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Critical performance evaluation of periwinkle and eggshells in drilling fluid rheology

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Abstract

The environmental impact of conventional drilling fluids necessitates exploring sustainable alternatives. This study investigates the potential of readily available eggshell and non-activated periwinkle shell powders as substitutes for Xanthan gum (XCD); a common fluid loss reducer in water-based drilling fluids. The study evaluates their effectiveness in reducing fluid loss, analyzes their physical and rheological properties, and offers insights into their potential advantages and limitations.

Eggshell exhibited promising results, achieving comparable fluid loss control to Xanthan gum at an optimal concentration of 4g. non-activated periwinkle shell, while showing some effectiveness, required further investigation for optimal dosage or formulation to compete with Xanthan gum's performance. Both shells had lower mud weight than Xanthan gum, potentially beneficial for specific scenarios, but their significantly lower viscosity and gel strength raise concerns about hole cleaning and cuttings suspension. This suggests their potential for low-pressure environments or situations where minimizing formation damage is crucial. Further research on dosage optimization, long-term stability, formation compatibility, cost-effectiveness, and environmental impact is recommended to fully assess the viability of these shell powders as sustainable fluid loss reducers for water-based drilling fluids. The promising initial findings pave the way for further exploration and development of this eco-friendly alternative, contributing to a more sustainable drilling industry.

Keyword: Mud; Eco-friendly; Formation; Xanthan gum; Rheology; Periwinkle; Egg shell and fluid loss

1. Introduction

An intricate and difficult procedure, drilling oil and gas wells is essential to the world's energy sector. For these projects to be financially viable, efficient and economical drilling operations are necessary. Mud, or drilling fluids, are essential to the oil and gas sector because they keep the wellbore stable and facilitate drilling. Water-based mud (WBM) is a widely used drilling fluid that is made up of different additives to improve its performance and water as the continuous phase. Drilling fluid management is a basic component of drilling operations and is essential to drilling stability, drilling ease, and cuttings transportation to the surface. Water-based mud (WBM) is one of the most popular forms of drilling fluids since it is inexpensive and environmentally friendly. Water and other additives are combined to make a stable drilling fluid in water-based mud systems. The management of lost circulation is one of the main difficulties in using WBM. The seepage of drilling fluid into the formation rock during drilling is known as "lost circulation," and it can seriously impair wellbore stability, drilling efficiency, and total operating expenses. Drillstring sticking from the differential, formation damage, and even problems with well control can result from excessive lost circulation (Bellis, 2008).

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Drilling operations are plagued by a significant issue called lost circulation, which can result in various issues such differential sticking, unstable boreholes, and lost circulation itself. When drilling fluid seeps into the porous strata being drilled through, loss circulation happens. Numerous variables, including as the formation pressure, drilling fluid viscosity, and formation permeability, affect the rate of fluid loss (Bellis, 2008).

The oil and gas sector has created a range of lost circulation additives, also referred to as fluid loss control additives, to meet this difficulty. By producing a thin, impermeable filter cake on the wellbore wall and preventing drilling fluid from penetrating into the formation, these additives are intended to reduce fluid loss. Nonetheless, there are a variety of lost circulation additives on the market, and how well they work will rely on the particular drilling conditions and features of the formation. Water-based muds employ a range of fluid lost circulation additives to lower the rate of lost circulation. In order to stop drilling fluid from seeping into the formation, these additives create a barrier on the formation's surface. The choice of lost circulation additives is contingent upon the particular drilling conditions and comes in a variety of forms. The most popular kinds of additives for preventing fluid loss are cellulose, starch, bentonite, synthetic polymers, etc. Bentonite is a mineral clay that expands when wet and becomes a gel. Drilling fluid cannot flow into the formation because of the barrier this gel creates on the formation's surface. The viscosity of the drilling fluid can be raised by adding starch, a naturally occurring polymer. By doing this, the rate of fluid loss is slowed down. Another naturally occurring polymer that can be utilized to lower the rate of fluid loss and raise the viscosity of the drilling fluid is cellulose. A wide range of synthetic polymers are available for use as additives to reduce fluid loss. According to Bellis (2008), these polymers create a thin layer on the formation's surface that keeps drilling fluid from seeping inside. The effectiveness of fluid loss additives in muds that are water-based has been extensively studied in the past few years. Numerous studies have demonstrated that a variety of parameters, such as the kind of fluid loss additive, the additive's content, the water-based mud's composition, and the drilling circumstances, affect the fluid loss additives' performance. For instance, one study discovered that the pH of the water-based mud affects how well starch works as a fluid loss enhancer. Another study discovered that the salinity of the water-based mud affects the effectiveness of cellulose as a fluid loss enhancer (Agwu and Akpabio, 2018). To determine which fluid loss additive is best for a certain set of drilling conditions, a comparative analysis of the various additives is required in WBM. Therefore, by methodically assessing and contrasting the effectiveness of different fluid loss additives in water-based mud under controlled laboratory circumstances, this comparative study aims to close this knowledge gap. It is anticipated that the study's conclusions will offer the oil and gas sector useful information that will help them make more educated decisions on fluid loss control during drilling operations, which will ultimately lead to safer, more effective, and ecologically friendly drilling techniques.

1.1. Environmental Pollution Caused by Agricultural Waste Disposal

Egg, periwinkle, and snail shells are examples of agricultural trash that is produced in accumulation from various farming procedures. Sufficient use of agricultural waste minimizes environmental issues brought on by careless trash disposal. According to Seadi and Holm-Nielsen (2004), managing agricultural wastes is essential and a key tactic in the worldwide waste management process. Olabode & associates (2022) reiterated that managing the massive volumes of trash generated by the food processing industry is a difficult issue. Any type of waste can become a major concern for plants, animals, and people when it is present in excess in the environment. The kind, amount, and composition of agricultural waste produced differ throughout nations. Waste management is under increasing strain around the globe. Waste production has been rising in tandem with population growth and an increase in human activity (The Washington Post 2017; World Bank 2018 According to World Bank estimates, 1.3 billion tons of municipal solid trash were produced worldwide in 2012; by 2025, that amount is predicted to rise to 2.2 billion tons (Hoornweg and Bhada-Tata 2012).

In the food processing sector, eggshells are a common example of product-specific waste that still contains pieces that can be used (Adeogun, *et al*., 2018). The food manufacturing and processing industries use eggs extensively. As seen in Plate 1.1, a lot of eggs are wasted every day since they are utilized in significant numbers in foods like salads, pastries, fast food, and food decorations. In addition to generating large disposal expenses and leaving behind organic waste. By 2030, the amount of eggs produced worldwide is expected to reach approximately 90 million tons (FAO, 2019; Ferraz, *et al*., 2018; Muliwa *et al*., 2018). In fact, according to the authors, over 2.5 thousand tons of eggshell waste are produced year worldwide. The majority of the eggs are discarded without any prior care. Eggshells are regarded as worthless, according to Cree and Rutter (2015) and Singh, *et al*. (2018). The majority of this waste is often disposed of in landfills without being converted into useful products. However, many individuals find waste disposal to be an unpleasant process, and air pollution is also caused by the odor that is added as eggs decompose. Eggshell waste has been identified by the Environmental Protection Agency as the fifteenth most significant pollutant produced by the food industry (Dheeraj, 2021). This garbage becomes a significant cause of pollution to the environment if it is not properly disposed of at a designated location. Therefore, there is a risk to your health when the fungus grows on the eggshell. Much work has been put into turning egg waste into a useful commodity in recent years. Nonetheless, the handling of this waste necessitates appropriate approaches that account for rising disposal expenses, environmental worries about the spread of pathogens, disagreeable odors, and the accessibility of disposal locations (Quina, *et al*, 2017; Meng and Deng, 2016; Sarder, *et al.,* 2019). Furthermore, eggshells are regarded as hazardous waste by European Union rules (Quina *et al*., 2017; Ummartyotin and Manuspiya, 2018). Finding alternate methods to transform eggshell into useful components for future uses is therefore essential. About 11% of the egg's total mass is made up of the shell, which is composed of 94% calcium carbonate, 1% magnesium carbonate, 1% calcium phosphate, and 4% organic content. Stadelman (2000) and Wu et al. (2013). According to this theory, recycling eggshell waste into a variety of uses would benefit the environment and the economy.

Figure 1 Eggshells

Eggshell waste has a variety of effects on the environment. First of all, disposing of eggshells as garbage or in landfills exacerbates environmental issues like resource waste, stench, and noise pollution. Second, the process of producing chicken eggs results in a greater volume of eggshell residue, which raises the total amount of trash produced. Eggshell waste, however, can also be put to good use (SCISPACE). Plate 1: Snail Shells that are the leftover bio-shell waste of discarded snails from cafes, restaurants, or snail vendors pose a significant environmental risk for little to no financial gain. Usually, once the edible flesh has been consumed, they are randomly abandoned. Therefore, wise use of snail shells can result in significant economic growth (Kolawole *et al*., 2017). Therefore, without therapy, shell decomposition is impossible. According to Kobatake and Kirihara (2019), their thermal disintegration necessitates temperatures above 1000 °C, which leads to substantial energy consumption and frequent greenhouse gas emissions. Waste shell management and disposal thus has the potential to become a significant operational and financial burden.

With gills and an operculum, the periwinkle, also known as winkle (*Littorina littorea*), is a type of small edible sea snail that belongs to the Littorinidae family of marine gastropod molluscs. Plate 2 illustrates this family. This species is a sturdy intertidal with a dark shell that might occasionally have bands on it.It was brought to the northwest Atlantic Ocean from its original rocky coasts in the northeast. Except when it is eroded, the thick, widely oval shell has sharp points (Chang *et al*., 2011). According to the authors, the hue of the shell can vary from grayish to gray-brown and frequently has black spiral bands due to its six to seven whorls, fine threads, and wrinkles. Additionally, Nwaobakata and Agwunwamba (2012) and Adewuyi and Adegoke (2008) defined them as tiny, greenish-blue sea snails with spherical apertures and spiral conical shells. At maturity, the shell's average length is between 16 and 38 mm, while its breadth varies between 10 and 12 mm. According to Chang et al. (2011), shell height can be as high as 30 mm, 43 mm, or 52 mm. They are located in the mudflats and lagoons of the Niger Delta, which stretches from Badagry in the west of Nigeria to Calabar in the south. The location is further supported by Aimikhe and Lekia, 2021, who note that the species is primarily found in coastal and riverine locations in nations like Nigeria, where it is extensively spread in sandbanks and littoral drifts.

The edible portion is consumed as sea food by the locals, who discard the shells as trash (Festus *et al*., 2012). In places without granite or stones, shells are rarely used as coarse aggregate in concrete projects. Large concentrations of these shells have accumulated over time in various locations, yet significant portions of them are still disposed of as waste and disposal is already problematic in places where they have no use for them (Festus, et al., 2012). Because of their unattractive look and bad stench, discarded shells are regarded as an environmental hazard in open dumpsites.

Figure 2 Periwinkle (*Littorina Littorea*) Wikipedia Image

2. Material and method

The list of supplies and tools includes items needed to perform the rheological experiments and simulate the bottom hole static temperature. Tables 3.1 and 3.2 contain a list of these supplies and tools.

Table 1 List of Materials Used

Item	Material	Function
1	Fresh water	Material used for mixing cement slurry
2	Bentonite	Additive used as rheological enhancer in drilling fluid
3	Soda Ash	Used to control hardness in fresh water
4	Caustic Soda	Used as pH enhancer
5 6	Xanthan gum/Egg shell/periwinkle shell Barite	Fluid loss control additives Used to control drilling fluid density

Table 2 List of Equipment Used

Item	Equipment/Apparatus	Type/Model	Function
1	Electric Stirrer		Constant Speed Mixer provides variable speed mixing from 100 to 21,000 no load RPM with two preset constant speeds of 4,000 and 12,000 no load RPM
2	Mud balance	Fann model 140	Device used to measure the density of drilling fluid

			
3	Viscometer	Chandler model 3530 	Used to measure the viscosity and gel strength of cement slurry.
4	Weighing balance	MT-2000 	This device is used for reading the weights of measured materials.
5	API Filter Press		Used to determine fluid loss and filter cake

2.1. Formulation of Drilling Fluids

The criteria and goals of the well are the basis for choosing the drilling fluid systems. The drilling fluid systems listed in Tables 3.3 and 3.4 were utilized to carry out the necessary experimental testing for this investigation at various temperatures starting at 80°F.

Table 3 Water Based Drilling Fluid of 2 Grams of Xanthan Gum, Egg and Periwinkle shells

Additives	**Weight (g)**
Fresh water	312 ml
Bentonite	15
Soda Ash	0.5
Caustic soda	0.5
Xanthan Gum, Egg and Periwinkle shells	2
Barite	20
Total	350

Table 4 Water Based Drilling Fluid of 4 Grams of Xanthan Gum, Egg and Periwinkle shells

Additives	**Weight**
Fresh water	310 ml
Bentonite	15
Soda Ash	0.5
Caustic soda	0.5
Xanthan Gum, Egg and Periwinkle shells	4
Barite	20
Total	350

2.2. Drilling Fluid Preparation

To eliminate the hardness in the fresh water, 0.5 grams of soda ash were added to 312 and 310 milliliters of water, respectively, and well mixed for five minutes. To obtain a sufficient yield effect, 15 grams of bentonite were added to the fresh water and agitated for 30 minutes. The mixture was mixed with 0.5 grams of caustic soda to make sure there was no acid in the drilling fluid. After that, 2 grams of xanthan gum was added to 312 milliliters of fresh water, and 4 grams of egg and periwinkle shells were added, respectively. Lastly, 20 grams of barite were added to each of the drilling fluid combinations, and an electric stirrer was used to mix everything thoroughly for 60 minutes. Mud balance is used to measure the density of the mud, while the Ofite Model 35 Viscometer is used to assess the viscosity of the mud. With the use of the viscometer, dial readings of the prepared drilling fluids were taken at 600, 300, 200, 100, 6, and 3 rpm.

2.3. Determination of Drilling Fluid Viscosity

2.3.1. Procedure

- The viscometer was cleaned and dried by the water and ethanol.
- A certain amount of formulated drilling fluid sample was put in the large bulge viscometer and pulled it by pipette until the small bulge was full.
- Viscometer vertically positioned in the water bath at the desired temperature.
- The drilling fluid sample was allowed to flow through the capillary tube with run time when the liquid reached the mark shown on the viscometer and then stopped at the time when the liquid reached the bottom mark.
- The experiment was repeated and the results recorded (The average of the results was taken).
- The experiment was repeated for other liquids.
- The temperature was varied and the viscosity was recorded.

2.4. Viscosity measurement using direct-indicating viscometer

Viscosity meters with direct indication are rotational devices driven by an electronic motor. The plastic viscosity (PV), yield point (YP), and gel strength can all be found using this procedure. The speed rheometer was used to measure these parameters in the manner described below:

2.4.1. The plastic Viscosity

- First, the mud sample will be placed at the container and the rotor sleeve and immersed until the line scribed
- The sleeve rotating at 600 rpm and after few seconds the reading was taken at the steady value. That was the reading for 600 rpm;
- Then to take the reading for 300 rpm was waited until the value became steady and the reading was taken;

2.4.2. Calculation of Plastic Viscosity (PV):

Plastic viscosities (PV) of the drilling fluid were calculated using equation (3.1)

$$PV\ (cP) = (\theta_{600} - \theta_{300}) \quad \ldots\ldots\ldots\ldots\ldots(3.1)$$

where θ = the dial reading

2.4.3. Calculation of Yield Point

Yield points (YP) of the drilling fluid were calculated using equation (3.2)

$$YP\ (\frac{Ib}{100ft^2}) = \theta_{300} - PV \quad \text{.....................(3.2)}$$

Where θ = the dial reading

2.5. Determination of Gel Strength of Drilling Fluid

The formulated mud was measured by using the direct-indicating viscometer and also using a shear-meter, the mud sample was placed in position as in the procedure for plastic viscosity;

Then, stirred at high speed for 10 seconds and then allowed to stand undisturbed for 10 seconds. Then the hand wheel was slowly and steadily turned to produce a positive dial reading.

The maximum reading was then taken as the initial gel strength at 3rpm; finally, the mud was retired at high speed for 10 seconds and allowed to stand undisturbed for 10 minutes.

2.6. Determination of Drilling Fluid Density

2.6.1. Procedure

First, the instrument was levelled;

- Then the fill was cleaned and the dry cup was tested with mud then was putted and rotated until was seated, was ensured that the mud was expelled through the hole in the cap in order to free the trapped gas,
- The mud was swiped outside the cup and the beam was placed to support the balance that because the beam is horizontal when the bubble is on the centre line,
- After that the read was taken at the side of the rider towards the knife edge

2.7. API Fluid Loss Test

Based on API RP 10B-2/ISO 10426-2, fluid loss tests were carried out utilizing a static filter press assembly at ambient (room) temperature and 100 psi differential pressure, as indicated in Plate 3.5. Following preparation, the drilling fluid was put into a filter press that had a cylindrical drilling fluid cell with an internal diameter of 3 inches (76.2 mm) and a minimum height of 2.5 inches (64 mm). This chamber is designed to allow a pressure medium to be easily admitted and bled from the top. It is constructed from materials resistant to strongly alkaline solutions. Additionally, the setup was made so that a 90 mm (3.54 in.) piece of filter paper was positioned at the bottom of the chamber, just above an appropriate support. The area under filtering is 45.8 ± 0.6 cm2 or (7.1 ± 0.1) in2. A drain tube that empties the filtrate into a graded cylinder is located beneath the support. Gaskets are used to seal areas. There is a stand supporting the entire assembly. Any non-hazardous fluid media, whether gas or liquid, was used to apply pressure.

2.7.1. Procedure

- Each part of the cell, particularly the screen was cleaned and dried, and the gaskets were not distorted or worn.
- Formulated drilling mud was poured into the cell to within 1cm to 1.5cm (0.4 into 0.6in) of the top to (minimize CO_2 contamination of filtrate) and the assembly was completed with the filter paper in place.
- A dry graduated cylinder was placed under the drain tube to receive the filtrate, the relief valve was closed and the regulators were adjusted so that a pressure of 100 psi ± 5psi (7.03 ± 0.356 Kg/sq cm.) is applied within 30 seconds or less. The test period (or duration of time) begins at, the time of pressure application.
- At the end of 30 minutes, the volume of the filtrate was measured. The pressure regulators were shut off and the relief valve was carefully opened. It may be desirable to use one-hour filtration tests for oil drilling fluids: the time interval is other than 30min. shall be reported.
- Report the volume of filtrate in milliliter as the API filtrate; also report the initial temperature in °F.
- The cell is removed from the frame, first making certain that all pressure has been relieved.
- The cell was disassembled, the mud was discarded, and use extreme care to save the filter paper with a minimum of disturbance to the cake.
- Wash the filter cake on the paper with a gentle stream of water
- Measure and report the thickness of the cake to the nearest milliliter.

- In the case of oil drilling fluids, diesel may be used in place of water for washing the cake.
- Clean and dry the apparatus thoroughly after each use.
- Although cake descriptions are subjective, such notations as hard, firm, fine, tough, soft, rubbery, etc may convey important information about cake quality.

3. Results

This part included a presentation of the various drilling fluid experiment outcomes. The impact of drilling fluid loss when xanthan gum, egg shells, and periwrinkle are applied, respectively. Investigations were conducted on the three drilling fluids at 2 and 4 grams, as well as the impact of rheological characteristics on the drilling fluid. Additionally, this part included the density and pH findings.

3.1. Rheological Properties of Drilling Fluid Formulated with xanthan gum, egg, and periwinkle shells

Figures 1 and 5 contain results of the rheological properties of drilling fluid formulated with xanthan gum, egg and periwinkle shells temperature of 80 ^{o}F.

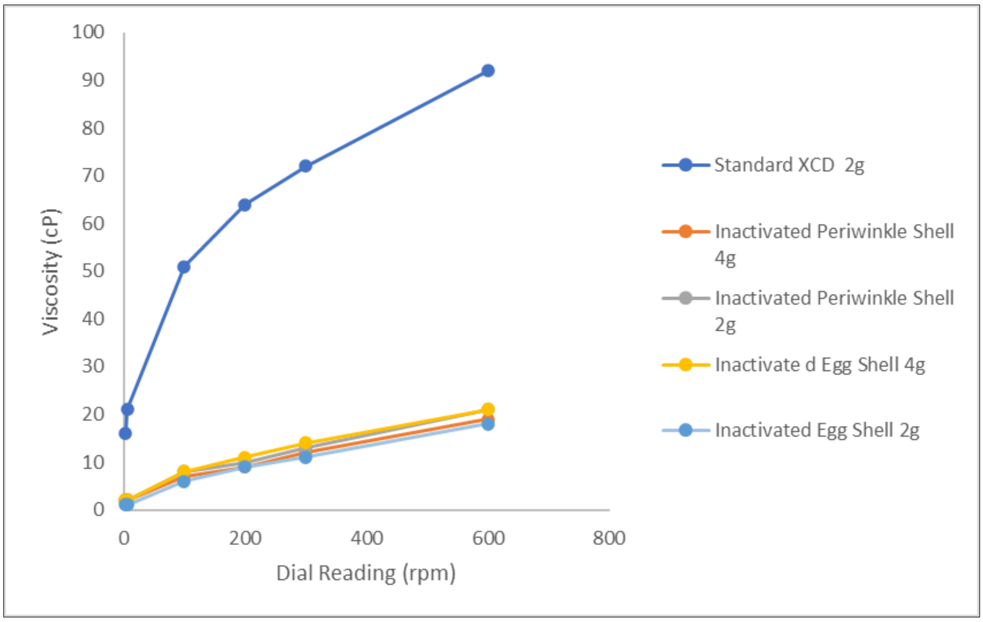

Figure 1 Graph of Viscosity vs Dial Reading of different Fluid Loss Reducers at 80 ^{o}F

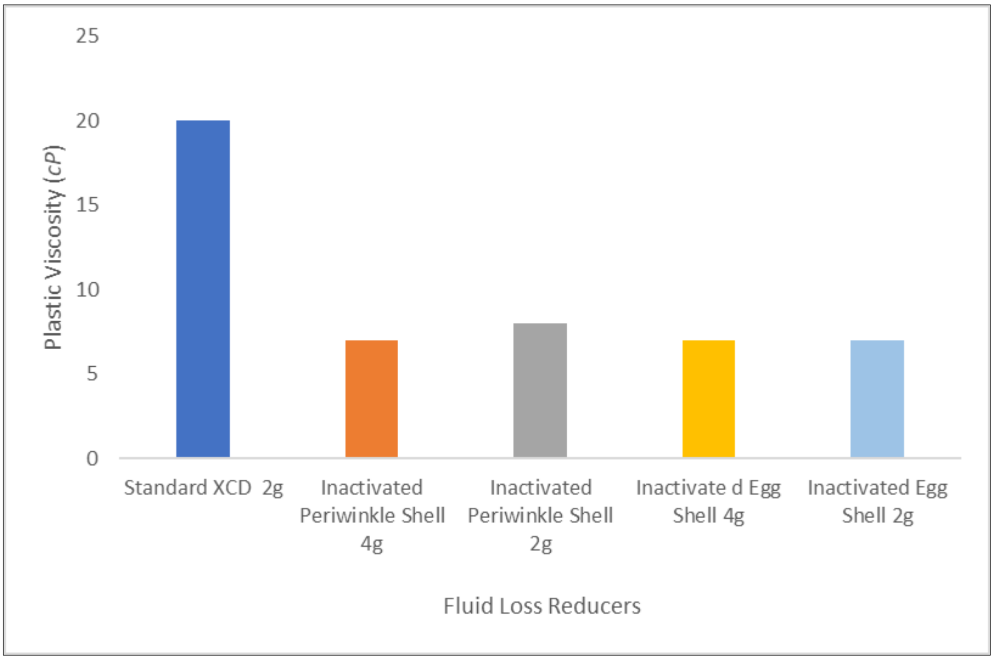

Figure 2 Graph of Plastic Viscosity vs different fluid loss reducers

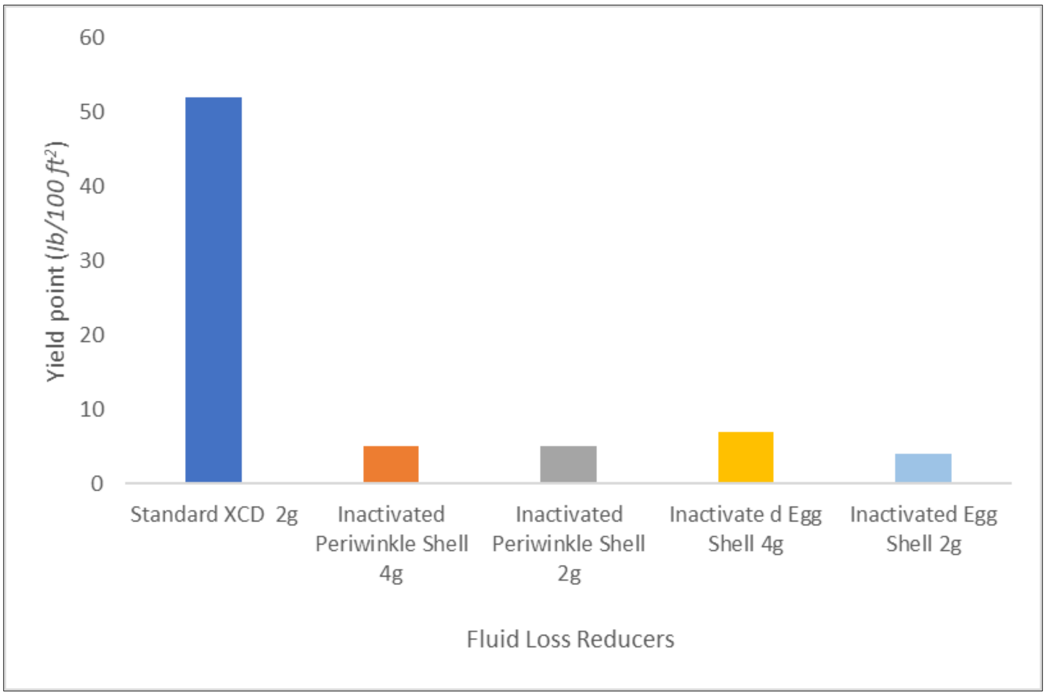

Figure 3 Graph of Yield Point vs different fluid loss reducers

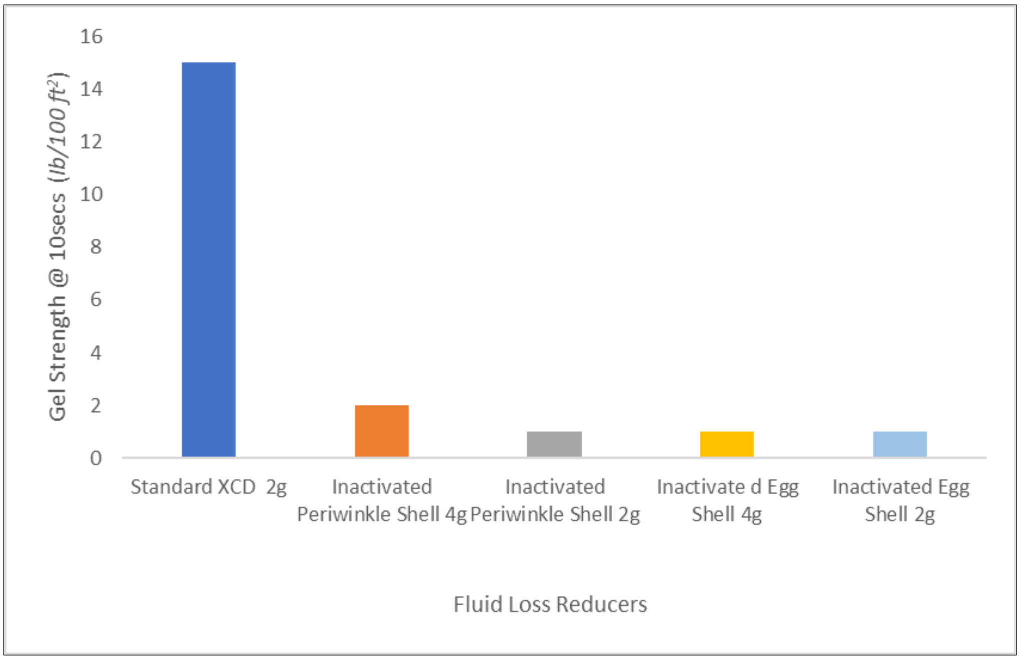

Figure 4 Graph of Gel Strength at 10secs vs different fluid loss reducers

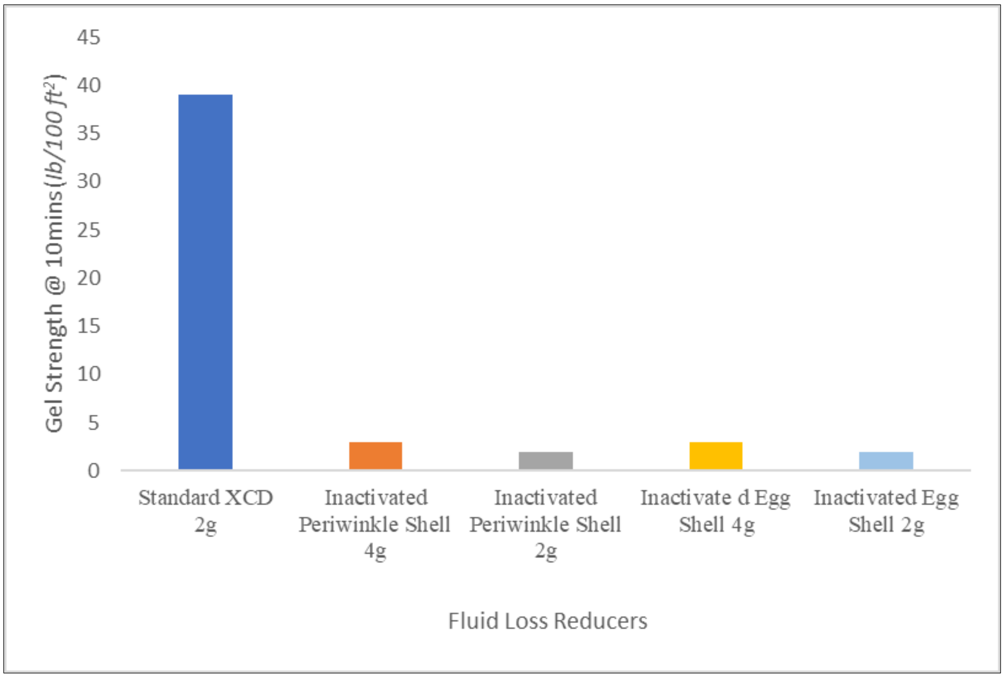

Figure 5 Graph of Gel Strength at10mins vs different fluid loss reducers

3.2. Results of pH of Drilling Fluid Formulated with xanthan gum, egg, and periwinkle shells

Figure 6 contain result of the pH of drilling fluid formulated with xanthan gum, egg and periwinkle shells temperature of 80 °F.

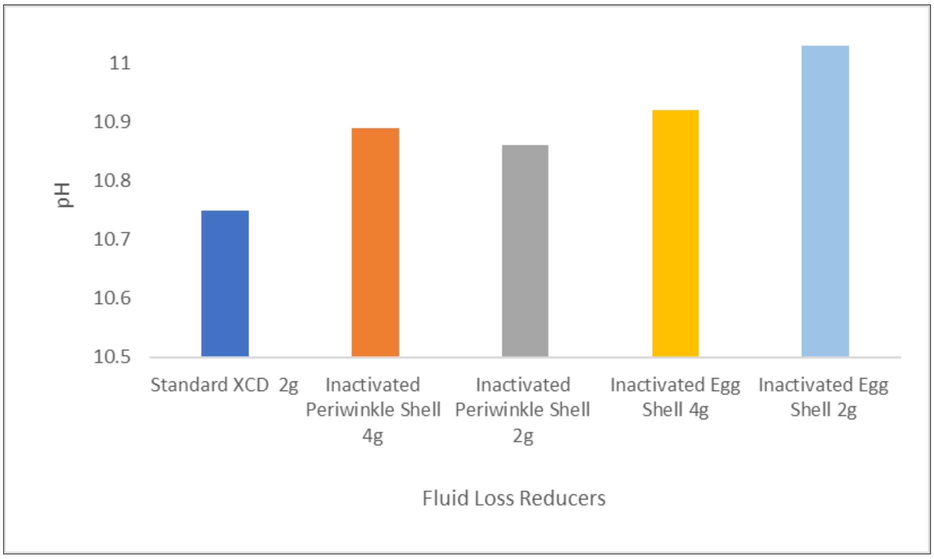

Figure 6 Graph of Concentration (pH) vs Different Fluid Loss Reducers

3.3. Results of Fluid loss of Drilling Fluid Formulated with xanthan gum, egg, and periwinkle shells

Figure 7 contain result of the fluid loss of drilling fluid formulated with xanthan gum, egg and periwinkle shells temperature of 80 ^{o}F.

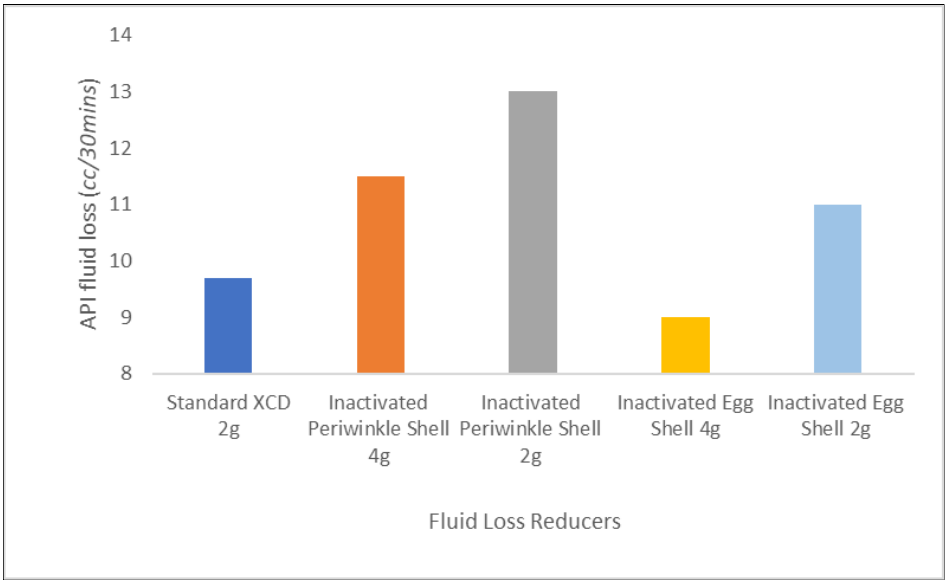

Figure 7 Graph of API fluid loss vs different fluid loss reduces

4. Discussion

The various discussion of the experiments on the drilling fluids was presented in this section.

4.1. Rheological Properties of Drilling Fluid Formulated with xanthan gum, egg, and periwinkle shells

Figure 1 illustrates that the viscosity of standard XCD was the highest at all shear rates, with a value of 72 at 300 reg/min speed. Eggshell came in second with a value of 14 at 300 reg/min speed, and non-activated periwinkle shell had a value of 13 at 300 reg/min speed. This implies that XCD might offer superior suspension and hole-cleaning abilities, but if improperly managed, it might also result in increased pumping pressures and possible formation damage.

At 10 seconds and 10 minutes, standard XCD exhibited significantly greater gel strengths (25 and 39, respectively) (Figures 4 - 5), suggesting a stronger capacity to hold cuttings in suspension when circulation is ceased. This is crucial to avoid sediments settling during tripping operations or during drilling pauses. The significantly lower gel strengths of the shell-based additives indicate that they may be less successful in keeping cuttings from settling.

4.2. Results of pH of Drilling Fluid Formulated with xanthan gum, egg, and periwinkle shells

The water-based drilling fluid's pH rose with all additions when compared to the conventional XCD (pH 10.75), whereas periwinkle and non-activated egg shell had pH values of 10.89 and 11.03, respectively. Xanthan gum exhibited the least increase in pH (11.03), while non-activated egg shell (at 2gram concentration) had the most increase. Elevated pH levels may signify a rise in alkalinity, which could influence the drilling fluid's stability and corrosion rates (Figure 6). To find the ideal dosage for each item, it would be beneficial to investigate a larger range of concentrations.

4.3. Results of Fluid loss and mud weight of Drilling Fluid Formulated with xanthan gum, egg, and periwinkle shells

The purpose of this study was to determine whether eggshells and non-activated periwinkle shells could be utilized as environmentally friendly substitutes for xanthan gum, which is a common fluid loss reduction in water-based drilling fluids. When it came to minimizing fluid loss, the egg shell performed comparably to xanthan gum (API fluid loss value of 9.7cc/30mins), especially at 4g concentration. The performance of the non-activated periwinkle shell was not uniform; the 4g concentration (API fluid loss value of 11.5cc/30min) outperformed the 2g concentration (API fluid loss value of 13cc/30min) (Figure 7). For minimizing fluid loss, eggshell might be a good substitute for xanthan gum, according on the required degree of performance. It might take further research to comprehend this behavior. Only two concentrations of each shell powder were investigated in this investigation. These results point to eggshell's potential as an effective Xanthan gum replacement; nonetheless, periwinkle shell may require additional modification.

Once more, eggshell showed encouraging findings, retaining a viscosity that was equivalent to Xanthan gum at lower shear rates, indicating good cuttings suspension and hole cleaning qualities. On the other hand, inactivated periwinkle shell consistently displayed reduced viscosity, which would require modifications for particular drilling requirements (Figure 2). There were only modest differences in mud weight between the eggshell (4g) and non-activated periwinkle shell (0.5g), with the eggshell barely surpassing the Xanthan gum. Across the investigated materials, there were modest variations in the effect of fluid loss reducers on mud weight. The highest mud weight (9.00 ppg) was found in egg shells (4 grams), followed by xanthan gum (8.90 ppg). At both concentrations, non-activated periwinkle shell had the lowest mud weight (8.80 ppg). Despite their tiny size, these variations may have an impact on drilling efficiency and wellbore pressure control. In deeper wells, more mud weight can aid in pressure control, but it can also raise the needed pumping power and perhaps affect formation stability.

The inferior gel strength of shell-based additions in comparison to Xanthan gum is a cause for concern. When drilling is stopped, this can cause more cuttings to settle. But this could also mean a lower chance of formation destruction, especially in delicate formations.

5. Conclusions

This study explored the viability of two readily available shell powders, eggshell and non-activated periwinkle shell, as sustainable alternatives to xanthan gum for reducing fluid loss in water-based drilling fluids.

Eggshell emerged as a strong contender, exhibiting comparable fluid loss control to Xanthan gum at the 4g concentration. This suggests its potential as an eco-friendly and cost-effective replacement in specific drilling scenarios.

Periwinkle shell exhibited highest API fluid loss at 2 grams concentration. This implies that the periwinkle shell is not fluid loss reducer in water-based mud.

While both shells had lower mud weight than Xanthan gum (all at 2gram concentration) a potentially desirable characteristic in certain situations, their significantly lower viscosity and gel strength compared to Xanthan gum raise concerns about hole cleaning and cuttings suspension.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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