

# PROSPECTS OF USING LOCALLY SOURCED OIL PALM FRONDS FIBRES AS FLUID LOSS CONTROL ADDITIVES FOR WATER BASED MUDS

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**Abstract** - Fluid loss control is inevitable during drilling. Fluid loss can cause irreversible change in the drilling fluid properties which can lead to numerous detrimental effects. Several additives are available to control fluid loss, but most used in Nigerian oil and industry are imported and costly.

In this study, the prospects of using oil palm frond fibres (OPFF) as filtration loss control agent in water based drilling muds (Fresh Water Mud, Salt Water Mud and CMC Polymer Mud) were examined. The muds were modified by adding sieved OPFF at varying concentrations and sizes.

The study showed that salt water muds are more prone to fluid loss, followed by fresh water muds and lastly CMC Polymer based water muds. The addition of OPFF into the mud improved the filtration properties of the water based muds. The fluid loss decreased with increased in OPFF concentrations while the filter cake thickness increased with increased in OPFF concentrations. The filtration loss and the filter cake thickness decreased with decreased in OPFF particle sizes. A good drilling mud should be capable of reducing fluid loss as well as producing a thin filter cake; therefore, it is advisable that while increasing OPFF concentrations in order to reduce fluid loss, there must be a corresponding decrease in particle sizes in order to reduce the mud cake thickness.

**Key Words:** Fluid loss, drilling fluid properties, Oil palm frond fibres, Mud cake thickness

## 1. INTRODUCTION

Drilling a well is the most common way to access oil and gas resources and geothermal reservoirs and the drilling fluids play a pivotal role. Drilling fluids are required to drill quality wells as efficiently as safely as possible. According to Bourgoyne et al, [1]; Rabia, [2]; IPIECA/OGP [3] and Pal [4] drilling fluids are needed to:

- (a) Remove cuttings from wellbore
- (b) Prevents formation fluid flow into the well
- (c) Maintain wellbore stability
- (d) Cools and lubricates the drill bit
- (e) Transmits hydraulic horsepower to the bit.

In addition to serving these functions, the drilling fluid should not:

- (i) Have detrimental properties to use of planned formation evaluation techniques,
- (ii) Cause any adverse effects upon the formation penetrated,
- (iii) Cause any corrosion of the drilling equipment and subsurface tubulars.

To perform its functions, the drilling mud is circulated from the steel tanks to the mud pump; it is then pumped through the standpipe, kelly hose, swivel, kelly and down the drillstring. At the bottom of the hole the mud passes through the nozzles of the bit and up the annular space between the drill string and hole, carrying cuttings up to surface. On surface the muds is directed from the annulus to contaminant-removal equipment and then back to the suction tank and the circulation continues (Figure 1). The mud is therefore in a continuous circulating system [1; 3; 5]. However, muds can lose fluid to the formations when the mud comes into contact with a permeable zone. According to Growcock and Harvey, [6] "When the hydrostatic pressure of the drilling fluid is greater than the pore pressure, drilling fluid invades the formation (spurt loss)". This is termed "Fluid loss or Filtration loss".

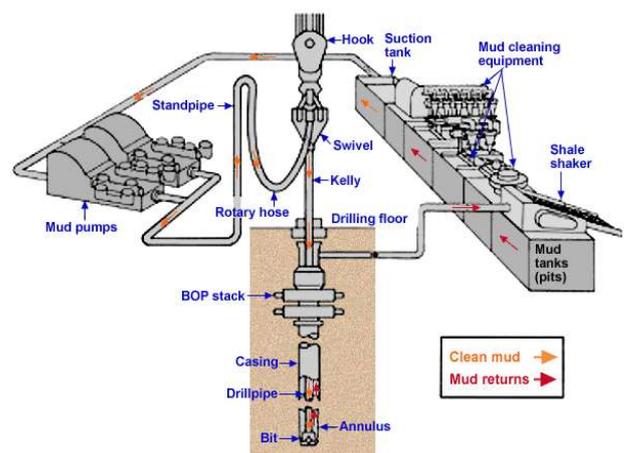


Fig -1: Drilling fluid circulating system [7]

Excessive fluid (or filtration) loss into the formation and subsequent filter cake build-up can cause irreversible change in the drilling fluid properties which can lead to several types of problems. Some of these problems include formation instability, Tight spots in the hole causing excessive drag; increased pressure surges when moving the pipe due to decreased hole diameter, formation damage

from filtrate invasion, loss of drilling fluid, differential pressure sticking and stuck pipe, inability to make accurate formation evaluation, cementing problems due to poor removal of dehydrated, thick filter cake [8; 9; 10; 11; 12]. Effective fluid loss control is therefore a significant concern for the oilfield industry.

Several additives have been developed to aid bentonite in filtration control. They include Starches, Sodium Carboxymethyl Cellulose (CMC), Polyanionic cellulose (Drispac), Sodium Polyacrylates (Cypan), Lignites and Lignosulfonate among others [13; 14; 15; 2; 9; 16]. But these conventional filtration control additives have their individual limitations [1; 17]. These limitations range from temperature factor, salinity or hardness factor, bacterial action factor, environmental factors, cost factor and other risks factors. Standard filtration control additives also available but they are expensive and are imported into Nigerian Oil and gas industry [18]. In fact the petroleum industry in Nigeria spends large sums of money during drilling operations to control the fluid-loss. This justifies the search for locally available natural, industrial and/or agricultural raw materials that can be used for development of fluid loss additives the Niger Delta.

*Elaeis guineensis*, a palm species popularly called African oil palm or macaw-fat [19], and a source of palm oil and the kernel oil is commonly found in the Niger Delta. However, the oil palm industries generate huge amounts of biomass wastes creating environmental problems [20]. These wastes include oil palm fronds (OPFs), Oil palm trunks (OPTs), Oil palm empty fruit bunches (OPEFBs), Oil Palm mesocarp fibres (OPMFs), Oil palm kernel shells (OPKs), Oil palm kernel cakes (OPKCs) and palm oil mill effluents (POMEs) (Table 1). Disposing of these wastes has been a challenge to oil palm industry. Studies have shown that most these wastes notably Oil palm trunks, Oil palm fronds, Oil palm empty fruit bunches, Oil Palm mesocarp fibbers, Oil palm kernel shells and Oil palm kernel cakes consist of cellulose, hemicellulose, and lignin, extractives and ash [21; 22; 23; 24; 25; 20].

Although the conversion of these wastes to high valued products has been of great interest to many researchers [26; 27; 28; 29], however, these enormous biomasses are yet to be utilized in the oil and gas industries. The purpose of this study is therefore, to determine the suitability of using oil palm fronds fibres (an Oil Palm wastes) as filtration control additives in drilling fluids. The conversion of oil palm fronds fibres into filtration control additives will lead to better management of these abundant agricultural wastes as well as contribute immensely to wastes to wealth concept [30; 31; 14; 15; 2; 9; 16]. Besides, the use of oil palm fronds fibres as local mud additives can drastically reduce the drilling cost as well as improve the economy of Nigeria through the local content initiative.

Table 1: Chemical Composition of various parts Oil Palm (wt%) [24]

Parts	Cellulose	Hemi-Cellulose	Lignin		Extractive(Ethanol: Benzene =1:2 (v/v))	Ash
			Kla-son	Acid soluble		
Trunks	30.6	33.2	24.7	3.8	3.6	4.1
Fronds	39.5	29.8	21.2	2.1	1.7	5.1
EFBs	37.9	35.0	22.9	1.1	2.7	1.5
Meso-carps	39.5	9.8	32.8	0.1	8.6	9.3
Shells	20.5	22.3	49.9	1.6	4.7	1.0
OPKCs	35.7	35.0	22.9	1.1	2.7	1.5

## 2. MATERIALS AND METHODS

### 2.1 Materials

The materials include the drilling mud materials, and the apparatus as well as the equipment that were used for the formulation and testing of the drilling fluids.

#### Drilling Mud Materials

The drilling mud materials used include Water, Bentonite, Barite, Caustic Soda, Soda Ash, Sodium Chloride, Carboxymethyl cellulose (CMC).

#### Equipment /Apparatus Used

They include Baroid Mud Balance Model 140, Filter press (API LTLF), Thermometer, Vernier Caliper (Series 530 Standard Model), Spatula, Sieve, Mortar grinder RM 200, Cutting mills SM 100, Muffle furnace BST/MF/900, Electric multi mixer (Fann® Model 9B), Measuring cup, Filter paper, Weighing Balance, Beakers, Flasks, containers, Stop-watch, Graduated cylinders (10mL, 25mL, 50mL and 100mL).

### 2.2 Methods

#### 2.2.1 Samples Preparation

##### Collection of samples of Oil palm fronds wastes

The oil palm fronds wastes were collected oil palm plantation at Okada, Ovia North East Local Government Area of Edo State, Nigeria.

##### Production Cellulosic fibres from Oil palm fronds wastes

The following simple processes were carried out to produce fibres from the oil palm wastes:

- Cutting and chopping of the wastes into small chips
- Washing of the chips with distilled water treated with 2.5g Sodium Chloride (NaCl) to remove dirt and any contaminant and oven drying at 80°C until a constant weight is obtained.
- Crushing, grindings and pulverizing of dried chips

(d) Sieving (Table 2), grading, packaging and labelling of fibres samples.

Table 2: Sieved Particle Size Distributions

Screen Mesh	Particle Diameter Microns ( $\mu$ )
80	180
100	150
120	125

### 2.2.2 Mud Samples Formulation

The following water based drilling muds samples were formulated in accordance with ANSI/API, [33].

- (a) Fresh Water Mud
- (b) Salt Water Mud
- (c) CMC Polymer Mud

The basic compositions of two types of water based drilling muds are shown in Table 3. In addition suitable amount of Barite were added as weighting agents.

Table.3: Composition of Water Based Drilling Muds

	FRESH WATER MUD	SALT WATER MUD	CMC POLYMER MUD
Water (mls)	350	350	350
Bentonite (g)	21	21	5
Barite (g)	20	20	52
Caustic Soda (g)	0.25	0.25	0.25
Soda Ash (g)	0.25	0.25	0.25
NaCl (g)		2.5	2.5
CMC (g)			2.5

### Experiment A - Preparation of Experimental samples using Fresh Water Mud

- (a) Sample A: (Fresh water mud: with compositions shown in table 3)
- (b) Sample A1 – Sample A9 (Modified Fresh water mud samples - obtained by adding Sieved cellulose fibres powder obtained from the Oil palm fronds (at varying concentrations (5g, 10g, 15g) and particle sizes (180, 150,125microns) to mud sample A).

### Experiment B - Preparation of Experimental samples using Salt Water Mud

- (a) Sample B: (Salt water mud: with compositions shown in table 3)
- (b) Sample B1 – Sample B9 (Modified Salt water mud samples - obtained by adding Sieved cellulose fibres powder obtained from the Oil palm fronds (at varying concentrations (5g, 10g, 15g) and particle sizes (180, 150,125microns) to mud sample B).

### Experiment C - Preparation of Experimental samples using CMC Polymer Mud

- (a) Sample C: (CMC polymer mud: with compositions shown in Table 3)
- (c) Sample C1 – Sample C9 (CMC polymer mud samples - obtained by adding Sieved cellulose fibres powder obtained from the Oil palm fronds (at varying concentrations (5g, 10g, 15g) and particle sizes (180, 150,125microns) to mud sample C).

All the components of the water based muds are shown in Table 3 were mix by using Electric multi mixer (Fann® Model 9B) for 30 minutes according to the API standard to achieve homogeneity. The mud samples were then stored at room temperature (25°C) in a sealed container for 24 hours to give room for aging.

### 2.2.3 Mud Properties Test

Filtration test experiments were carried out to determine the following mud properties of interest in accordance with the API Recommended Practice, ANSI/API [33] and as stated below.

- (a) Filtrate volume and
- (b) Filter cake thickness.

The filtrate volume and filter cake of a drilling fluid were determined using the API filtrate (LPLT) method as described by Baroid, [15]; Amoco, [9]; Baker Hughes, [16]; Baroid and Halliburton[33] ; ANSI/API, [34].

## 3. RESULTS AND DISCUSSIONS

Several compositions of the foreign based and local based were investigated. Subsequent sessions present the compositions and the results that closely approximate the API standard.

### 3.1 Result of experiment A – Impacts of oil palm fronds mg/l (OPFF) on filtration loss and mud cake thickness of fresh water muds

The influence of OPFF on filtration loss and mud cake thickness of fresh water muds is shown in Chart 1 – 3. The result showed that filtration loss decreases with increases in OPFF concentrations while the filter cake thickness increases as the concentration of OPFF increases. This showed that the OPFF particles have filled the pore spaces and formed a thicker mud cake which prevents the fluid loss from mud. The result also showed that filtration loss as well as the filter cake thickness decreases as the OPFF particles sizes decreases. This showed that the smaller the OPFF particles sizes, the more effective it can bridge, preventing the fluid loss from the mud as well as forming thin mud filter cake.

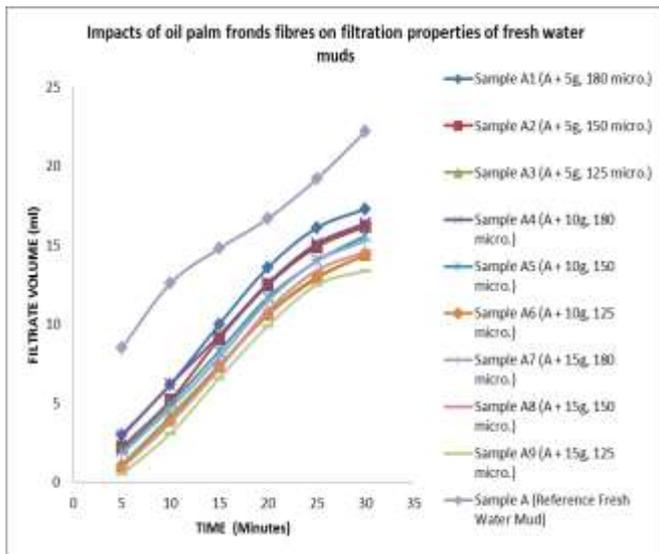


Chart -1: Filtrate Volume from the various fresh water mud samples

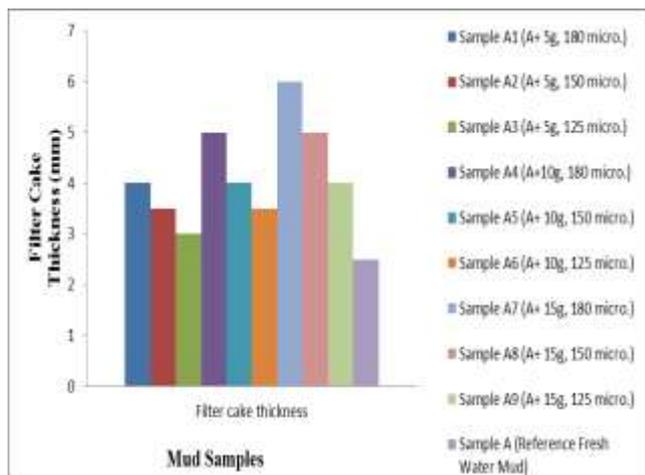


Chart -2: Filter Cake thickness of the various fresh water mud samples

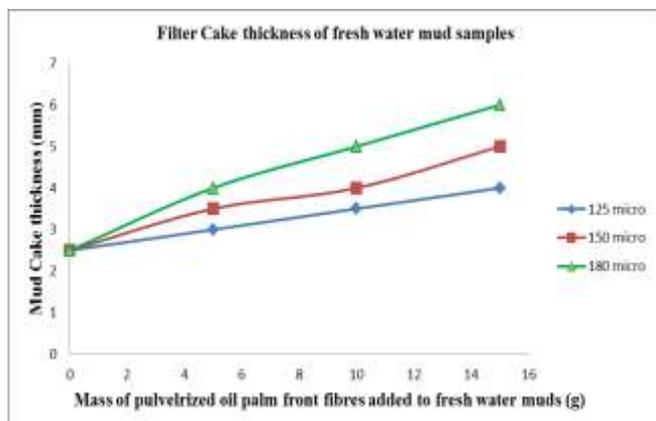


Chart -3: Filter Cake thickness (ml) fresh water mud samples as function mass concentrations and particles sizes of OPFF

### 3.2 Result of experiment B – Impacts of oil palm fronds mg/l (OPFF) on filtration loss and mud cake thickness of salt water muds

The influence of OPFF on filtration loss and mud cake thickness of salt water muds is shown in Chart 4 – 6.

The result showed that filtration loss decreases with increases in OPFF concentrations while the filter cake thickness increases as the concentration of OPFF increases. This showed that the OPFF particles have filled the pore spaces and formed a thicker mud cake which prevents the fluid loss from mud.

The result also showed that filtration loss as well as the filter cake thickness decreases as the OPFF particles sizes decreases. This showed that the smaller the OPFF particles sizes, the more effective it can bridge, preventing the fluid loss from the mud as well as forming thin mud filter cake.

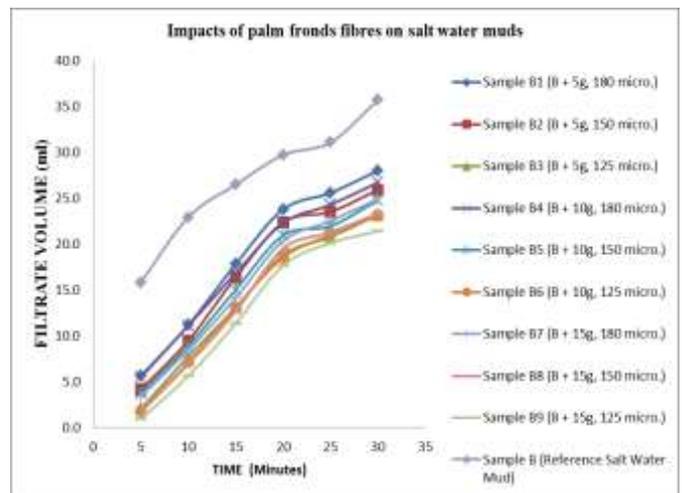


Chart -4: Filtrate volume from the various salt water mud samples

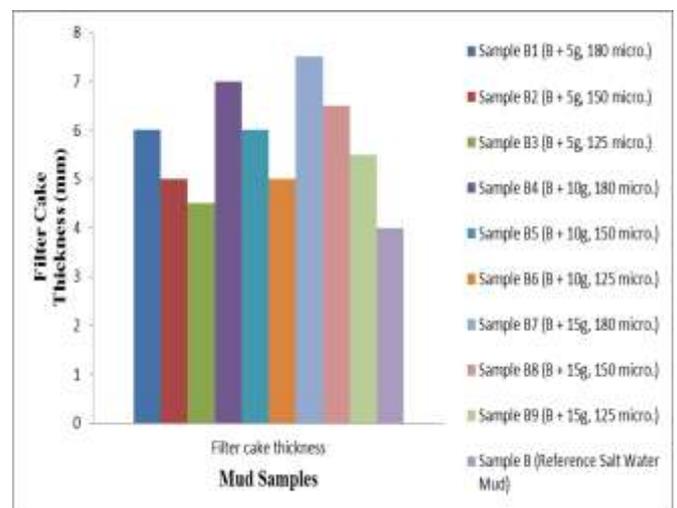
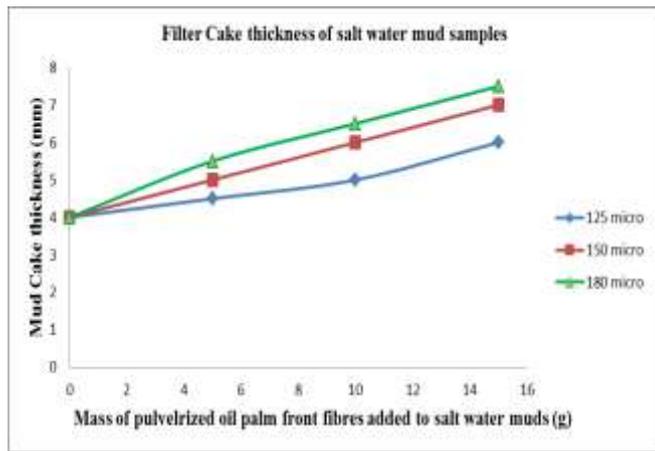


Chart -5: Filter Cake thickness of the various salt water mud samples



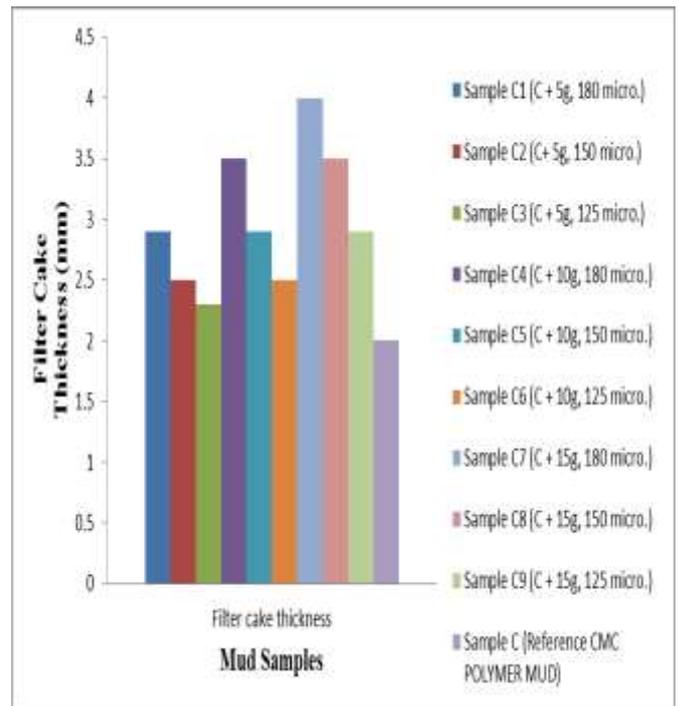
**Chart -6:** Filter Cake thickness (ml) of salt water mud samples as function mass concentrations and particles sizes of OPFF

### 3.3 Result of experiment C – Impacts of oil palm fronds mg/l (OPFF) on filtration loss and mud cake thickness of CMC polymer based water muds

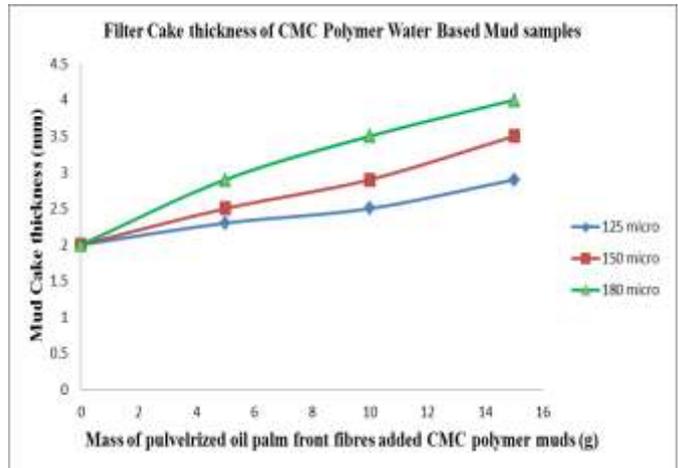
The influence of OPFF on filtration loss and mud cake thickness of salt water muds is shown in Chart 7 – 9.

The result showed that filtration loss decreases with increases in OPFF concentrations while the filter cake thickness increases as the concentration of OPFF increases. This showed that the OPFF particles have filled the pore spaces and formed a thicker mud cake which prevents the fluid loss from mud.

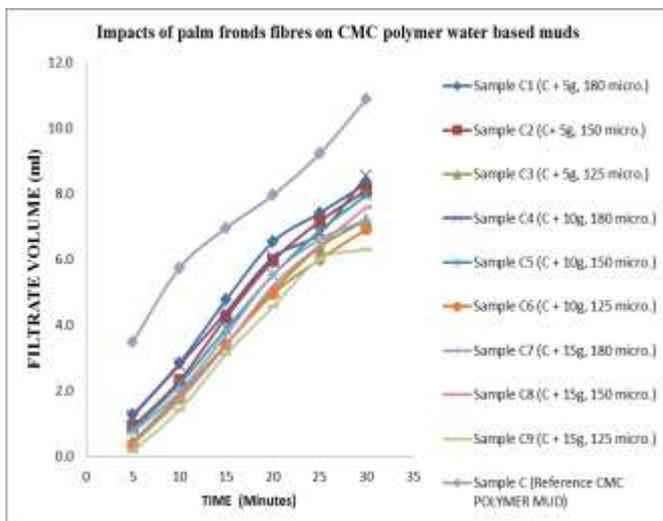
The result also showed that filtration loss as well as the filter cake thickness decreases as the OPFF particles sizes decreases. This showed that the smaller the OPFF particles sizes, the more effective it can bridge, preventing the fluid loss from the mud as well as forming thin mud filter cake.



**Chart -8:** Filter Cake thickness of the various CMC polymer mud samples



**Chart -9:** Filter Cake thickness (ml) of CMC Polymer Water Based Mud samples as function mass concentrations and particles sizes of OPFF



**Chart -7:** Filtrate volume from the various CMC polymer water based mud samples

### 3.4 Summary of Results

From Chart 1, 4 and 5, it is observed that salt water muds are more prone to filtration loss, followed by fresh water muds and lastly CMC Polymer based water muds.

Results also showed that filtration loss decreases with increases in OPFF concentrations while the filter cake thickness increases as the concentration of OPFF increases. The result further showed that filtration loss as well the filter cake thickness decreases as the OPFF particles sizes decreases. A good drilling mud should be capable of reducing fluid loss, and also producing a filter cake thickness

of less than 3 mm [15; 9; 16 33; 34]. However, higher concentration and the higher the particle size of OPFF increases the filter cake forming process, thereby increases the mud cake thickness (Chart 2, 3, 5, 6, 8 and 9). It is therefore advisable that while increasing OPFF concentrations in order to reduce filtrate loss, there must be a corresponding decrease in particle size in order to reduce the mud cake thickness below 3mm.

### 3. CONCLUSIONS

Locally sourced palm fronds as filtration control additives for water based muds were developed and tested. It can be generally concluded that salt water muds are more prone to filtration loss, followed by fresh water muds and lastly CMC Polymer based water muds that the addition of OPFF into the mud could improve the filtration properties of water based mud.

Results also showed that filtration loss decreases with increases in OPFF concentrations while the filter cake thickness increases as the concentration of OPFF increases. The result further showed that filtration loss as well the filter cake thickness decreases as the OPFF particles sizes decreases. A good drilling mud should be capable of reducing fluid loss as well as producing a thin filter cake; therefore, it is advisable that while increasing OPFF concentrations in order to reduce fluid loss, there must be a corresponding decrease in particle sizes in order to reduce the mud cake thickness.

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