Evaluation of Wheat Husk as Environment Friendly Fluid Loss Additive as a Substitute of CMC(LVG) in Water based Drilling Fluid up to 100 ⁰C.

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Abstract - *Filtration control is an important property of a drilling fluid particularly while drilling through the permeable formations. This property of a drilling mud is obtained or enhanced using various additives. Currently organic polymers are commonly used as additives to control filtrate loss in water based drilling mud and exhibits negative impacts on the environment when released, Hence there is a tremendous need for new environmental friendly, biodegradable additives which can help in controlling filtration loss with least effect on environment and also on worker's health. this study involves the introduction of environmental friendly food waste product i.e. "wheat husk powder" (WHP) as a filtration loss additive. The effects of various concentration of WHP on physical and chemical properties of a mud such as mud weight, pH, PV, AV, YP, gel strength, filtration loss (API), BHR and AHR rheological properties were evaluated and all the results were compared with the properties of the reference mud prepared with the conventionally used filtration loss additive CMC(LVG) in order to asses and validate the effectiveness of WHP in optimizing the performance of drilling mud. The results obtained showed that WHP was behaving as a filtration loss reducer and the drilling mud prepared with WHP was thermally stable at up to 100 ⁰C. Hence WHP is successful replacement of CMC(LVG) in aspect of cost effectiveness, filtration loss reduction, environmental friendly and thermal stability.*

***Key Words*: WHP - wheat husk powder ,Filtration loss, Mud cake, CMC(LVG) - carboxy methyl cellulose (Low Viscous Grade), Water based mud, Natural additive.**

1. INTRODUCTION

Drilling fluids are the most important parameter in the drilling operations[1].The main function of the drilling fluid is to provide sufficient density to counter balance the formation pressure and seal the permeable formation by forming a filter cake[2-3]. Among the various functions of the drilling mud the most desired application is the minimum fluid loss volume by forming a low-permeable mud cake across the wall of the borehole [4]. Drilling fluid with excessive filtration loss may influence the property of the well such as wellbore stability, differential sticking, core recovery process, loss in mud volume and formation damage [5]. Hence an efficient drilling fluid is one which minimizes the filtrate loss in the formation by forming a thin filter cake with low permeability [6]. In the formulation of conventional water based mud additives such as carboxy methyl cellulose, starch, poly anionic cellulose, acryl amide polymers are widely used as filtration control agents [7]. carboxy methyl cellulose is probably the most common and is used routinely both to control fluid loss and to increase the viscosity of the drilling fluid[8]. Various chemicals that are used in formulation of drilling fluid to enhance its properties have an adverse effect on the environment. These concerns have made the oil industry to shift towards the use of safer and eco-friendly additives in drilling mud [9].

In recent years various studies have been performed to develop an eco-friendly additive for drilling mud. Natural products such as rice husk was used to control fluid loss[10], iheagwara 2005, Adebowale and raji 2015 used banana peels as replacement to NaoH to control pH of the mud[11]. In order To enhance the rheology and the filtration loss property of drilling mud cellulose from corncob[nmeghu 2014],waste grass[al hameedi 2019], cashew and mango leaves extract[omotioma], potato peel powder [al hameedi] were used.

In this study we have implemented the use of waste food product i.e. wheat husk powder to enhance the filtration loss property of the drilling fluid. Wheat husk is a by-product of milling and is used in the preparation of some food products [15]. Recent studies have shown that India alone generates 21million tones of wheat waste ever year.[16].

1.1 Properties of wheat husk:

Table 1: Physical and Chemical properties of WHP

Color	Light brown
Odor	**Odorless**
Physical state	**Amorphous**
Moisture Content	**4.6**
Organic %	**87%**

2. Materials and Methods:

2.1. Sample preparation:

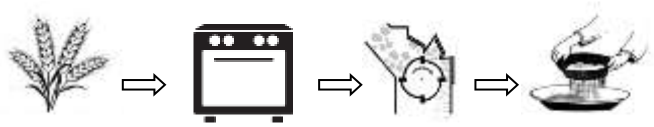

Figure 1: Flowchart representing sample preparation

The WHP sample was a collected and processed product from wheat fields; the sample was then kept in a hot vacuum oven at 100°C to remove all the moisture content present. Later it was crushed down into fine particles with a grinding machine for duration of 20minutes. The crushed sample was then sieved to 125 microns to obtain fine particles of that size (As it completely gets dispersed with the additives added) . The complete procedure is illustrated in the form of a flow chart as shown in Fig 1.

2.2. Experimental procedure:

The effect of WHP was studied by preparing 9 samples of mud (each of 500 ml) categorized as set A, set B, set C. **set A** is considered as reference mud with the composition 500ml of water, 0.3% XC-polymer and 0.1% soda ash. **Set B** comprises of four muds with 1,2,3,4 percent of CMC(LVG) along with 500ml of water(dispersion medium), 0.3% XC-polymer (viscosifier) and 0.1% soda ash(to reduce salt content in water) and in **Set C** 1,2,3,4 wt% of wheat husk powder was added by replacing CMC(LVG) while maintaining the same aforementioned composition. For the preparation of mud samples the following equipments were used

- Electronic Precision balance to measure the mass of different chemicals for proper composition.
- 1000ml measuring cylinder to measure the volume of the water.

Hamilton Beach Mixer for proper stirring/mixing of water and additives in order to generate desired homogeneous mixture of drilling mud. The prepared mud sample was evaluated for rheological parameters followed by filtration loss and mud cake thickness measurements. The pH of the sample was tested and the mud sample was kept in hot roller oven for a period of 16 hours at 100°C to obtain dynamic fluid properties. The drill mud's physical and chemical parameters were observed before and after hot roll condition.

2.3. Laboratory measurement procedure:

2.3.1Rheological Properties:

In the R&D perspective rotational viscometer provides accurate results of the characteristics of a drilling mud compared to marsh funnel. Hence a rotation viscometer was used for measurements. Mud samples (Set A,B,C) were poured into the viscometer cup up to the mark and was placed on a stand and was lifted up, to immerse the rotating sleeve of the viscometer. A steady dial reading was noted at different RPM, (600, 300, 200, 100, 6, 3) to determine plastic viscosity, apparent viscosity, yield point, which are considered as fundamental rheological properties. Gel strength determination is an extension of mud rheological property **(10)**, The gel strength at 10 second and 10 min was determined at 3 rpm. the obtained results are represented in **Table 2,3,4,5,6.**

Formulae: to determine rheological properties

$$AV = \theta_{600}/2$$

$$PV = \theta_{600} - \theta_{300}$$

$$YP = PV - \theta_{300}$$

2.3.2 Filtration properties:

The API standard LP-LT test was carried out to determine filtration loss of the prepared sample at room temperature and 700 kPa (100 psi). Mud was contained in a cell fitted with a Whatman 50 filter paper with a diameter 90mm at bottom along with a filter screen. After the necessary connections a 100 Psi pressure was exerted on drilling mud using Nitrogen gas for a period of 30 min. filtrate was collected below using measuring cylinder and readings were noted along with the mud cake thickness deposited on the bottom . The same procedure was repeated with different concentrations.

3. RESULTS AND DISCUSSIONS:

The following section includes all the comparisons made between the reference mud(**Set A**) and the 2 category of mud samples composed of CMC(LVG) and WHP. The basis of comparison included the readings of PV,YP,YP, Gel strength and filtration properties. Moreover filtration property comparison stands out to be the core of this paper as it is directly related to mud cake thickness (MCT). The more thin and impermeable the mud cake is, the best drilling mud it tends out to be. The study includes

Table 2: Rheological properties of reference mud

Parameters	BHR	AHR
AV	11	14
PV	5	7
YP	12	13
Gel0	7	10
Gel10	8	9
API	30	35
PH	10.4	10.3

Table 3: Rheological properties of CMC(LVG) mud (BHR)

Parameters	Concentration			
	1%	2%	3%	4%
AV	17.5	29.5	55	62
PV	10	19	40	44
YP	15	21	30	36
Gel0	5	6	6	7
Gel10	7	6	7	8
API	17	12	10	9
Mud cake thickness(mm)	1.1	1.2	1.4	1.7

Table 4: Rheological properties of CMC(LVG) mud (AHR)

Parameters	Concentration			
	1%	2%	3%	4%
AV	15	27.5	54	60
PV	9	20	39	45
YP	12	15	30	35
Gel0	4	7	8	9
Gel10	5	8	9	10
API	18.5	16	13	12.5
PH	9.8	9.9	9.9	9.9
Mud cake thickness (mm)	1.5	1.6	1.8	2.4

Table 5: Rheological properties of WHP mud (BHR)

Parameters	Concentration			
	1%	2%	3%	4%
AV	12.5	21	27.5	32.5
PV	7	11	15	20

YP	11	20	25	30
Gel0	5	7	10	12
Gel10	6	9	11	13
API	16	8	7.4	6
PH	9.7	9.7	9.8	9.7
Mud cake thickness (mm)	1.8	2.0	2.1	2.5

Table 6: Rheological properties of WHP mud (AHR)

Parameters	Concentration			
	1%	2%	3%	4%
AV	17	22.5	27.5	32.5
PV	11	14	18	19
YP	12	17	19	24
Gel0	6	8	12	14
Gel10	7	9	10	15
API	18	8.4	8	6.5
PH	9.7	9.7	9.8	9.7
Mud cake thickness (mm)	1.6	1.7	1.9	2.6

3.1Effect on Filtration properties:

The comparison made is based on the concentration (1-4% CMC(LVG) and WHP) in mud. From **Table 3,4,5&6 and Fig 1, 2** it is clear that 3-4% of WHP works best as a filtration loss agent as compared to 3-4% CMC(LVG). The filter loss volume obtained from the reference mud was 35ml, this when compared with 1-4% CMC(LVG) AHR filter loss volume the percentages obtained are 47.14%, 54.28%, 62.85% and 64.28% respectively. Whereas WHP Filter loss volumes obtained with WHP samples were better than that of CMC(LVG), as 1-4% of AHR WHP showed 48.571%, 76%, 77.14% and 81.42% reduction in filter loss. (Note: All were compared with respect to reference mud)

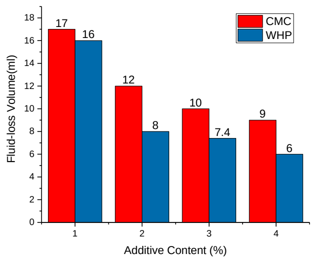

Figure 2: Filtrate Volume of CMC(LVG) & WHP mud BHR

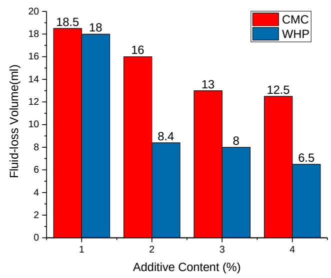

Figure 3:Filtrate Volume of CMC(LVG) & WHP mud AHR.

3.2 Effect on Rheological properties:

Reference mud had very less gel strength, PV, AV and YP. Whereas drilling fluids with WHP had significant effect on the rheological properties especially at 3% and 4% were the corresponding Gel_0 and Gel_{10} values were 10, 12 and 11, 13 respectively as shown in Table 5. Later the same sample showed a slight increase in their gel0 and gel10 values that is 12,14 and 10,15 respectively after hot roll conditions. In most of the drilling operations CMC(LVG) is used as the viscosifier and loss reducing agent and from the study the optimum concentration of CMC(LVG) ranges from 3-4% with gel_0, gel_{10} values of 6,7 and 7,8 respectively in BHR conditions and whereas in AHR it was 8,9 and 9,10 respectively as shown in **Table 3,4**. Though gel strength is high for WHP, the filtration loss volume was significantly less. PV, YP and AV showed a steep increase in their values but most significant increase was found after AHR as shown in **figure 4**.

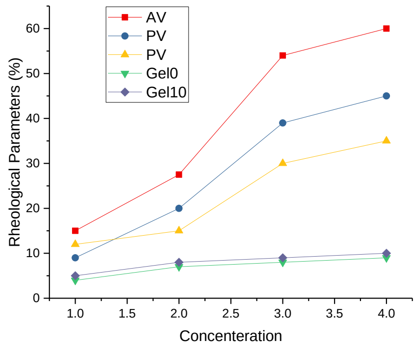

Figure 4: Rheological parameters of CMC(LVG) mud AHR

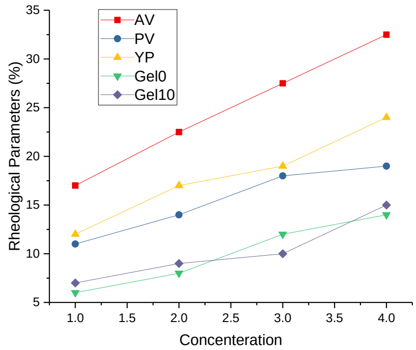

Figure 5: Rheological parameters of WHP mud AHR

3.3 Effect on Mud cake thickness:

A desired mud cake is one which is thin and has low permeability. A thick mud cake is also efficient sometimes as it may restrict fluid penetration on other hand it may cause other drilling problems such as stuck pipe and excessive torque and drag (Ottesen et al 1999). From the results obtained we can observe that the mud cake thickness of mud sample with WHP ranges between 1.6-2.6 mm. while sample of CMC(LVG) showed thickness in the range of 1.5-2.4 mm. The results can be seen from figure 5.

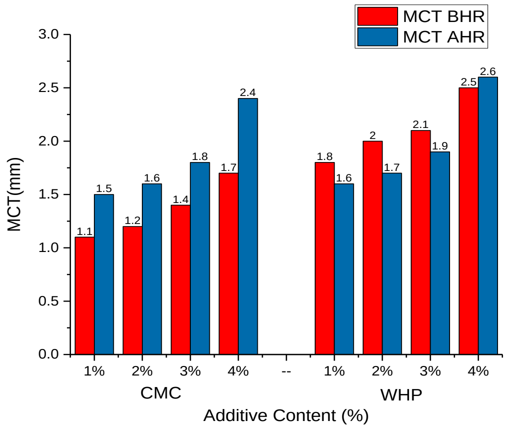

Figure 6: Mud cake thickness (CMC(LVG) Vs WHP)

4. CONCLUSION:

Fluid loss control is the parameter of drill mud and is dependent on type and quantity of the solids added and also the temperature and pressure, thus the WHP can be evaluated as a filter loss additive in water referenced drilling fluid. The following observations are made from obtained results

- The WHP mud show that there has been a filtration loss reduction of about 48.571%, 76%, 77.14% and 81.42% with concentration of 1%, 2%, 3%,4% respectively, however the following reduction in filtration loss of CMC(LVG) mud with respect to reference mud was 47.14%, 54.28%, 62.85% and 64.28% with concentration 1%, 2%, 3%,4% respectively.
- Mud cake thickness of the CMC(LVG) and WHP was nearly identical with negligible effect on mud weight.
- The alkalinity of both the mud's had a change and was decreasing with increase in concentrations.
- It was observed that WHP and CMC(LVG) have similar temperature stability up to. 100 ^{o}C.

Since the wheat husk powder is providing the similar properties to that of CMC(LVG) in a cost effective manner. Hence it can be concluded that 3-4% of WHP is a better substitute of CMC(LVG).

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6. ABBREVITATIONS:

AV	Apparent viscosity
PV	Plastic viscosity
YP	Yield point
GEL_0	Gel strength at 10 sec
GEL_{10}	Gel strength at 10 sec
WHP	Wheat husk powder
CMC(LVG)	Carboxy methyl cellulose (Low Viscous Grade)
MCT	Mud cake thickness
AHR	After hot roll
BHR	Before hot roll
Ml	Mille Liter
Mm	Mille meter
AV	Apparent viscosity
PV	Plastic viscosity

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