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Effects of Solid Contents and Various Additives in Drilling Fluids

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Abstract: *The project is done to study about the effects of solid contents and various additives in drilling fluids. The objectives of this project work were to determine the Viscosity & Density of Mud Additive (Barite BASO4 specific gravity :4.10 ~ 4.20), while STPP(sodium tri-polyphosphate $Na_5P_3O_{10}$) is Viscosifier.The scope of this project is limited to Water based muds only.*
Keywords: *Bentonite, mud weight, mud viscosity, olefins, synthetic paraffins*

I. Introduction

1.1 Drilling Fluid

In geotechnical engineering, drilling fluid is used to aid the drilling of boreholes into the earth. Often used while drilling oil and natural gas wells and on exploration drilling rigs, drilling fluids are also used for much simpler boreholes, such as water wells. Liquid drilling fluid is often called drilling mud. The three main categories of drilling fluids are water-based muds (which can be dispersed and non-dispersed), non-aqueous muds, usually called oil-based mud, and gaseous drilling fluid, in which a wide range of gases can be used.

The main functions of drilling fluids include providing hydrostatic pressure to prevent formation fluids from entering into the well bore, keeping the drill bit cool and clean during drilling, carrying out drill cuttings, and suspending the drill cuttings while drilling is paused and when the drilling assembly is brought in and out of the hole. The drilling fluid used for a particular job is selected to avoid formation damage and to limit corrosion.

1.1.1 Types

Many types of drilling fluids are used on a day-to-day basis. Some wells require that different types be used at different parts in the hole, or that some types be used in combination with others. The various types of fluid generally fall into a few broad categories [1]

Air: Compressed air is pumped either down the bore hole's annular space or down the drill string itself.

Air/water: The same as above, with water added to increase viscosity, flush the hole, provide more cooling, and/or to control dust.

Air/polymer: A specially formulated chemical, most often referred to as a type of polymer, is added to the water & air mixture to create specific conditions. A foaming agent is a good example of a polymer.

Water: Water by itself is sometimes used. In offshore drilling sea water is typically used while drilling the top section of the hole.

Water-based mud (WBM): Most basic water-based mud systems begin with water, then clays and other chemicals are incorporated into the water to create a homogeneous blend resembling something between chocolate milk and a malt (depending on viscosity). The clay (called "shale" in its rock form) is usually a combination of native clays that are suspended in the fluid while drilling, or specific types of clay that are processed and sold as additives for the WBM system. The most common of these is bentonite, frequently referred to in the oilfield as "gel". Gel likely makes reference to the fact that while the fluid is being pumped, it can be very thin and free-flowing (like chocolate milk), though when pumping is stopped, the static fluid builds a "gel" structure that resists flow. When an adequate pumping force is applied to "break the gel", flow resumes and the fluid returns to its previously free-flowing state. Many other chemicals (e.g. potassium formate) are added to a WBM system to achieve various effects, including: viscosity control, shale stability, enhance drilling rate of penetration, cooling and lubricating of equipment. Oil-based mud (OBM): Oil-based mud is a mud where the base fluid is a petroleum product such as diesel fuel. Oil-based muds are used for many reasons, including increased lubricity, enhanced shale inhibition, and greater cleaning abilities with less viscosity. Oil-based muds also withstand greater heat without breaking down.The use of oil-based muds has special considerations, including cost, environmental considerations such as disposal of cuttings in an appropriate place, and the exploratory disadvantages of using oil-based mud, especially in wildcat wells. Using an oil-based mud interferes with the geochemical analysis of cuttings and cores and with the determination of API gravity because the base fluid cannot be distinguished from oil returned from the formation.

Synthetic-based fluid (SBM) (Otherwise known as Low Toxicity Oil Based Mud or LTOBM): Synthetic-based fluid is a mud where the base fluid is synthetic oil. This is most often used on offshore rigs because it has the properties of an oil-based mud, but the toxicity of the fluid fumes are much less than an oil-based fluid. This is important when men work with the fluid in an enclosed space such as an offshore drilling rig. Synthetic-based fluid poses the same environmental and analysis problems as oil-based fluid.

On a drilling rig, mud is pumped from the mud pits through the drill string where it sprays out of nozzles on the drill bit, cleaning and cooling the drill bit in the process. The mud then carries the crushed or cut rock ("cuttings") up the annular space ("annulus") between the drill string and the sides of the hole being drilled, up through the surface casing, where it emerges back at the surface. Cuttings are then filtered out with either a shale shaker, or the newer shale conveyor technology, and the mud returns to the mud pits. The mud pits let the drilled "fines" settle; the pits are also where the fluid is treated by adding chemicals and other substances.

The returning mud can contain natural gases or other flammable materials which will collect in and around the shale shaker / conveyor area or in other work areas. Because of the risk of a fire or an explosion if they ignite, special monitoring sensors and explosion-proof certified equipment is commonly installed, and workers are advised to take safety precautions. The mud is then pumped back down the hole and further re-circulated. After testing, the mud is treated periodically in the mud pits to ensure properties which optimize and improve drilling efficiency, borehole stability, and other requirements. [2]

II. Equipment Used

Ford Cup: The Ford cup is a simple gravity device for measuring viscosity by observing the time it takes a known volume of liquid passing through an orifice located at the bottom.

Fig 1. Ford cup

Marsh-Funnel: The Marsh funnel is a simple device for measuring viscosity by observing the time it takes a known volume of liquid to flow from a cone through a short tube.

Fig 2. Marsh Funnel

***Variable Speed Mixer*:** A single spindle Hamilton Beach Commercial mixer was utilized for preparing mud samples. Mixer used had 3 speeds setting with an additional pulsating switch.

Fig 3. Variable speed mixer

***Stop Watch*:** A stopwatch is a handheld timepiece designed to measure the amount of time elapsed from a particular time when it is activated. Large digital version of a stop-watch designed for viewing at a distance, as in a sports stadium is called a stop-watch.

III. Experimental Procedure

An experimental procedure was developed with the purpose of determining Viscosity & Density:

- First make barite solution by adding water + barite and little amount of STPP in a bucket.
- Then with the help of Variable speed mixer, mix the solution.
- After these take some amount of solution and pour in Ford cup, and with the help of stop-watch, check how much time taken to move into the vessel. Note the time.
- Then fill 1ltr of solution in marsh funnel and check how much time taken to move into the vessel. Note the time.
- Repeat this experiment by adding little more amount of STPP in the barite solution, and take the reading.

IV. Observation

Table 1 Observation & Result

BEFORE ADDING STPP		AFTER ADDING STPP	
MARSH FUNNEL	**FORDCUP VISCOMETER**	**MARSH FUNNEL**	**FORDCUP VISCOMETER**
10.37cP	90.90cP	9.12cP	87.57cP
11.048cP	92.42cP	11.01cP	91.212cP

Density in 1st case = 1.482 gm/cm^3
Density in 2nd case= 1.57 gm/cm^3

V. Conclusions

From current research work it is concluded that the drilling fluids that are tested are equally efficient.

References

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