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Determination Of Loss Of Liquid From A Mud And Filter Cake Thickness (Pam, Pac, Starch)

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Abstract: Drilling is an important part of the oil industry and penetration rate must be enhanced to ensure speedy completion of drilling operation. Drilling fluid, or drilling mud, is a critical component in the rotary drilling process. The loss of liquid from a mud due to filtration is controlled by the filter cake formed of the solid constituents in the drilling fluid. The test in the laboratory consists of measuring the volume of liquid forced through the mud cake into the formation drilled in a period under given pressure and temperature using a standard size cell. The idea behind the current work is to determining the loss of drilling mud using additives as, starch bentonite, barite, PAM, PAC.

Keywords: - Additives, drilling, filter, mud, starch

I. INTRODUCTION

Oil has been used for lighting purposes for many thousands of years. In areas where oil is found in shallow reservoirs, seeps of crude oil or gas may naturally develop, and some oil could simply be collected from seepage or tar ponds. Historically, we know the tales of eternal fires where oil and gas seeps ignited and burned. One example is the site where the famous oracle of Delphi was built around 1,000 B.C. Written sources from 500 B.C. describe how the Chinese used natural gas to boil water. It was not until 1859 that "Colonel" Edwin Drake drilled the first successful oil well, with the sole purpose of finding oil. The Drake Well was located in the middle of quiet farm country in northwestern Pennsylvania, and sparked the international search for an industrial use for petroleum. The oil and gas industry is usually divided into three major sectors: upstream, midstream and downstream. The upstream oil sector is also commonly known as the exploration and production (E&P) sector. The upstream sector includes searching for potential underground or underwater crude oil and natural gas fields, drilling exploratory wells, and subsequently drilling and operating the wells that recover and bring the crude oil and/or raw natural gas to the surface. There has been a significant shift toward including unconventional gas as a part of the upstream sector, and corresponding developments in liquefied natural gas (LNG) processing and transport. The oil well is created by drilling a long hole into the earth with an oil rig. A steel pipe (casing) is placed in the hole, to provide structural integrity to the newly drilled well bore. Holes are then made in the base of the well to enable oil to pass into the bore. Drilling/penetrating the rock formations, utmost care requires to be exercised to balance the formation pressures, subsurface temperatures and at the same time exercising caution not to damage the reservoir or the well bore. The drill bit, aided by the weight of thick walled pipes called "drill collars" above it, cuts into the rock. There are different types of drill bit; some cause the rock to disintegrate by compressive failure, while others shear slices off the rock as the bit turns. Drilling fluid or "mud", is pumped down the inside of the drill pipe and exits at the drill bit. The principal components of drilling fluid are usually water and clay, but it also typically contains a complex mixture of fluids, solids and chemicals that must be carefully tailored to provide the correct physical and chemical characteristics required to safely drill the well. Particular functions of the drilling mud include cooling the bit, lifting rock cuttings to the surface, preventing destabilization of the rock in the wellbore walls and overcoming the pressure of fluids inside the rock so that these fluids do not enter the wellbore. Some oil wells are drilled with air or foam as the drilling fluid.

Drilling fluid is an important component in the drilling process.There is a number of functions of a drilling fluid. The more basic of these are listed below:

- Balance formation pressure.
- Carry cuttings and sloughing's to the surface and clean beneath the bit.
- Cool and lubricate bit and drill string.
- Seal permeable formations.
- Stabilize borehole and corrosion control.

In addition to these functions, there are several other functions with which the drilling fluid should not interfere:

- Formation evaluation.
- Completion operations and Production operations

The drilling fluid is related either directly or indirectly to almost every drilling problem. This is not to say that the drilling fluid is the cause or solution of all drilling problems, but it is a tool that can often be used to alleviate a problem situation. Many have thought that a magic additive would solve all of their problems and that the drilling fluid could somehow make up for poor drilling practices. This is simply not the case. It is a part of the drilling process and should be used to complement all other facets of the operation. Selection and application of the drilling fluid are key factors in the success of any drilling operation. The first objective in planning a mud program is the selection of a mud that will minimize the amount of lost time in the drilling operation. Such a mud will usually be economical regardless of its cost per barrel. Generally, a good drilling fluid is simple and contains a minimum number of additives. This allows easier maintenance and control of properties. It is desirable to have a mud system that is flexible enough to allow changes to be made to meet changing requirements as they occur. Each change in the mud should be planned well in advance of the time it is required. This will allow current treatment of the mud consistent with future requirements.

1.1 Water-based muds

Water-based drilling fluids are the most commonly used of the mud systems. They are generally less expensive and less difficult to maintain than oil mud, and in some special types of systems, they are almost as shale inhibitive. However, inevitably the action of drilling the hole in a consolidated formation relieves stress. If a water-based fluid is used, the water will tend to enter the formation and change the mechanical properties of the rock. These changes may be enough to cause formation damage and borehole instability. These damaging effects can be minimized by using an inhibited water-based fluid. The inhibited water-based systems cannot totally prevent water wetting of the rock pores, but they can minimize it.

Water-based muds fall into two basic categories: dispersed and nondispersed muds.

1.1.1 Dispersed muds

These muds have a chemical dispersant added to the system which is used to deflocculate mud solids. Most of the chemical dispersants in use (such as lignite and lignosulfonate) are acidic and require an alkaline environment in which to function properly. Of all the water-based muds, high pH muds are the most tolerant of solids and contamination. They are, without a doubt, the least difficult of the water muds to maintain. Clay (bentonite) is used as a viscosifier and fluid loss agent. Dispersants are use to permit enough clay into the system to control fluid losses. Caustic soda ($NaOH$) is used for pH control, and the density is adjusted with weight materials.

1.1.2 Nondispersed muds

A basic difference between dispersed and nondispersed muds is the lack of dispersants. Nondispersed drilling muds do not require an elevated pH. By not having a dispersant present, they are less tolerant of solids and contamination. The majority of the fluid loss control and viscosity is maintained via polymers, and these products are very susceptible to contamination from the formation, produced gases, and fluids.

2. Oil-based muds

Oil-based muds were developed to prevent water from entering the pore spaces and causing formation damage. There are several advantages and disadvantages of this type of mud system. The advantages include the following:

- Shale inhibition—in highly smectitic or "gumbo" shales, the borehole maintains stability and cuttings samples are generally intact.

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- Reduction of torque and drag problems—since oil is the continuous phase, the borehole and the tubulars are wetted with a lubricating fluid. This is a distinct advantage in deviated wellbores.
- Thermal stability—Oil-based muds have shown stability in wells, with BHTs of 585°F
- Resistance to chemical contamination—Carbonate, evaporite, and salt formations do not adversely affect the properties of an oil mud. CO_2 and H_2S can easily be removed with the addition of lime ($CaCO_3$).

Oil-based muds contain three phases: oil, brine, and solids phase

2.1 Oil phase

The oil phase is the continuous phase in which everything else in the system is mixed. The oil can be diesel, mineral oil, or one of the new types of synthetic oils.

2.2 Brine phase

The brine phase is present in the system as a high concentration salt solution that is emulsified into the base oil. Usually a solution of calcium chloride is used because it gives a greater flexibility in adjusting the concentration of the salts. This phase is difficult to control because, if the salt concentration nears saturation, the emulsifiers and oil-wetting compounds precipitate.

2.3 Solids phase

The solids phase includes the weight material, viscosifiers, and fluid loss reducers. A primary requirement for this phase is that it remains oil wet. Compounds exclusively developed for this purpose are included in the oil mud make-up. If the solid phase ever becomes water wet, the system is said to have "flipped" and the consequences are severe and operationally expensive. The system will separate into two phases: solid and liquid. The solid phase will pack and plug the wellbore, necessitating remedial drilling.

3. Additives for Drilling Fluids

Just as drilling fluids are integral to the bore well drilling process, additives that are very much a part of their composition, have a unique role to play. Most of these additives have distinct properties that specifically help in countering specific challenges encountered during the drilling process. They help in accomplishing the drilling work with efficiency and precision. They also help in minimizing human hazards. Some of the significant compounds that work well as additives have been detailed out below,

3.1. Baryte

77% of baryte worldwide is used as a weighting agent for drilling fluids in oil and gas exploration to suppress high formation pressures and prevent blowouts. As a well is drilled, the bit passes through various formations, each with different characteristics. The deeper the hole, the more baryte is needed as a percentage of the total mud mix. An additional benefit of baryte is that it is non-magnetic and thus does not interfere with magnetic measurements taken in the borehole, either during logging-while-drilling or in separate drill hole logging. Baryte used for drilling petroleum wells can be black, blue, brown or gray depending on the ore body. The ground baryte also must be dense enough so that its specific gravity is 4.2 or greater, soft enough to not damage the bearings of a tricone drill bit, chemically inert, and containing no more than 250 milligrams per kilogram of soluble alkaline salts.

Figure 1:- Baryte

3.2. Bentonite

Bentonite is usefulness in the drilling and geotechnical engineering industry comes from its unique rheological properties. Relatively small quantities of bentonite suspended in water form a viscous, shear-thinning material. Most often, bentonite suspensions are also thixotropic, although rare cases of rheopectic behaviour have also been reported. At high enough concentrations (about 60 grams of bentonite per litre of suspension), bentonite suspensions begin to take on the characteristics of a gel (a fluid with a minimum yield strength required to make it move). So, 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. Bentonite is used in drilling fluids to lubricate and cool the cutting tools, to remove cuttings,

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and to help prevent blowouts. Much of bentonite's usefulness in the drilling and geotechnical engineering industry comes from its unique rheological properties.

Figure 2:- Bentonite

3.3 Starch

Oil Drilling Starch Starch is used for reducing fluid loss in a variety of water based drilling fluids and has beneficial secondary effects on mud rheology. In drilling wells, a liquid (mud) is pumped into the hole to clean and cool the drill bit and to flush to the surface the drill bit cuttings and suspending the drill cuttings while drilling is paused. The most important physical characteristics of the drilling fluid is the viscosity and the water holding/retaining characteristics.

Figure 3:- Starch

3.4. Polyanionic cellulose (PAC)

Oil Drilling PAC is a kind of water-soluble cellulose ether derivative made from natural cellulose by chemical modification, and an important kind of water-soluble cellulose ether. Usually the sodium salt of Oil Drilling PAC R is in application. Oil Drilling PAC has excellent heat-resistant stability, salt tolerance and strong antibacterial activity. The slurry or fluid prepared from the product has better fluid loss reducing capability, rejection capability and higher temperature tolerance. Oil Drilling PAC is widely used in petroleum drilling, especially in salt well and offshore oil drilling.

Figure 4:- PAC

3.5. PAM (polyacrylamide)

PAM is a polymer (-$CH_2CHCONH_2$-) formed from acrylamide subunits. It can be synthesized as a simple linear-chain structure or cross-linked, typically using N.N'-methylenebisacrylamide. In the cross-linked form, the possibility of the monomer being present is reduced even further. It is highly water-absorbent, forming a soft gel when hydrated, used in such applications as polyacrylamide gel electrophoresis, and can also be called ghost crystals when cross-linked, and in manufacturing soft contact lenses. In the straight-chain form, it is also used as a thickener and suspending agent

Figure 5:- Polyacrylamide

II. PLATE AND FRAME FILTER PRESS

This is the simplest type of pressure filter. It consists of plates and frames arranged alternately and supported on a pair of rails.The plate are a solid piece having a ribbed surface. The frame is hollow and provides the space for the filter cake. By this alternate arrangement of frame and filter the chamber form in which cake will deposit. The plate and frame are square or rectangular in shape which made from cast iron, stainless steel, nickel, aluminium, monel, wood, hard rubber or plastics (polypropylene). Generally, the slurry needed to be dewatered is injected into the center of the press and each chamber filled. The filling time should be as quick as possible in order to avoid cake formation in the first chamber before the last chamber is filled. While the chambers are being filled up, the pressure inside the system will increase due to the formation of thick sludge. Then, the liquid is filtered out through the filter cloths by adding streams of compressed air or water. The use of pressurized water requires more time to pass into the chamber compared to pressurized air, however this method is much more cost efficient

Figure 6:- Plate and Frame Filter Press

III. PROCEDURE

a) Firstly, cleaning all the equipment with clean water. Then, add the distilled water into the tank up to some liters. Now, check all the power supply for the agitator and pump.

b) Now adding the mud ingredients i.e.; barites, bentonite for the first sample and there after adding additives (i.e., Baryte, Bentonite, PAM, Starch, PAC) to the mud in the other samples, this solution is made in the water so; these are called water based mud.

c) Then the mud is mixed and continuously, stirred because the mud in the tank should not be kept still as, it will settle in the bottom of the tank, so for this reason the agitator is given to it for continue mixing of the mud.

d) After mixing of the whole mud till 15mins then we should check the consistency of the mud in the tank. Now, we can start the pump and allow the transportation of the mud which is in the tank to the plates present in the filter press.

e) Now under the pressure the mud is passed through the plates where the canvas acts like a membrane.

f) The mud settles on the canvas and the liquid gets off by the pressure, the liquid which comes from the canvas/membrane is collected in to the rectangular tank which is called as loss of liquid.

g) The loss of liquid is calculated with respect to time, the stop watch is used here to note down the time.

h) Now, for every mixture of additives we must carry on the same procedure this is how the result of loss of liquid and cake thickness can be measured.

IV. OBSERVATION

Samples	WBM(sample1)	Sample 2	Sample 3	Sample 4	Sample 5
Barite	1500gm	1500gm	1000gm	1000gm	1000gm
Bentonite	500gm	500gm	500gm	500gm	500gm
Distilled Water	3000ml	3000ml	3000ml	3000ml	3000ml
Starch	N/A	N/A	100gm	100gm	100gm
PAC	N/A	N/A	N/A	N/A	10gm
PAM	N/A	50gm	N/A	50gm	10gm
Loss of Liquid (time)in sec	18.36cm 37.5sec	7cm 52.5sec	1.5cm 48.75sec	0.94cm 45sec	0.23cm 60sec
Filter cake Thickness(mm)	50mm	35mm	10mm	3mm	0.3mm

Table 1:- Observed readings by using different additives

V. CONCLUSION

So, by this experiment we concluded to a point that when additives are added to the mud the mud property of viscosity in increases and the filter cake thickness to be formed will decrease in size.

When we added the additive PAM the loss of liquid from the mud was low then the simple mud and the filter cake thickness was also lesser. But the PAM is a toxic chemical so we should avoid using this chemical.

Instead we can use the Starch and PAC which are eco friendly and harm less to the environment, as the dumping of the mud is a major problem faced by the drilling projects and sectors. The above mentioned chemicals have effective nature on the mud mainly the PAC which has the gel forming factor when come under contact with the solution or water. These chemicals can be very useful and beneficial in the mud making processes which can create almost negligible loss of liquid and the thickness of the filter cake is also relatively low. As this is the reason of this project to be conducted and calculated the loss of liquid and the filter cake should be very low to keep the mud save and can be recycled for further purposes.

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