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Preliminary Investigation of African Oil Bean Husk as a Feasible Fluid-Loss Control Agent in Drilling Muds

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Abstract

This paper presents a preliminary study on the suitability of African oil bean husk (AOBH), as a fluid loss control additive for water-based drilling mud (WBM) and oil-based drilling mud (OBM). AOBH was dried, ground and sieved into particle sizes of 63µm, 125µm and 250µm. The chemical properties and morphology of AOBH was studied using Scanning Electron Microscope energy dispersive X-ray spectroscopy (SEM-EDS) and Fourier Transform Infrared Spectrophotometer (FTIR). Six samples of WBM and OBM containing the various sizes of AOBH as flood-loss control additives were prepared. Also, mud without additives as well as mud containing industrial grade additive materials (Grel Alphatex and Soltex) were prepared. Filtration properties and some other properties (mud density, pH, etc.) of the prepared drilling muds were assessed. Results acquired from FTIR and SEM-EDS showed that carbon is the major element present in AOBH. AOBH contains asphaltic compounds (Alkane and Benzene ring). Filter cake thickness formed using AOBH additives was between 2.1mm - 2.28mm for WBM and between 2.3mm - 2.9mm for OBM, while filter cake thickness formed containing contemporary industrial additives was 2.0 mm for WBM and 2.3mm for OBM. Filtrate-loss from mud using AOBH additives was 2.0ml – 3.4ml for WBM and 2.3ml – 3.3ml for OBM, while filtrate loss from mud containing contemporary industrial additives was 2.1ml for WBM and 2.3ml for OBM. Results for pH showed 8.31 for mud containing Grel Alphatex additives and 8.50 - 8.69 for mud containing AOBH additives. Results for Marsh Funnel Test showed 47.21 secs for mud using Grel Alphatex additives and 44.36secs – 45. 57secs for mud using AOBH additives. Also, the chemical composition of AOBH indicates that it is biodegradable and eco-friendly. Therefore, AOBH is a prospective material that can be used as fluid-loss control additives in both WBM and OBM.

1.0 Introduction

The drilling fluid is intended, among other functions, to clean the well, convey the cuttings to the surface, cool the drilling and prevent influx of formation fluid into the well [1]. To effectively perform these functions, drilling muds are designed to meet major functional requirements such as appropriate mud rheology, density, fluid loss control property and pH [2]. Different types of chemicals are used to achieve these functional requirements. Fluid-loss control is achieved by the use of fluid loss control additives. Fluid-loss is minimized by the creation of a low permeable filter cake at the wellbore surface, thereby preventing solid particles, filtrate and formation fluid from flowing into the wellbore. Also, it prevents mud fluid from damaging the formation by flowing into it. If damage occur, the pore spaces of the formation are plugged, thus, reducing porosity and permeability of the formation are reduced [3]. In the Petroleum industry, some natural polymers such as starch and synthetic starch such as carboxymethyl cellulose (CMC) are used to control fluid loss [4]. But the problem with these polymers is that they are expensive, not easily degradable chemical and toxic to the environment. These challenges have necessitated strong desire to source for cheaper and local additives. [5], stated that though the technical requirements of the drilling fluid cannot be disregarded, its impact on the environment must not be disregarded.

Literature has shown that the choice of drilling fluid is based on four factors - type of formation, temperature and pressure of formation, nature of the formation fluid and operational factors [6]. In the industry, polymeric materials and starches are added to the mud to enhance its performance [7]. Other additives such as bentonite or Attapulgite clay may be added to help in fluid-loss control. Bageri et al., (2020)[8] in their article reasoned that that determined effort to find effective ways to reduce the volume of mud filtration is ongoing. High cost of these fluid-loss control additives is contributed by the cost of importation. Use of locally sourced fluid-loss control material that can offer comparatively similar performance would be a cheaper substitute Such material should be safe to the environment. Starch obtained from various crops has been used as a fluid-loss control additive Such crops are: cassava [9, 10], corn [11], potatao [12], rice [13] and starch generally [14, 15]. [16] used powder made from sunflower seed as a fluid-loss control additive. [17] evaluated the suitability of ash formed from shells of periwinkle for use as a fluid-loss control additive in water-based drilling mud. [18] studied suitability of some local materials: “offor” (*Detariummicrocarpum*) and “Achi” (*Brachystegia Eurycoma*) as fluid-loss control additives. Also suitability of *Pleurotus* was studied [19]. Adebayo et. al. (2014)[20] researched on the applications of sawdust as a filter loss additive in water-based mud. Results obtained from these studies showed that these locally sourced materials are derivatives from plants. They are organic materials; they contain carbon as major element. The results of their mud tests show comparable performance of local materials with the contemporary industrial grade materials. However, suitability of these materials as fluid-loss control additives is limited by constrained availability, low affordability and existence of highly competitive alternative use.

Africa oil bean (*PentaclethraMacophylla-Benth*) plant is a perennial plant in Nigeria locally called “Ugba” by the Igbos, “Apara” by the Yorubas and “Ukana” by the Efik. It is a tropical tree in the family – Leguminosae Mimosoideae. The tree flourishes in the Eastern and Southern parts of Nigeria [21]. It has pods (husk) containing up to 10 seeds. Africa oil bean pod is shown in Figure 1.

Figure 1: African Oil Bean Husk (AOBH)

When mature, the seed is shed from the pod by explosive mechanism [22]. The pod (husk) are brown and woody when mature.

The mesocarp of *P. macrophylla* seed serve as food eaten as snack or desert (evening meal) or used as condiment. It has been reported to be rich in protein (45%), amino acids and fatty acids. Total saturated fatty acids and lingering anti-nutritional components were reduced in it [23]. Because *P. macrophylla* seeds contain alkaloids, saponins, flavonoids, and tannins, they have medicinal and therapeutic properties. Some phytochemicals may operate on cells to inhibit the development of cancer, stop the effect of certain carcinogens on their target organs or tissues, or help avoid the production of potential carcinogens (substances that cause cancer). However, the husk does not have much use and the demand for them is low. Dry husk is used as fuel. Use of the husk as fuel is not encouraged since it leads to air pollution. Also, the heating value of the husk is low. There are fuels that have better heating value. Therefore, creating a more profitable use for AOBH will be a welcomed development. AOBH promises to be a good candidate of profitable locally-sourced fluid-loss control additive because it will have no competitive alternative use. *Pentaclethra macrophylla, Bentham*, commonly called the oil bean tree are currently farmed on numerous farms throughout Africa [24]. Hence, this article presents investigation on the suitability of African Oil Bean Husk (AOBH) as a fluid-loss control additive in water-based mud (WBM) and oil-based mud (OBM). The significance of this study is on discovery of biodegradable and ecologically-friendly additives. Being locally sourced, cost is reduced the drilling mud, dependence on imported additives is discouraged, involvement of local content is increased, create and reduction in the rate of pollution.

2. Materials and Method

This section is in three parts; the first part presents the materials and instruments used. Also, preparation and characterization of the African oil bean husk (AOBH) to reveal its physico-chemical characteristics. The second part is to prepare a standard water-based drilling fluid (WBM and OBM) with a varying concentration of the AOBH. The third part is to conduct test according to the standard procedures stipulated in API recommended practice code (API RP 13B-1) and (API RP 13B-2) for characterizing WBM and OBM respectively. In this work, emphasis was on the filtration property of AOBH at ambient condition (LPLT) and at HPHT conditions for WBM and OBM respectively. Other mud compatibility tests were conducted as well.

2.1. Materials and Equipment

The materials used and their function in the WBM and OBM are presented in Table 1.

Table 1: Materials used for WBM and OBM

Materials	Function
De Ionized water	Continuous phase
Bentonite	Primary viscosifier for WBM
Barite	Weighing material
Lime	pH enhancer
Xanthan gum (XG)	Fluid loss control/viscosifier for OBM
Starch	Viscosifier for WBM
Organophilic clay	Primary viscosifier for OBM
Grel Alphatex	Fluid loss control agent for LPLT drilling
Soltex	Fluid loss control agent for HPHT drilling
AOBS	Eco-friendly fluid loss control additive
$CaCO_3$	Soluble weighing material for OBM
$CaCl_2$	Shale inhibitor for OBM
KCl	Shale inhibitor for WBM

The equipment used and their function are presented in Table 2.

Table 2: Equipment used in testing WBM and OBM

Equipment	Function
HPHT filter press machine	Filtration property at HPHT drilling condition for OBM
LPLT filter press machine	Filtration property at ambient for WBM drilling condition
Baroid Mud balance	Mud density
Ofite HPHT Rheometer	Mud viscosity of OBM
Fann LPLT rheometer	Mud rheology of WBM
Marsh funnel viscosity	Quick viscosity measurement
FTIR Spectrophotometer- FTIR 8400 S	For functional group and bond type identification
SEM-EDS	Morphology and elemental composition of AOBH

1.1. Preparation and Characterization of AOBH

AOBH was dried for a week and crushed with grinder to smooth powder. The ground husks were further dried. Sieve sizes of 63µm, 125µm and 250µm were used to recover the various particle sizes. Fourier Transform Infrared test and SEM EDS of AOBH sample were taken to determine its chemical and physical properties. Shimadzu spectrophotometer (FTIR 8400S) was used to classify the functional groups present in AOBH, Graseby Specac fitted with a vacuum hydraulic was used to press the sample at 1.2 psi pressure. The samples were made to pass through an infrared detector connected to a computer. With an adsorption range of 600 to 400cm^{-1}, the sample was scanned and the reflectance of the sample was interpreted to obtain the dominant functional group and its bond structure/type. Phenom Prox model of the Scanning Electron Microscope energy dispersive X-ray spectroscopy (SEM-EDS) was used to determine the morphology and elemental composition of the AOBH.

1.2. Preparation and Testing of Mud Samples

Samples of WBM and OBM were formulated without fluid loss material as blank mud (Sample A). Sample B of WBM were formulated with 1.0wt% of Grel Alphatex as fluid-loss additives for WBM. Sample B of OBM were formulated with 1.0 wt% of Soltex as fluid-loss additives for OBM. Other samples are- C: 1.0 wt% of 63µm AOBH, D: 2.0wt% of 63µm AOBH, E: 1.0 wt% of 125µm AOBH, F: 2.0 wt% of 125µm AOBH, G: 1.0 wt% of 250µm AOBH and H: 2.0 wt% of 250µm AOBH. The weight percent is based on the density of the base fluid, for WBM, 350g of the 350mL of the continuous phase. Composition of samples are presented in Table 3 and Table 4.

Table 3: Composition of WBM

Sample	Water (ml)	Bentonite (g)	Barite (g)	CaOH (g)	KCL (g)	Starch (g)	Fluid loss additive (g)
A	350	21.00	12.00	2.50	2.00	2.40	Nil
B	350	21.00	12.00	2.50	2.00	2.40	1.0wt% Grel Alphatex
C	350	21.00	12.00	2.50	2.00	2.40	1.0wt% 63µm AOBH
D	350	21.00	12.00	2.50	2.00	2.40	2.0wt% 63µm AOBH
E	350	21.00	12.00	2.50	2.00	2.40	1.0wt% 125µm AOBH
F	350	21.00	12.00	2.50	2.00	2.40	2.0wt% 125µm AOBH
G	350	21.00	12.00	2.50	2.00	2.40	1.0wt% 250µm AOBH
H	350	21.00	12.00	2.50	2.00	2.40	2.0wt% 250µm AOBH

Table 4: Composition of OBM

Sample	Base Oil (ml)	Org. Clay (g)	Pri Emul (g)	Barite (g)	CaOH (g)	Sec Emul (g)	$CaCO_3$ (g)	$CaCl_2$ (g)	XG (g)	FLA (g)
A	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	Nil
B	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	1.0wt% Soltex
C	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	1.0wt% 63μm AOBH
D	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	2.0wt% 63μm AOBH
E	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	1.0wt% 125μm AOBH
F	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	2.0wt% 125μm AOBH
G	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	1.0wt% 250μm AOBH
H	350	30.0	11.0	18.0	5.0	8.0	8.0	3.50	7.50	2.0wt% 250μm AOBH

The filtration properties at ambient and at HPHT conditions for WBM and OBM were studied. Compatibility tests (rheological property, mud density, marsh funnel viscosity and mud pH) of these drilling fluids under the influence of the fluid loss control agent were also studied.

3.0.Results and Discussion

Results of experiments and tests conducted in line with the recommended API standard are presented.

3.1.Characterization of AOBH

3.1.1.Results from Fourier Transform Infrared (FTIR) Test

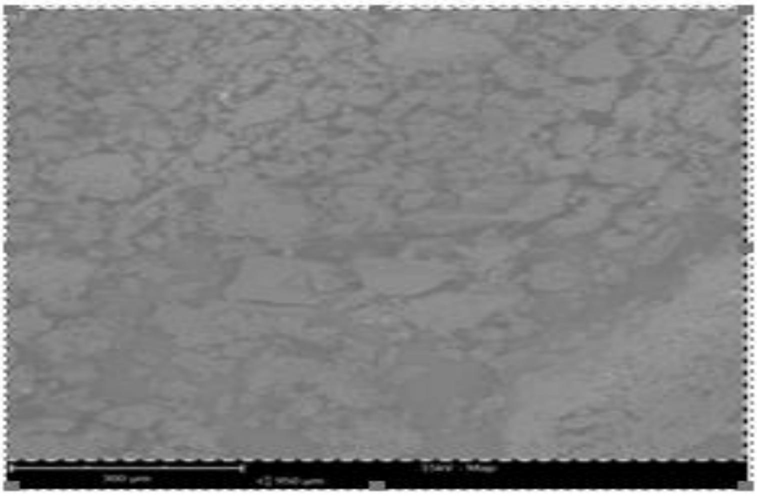
Table 5 presents the result of FTIR as extracted from the FTIR spectrum analysis shown in Appendix I.

Table 5: Compositional framework of AOBH

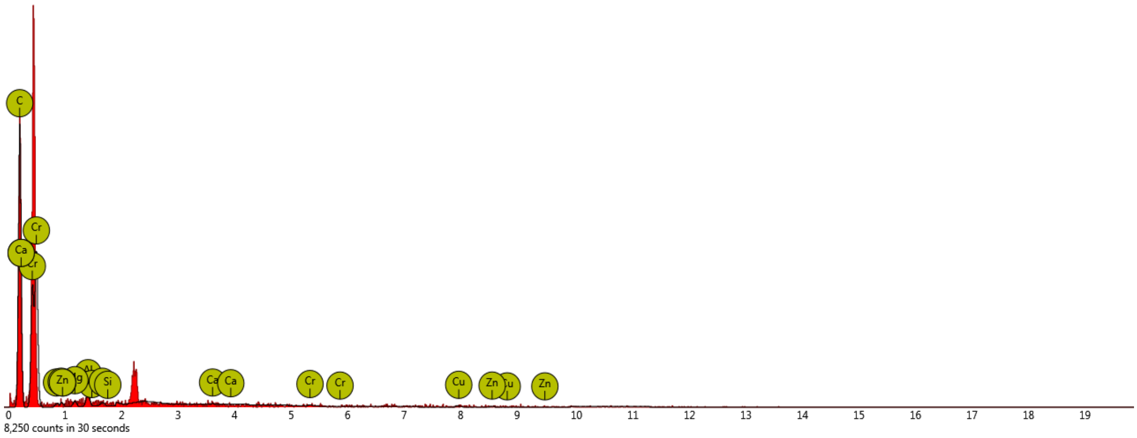
Group	Molecular motion	Type of vibration	Intensity	Band (cm^{-1})	Area
Benzene	$C-C$	bending	strong	709.83	16.04
Anhydride	$CO-O-CO$	stretching	strong	1018.45	5.404
primary alcohol	$C-O$	stretching	strong	1087.89	2.794
aromatic ester	$C-O$	stretching	strong	1373.36	4.09
carboxylic group	$-OH$	bending	medium	1458.23	4.709
Alkene	$C=C$	stretching	strong	1643.41	4.601
Azide	$N=N=N$	`stretching	strong	2160.35	2.336
Thiol	$S-H$	stretching	weak	2522.98	1.477
Alkane	$C-H$	stretching	medium	2924.18	29.244
aliphatic primary amine	$N-H$	stretching	medium	3340.82	29.076
aliphatic primary amine	$N-H$	stretching	medium	3441.12	22.478
Alcohol	$-OH$	stretching	medium	3780.6	2.892
Alcohol	$-OH$	stretching	medium	3896.34	2.929
Alcohol	$-OH$	stretching	medium	3958.06	1.235

As shown in Appendix I, the FTIR spectrum analysis revealed the functional group compositions present in the sample at wavelengths spanning from 4000 to 750cm^{-1}. The potential functional group compositions and compounds are listed in Table 5. The dominant functional groups present are C-H and N-H groups with wavelengths of 2924.18cm^{-1} and 3340.82cm^{-1} respectively. Others include carboxylic acid, alcohols, alkene and thiol. The N-H is found also in primary amine. Primary amine possesses an outstanding shale stability in WBMs [25, 26].

3.1.1. Scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM-EDS) of AOBH



(a): Scanning electron microscopy



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(b): Energy dispersive X-ray spectroscopy

Figure 2: (a) Scanning electron microscopy and (b) energy dispersive X-ray spectroscopy (SEM-EDS) of AOBH

As shown in Figure 2(a), it can be seen that AOBH contains grains that are randomly and poorly bonded together with similar orientation. A non-destructive technique applied to study the morphology and chemical composition (elements) present in AOBH. As shown in Figure 2(b), the material tends to possess high amount of carbon with a weight concentration of 93.96%, other elements in the material include, potassium, copper, zinc, sodium, magnesium, silicon and calcium. Elements present and their concentration are shown in Table 5.

Table 6: Elements present in AOBH and their concentration

Element Number	Element Symbol	Element Name	Atomic Conc.	Weight Conc.
6	C	Carbon	96.56	93.96
19	K	Potassium	1.84	1.73
29	Cu	Copper	0.73	3.55
30	Zn	Zinc	0.64	3.19
11	Na	Sodium	1.44	1.77
12	Mg	Magnesium	0.41	0.76
14	Si	Silicon	0.21	0.45
20	Ca	Calcium	0.06	0.18

As shown in Table 6, the elements present in AOBH constitute mainly alkali metals. These alkali metals are responsible for keeping the pH of the drilling muds higher than that of the blank mud. It was also observed from the characterization of AOBH that it is non-toxic, biodegradable, and lack bacterial habitation. Hence, AOBH is eco-friendly. Since AOBH is eco-friendly, it can be recommended as suitable for various green product development for petroleum industry operations. Also, unlike salts, polymers, CMC that require treatments before disposing into the environment, AOBH does not require treatment before disposal. Additional cost needed for treatment before disposal can be avoided thereby making AOBH more economical.

3.2.Characterization of Drilling Mud

3.2.1 Filtration Properties

This property of the mud is vital in ensuring that a safe and reliable filter cake is deposited on the formation wall. The thickness of the deposit must be controlled so as to maintain hole size. Very thick filter cake signifies reduction of actual hole size and difficulties in running tubular members in and out of the well will become inevitable. Figures 3 and 4 show the filtration properties of WBM and OBM samples respectively: filter cake thickness (FCT) and fluid loss (FL).

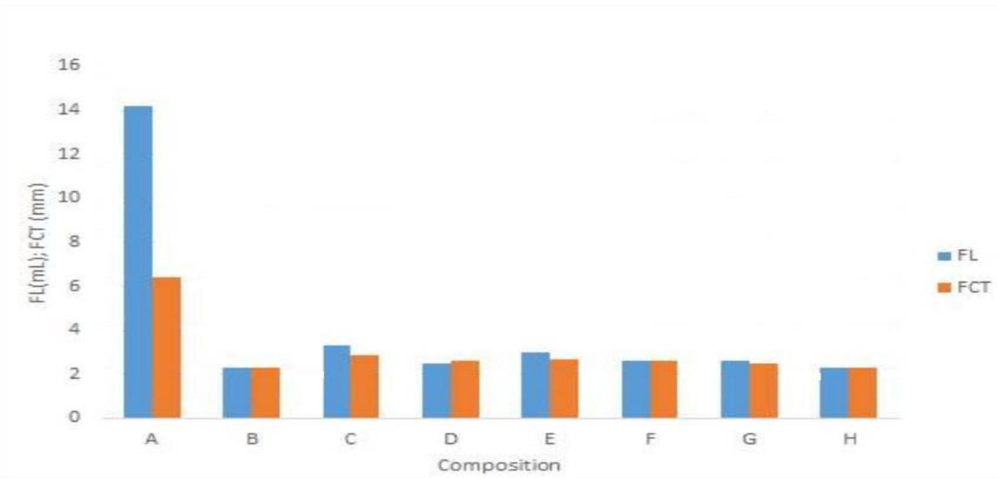

Figure 3: Filtration properties of WBM: filter cake thickness (FCT) and fluid loss(FL)

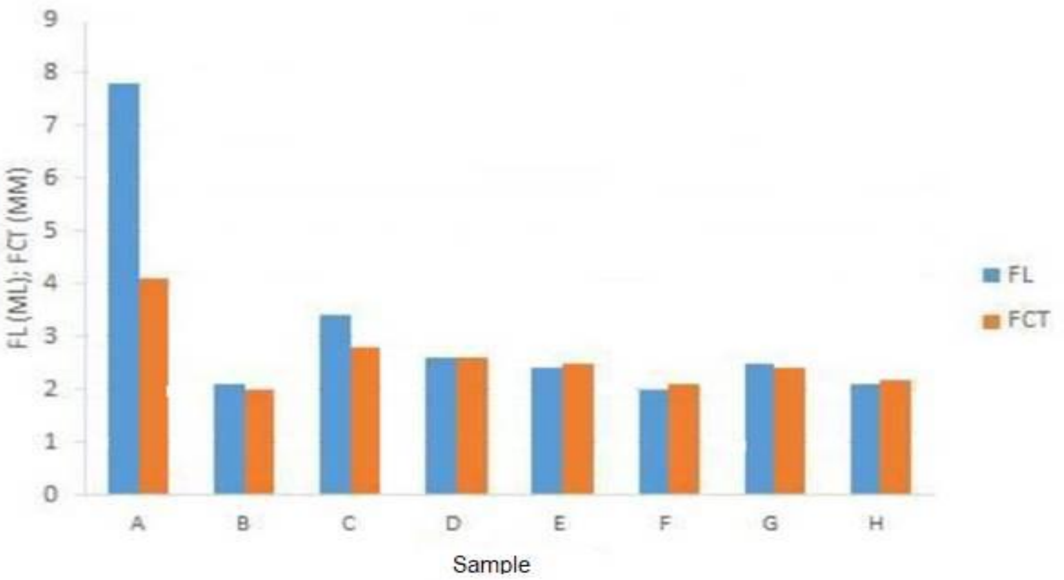

Figure 4: Filtration properties of OBM: filter cake thickness (FCT) and fluid loss(FL)

As shown in Figure 3, drilling mud without fluid-loss control additive has a significant amount of fluid loss to the formation (14.2ml) with a thick filter cake (6.4mm). The results indicate that the filter cake thickness reduced to 2.3mm (64.1% reduction) and 2.6mm (59.4% reduction) for commercial additive and AOBH respectively in WBM.

As shown in Figures 4, drilling mud without a fluid-loss control additive has a significant amount of fluid loss to the formation (7.8ml) with a thick filter cake (4.1mm). The results indicate that the commercial fluid loss control additive possesses the ability to reduce filter cake thickness to 2.0mm (51.2% reduction) while AOBH recorded average reduction of 2.43mm (40.7% reduction) for the OBM. Both fluid loss and filter cake thickness decreased with increase in grain size and concentration for both OBM and WBM. The results revealed that the mud with AOBH as fluid loss control agent had a closer wall building capacity especially with sample F (OBM) and same wall building capacity for WBM for sample H.

The amount of fluid-loss from the mud sample represents invasion of clear filtrate from the mud into the formation. It is a significant parameter that must be controlled so that such fluid invasion does not cause peculiar challenges. These challenges are: poor logging data, not observing hydrocarbon zone and formation damage [27]. Poor logging data can result if logging tools records mud filtrate instead of in-situ fluids from formation. Hydrocarbons zone may not be observed hence ignored if reservoir fluids in such zone are pushed further from the well bore. Formation damage results if fluid invasion causes reduction in permeability of formation.

Also, the results presented in Figures 3 and 4, there was a significant fluid loss in both mud types. There was a 73% reduction of fluid loss (2.1ml) with the commercial material for fluid loss control whereas the AOBH had a reduction in average mud loss into the formation at 2.5ml (67.9% reduction) for the OBM. For the aqueous mud, there was a reduction of fluid loss at 2.3ml representing (83.8% reduction) and 2.7ml representing (80.1% reduction) for the commercial agent and AOBH as fluid loss control agent. Sample H which consists of 250μm at double dosage had same performance with the commercial wall builder.

From the results, the filtration property of AOBH material is acceptable because the fluid loss from all the compositions were within the acceptable range for drilling operation since the fluid loss were below or equal to 5ml [19]. This performance could be due to larger particles of the AOBH and

adhering to the pores throats of the formation thereby minimizing the spurt loss (reduced mud permeability into the formation) and proving a moderate filter cake on the formation wall [28]. The filtration property of AOBH is dissimilar to the use of orange peel and sunflower seed as fluid-loss control additives where reduction of fluid loss was prominent with finer particles [29].
The filtration property performance of the AOBH could also be due to the presence of dual strong double bond stretching of carbon/carbon and Nitrogen/Nitrogen/Nitrogen signifying Alkene and Azide respectively, supporting the formation of thin layered filter cake in both mud types.
Also, the presence of strong bending carbon-carbon single bond (C-C) on a medium stretching carbon-hydrogen single bond (C-H) representing Benzene ring and Alkane respectively possess the property of an Asphalt according to [30]. This possibly led to the formation of a thin plaster in the form of filter cake and also resulted in a low fluid-loss from the mud.

3.2.2. Mud Density

Table 7 and Table 8 present results for the mud density, pH and Marsh Funnel Test. The drilling mud density helps to control formation pressure while drilling. Comparing Tables 7 and 8, it can be seen that fluid properties followed similar trend.

Table 7: Mud Density, pH and Marsh Funnel Time of the WBM samples

Composition (WBMs)	A	B	C	D	E	F	G	H
Mud Density (ppg)	8.90	9.10	8.85	8.90	8.80	8.80	8.75	8.80
pH	8.2	8.31	8.50	8.64	8.52	8.68	8.52	8.69
Marsh Funnel Time	46.14	47.21	46.58	45.57	45.10	45.08	44.54	44.36

Table 7: Mud Density and Marsh Funnel Time of the OBM samples

Composition (OBMs)	A	B	C	D	E	F	G	H
Mud Density (ppg)	14.90	14.55	14.20	14.20	14.00	13.95	13.90	13.90
Marsh Funnel Time (seconds)	78.45	78.18	75.87	75.43	73.89	73.50	73.67	73.09

Control agent made from AOBH caused little or no reduction in the density of the drilling mud. The results are satisfactory because conspicuously high or low reduction in mud density, caused by adding mud additive, would require alteration in the drilling design. The reduction in mud density observed by adding AOBH as fluid-loss additive is similar to that reported by [11] where mud density values were almost flattened under the effect of a fluid-loss control additive made from corn starch. For most drilling operations the mud density values are within the range 8.65ppg and 9.6ppg [31].

3.3.3. Mud pH

The hydrogen ion concentration of the WBM is presented in Table 7. The pH of the various muds tends to increase when fluid-loss agents are added. Higher pH values were obtained for mud that had AOBH as fluid-loss additive than mud that had the commercial fluid-loss additive. The increase in pH of the WBM that had AOBH could be attributed to the presence of Aliphatic primary amine in the AOBH material as revealed by FTIR shown in Table 5. The Aliphatic primary amine is the dominant component of the AOBH with pH values of 11-12. The Aliphatic primary amine in

AOBH make the muds to be more alkaline. Alkalinity does not pose a serious operational challenge. Unlike acids, alkaline is non-reactive with components of the drill string. Alkaline mud will not pose serious threat to the environment when disposed after use.

3.3.4. Marsh Funnel Viscosity (MFV)

MFV is a quicker method adopted in observing the change in the viscosity of drilling mud. From Tables 7 and 8, it can be seen that there were proportionate slight reduction in marsh funnel viscosity and mud density under the influence of AOBH, this is in agreement with Bayat et al. (2018)[25] stating a direct relationship between viscosity and hydrostatic pressure. These reductions in marsh funnel viscosity under the influence of AOBH will cause a slight reduction in the wellbore cleaning and cutting-carrying capacity of the drilling muds, thus, leading to a slight reduced rate of penetration (ROP).

4.0. Conclusion

Based on the experimental investigation, the following conclusion can be advanced.

1. The locally sourced material (AOBH) is non-toxic, biodegradable, and lack bacterial habitation. It is cheaper to obtain and eco-friendly.
2. The locally sourced material (AOBH) possesses similar performance with the foreign fluid loss control agent as applied to WBM and OBM. The AOBH is suitable for drilling all formation types based on its filtration properties.
3. The performance of the AOBH yielded excellent performance in filtration property of mud in drilling through all type of formations as regards pressure and temperature. This performance was as a result of an asphalt property observed from the FTIR test result.
4. Compatibility rests revealed a reduction in some properties of the drilling fluids in the presence of AOBH such as mud density and marsh funnel viscosity but the mud pH was increased. The increase in mud pH leading to a more alkaline mud, this will enhance its applicability in drilling salt dome formations.
5. With the performance recorded from these preliminary experimental investigations, the AOBH has been shown to be a potential candidate as field-loss control additive for WBM and OBM.

From the foregoing, it becomes imperative to state that results obtained have shown prospects in using AOBH as locally-sourced fluid-loss control agent.

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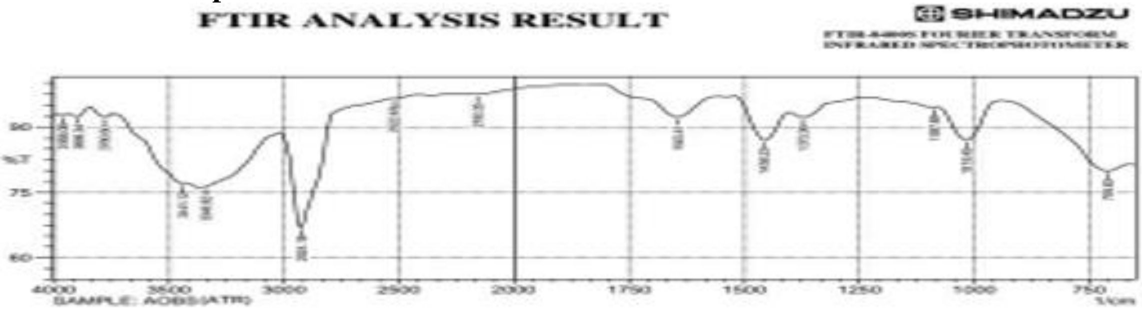
APPENDIX

Appendix I: FTIR spectrum of AOBH



No.	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	729.83	79.994	3.967	941.29	663.53	16.04	1.326
2	1018.45	87.039	8.24	1080.17	941.29	5.404	2.537
3	1087.89	94.601	0.136	1226.77	1080.17	2.794	-0.003
4	1373.36	92.241	1.719	1404.22	1226.77	4.09	0.188
5	1458.23	87.049	8.092	1519.96	1404.22	4.709	2.283
6	1643.41	92.283	5.603	1844.01	1558.54	4.601	2.683
7	2160.35	97.469	0.58	2222.07	1944.51	2.336	0.383
8	2522.96	96.523	0.156	2535.41	2430.38	1.477	0.046
9	2924.18	66.959	23.343	3016.77	2538.41	29.244	13.262
10	3340.82	76.201	0.321	3348.54	3016.77	29.076	0.865
11	3441.12	76.971	0.969	3718.86	3425.69	22.479	1.176
12	3780.6	92.327	1.343	3842.33	3749.74	2.892	0.367
13	3896.34	92.523	1.221	3834.92	3842.33	2.629	0.289
14	3958.06	92.694	0.301	3973.49	3934.92	1.235	0.022

No. of Scans: 10

Date/Time: 09/26/2022 7:47:08 AM

Apodization: Happ-Genzel Resolution: 2.0