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Laboratory Analysis Using Coconut Shell from Bekasi Regency for Drilling Mud Additives on Oil and Gas Wells

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Abstract

Oil and gas Increasing oil and gas demand for oil and gas, the deeper ones have a much higher temperature and pressure. One effort to overcome this problem is to create a drilling fluid that can minimize drilling problems caused by high temperatures and pressures. The making of fluid for drilling or commonly known as drilling mud is carried out in the laboratory for the initial stage. The drilling mud composed of various materials and additives. In certain conditions, including high temperature and pressure, additives are needed to maintain their performance. This study aims to improve the quality of drilling mud by adding additives from carbon powder originating from coconut shells. The drilling mud quality does not significantly decrease, it simply requires better quality of mud at certain points. when at high temperatures. Coconut shells are burned and processed until they become nanometer-sized, then used as additives in drilling mud. Laboratory analysis results show that drilling mud with coconut shell powder provides better rheological value compared to the drilling mud without the additives. Additives made from coconut shells can be used to improve the rheology of a drilling mud water base at high temperatures and high pressures. It can be concluded that the rheological quality of drilling mud with additives is much more developed and reliable.

INTRODUCTION

Higher demand on fossil energy have motivated the oil and gas industry to drill in deeper zones that have much higher temperatures and pressures. The drilling activity is related to problems caused by complex conditions in the formation due to high temperature and pressure. One of the efforts to overcome this problem is to create a drilling fluid that can minimize drilling problems in the field caused by improper use of drilling fluid in a formation. The making of fluid for drilling or commonly known as drilling mud is carried out in the laboratory for the initial stage (Agwu & Akpabio, 2018).

Various additives are used to improve the performance of drilling mud and overcome problems that arise (Fitrianti, 2012; Novrianti, Khalid, & Melysa, 2018; Novrianti & Umar, 2015). One of the problems that are often encountered is a decrease in quality when drilling in formation with high pressure and high temperature (Ekeinde, Okoro, Dosunmu, & Iyuke, 2019; Minaev et al., 2016; Okon, Udoh, & Bassey, 2014; Prince, Dosunmu, & Anyanwu, 2019). This decrease in quality causes the drilling mud to lose its normal function (Ewy & Morton, 2008; Ghazali, Alias, Mohd, Adeib, & Noorsuhana, 2015; Inemugha, Chukwuma, Akaranta, & Ajienka, 2019). This malfunctioning drilling mud is economically detrimental because drilling mud must be added in quantities greater than it should be given when inserted into the well (Al-Hameedi et al., 2019; Amanullash, 2007; Hamad, Xu, & Liu, 2019). The problem of malfunctioning drilling mud when in the well can be minimized by adding additives to the drilling mud (Akbar, Hamid, & Sitaresmi, 2019; Ganesh, Sivasankar, Pandian, & Sircar, 2019; Samavati, Abdullah, Tahmasbi, Hussain, & Awang, 2014; Zhang et al., 2013). One of the additives examined in this study to overcome this problem is carbon powder derived from coconut shells.

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The Purpose of the drilling operation is to drill, evaluate, and complete a well that will produce oil and/or gas efficiently and safely. Drilling mud is one important tool in drilling operation wells of oil and natural gas to achieve the planned targets. At first, people only use water to lift cuttings, then in times, mud began to be used.

This mud is in the form of a solution or suspension of various chemicals and minerals in the water, oil, gas, air, or foam with a certain composition so that it looks like mud and therefore named drilling mud. This drilling mud works byroads circulating using mud pumps that can produce the pressure of up to 5,000 psi.

The success of drilling operations is highly dependent on drilling mud. The main functions of the drilling mud include balancing formation pressure, lubricating beets, and lifting cuttings to the surface. In general, drilling mud has four components or phases, including liquid phase, reactive solids, inert solids, and chemical phases. The liquid phase can be in the form of oil or water. Water can be divided into two categories, namely fresh and saltwater. Seventy-five percent of drilling mud uses water, while water can be divided into unsaturated and saturated brine. The term oil-base is used when the oil is more than 95%. Invert emulsions have an oil composition of 50 -70% (as a continuous phase) and water 30-50% (as a dispersed phase).

The phase reactive solids are solids that react with the surroundings to form colloids. This is like bentonite sucking (absorption) off freshwater and forming mud. The term "yield" is used to describe the number of barrels of mud that can be produced in order to have mud viscosity of 15 cP. Bentonite, for example, has a yield of about 100 bbl/ton. Bentonite absorbs fresh water on the surface of the particles, so that the volume increases up to 10 times or more, which is called "swelling" or "hydration". For saltwater clay (attapulgite), swelling will occur either in freshwater or in saltwater and is therefore used for drilling with "saltwater muds." Both bentonite and attapulgite will increase the viscosity of the mud. For oil-based mud, viscosity is increased by increasing the water content and using asphalt.

The phase inert solids are usually barite ($BaSO_4$) which is used to increase the density of sludge, or galena or iron ore. Inert solids can also come from formations that are drilled and carried by mud, such as flint, sand or clay non-swelling, and other solids. Those provide increased density sludge and need to be removed as quickly as possible because they can cause abrasion, damage Pump, and others.

The chemical phase is part of the system used to control the properties of sludge, for example, in dispersion, which is the dispersion of clay particles or flocculation, which is the gathering of clay particles. The effect of the presence of a chemical phase is mainly on the "colloid" of the clay. Lots of chemicals are used to reduce viscosity, reduce water loss, and control the colloidal phase or so-called surface-active agent.

Meng et al. (2010) conclude dash that carbon made by Kaitai Company, China, could improve the rheological resistance of water-based drilling mud. The density of drilling mud water-based decreases slightly with the addition of carbon powder. In 2013 they also reported that powder Carbon could improve the rheological properties of bentonite dispersion.

The composition Chemical of coconut shell usually consists of cellulose, 26.60%; pentosan 27.70%; lignin 29.40%; ash 0.60%; 4.20% extractive solvent; uronate anhydrous 3,50%; nitrogen 0.11% and water 8.00% (American Oil Institute, 1990). Coconut shells can be processed into powder or powder up to the nanometer scale. The size of the nanometer on the powder can improve dispersion when mixed into a liquid.

MATERIAL AND METHOD

This research uses experimental methods. An additive sample is from coconut shell, which is burned and then turned into powder to the size of a nanometer and then added to an A drilling mud, which is a variant of the mud that was once used somewhere. Drilling mud sample A with additives was analyzed and then compared with drilling mud A without additives in various conditions.

Research Stages

1. Making coconut shell charcoal powder. Coconut is taken from coconut plants around the Bekasi regency, which then takes its coconut shell. The coconut shell is then cleaned and burned to make charcoal. Coconut shell charcoal is crushed and then ground into powder.
2. Coconut shell powder is analyzed in the laboratory by XRD, SEM and physical analysis
3. Coconut shell charcoal powder is added to mud A in the form of water-base mud.

4. Drilling mud, which has been added by coconut shell charcoal powder, is then given high pressure and high-temperature conditions, then tested in a laboratory.
5. Laboratory test results are analyzed to see the effect of coconut shell charcoal additives in a drilling mud with variations in temperature rise.

Observed Variables

1. Density
2. Rheology
3. Filtration
4. PH

Data Analysis

Measurement data from the laboratory are analyzed statistically to obtain a relationship so that conclusions can be drawn.

Location and Time of Implementation

The research was carried out in:

1. Margamulya Bekasi Village and Bekasi Tambun Market to look for sources of material
2. Fresh coconut shell.
3. Laboratory of the University of Bhayangkara Jakarta Raya, for the preparation of tools and materials.
4. LIPI Laboratory -Puspitek Serporng, for the use of powder making equipment coconut shell charcoal and material analysis.
5. Malaysian University Technology Laboratory for testing and analyzing the effect of additives from coconut shells on drilling mud.

RESULTS AND DISCUSSION

Results of XRD analysis of additive powder from coconut shell material. The results of XRD analysis on coconut shell powder (see Figure 1 and Figure 2) shows that the element that appeared was graphite. SEM analysis is carried out on coconut shell powder that has been burned and mashed, as shown in Figure 3. The size of coconut shell powder is from 20 nm to 500 nm. The analysis of drilling mud additive before and after the additive is added in Table 1. Data observations of rheology of the drilling mud with no additives under various temperature are presented in Figure 4, Figure 5, Figure 6, Figure 7, Figure 8, Figure 9, and Figure 10. Apparent viscosity is shear stress on fluid divided by shear rate. In Newtonian fluid, th apparent viscosity is constant. Whereas in non-newtonian fluid, the value of apparent viscosity depends on the shear rate (Baroid, 1979). Shlumberger said apparent viscosity is the viscosity of a liquid measured at a certain shear rate.

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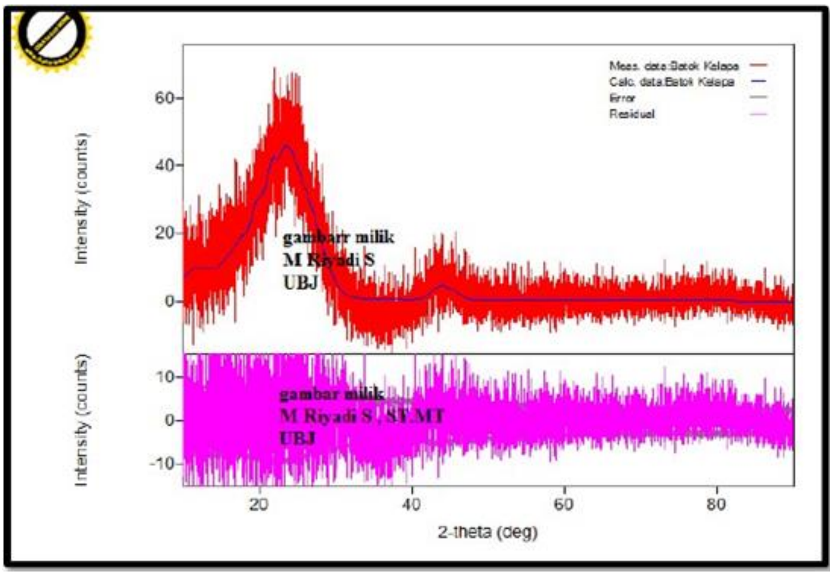

Figure 1. XRD analysis result on coconut shell powder.

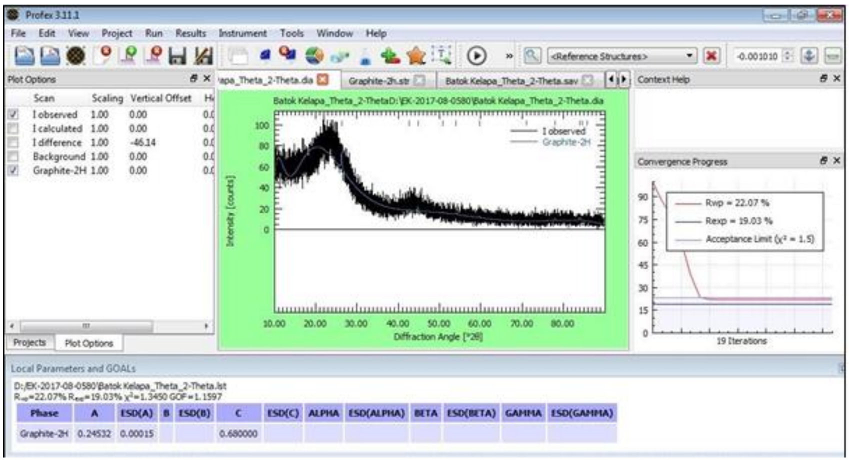

Figure 2. Diagram analysis XRD with Profex 3.11.1

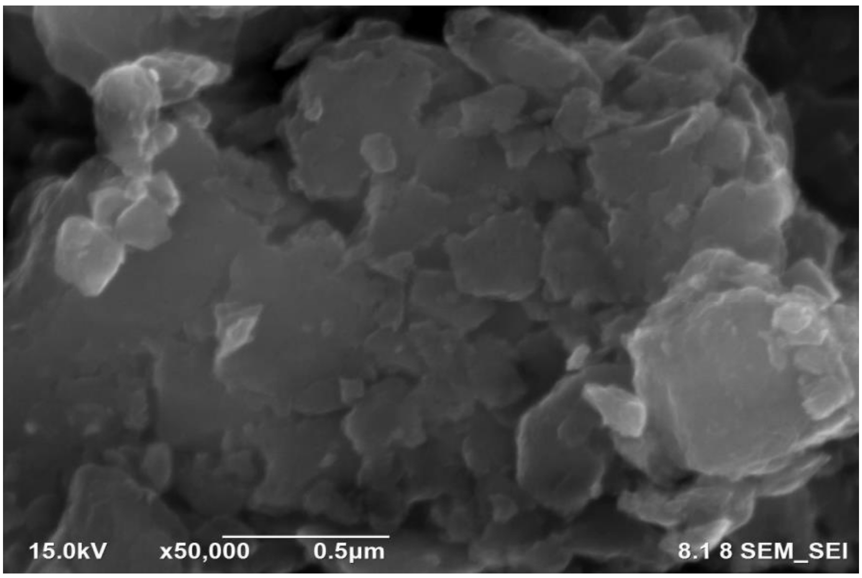

Figure 3. The result of the FESEM analysis of nanometer-sized coconut shell powder.

Table 1. Drilling mud analysis.

Description	Drilling Mud A	Drilling Mud A and Additives
Weight per volume	1.4 gr/cc	1.4 gr/cc
Viscosity, Mars Funnel, 946 cc	24,480 sec	25,560 sec
pH	11	12
Filtrat @pressure: 100 psia, Standard temperature	After 15 minutes: 3,9 cc After 30 minutes: 12,9 cc	After 15 minutes: 3,7 cc After 30 minutes: 12,5 cc
Filtrat @Pressure: 1500 psia, Temperature: 270 F	After 15 minutes: 13 cc	After 15 minutes: 11,5 cc
Mud Cake	3/32 inch	1/32 inch
Oven rolling	16 hours: Dark green color	16 hours: Darker green color

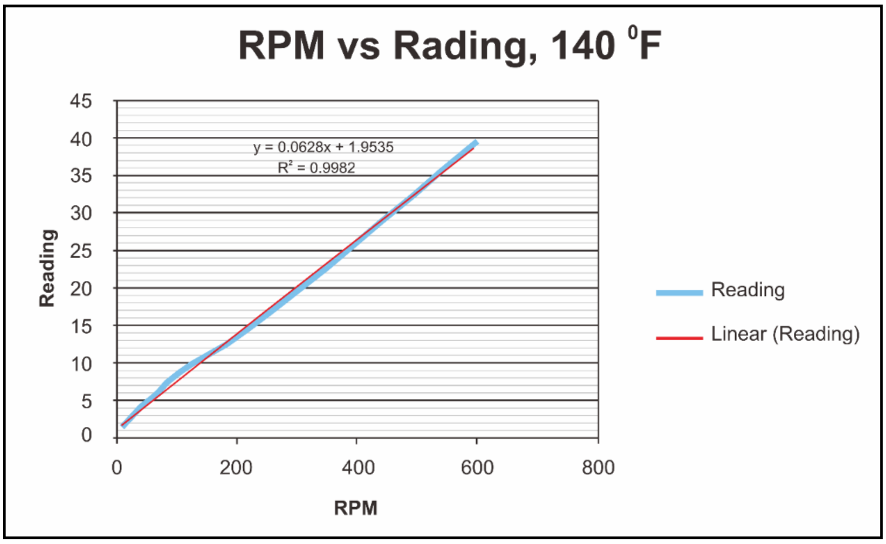

Figure 4. Reading vs. RPM, mud without additives @140 °F.

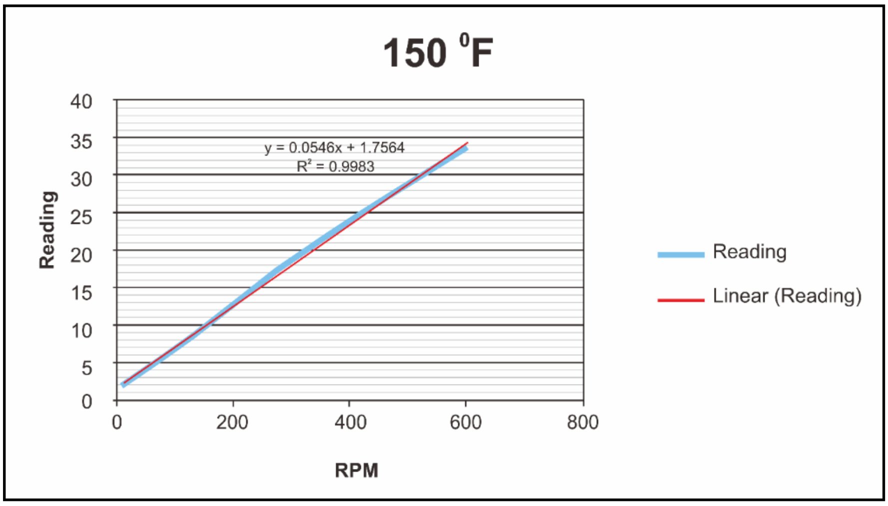

Figure 5. Reading vs. RPM, mud without additives @150 °F.

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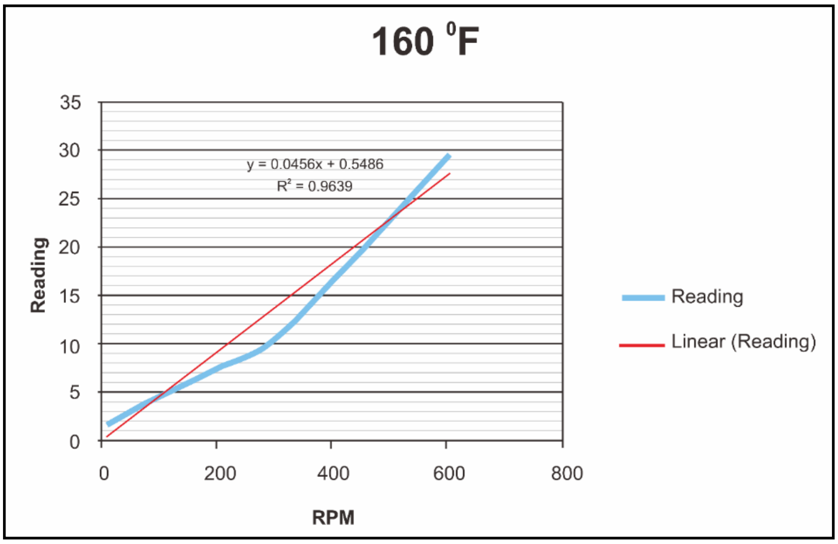

Figure 6. Reading vs. RPM, mud without additives @160 °F.

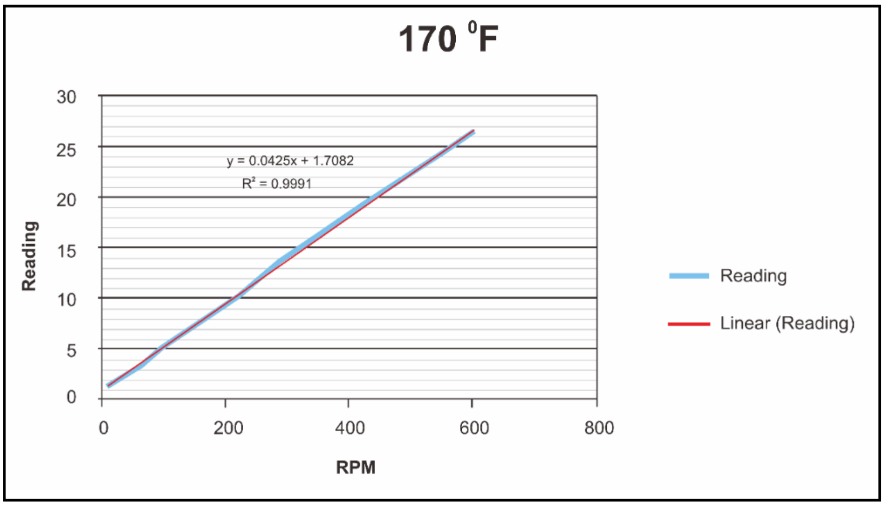

Figure 7. Reading vs. RPM, mud without additives @170 °F.

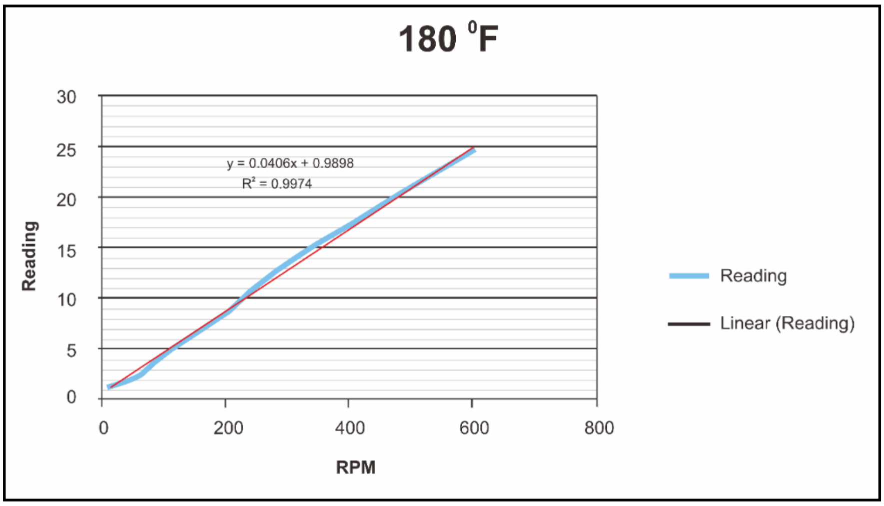

Figure 8. Reading vs. RPM, mud without additives @180 °F.

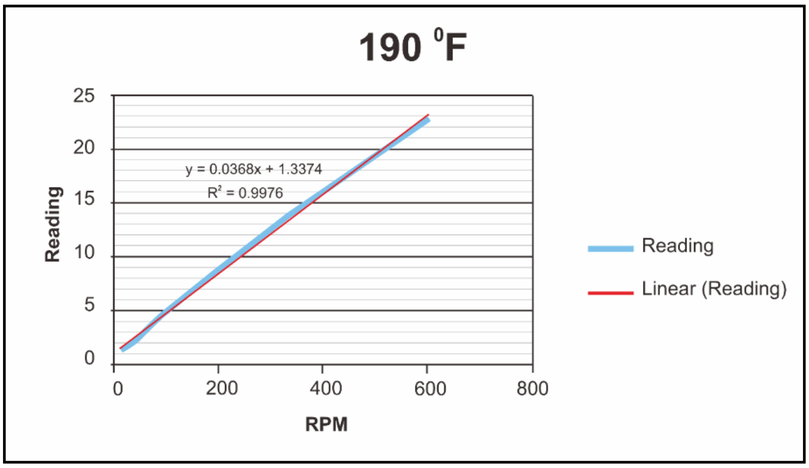

Figure 9. Reading vs. RPM, mud without additives @190 °F.

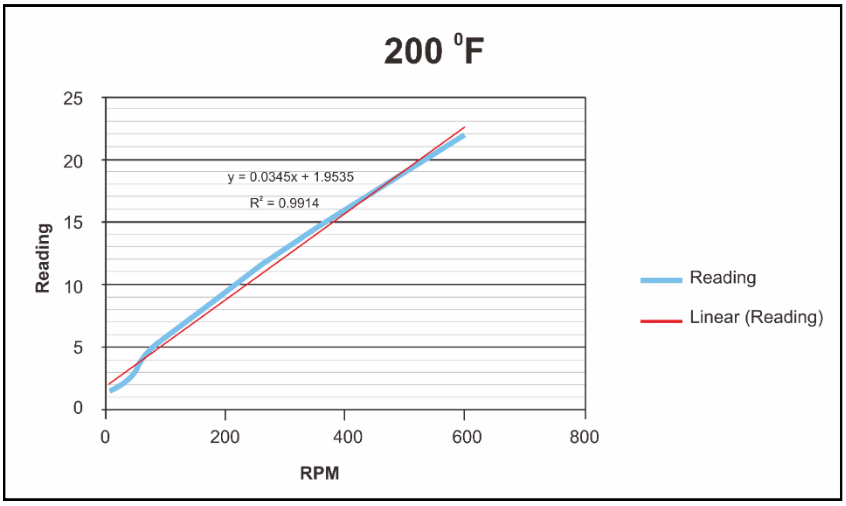

Figure 10. Reading vs. RPM, mud without additives @200 °F.

Apparent Viscosity or AV shows the ability of mud to flow and is related to the speed of mud penetration. The value of plastic viscosity is caused by suspended dissolved particles and is influenced by viscosity in the base liquid. The yield point is an indicator of the tensile strength between solids. Data observations of rheology of the drilling mud with the coconut shell additives under various temperature are presented in Figure 11, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, and Figure 17.

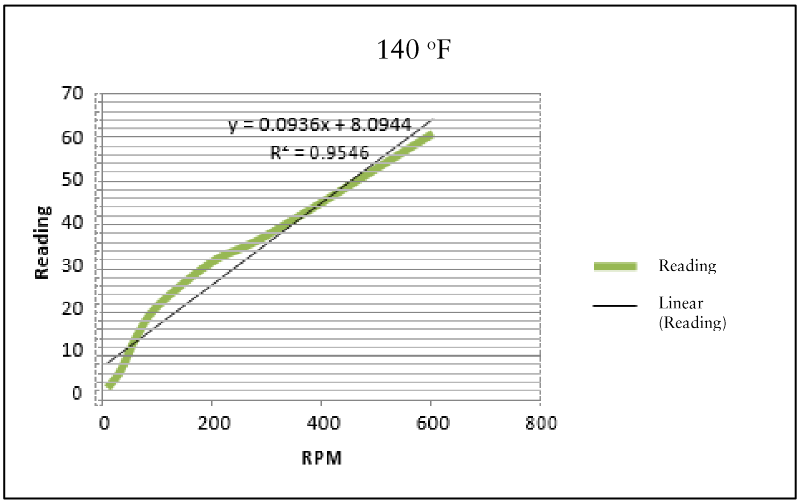

Figure 11. Reading vs. RPM, mud with additives @140 °F.

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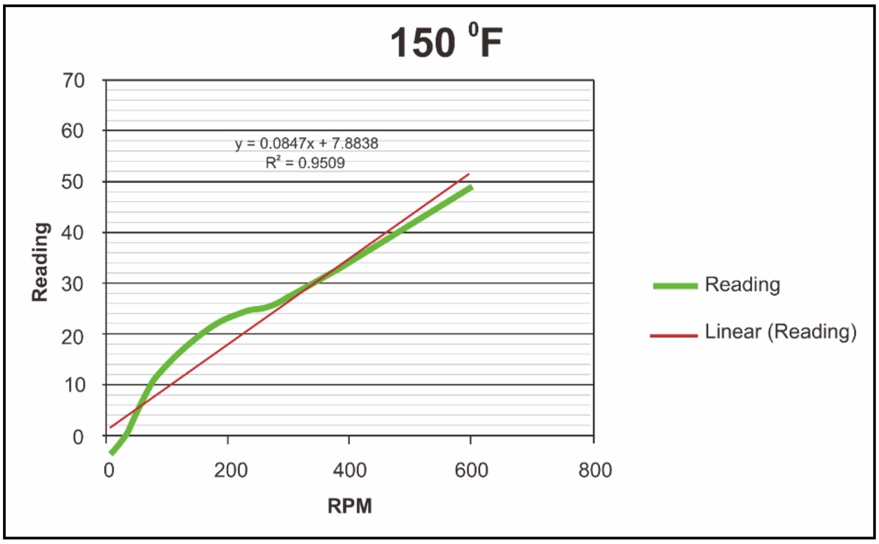

Figure 12. Reading vs. RPM, mud with additives @150 °F.

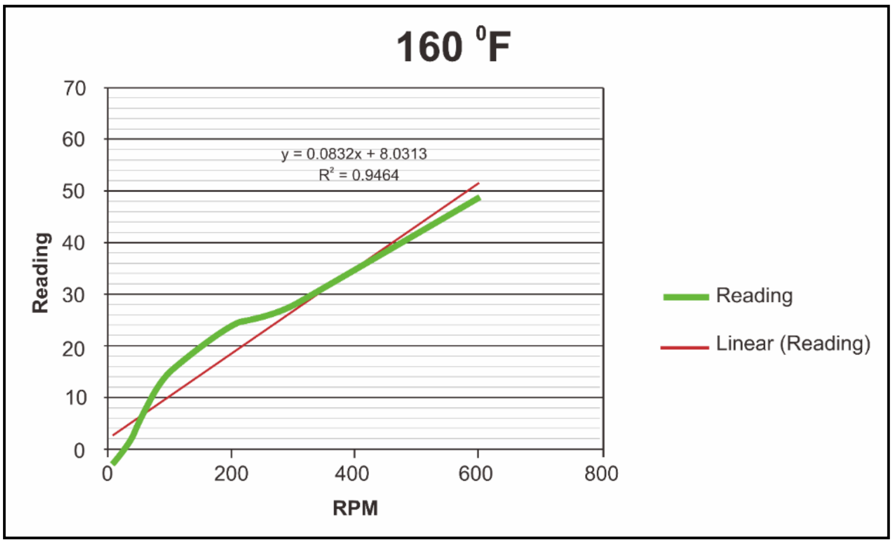

Figure 13. Reading vs. RPM, mud with additives @160 °F.

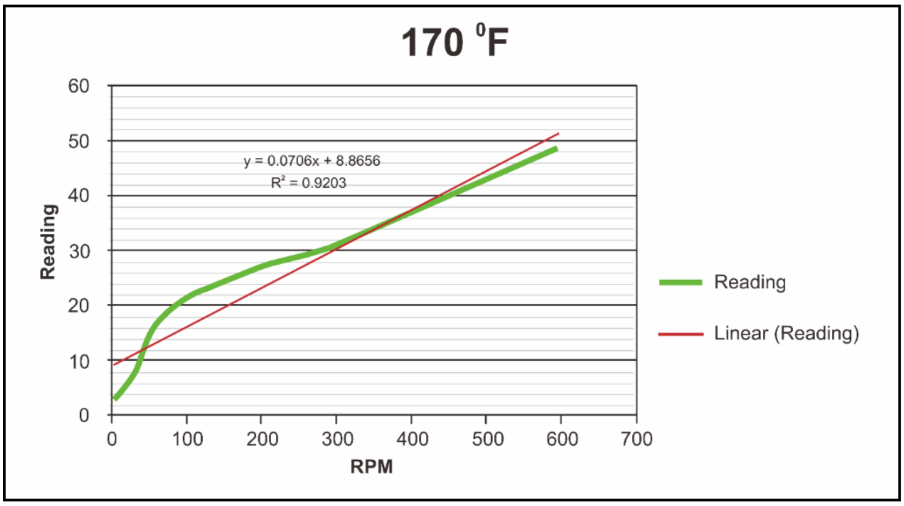

Figure 14. Reading vs. RPM, mud with additives @170 °F.

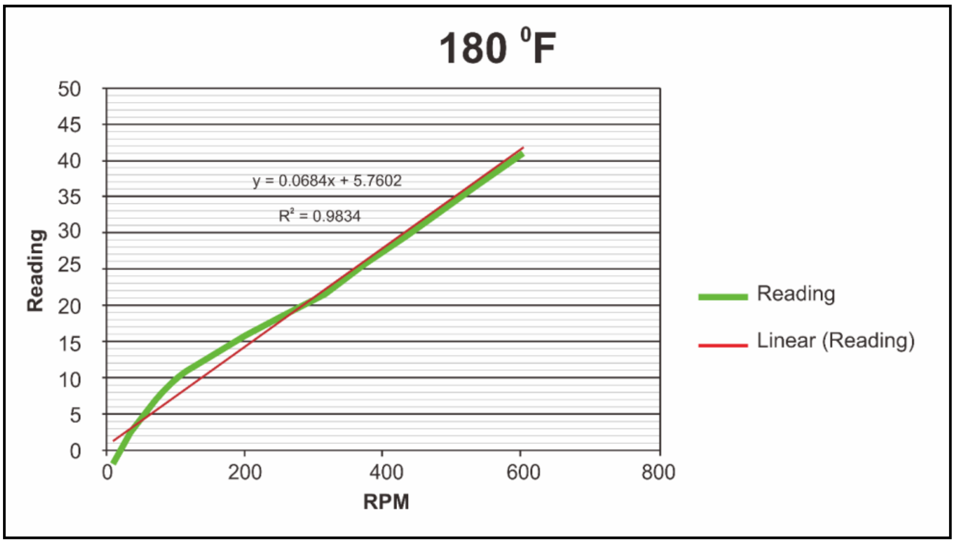

Figure 15. Reading vs. RPM, mud with additives @180 °F

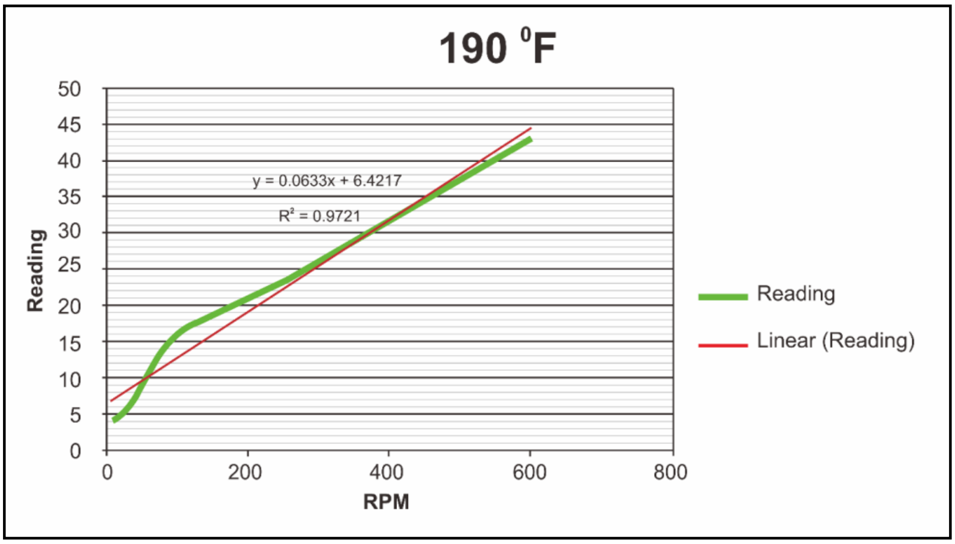

Figure 16. Reading vs. RPM, mud with additives @190 °F

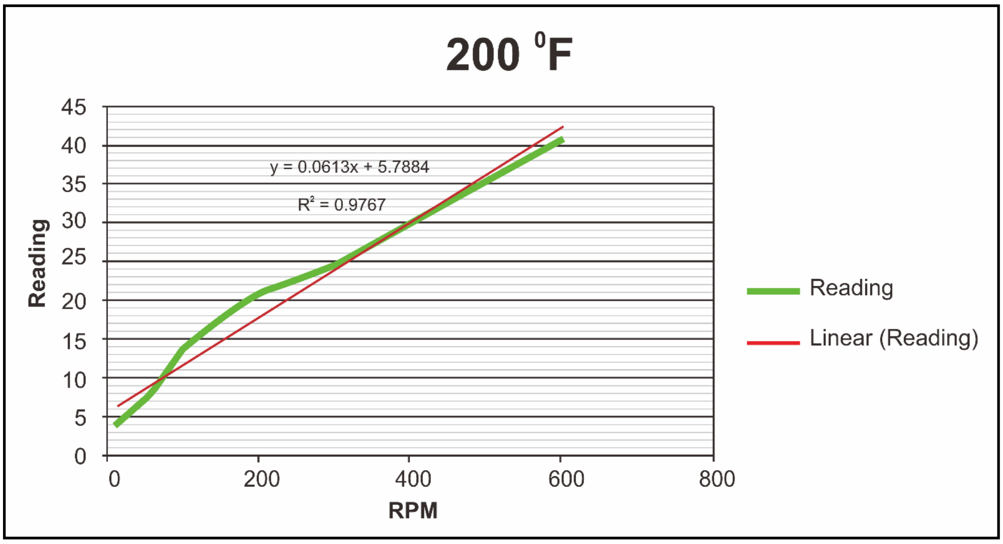

Figure 17. Reading vs. RPM, mud with additives @200 °F

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Filtration loss shows the value of loss in part of the liquid phase of the mud. Large filtration loss has a negative effect on drilling mud. In this experiment, the filtration loss value in the drilling mud can go down, from 13 cc to 11.5 cc after adding the additives from the coconut shell. The cake that occurs in drilling mud filtration also decreases after the mud is added with additives from coconut shells.

Under high pressure and high temperature (HPHT) conditions, apparent viscosity (Figure 18) in drilling mud that has been given additives from coconut shells is displayed in the form of equation y = -0.1696x + 53.875 and R^2 = 0.9761. In contrast, in drilling mud not added additive, the apparent viscosity value is in the form, y = -0.1446 x + 38,946 and R^2 = 0.932. Meanwhile, plastic viscosity in drilling mud that has been given additives from coconut shells can be displayed in the form of equation y = -0.1071x + 37.571 and R^2 = 0.8167, whereas in drilling mud without additives, the value of Plastic Viscosity is in the form of equation y = - 0.1393x + 36.25 and R^2 = 0.9412 (See Figure 19). In HPHT conditions, the Yield Point, shown by Figure 20, on drilling mud that has been given additives from coconut shells can be displayed in the form of an equation, y = -0.125x + 32.607 and R^2 = 0.6495, while in drilling mud without additives, the Yield Point value is the equation y =-0.1393x + 36.25 and R^2 = 0.9412.

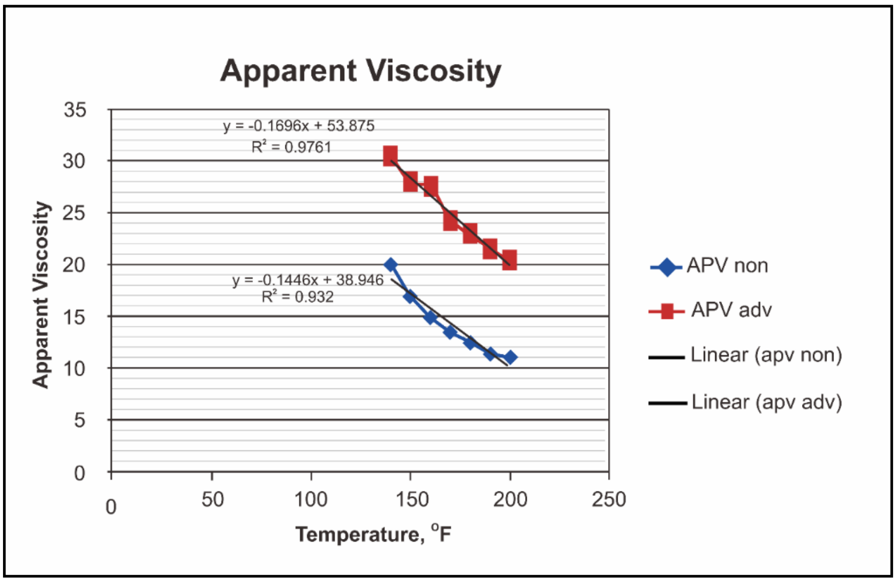

Figure 18. Apparent viscosity with and without coconut shell additive.

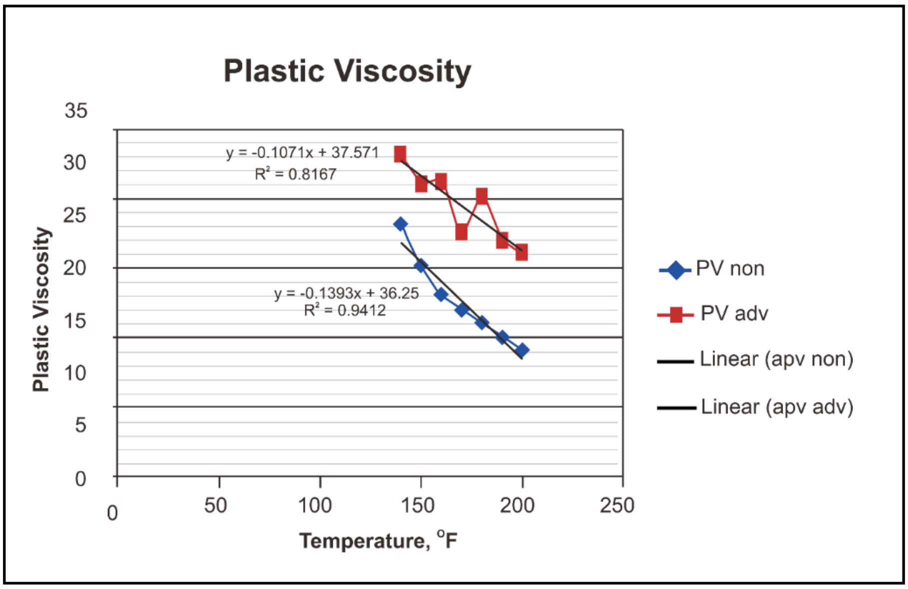

Figure 19. Plastic Viscosity on drilling mud with and without coconut shell additives.

The value of Apparent Viscosity, Yield Points, and Plastic viscosity on mud using coconut shell additives in HPHT conditions, is higher in value than those not using these additives. This indicates an increase in the rheological quality of drilling mud at high pressure. Temperature affects the value of Apparent Viscosity, Plastic Viscosity, and Yield Points. This can be seen from the curve equation at Apparent Viscosity vs. Temperature (Figure 18), Plastic Viscosity vs. Temperature (Figure 19), and Yield Point vs. Temperature (Figure 20). The higher the temperature, the value of Apparent Viscosity, Yield Points, and Plastic viscosity decreases. ANOVA analysis (Table 2 and Table 3) found that there are real differences due to differences in the presence of additives and non-additives, as well as the differences due to differences in temperature.

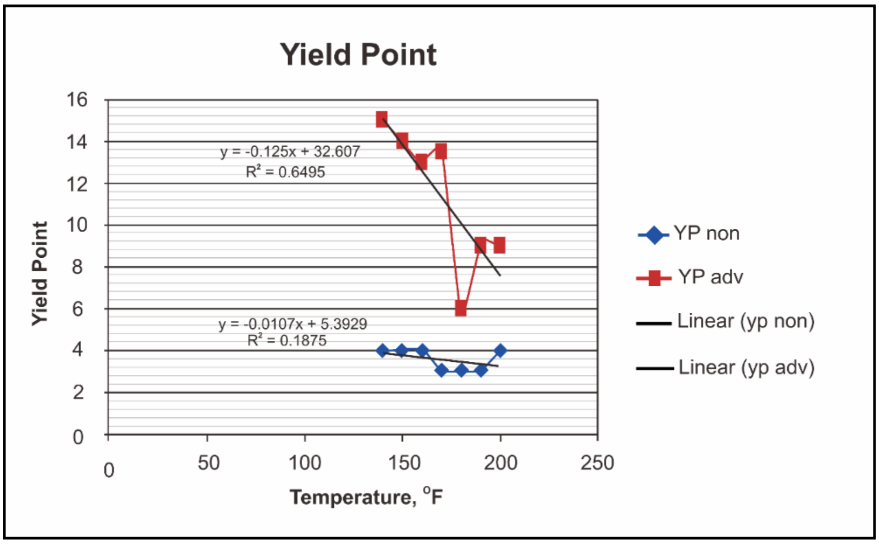

Figure 20. Yield Point of drilling mud with and without coconut shells additives.

Table 2. Anova: Two-factor without replication

SUMMARY	Count	Sum	Average	Variance
Additive 1	2	50.5	25.25	55.125
Additive 2	2	45	22.5	60.5
Additive 3	2	42.5	21.25	78.125
Additive 4	2	37.75	18.875	57.78125
Additive 5	2	35.5	17.75	55.125
Additive 6	2	33	16.5	50
Additive 7	2	31.5	15.75	45.125
Temperature 1	7	100.5	14.35714	10.47619
Temperature 2	7	175.25	25.03571	13.758929

Table 3. Analysis of Variance (ANOVA)

Source of Variation	SS	Df	MS	F	P-value	F crit	
Additives	142.7411	6	23.79018	53.468227	6.01912E-05	4.283865714	p<0.05
Temperature	399.1116	1	399.1116	897	9.19021E-08	5.987377607	p<0.05
Error	2.669643	6	0.44494				
Total	544.5223	13					

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CONCLUSION

Additives made from coconut shells can be used to improve the rheology of a drilling mud water base at high temperatures and high pressures. The rheological quality of drilling mud is developed and is more stable. The quality of filtration drilling mud using additives from coconut shells is getting better. The apparent viscosity in drilling mud forms equation y = -0.1696x + 53.875 and R2 = 0.9761. The plastic viscosity is y = -0.1071x + 37.571 with R2 = 0.8167. The Yield Point on drilling mud is y = -0.125x + 32.607 with R2 = 0.6495. ANOVA analysis illustrates that there are real differences due to differences in the presence of additives from coconut shells and the absence of these additives, as well as the presence of real differences due to the influence of temperature.

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