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Determining Loss of Liquid from Different Types of Mud by Various Addictives for Cost Effective Drilling

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Abstract :- Filtration is used in many industries to separate water from the solid. It is important to find fluid loss in drilling, cementing, fracturing, and almost every other type of downhole treatment design. The filter cake characterization is very essential for well selection of drilling fluid problems and formation damage. Therefore this study is taken up to experimentally investigate the effect of different concentrations of CMC, Starch, Wood fibers, Soda ash, Caustic soda, Bentonite and Barite on filtration loss and formation damages. Three different samples are used in this study at different concentration and a comparison is made. Although the discussion presented here is confined to fluid loss during drilling. Water-based drilling mud's including Bentonite is well-known and is being widely used in the petroleum industry. Among the important functions of water-based drilling fluid were to form filter cake on the wall of the well bore, prevent water leakage, and maintain the stability of the well wall. The properties of the water-based drilling fluid, such as the rheology and filtration loss, are affected by the fluid loss additive. Polymers, which are nontoxic, degradable, and environment friendly, are the best choice to be used as drilling fluids additives.

Keywords:- Addictives, Drilling fluid, Filter cake, Filtration, Fluid loss, Property testing.

I. INTRODUCTION

The leakage of the liquid phase of drilling fluid, slurry or treatment fluid containing solid particles into the formation matrix is called drilling mud fluid loss. The resulting buildup of solid materials or filter cake may be undesirable, as may the penetration of filtrate through the formation. Drilling fluid systems are designed and formulated to perform efficiently under expected wellbore conditions. Fluid-loss addictives are used to control the process and avoid potential reservoir damages. A group of specially designed fluid loss controlling addictives are used to lower the volume of filtration. These specific materials are available for all different type of water and oil based mud's and are evaluated by static filtration tests. A standard plate and frame filter press is used to test the fluid loss. This method of separating a mixture of liquid and insoluble solids is called as dewatering. It is very useful to explain the properties of drilling fluid and mud cake. Advances in drilling-fluid technology have made it possible to implement a cost-effective, fit-for-purpose system for each interval in the well-construction process. The functions of the drilling fluid is to clean the bore hole, balances or overcome formation pressure, supports and stabilizes the walls of the wellbore until casing can be set, lubricate the drill bit, suspend the drill cuttings and carrying the wellbore details to the surface. The mud viscosity is another important property, as cuttings will settle to the bottom of the well if the viscosity is too low. Various properties of drilling fluid are monitored and adjusted to achieve desired performances. The interpretation of the results of the various tests and treatments to maintain appropriate fluid properties to the success of the drilling program.

II. DRILLING FLUID FUNCTION AND OPERATIONS

Drilling fluids may be simply water or oil to compressed air and pneumatic fluids to more complex water-based or oil-based systems. Drilling fluid additives include weighting agents; viscosifiers; filtration control additives; PH/alkalinity control chemicals; fluid loss control chemicals these categories are included later in this section. Drilling fluids are prepared to maintain some functions such as,

- Control subsurface pressure.
- Maintaining well control to improve the counter pressure.

- Remove the drill cuttings from the beneath and bring them to surface.
- Maintaining wellbore stability.
- Transmit hydraulic energy to the drill bit and downhole tools.
- Cool and lubricate drill string and bit.

The performance of these functions depends upon the type of formation being drilled and the various properties of the drilling fluid. Drilling and completion fluids are one of the most important parts of the well construction process and ultimately the performance of the fluid will determine the success or failure of the operation.

III. TESTING DRILLING FLUID PROPERTIES

These instruments are used for testing drilling fluids in the field or in the lab.

a) Density or mud weight

Density or mud weight is the mass per unit volume. In the field, Baroid mud balance is used to determine density or mud weight of the drilling fluid and is most often reported in pounds per gallon. The instrument consist of a constant volume cup with a lever arm and rider calibrated to read directly the density of the fluid in ppg (water = 8.33), pcf (water = 62.4), specific gravity (water =1.0) and pressure gradient in psi/1000 ft (water = 433psi/1000 ft). Density is used to determine the hydrostatic pressure of the mud. This allows for easy calculation of the hydrostatic pressure at any depth.

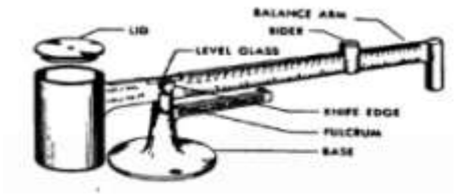

Fig.1, Baroid mud balance used to measure mud weight.

b) Viscosity

Viscosity is defined as the internal resistance to flow, or how thick or thin it is. Drilling fluids have lower viscosity at high-shear rates and higher viscosity at low-shear rates. This will depends on the base mud and the solids in it. Viscosity is usually higher for higher density fluids due to the weight of the material. Here, the Marsh funnel is used to monitor viscosity and is commonly reported as "funnel viscosity". The Marsh funnel viscosity is reported as the number of seconds required for a given fluid to flow out of the funnel. Its design and calibration can be verified using water. One quart of fresh water should be collected in 26 (±0.5) sec at a temperature of 70 (±5) °F. The marsh funnel measures the apparent viscosity.

Fig.2, Marsh funnel are used to measure fluid viscosity.

c) Surfsce tension

Surface tension of a liquid results from the molecular properties occurring at the surface. In practical it is determined by using tensiometers. It is the tendency of the liquid surface to expose a minimum free surface. The drilling fluid liquid's surface tension must be lowered by adding a third component (addictives) that to obtain desirable conditions.

Fig.3, Tensiometer used for testing surface tension and IFT

d) P^H test

P^H is a value representing the hydrogen ion concentration in liquid. We use it to indicate acidity or alkalinity of drilling mud. A P^H of 7.0 is neutral, a P^H lower than 7.0 is in the acidic range, and a P^H higher than 7.0 is in the alkaline range. Drilling fluid additives were developed to be mixed with water with a P^H level from 8.5 to 10 in order for the required chemical reaction to occur and to provide a proper yield. Field measurements of drilling fluid and filtrate P^H are fundamental to drilling fluid control. It is used to monitor specifications and to identify contamination of the drilling mud which we are going to use in the wellbore. It is essential to test the P^H level of drilling mud before doing the drilling for better safety and protection.

Fig.4, Laboratory P^H paper used for testing acidity or alkalinity

IV. EQUIPMENT USED

Fig.5: Plate and frame filter press

A plate and frame filter press is the most fundamental design, and many now refer it as a "membrane filter plate". This type of filter press consists of many plates and frames assembled alternately with the supports of a pair of rails. The presence of a centrifuge pump ensures the remaining suspended solids do not settle in the system, and its main function is to deliver the suspension into each of the separating chambers in the plate and frame filter. For each of the individual separating chambers, there is one hollow filter frame separated from two filter plates by filter cloths. The introduced slurry flows through a port in each individual frame, and the filter cakes are accumulated in each hollow frame under pressure.

As the filter cake becomes thicker, the filter resistance increases as well. So when the separating chamber is full, the filtration process is stopped as the optimum pressure difference is reached. The filtrate that passes through filter cloth is collected through collection pipes and stored in the filter tank. Filter cake (suspended solid) accumulation occurs at the hollow plate frame, then being separated at the filter plates by pulling the plate and frame filter press apart. The cakes then fall off from those plates and are discharged to the final collection point. Cake discharge can be done in many ways. For example: Shaking the plates while they are being opened or shaking the cloths. A scraper can also be used, by moving from one chamber to another and scraping the cake off the cloth. At the end of each run, the cloths are cleaned using wash liquid and are ready to start the next cycle.

V. MATERIALS USED

1. CMC (Carboxymethyl Cellulose)

It is a cellulose derivative with carboxymethyl groups (-CH_2-COOH) also known as cellulose gum. Another popular addictive being increasingly considered for easing the challenges associated with borehole drilling mechanisms. It is basically a technical grade, low viscosity, and dispersible addictive. It has a wide acceptance in cost effective solutions for controlling fluid loss during the course of the drilling process. Considering as highly effective chemical even in low concentrations, for excellent water retention. It is a non toxic material.

2. STARCH

A drilling mud addictive used to control fluid loss. The use of **starch** typically causes a minimal increase in viscosity while effectively controlling **fluid** loss. Drilling-grade natural starch has API/ISO specifications for quality. Starches are carbohydrates of a general formula ($C_6H_{10}O_5$) *n* and are derived from corn, wheat, oats, rice, potatoes, yucca and similar plants and vegetables. They consist of about 27% linear polymers (amylose) and about 73% branched polymers (amylopectin).

3. SODA ASH (sodium carbonate)

This is used as a hardness control agent. In Addition of Soda Ash should always be done prior to addition of Bentonite or polymer to the drilling fluid system.

4. CAUSTIC SODA (sodium hydroxide)

It is used in water-base mud's as a source of hydroxyl ions to **control PH**. The PH of the drilling fluid must be ranges from 8.5 to 10 for getting better result and for reducing water hardness when mixing bentonite spud mud.

5. WOOD FIBERS

These wood fines (sawdust) are ideal for adding to drilling fluids and drilling mud, well fluids and for spills or mixing with drill cuttings. Our sawdust wood fines are dried to an average of10% or less assuring that they will mix well and absorb moisture properly.

6. *BENTONITE*

The mineral bentonite can be found all over the world. It is formed from weathering volcanic ash. It has some exceptional properties: when stirred into water, it demonstrates a so-called thixotropic reaction. It reacts as a fluid when mechanically stressed, for example shaken or stirred. However, it hardens in quiescent condition because its viscosity increases. Bentonite is used in drilling_fluids to lubricate and cool the cutting tools, to remove cuttings, and to help prevent blowouts. it is a common component of drilling_mud used to curtail drilling fluid_invasion by its propensity for aiding in the formation of mud cake.

7. BARITE

The overwhelming majority of the barite that is mined is used by the petroleum industry as a weighting material in the formulation of drilling mud. Barite increases the hydrostatic pressure of the drilling mud allowing it to compensate for high-pressure zones experienced during drilling. The softness of the mineral also prevents it from damaging drilling tools during drilling and enables it to serve as a lubricant. Barite is also used in a wide variety of other applications including plastics, clutch pads, rubber mud flaps, mold release compounds, radiation shielding, television and computer monitors, sound-deadening material in automobiles, traffic cones, brake linings, paint and golf balls.

VI. PROCEDURE

1. Clean all the vessels and equipments with fresh water. Then add the distilled water to the tank up to some liters. Switch on the power supply and open all control valves and check whether everything is working properly.
2. Note down the pressure.
3. Add the basic mud ingredients (Barite, Water and Bentonite) into the tank and mixing it by using the stirrer for some time. (There after adding the addictives for the other samples).
4. The mud is continuously stirred because it should not settle down to the tank. And mix it for 15 minute for better consistency.
5. Now start the pump and allow the mud in the tank to pass through the filter plates in the filter press (frame have circular holes on the corners for feed and discharge). The filtrate passes through the cloth, runs down the faces of plates and finally leaves the filter through discharged valves.

6. Fluid passes through the holes in the filter cloth and the solids are deposited on the filter cloth. After some time chamber is fully charged then the press is said to be jammed. And it acts as a membrane.
7. The mud settled on the canvas and the liquid gets off. This liquid will be collected in a rectangular tank which is called as the loss of liquid.
8. Note down the loss of liquid according to time by using stop watch.
9. Note down the cake thickness by using ruler.
10. By adding the different addictives in the mud and repeat the procedure for different muds

VII. OBSERVATION

Mud samples and materials used	**Sample 1**	**Sample 2**	**Sample 3**
Barite	1050 grams	1050 grams	1050 grams
Bentonite	350 grams	350 grams	350 grams
Water	30L	30L	30L
CMC	Nil	35 grams	70 grams
Wood fibers	Nil	35 grams	70 grams
Starch	Nil	35 grams	70 grams
Sodium carbonate	Nil	10 grams	20 grams
Sodium hydroxide	Nil	10 grams	20 grams

Tested Properties of samples	**Sample 1**	**Sample 2**	**Sample 3**
Viscosity	8.784 Cp	15.12 Cp	25.76 Cp
Marsh funnel viscosity	34 seconds	40 seconds	48 seconds
Mud weight	61 lbs/cuft	63 lbs/cuft	70 lbs/cuft
Surface tension	46 dy/cm^2	49 dy/cm^2	58 dy/cm^2
Specific gravity	0.97	1	1.12
Cake thickness	38mm	30mm	42mm
Density	0.976 g/cm^3	1.008 g/cm^3	1.12 g/cm^3

Time(second) \ Mud	Sample 1 Fluid loss Rise in water tank (cm)	Sample 2 Fluid loss Rise in water tank (cm)	Sample 3 Fluid loss Rise in water tank (cm)
60	6.0	4.0	3.5
60	4.0	3.5	3.2
60	4.0	3.0	2.8
60	3.0	2.5	2.2

VIII. GRAPHS

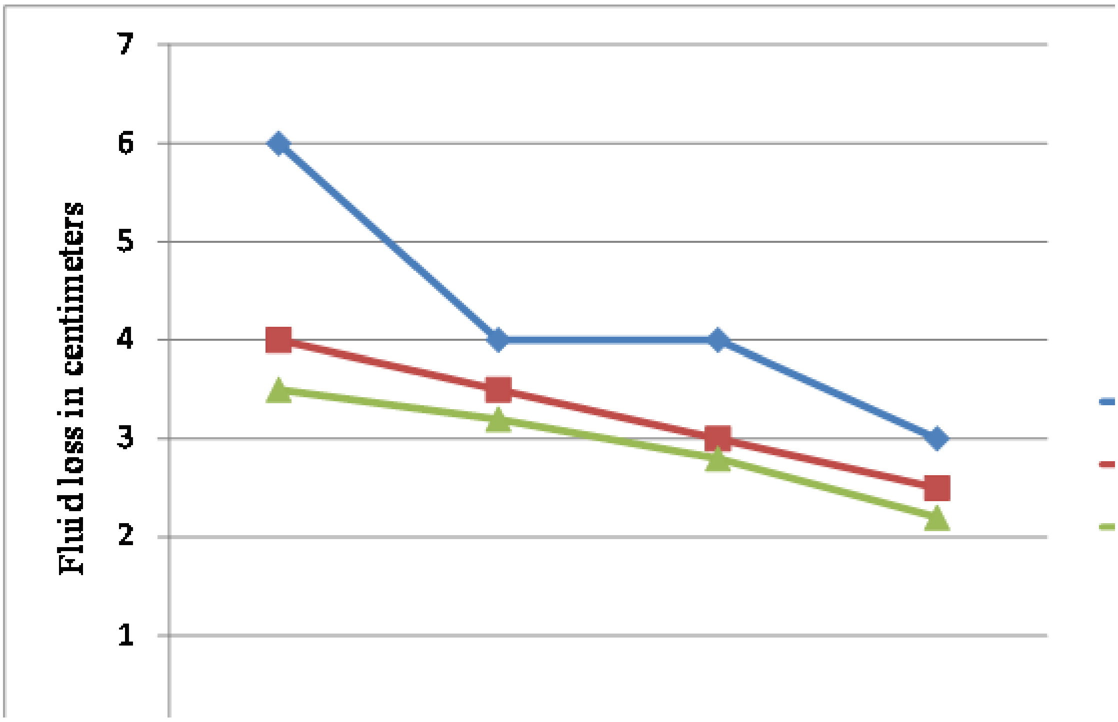

Fig.6: Profile of time Vs fluid loss

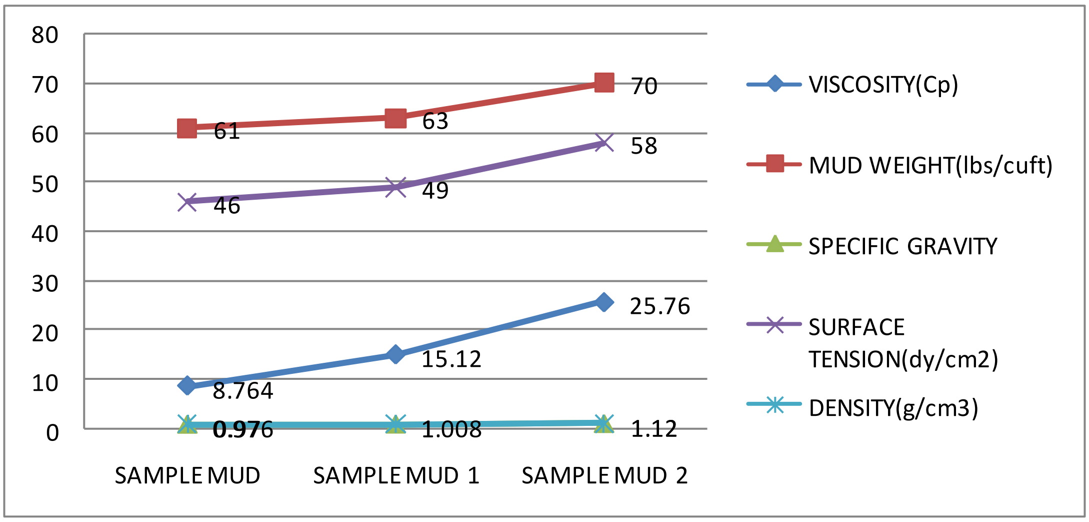

Fig.7: Detailed graphical representation of sample muds Vs properties.

IX. RESULT AND CONCLUSION

From this experiment we have found that the fluid loss will be more for the simple mud(Bentonite, Barite and Water) and it will be reducing if we are adding the addictives. Because of this fluid loss we will be adding appropriate addictives to reduce the amount of loss of fluid. Thus addictives will helps to increase the properties such as Viscosity, Density, PH level, Surface tension, and Mud weight. If the addictives is not used the fluid loss will be high and it will also cause to formation damages and possibility of having differentially stuck pipe. A desirable drilling fluid is achieved by minimizing the drill solids content (colloidal-sized solids) and maintaining the proper concentration of filtration control additives. So always we need to use adequate quantity of high-quality bentonite, barite, and best addictives in proper proportion. Filtration control comes with increased cost. The high fluid loss will leads to formation damages and we need to reduce it by using addictives. But we should be careful to the chemicals; if it is a toxic substance it will destroy all the surface ecosystems.

By this we can conclude that the addictives are necessary for the drilling mud to obtain the better properties. And the amount of addictives which we are adding will depend on the sub-surface properties. The fluid loss and the filter cake properties can be adjusted by using these chemicals for better output.

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