P008: USE OF CASSAVA SKIN AND COCONUT HUSK AS LOST CIRCULATION MATERIAL IN WATER-BASED MUD

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Abstract

During oil and gas drilling operations, lost circulation of the drilling fluid could result in higher operational expenses this makes it imperative to design the drilling fluid to be used so as to minimize the invasion of the drilling fluid into the formation. Several materials had been proposed for use as Lost Circulation Material (LCM) but the use of the cassava skin and coconut husk have not been investigated. Water based mud prepared from bentonite and water, was used for the mud formulation Cassava Skins (CSS), Coconut Husks (CCH), were sun dried, shredded and blended to obtain fine to coarse fibrous and flaky particles respectively, Ground Marble (GM) was used as the control. These were used in the different concentrations ranging from 5ppb to 25ppb for the various drilling mud sample, and analyzed in the laboratory for particle sizing (which depends on the type of loss zone) using particle size distribution of material with the densities of the various samples ranging between 8.6 to 8.9 ppg. The viscosity for the mud sample with no LCM (16 cp) was a little higher while a gradual (but not linear) increase was observed for the 5 ppb to 25 ppb concentrations . A lost circulation test procedure for high permeability and fractured loss zones was performed using a 300 microns pore size, 508 and 1016 micron fracture width at 1000 psi pressure differential and temperature of 120 ° F. This study is aimed at examining the impact of these local Lost Circulation Materials (LCMs) - Coconut Husk and Cassava skin on the rheological and thixotropic properties of a water based mud and its effectiveness as a loss circulation material under static condition. Although the LCMs had no significant effect on mud rheology, ,it passed the API acceptability test range for plastic viscosity and yield point.

Keywords: Cassava skin, Coconut husk, ground marble, Lost Circulation Material and Water-based Mud

1.0 INTRODUCTION

Drilling fluids are viscous heavy fluid designed to perform variety of functions as a result they must be properly designed in order to efficiently construct a well. The selection of drilling fluid types is governed by the geological condition of the area and the fluids ability to perform the necessary function as may be determined from time to time. Drilling operations face great technical challenges with loss of circulation being one of the most notable. During the drilling of wells, fractures which are created or widened by drilling fluid pressure are suspected of being a frequent cause of lost circulation; it could also happen in cement slurries during cementing operation. These losses may vary from a gradual lowering of the mud level in the pits to a complete loss of returns. (Howard and Scott, 1951).

The loss of drilling mud or cement slurry results in increased drilling time, loss of expensive mud, plugging of productive formations, and/or loss of well control. Even with the best drilling practices, circulation losses can occur. Lost circulation is both troublesome and costly to the drilling company.

Drilling fluids are usually lost to natural or induced formation fractures. These fluids may also be lost through highly permeable formations (Kim and Wampler, 2010). An additive which can be used to seal the fractures inside the well bore is essential, thus a, Lost Circulation Materials (LCM) are used to achieve this purpose

The total cost of exploitation, of which drilling fluid is one, must comply with three requirements, which are easy to use, cost effectiveness and environmentally friendliness. Lost circulation, in turn, impacts the cost of drilling, as more rig time for regaining circulation, loss circulation materials (LCM's) to be used, all puts the cost of drilling on the high side. The control measures depend on the type of loss zone, which depends on the type of formation, loss severity and location in the hole. The plugging mechanisms in horizontal and vertical loss zones would be different since the borehole geometry of the fractures is different. While horizontal zones contact on a circle, the zone would be limited in height and lost circulation materials would cake out in a horizontal plane or on the face of the hole.

Some ways of mitigating the loss of circulation in different zones can be through: the use of porous sands and gravels, horizontal fractures and vertical fractures: The loss circulation problems may be solved through preventive method, when it is addressed during the planning phase, or through corrective method during the execution phase when the well is being drilled. The choice between this strategy is usually dictated by the "Pay now, or pay later" principle. The primary function of LCM is to plug the zone of loss in the formation, away from the borehole face so that subsequent operation will not suffer additional mud losses. The effectiveness of LCM greatly depends on factors such as solubility, the particle sizing; and absorption behavior in water, hydrocarbon and acids; behavior under pressure and temperature.

Also the longevity on the seal formed by the LCM depends on its solubility in water or hydrocarbon respectively. In the pay zone, the removal seals formed is important for production. Hence, the solubility in acids which are used for treating pay zone before production is also important. LCMs are generally divided into four categories; fibrous materials, flaky (lamellated) materials, and granular materials. The desirable condition is high ability of the material to maintain its properties under high pressure and temperature without the material breaking down or decomposing.

Nigeria produces about 210,000 tons coconut per year. This shows the abundance of husk which is mainly a waste product during harvesting. Coconut (*cocos nucifera*) husk is the fibrous cover of coconut tree fruit, the husk fiber is relatively waterproof, (natural fibers resistant to damage by saltwater), soluble in inorganic acids.(can be used in the payzone) while cassava skin is the periderm of cassava tuber, it consists of a few layers of dead cells that seal off the surface of the tuberous root, varies in color, and can be thick and rough, or thin and smooth. The periderm is about 3% of the weight of the whole tuber. It has a flaky structure which makes it a potential LCM. The periderm is soluble in organic acids and insoluble in water and hydrocarbons which is a desirable property for LCM.

2.0 Literature Review

Rogers (1953) as well as Scott and Lummus (1955) indicated that variations in the maximum size fracture can be sealed by different granular materials graded in identical particle size ranges, they all suggested that certain physical properties must be required of a material for optimum fracture sealing characteristic. Composite materials are been used as LCM, Qinglin Wu (2008) in his study made five5 composites comprising a thermoplastic polymer and cellulosic fibers in a WBM, a pressure up above 1000 psi used applied and all composites passed the test showing a trend of a better seal with the use high concentrations of the LCMs. With acid-soluble mineral, Williams et al (2001) used a high fluid loss spotting pill which included a carrier fluid, a LCM containing acid soluble mineral particulates, preferably calcium carbonate (fine and coarse particles and fine flakes) along with acid-soluble mineral fibers, preferably fine fibers such as extruded mineral wool having a diameter of 4 to 20microns, preferably from about 5 to 6 microns and a length of fiber about 200 microns, preferably 8 to 25 microns. Xiang (2007) considered a loss circulation material combination containing alkali metal silicate and Water-insoluble particulate material as an integral component of a Water-based drilling fluid system and a quantity of Water-soluble activating agent effective to reduce the pH of the Water-based mud system low enough to cause precipitation of the silicate; the Water-in soluble particulate materials included cellulose fiber selected from corn cobs, nut shells, seeds, pith, and lignin and had sizes from about 0.025 to about 2 mm (about 10 to about500 mesh). Akeju et al (2014), in their work used fine grain particles Crassostrea Virginica (Sea shells) in a water based mud. The test was run based on a fractured zone lost circulation test procedure using a medium-sized fracture at 1000 psi. and temperature of 808 °F. The fine-sized grades of the Oyster Sea shell can be used as a lost circulation material as it performed excellently in controlling mud loss as the 2:1 blend of Oyster Sea-shell outperformed the 2:1 blend of coarse and medium ground walnut shells in the water-based drilling mud for the water-based mud in the laboratory.

3.0 Materials and Method

3.1 Cassava skin (CSS) and Coconut husk (CCH) Processing

The cassava skin (CSS) collected from a cassava mill center at Alaro, Ibadan, Oyo State was hand skinned from the peels to remove the cortex layer leaving the periderm alone and the sun dried.the dried skin was pounded and then blended using an electric type Kenwood blender to a fine to coarse size particles, before sieving. The coconut husk (CCH) collected from a local market in Ibadan, Oyo state was sun dried before it was hand shredded into smaller sizes and blended into shorter fibers into a fine to coarse particle sizes. Ground marble (GM) was obtained from the department of Petroleum Engineering Laboratory.

3.2 Equipment

A Lost circulation test cell - 0.75 inch thick and 3.5 inch diameter disk with 300-micron perforations, 0.75inch thick and 3.5 inch diameter disk with 2 inch long slot of 508 micron and 1016 micron wide Kenwood blender, rheometer (Fann 900), weighing balance (digital), sieve, spatula mud density balance, and multimixer, filter paper .mud balance, bentonite, distilled water, coconut husk and cassava skin, and ground marble.

3.3 Methodology

The CSS and CCH particle size were determined using particle size distribution for varying particle size ranging from 15 microns to 1500 microns in different proportions. A water based mud was prepared using 350 ml of water and 24.5 g bentonite, LCMs were added in concentrations ranging from 5 ppb to 25 ppb and their density and rheological properties measured at 120 °F using a mud balance and a rheometer (Fann 900) respectively.

The tests for lost circulation were conducted using a lost circulation test cell which was built using metal disks as the base cap in a HTHP fluid loss cell (without the screen and filter) (Figure 1.0). This was designed to simulate seepage loss (high permeability formations) and fracture zone loss. For the high permeability formation, a 0.75 inch thick and 3.5 inch diameter disk with 300-micron perforations (Figure 2.0 a) was used, while the fracture zone was simulated using two 0.75 inch thick and 3.5 inch diameter disk with 2 inch long slot of 508 micron and 1016 micron wide (Figures 2.0 b and 2.0 c). The measurements were taken at temperature of 120 °F and pressure of 1000 psi.

4.0 Results and Discussion

The Figure 3.0 presents the particle size distribution for the three LCMs. The density of the fresh water mud without LCM was 8.7 ppg while samples formulated with varying concentrations of the LCMs are presented on Table 1.0. The result shows no significant difference in densities except for the GM-mud with 25 ppb (density of 8.9 ppg). This indicates that the grounded marble LCM has a specific gravity a little higher than that of bentonite and can only affect (increase) the mud weight when added in large concentrations.

The 8.6 ppg mud weights recorded for mud with 25 ppb concentration of CSS shows a little deviation from 8.7 ppg (density of mud without LCM) likewise those for 20 ppb and 25 ppb concentrations of CHH. This implies that the CSS and CHH have a lesser specific gravity than bentonite, and only their addition in very large concentration will produce a substantial decrease on the mud weight.

Table 1.0: Mud Weights with Varying Concentration of LCMs in ppg

Mud with different LCMs	5ppb	10ppb	15ppb	20ppb	25ppb
Mud + CSS	8.7	8.7	8.7	8.7	8.6
Mud + CCH	8.6	8.7	8.7	8.6	8.6
Mud + GM	8.7	8.7	8.7	8.8	8.9

The apparent viscosity, yield point and plastic viscosity of the mud samples with different LCMs concentrations were obtained and presented in Figures 4.0 to 6.0. A trend was observed in the apparent viscosity profile for the three LCMs, as their viscosities were all a little higher than mud with no LCM (16 cp) but with a gradual (though not linear) increase from 5 ppb to 25 ppb concentrations, the yield point dropped to as low as 6 lb/100ft^2 with increasing concentration from 5 ppb to 15 ppb but with a sudden rise from 6 lb/100ft^2 to 12 lb/100ft^2 at 20 ppb concentration. At 25 ppb concentrations, CSS-mud had the highest yield point of 15 lb/100ft^2, but the GM-mud maintained 12 lb/100ft^2, while CCH-mud had the lowest value of 9 lb/100ft^2.

The volume of mud loss (ml) for each mud sample was taken using different base caps. It was observed that the total mud loss after 30 mins for each mud sample using 300 microns diameter perforations base cap are smaller compared to the 508 and 1016 micron slots base caps. This was expected in a high permeable formation loss zones compared to fracture loss zones (Figures 7.0; 7.1 and 7.2).

Considering the 300 micron diameter perforation base cap (high permeability formation loss zone), Figures 8.0; 8.1 and 8.2 to shows that the mud loss volume with time for CSS and CCH follows the same trend as that of the control sample (GM) with no significant difference. For the 508 microns wide slot (fracture loss zone), the trend of the profiles in Figures 9.0; 9.1 and 9.2 to are the same. The CCH performed almost the same as the GM sealing the slot better than CSS evidenced from the total mud loss volumes. The profile for the 1016 microns wide slot, the profiles followed the same trend at different concentrations except for the 25ppb concentration where CCH and GM sealed better

5.0 Conclusion and Recommendation

5.1 Conclusion

The two materials were able to seal the high permeability loss zone and the fracture loss zones. The comparison of the GM and the two material (CSS and CCH) results also proved they sealed the loss zones well. The flaky Cassava Skin excellently sealed high permeable formation loss zone type, and also did well in sealing fracture loss zone type up to 1016 microns wide. Coconut Husk also performed excellently in sealing the fracture loss zone type

5.2 Recommendation

Based on the series of tests, the cassava skin and the coconut husk have exhibited the characteristics of a good lost circulation material with the Cassava Skin more effective for seepage loss (high permeable formations) and the Coconut Husk performed better in small width fractures. Thus more research should be done on their view as substitutes for expensive loss circulation material imported. Use of pelletized particles can be a good means for preventing the loose cassava skin and coconut husk particle from being blown around and losing some of the volume, when added to the mud hopper. Storage should be in moist free environment and the use of biocides should be considered due to the biodegradability.

Acknowledgement

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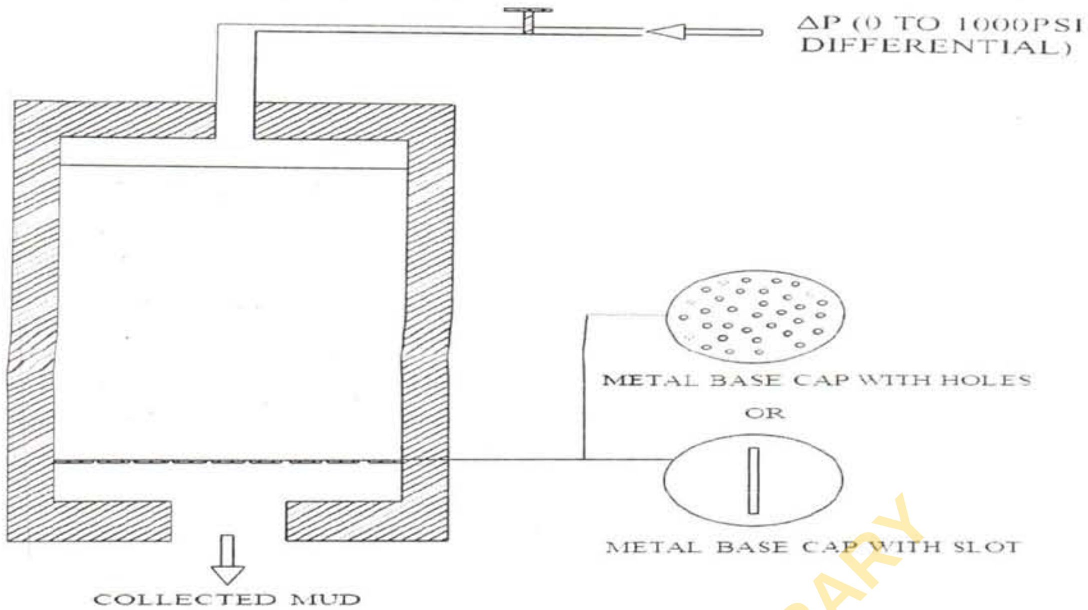


Figure 1.0: Loss Circulation Test Cell Schematics

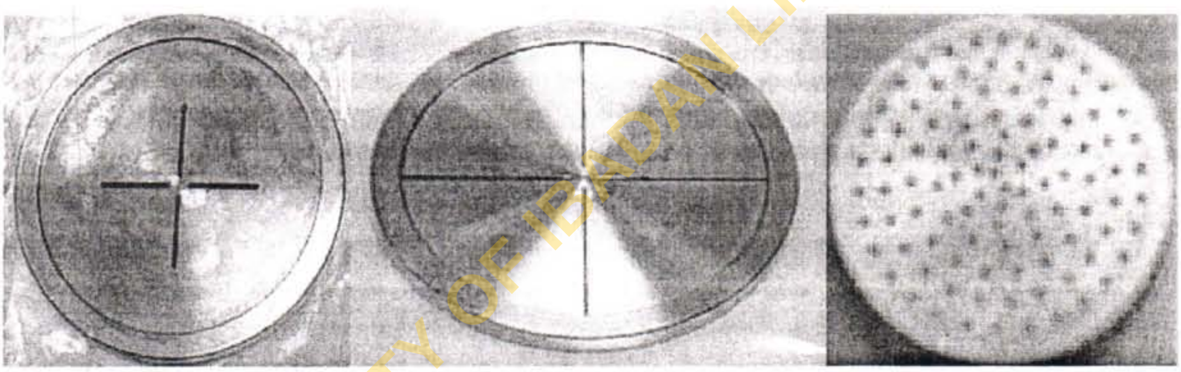


Figure 2a: Base cap with slot (1016 micron wide and 0.75 inch thick)
Figure 2b: Base cap with slot (508 micron wide and 0.75 inch thick)
Figure 2c: Perforated base cap (300 micron diameter and 0.75 inch thick)

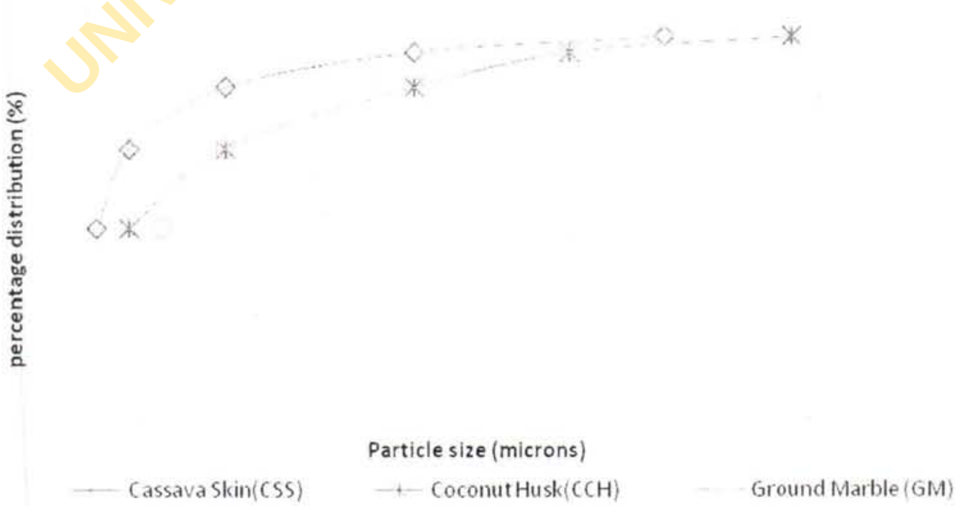


Figure 3.0: Particle Size Distribution

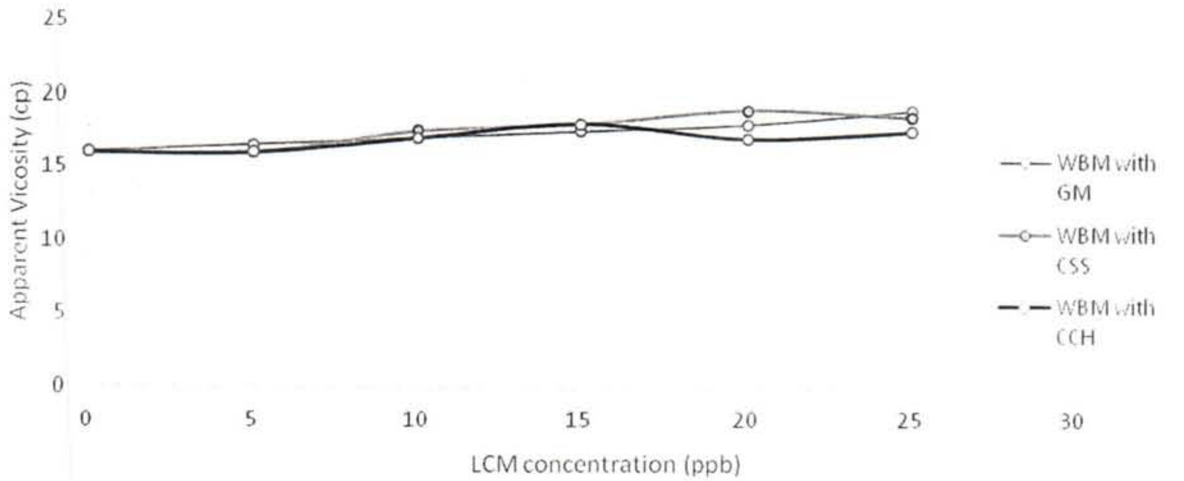


Figure 4.0: Apparent Viscosity against LCM concentrations of mud samples with different LCMs

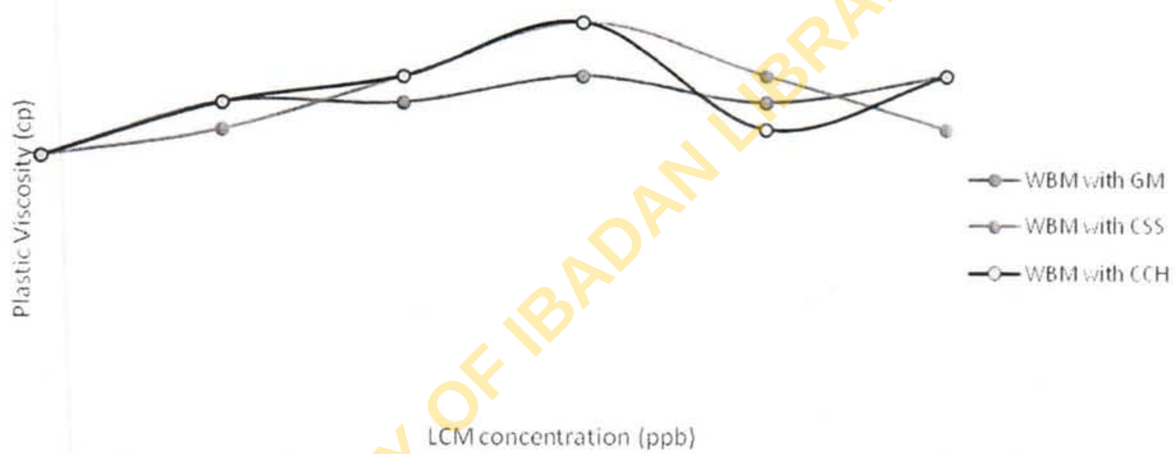


Figure 5.0: Plastic Viscosity against LCM concentrations of mud samples with different LCMs

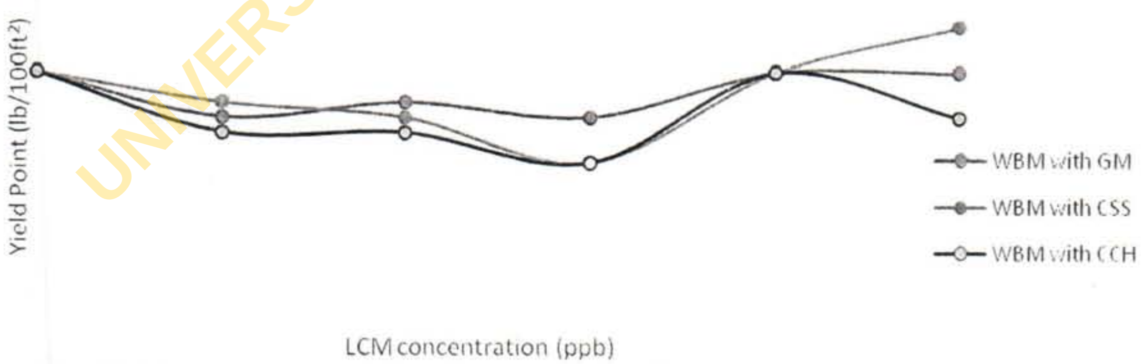


Figure 6.0: Yield Points against LCM concentrations of mud samples with different LCMs

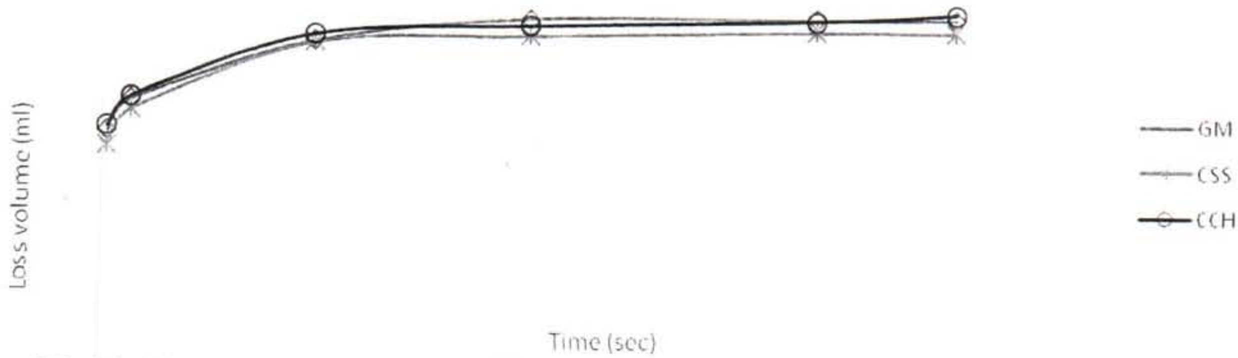


Figure 7.0: Mud loss volume (ml) against Time (sec) for mud with 5ppb LCMs (with a base cap with 300 microns diameter perforations).

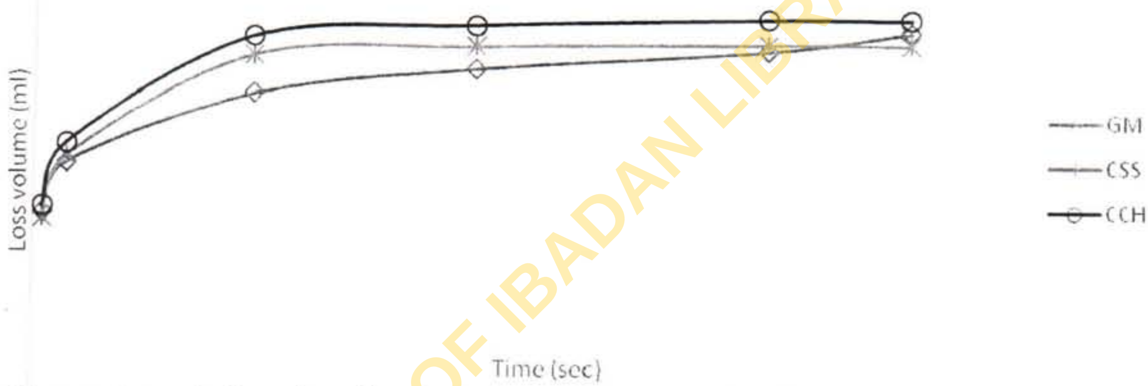


Figure 7.1 Mud loss volume (ml) against time (sec) for mud with 15ppb LCMs (with a base cap with 300 microns diameter perforations).

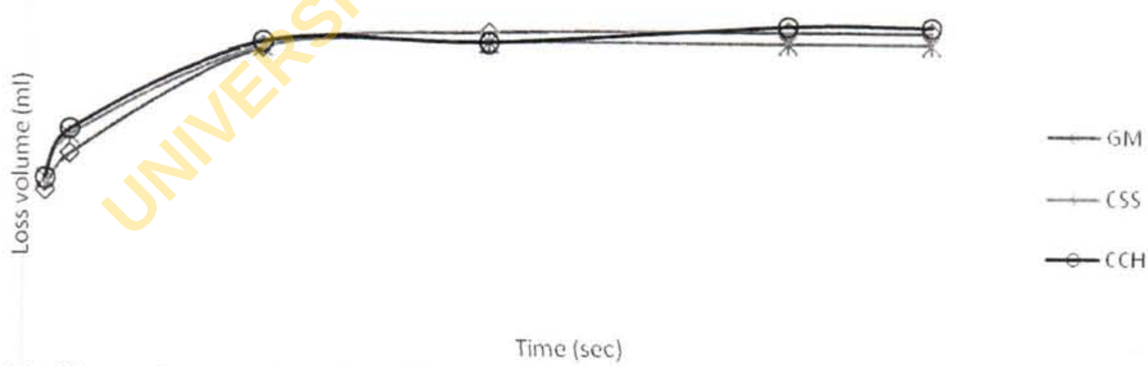


Figure 7.2 Mud loss volume (ml) against time (sec) for mud with 25ppb LCMs (with a base cap with 300 microns diameter perforations).

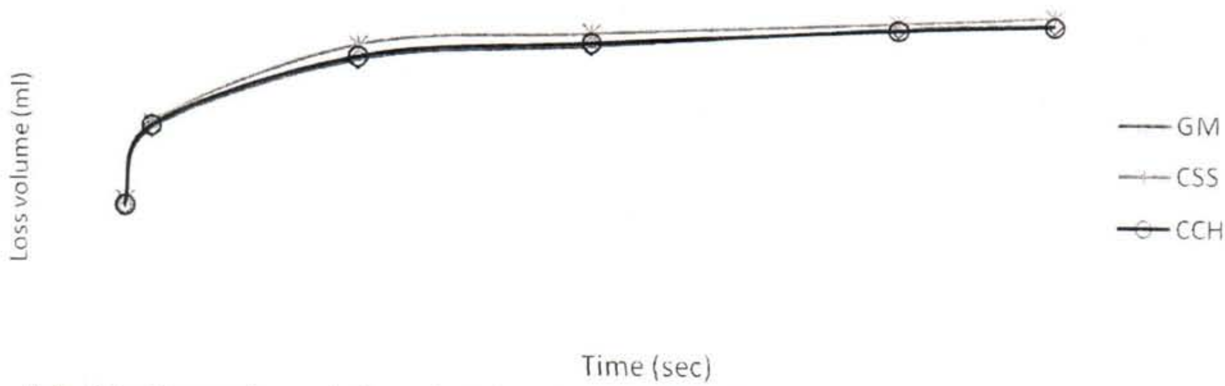
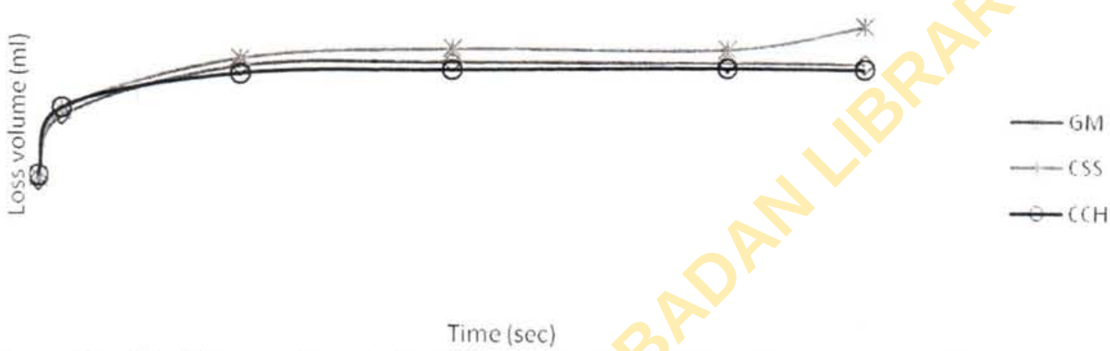


Figure 8.0: Mud loss volume (ml) againt Time (sec) for mud with 5ppb LCMs (with a base cap of 508 microns slot).



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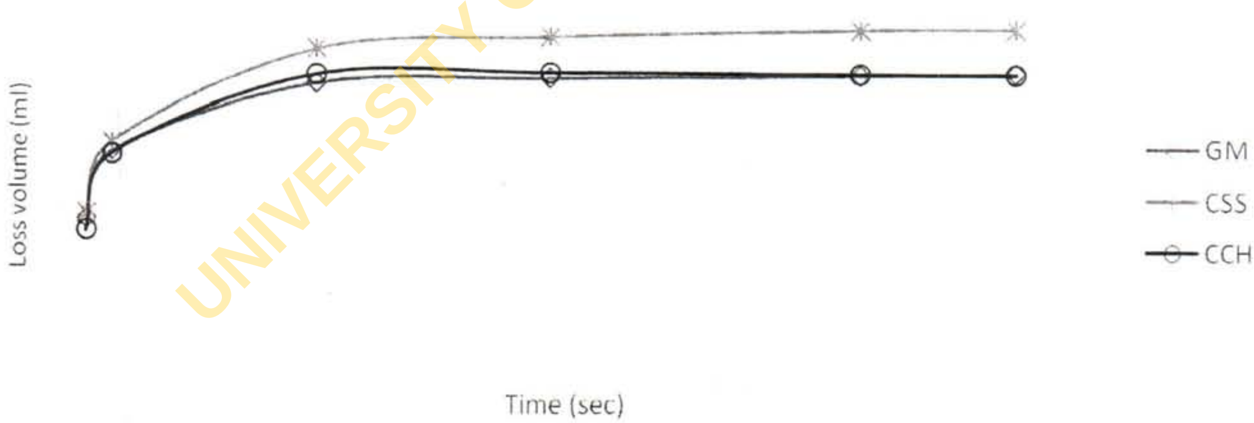

Figure 8.2: Mud loss volume (ml) vs time (sec) for muds with 25ppb concentration of each LCMs (using a base cap of 508 microns slot.)

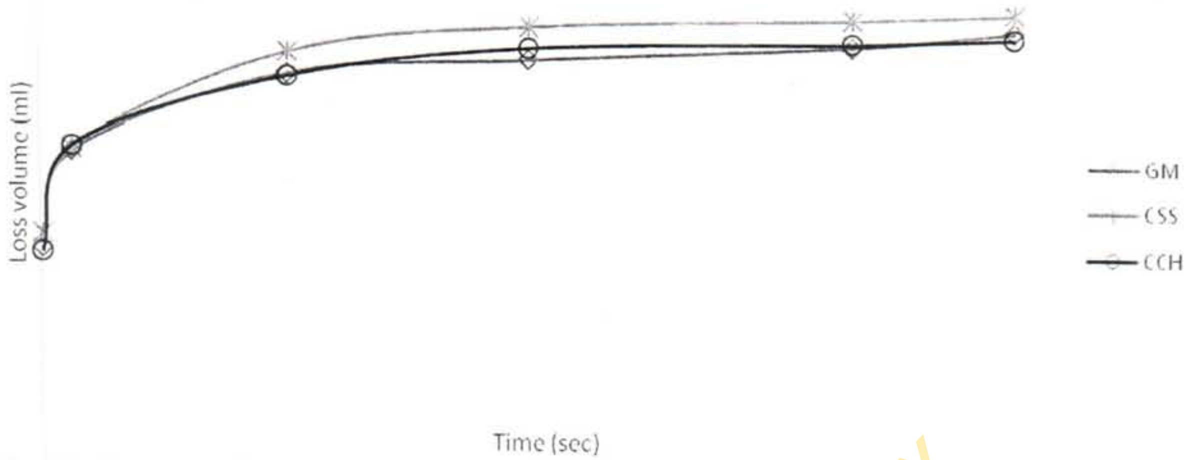

Figure 9.0: Mud loss volume (ml) against Time (sec) for mud with 5ppb LCMs (using a base cap with 1016 microns slot).

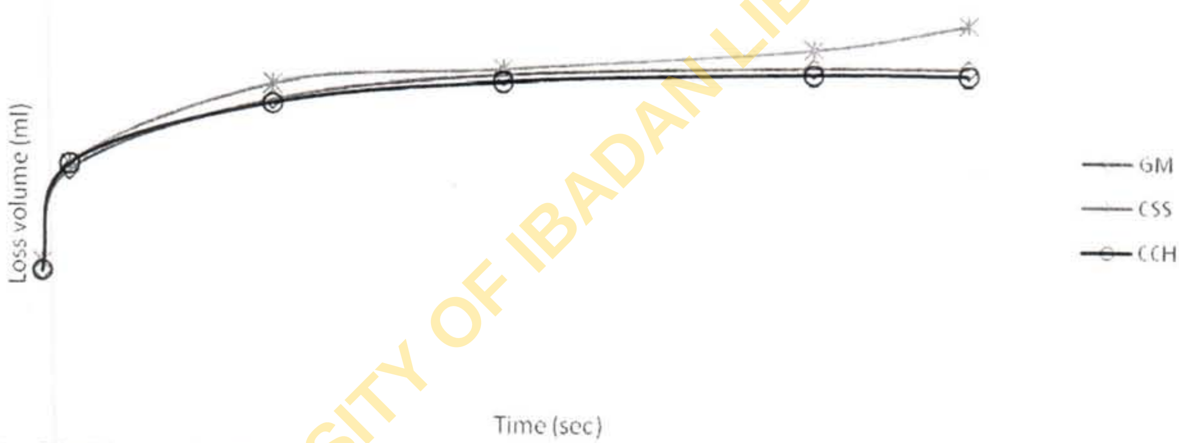

Figure 9.1: Mud loss volume (ml) against Time (sec) for mud with 15ppb LCMs (using a base cap with 1016 microns slot).

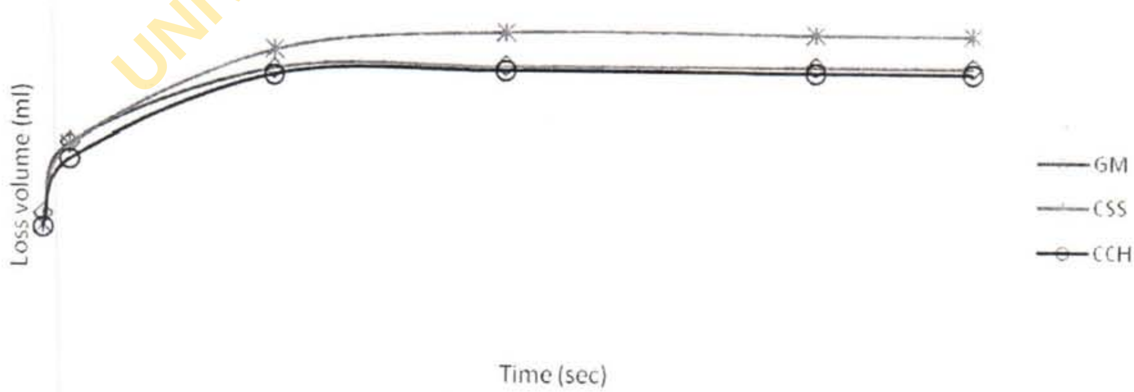

Figure 9.2 Mud loss volume (ml) against Time (sec) for muds with 25ppb concentration of each LCMs and using a base cap with 1016 microns slot.