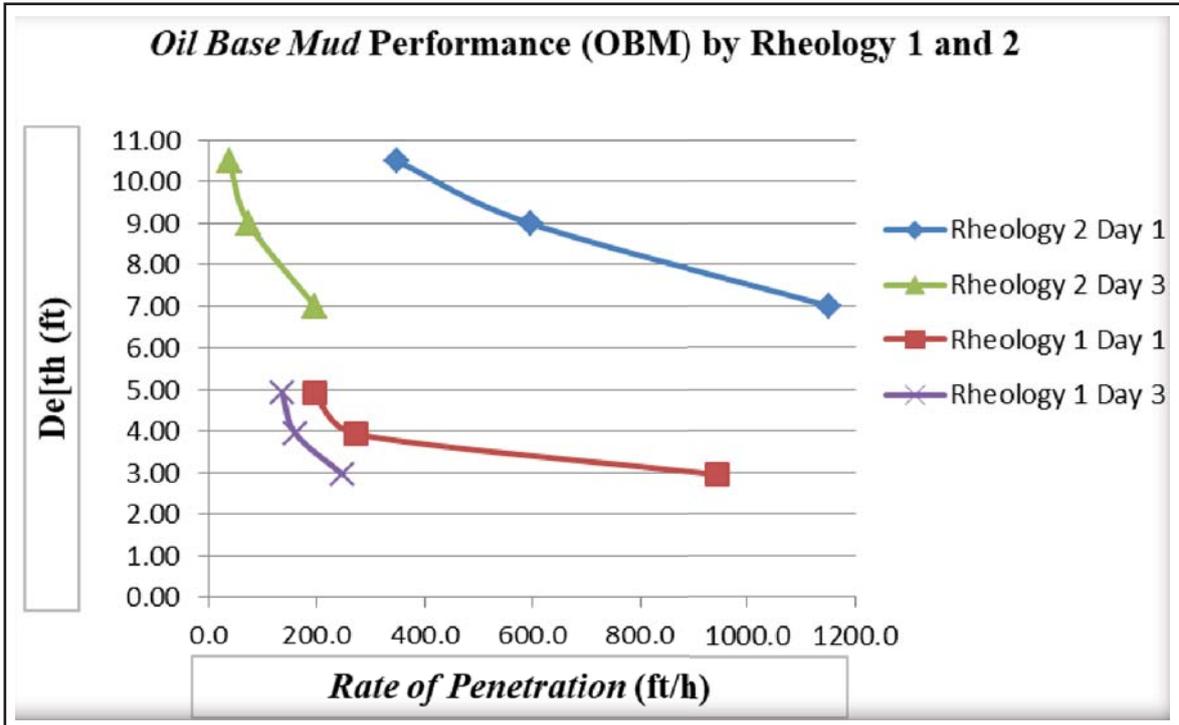


Figure 11
 Oil base mud (OBM) performance of rheology 1 and 2.

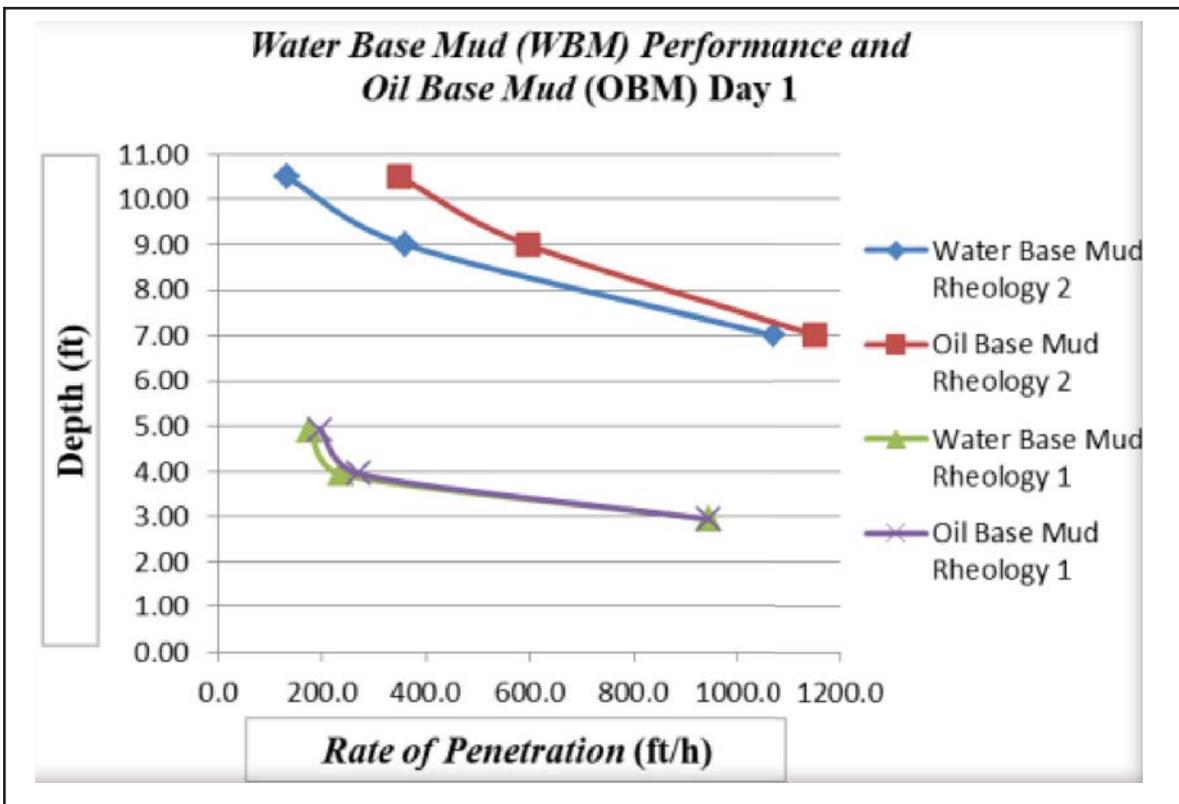


Figure 12
 Comparison of the performance of water base mud (WBM) and oil base mud (OBM) on the first day of Rheology 1 and 2.

is 589.1 ft/h. The smaller ROP WBM results were caused by a swelling problem that resulted in pipe sticking.

Based on cutting analysis, from bulk mineral analysis it is known that the mineral content clay minerals are 23.84 %. Based on Clay Oriented, the content of clay mineral dominated by smectite 29.09 %, Based on MBT test, shale include in the B class (illite and mixed layer) where this mineral can be swelling. Based on Geonoor As, there are 5.18% the cutting can be swelling if contact with water.

Compressive Strength interval A testing on the first, third and fifth day is 31,699 psi, 42,265 psi, and 52,831 psi. The results of the CS interval B testing on the first, second and third day is 31,496 psi, 41,517 psi, and 52,971 psi.

Based on the results of the clay mineral analysis and the magnitude of the ROP value, it can be seen that the use of Crude Coconut Oil (CCO) based Oil Base Mud is effective because during the simulation there are no drilling problems and the resulting ROP value is greater than the first day Water Base Mud.

ACKNOWLEDGEMENTS

The Author would like to thank PPPTMGB “LEMIGAS” for the permission to publish this paper and LPPM UPN “Veteran” Yogyakarta for the participation of funds provided during the research.

GLOSSARY OF TERMS

Symbol	Definition	Unit
Cation	A cation is an ion with fewer electrons than protons. Therefore, it has a positive charge.	
Compressive strength	The maximum compressive stress that, under gradually applied load, a given solid material can sustain without fracture.	
Crude Coconut Oil	Coconut Oil or Crude coconut oil (CCO) is a processed product from coconut meat in the form of a clear, tasteless liquid with a distinctive coconut odor.	

Symbol	Definition	Unit
Cutting	Drill cutting are broken bits of solid material removed from a borehole drilled by rotary, percussion, or auger method and brought to the surface in the drilling mud.	
Diffraction	The spreading of waves around obstacles.	
Hydration	A substance that contain water.	
Mineral	A solid chemical compound with a fairly well-defined chemical composition and a specific crystal structure that occurs naturally in pure form.	
Montmorillonite	A very soft phyllosilicate group of mineral that form when they precipitate from water solution as microscopic crystals, known as clay.	
Mud	A heavy viscous fluid mixture that is used in oil and gas drilling operation to carry rock cuttings to the surface and also to lubricate and cool the drill bit.	
Oil Base Mud	Drilling fluid in drilling engineering, composed of oil as the continuous phase and water as the dispersed phase in conjunction with emulsifiers, wetting agents and gellants.	
Pipe Sticking	A drill pipe is stuck in a borehole and cannot be recovered from the bore without damage to the drill pipe.	
Rate of Penetration	The speed at which a drill bit breaks the rock under it to deepen the borehole.	
Rheology	The study of relationship between force (stress) and deformation (strain) of engineering materials under a set of loading and environmental conditions.	

Symbol	Definition	Unit
Rig	The machine components used to drill a wellbore.	
Sloughing	The collapse of the borehole wall due to the nature of the formation that it easy to collapse, brittle and the presence of cracking in the hole.	
Swelling	A part of the body of rock increase in size, typically as a result of injury, inflammation, or fluid retention.	
Water Base Mud	A drilling fluid composed os water and bentonite and heavy minerals which are also added for weight.	
Weight on Bit	The amount of downward force exerted on the drill bit and is normally measured in thousands of pounds.	
Wellbore	A hole that is drilled to aid in the exploration and recovery of natural resources, including oil, gas, or water.	
X-Ray Diffraction	A method or tool used to determine the atomic and molecular structure of a crystal by diffracting a beam of x-ray in all directions.	

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