Tikrit University

The College of Petroleum Processes Engineering

Petroleum and Gas Refining Engineering Department

An Introduction to Petroleum Technology

First Class

Lecture (12)

By

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Types of Drilling Fluid:

1- Water – based muds. (مائي القاعدة)

   a- Fresh water mud.

   b- Salt water mud.

2- Oil- based muds. (نفطي القاعدة)

3- Gas – liquid mixture:

   a- Foam mostly gas.

   b- Aerated water mostly water.

4- Gas systems.

   a- Natural gas.

   b- Air.

Composition of drilling fluids:

1- A continuous phase (liquid) such as water and oil.

2- A dispersed gel- forming phase Such as Bentonite or colloidal organic matter.

3- Inert an active dispersed phase: These materials do not react with the liquid, that is, they do not give colloidal properties and do not disperse in water, but they lead to the thickening of the drilling fluid, such as Barite, sand, weighting material, and cuttings.

4- Various chemicals necessary to control mud properties with in desired limits.Maintains the properties of the drilling fluid or restores the properties of the drilling fluid if it loses it.

1-Water-Based Muds

Advantages of water-Based Muds:

- Increased drillability when using fresh water (drillability increases when density and viscosity decrease).).
- Less expensive than oil-base muds.

2- Oil- base muds consist of a continuous phase of oil in which clay and other solids are suspended.

it is used in special drilling operations:

- Drilling in extremely high temperatures.
- Drilling in water - sensitive formations.
- Penetrating productive zones.

Advantages of oil-Based Muds:

- Minimized formation damage.
- Prevents clay hydration.
- Provides better lubrication (reducing torque, drag and pipe sticking).
- Minimizes drill string corrosion . high temperature stability.

Disadvantages of oil-Based Muds:

- Foaming at surface when adding water.
- Flammable.
- Significantly more expensive than water-base muds.

- Dirty and hazardous.
- Environmentally unfriendly.

3-Air and gas systems: using comressed air, natural gas, inert gas or mixtures with water has an economic advantage in hard rock areas.

استخدام الهواء المضغوط أو الغاز الطبيعي أو الغاز الخامل أو الخلائط مع الماء له ميزة اقتصادية في مناطق الصخور الصلبة

Advantages of air and gas systems:

- Fastest penetration rate of any drilling fluid.
- Cleaner cores.
- Better cement jobs.
- Better completion jobs.
- No danger of lost circulation.
- No reaction with shale.

Disadvantages of Air and Gas systems:

- Combustible with other gases (possibility of downhole explosions and fire) .
- Pipe corrosion.
- Finely crushed cutting (making analysis difficult).
- No pressure control (permitting caving or requiring additional equipment) .

- No filter cake.
- Influx of formation water (creating mud rings and causing stuck pipe).
- No cooling or lubrication.

Drilling fluid properties:

The most important properties of drilling fluids are:

1- Mud Density.

2- Mud Viscosity.

3- Gel Strength.

4- Mud PH Level.

5- Filtration

6- Sand Content.

7- Stability.

1- **Density** is the mass of a unit volume and is measured in several units: gm/cm3 , lb/ gal , lb/ft3 , kg/m3.

Mud density is measured with a Mud Balance.

Mud density is the single- most important factor in controlling formation pressure throughout the wellbore.

For a balanced well, the formation pressure must not exceed the hydrostatic pressure exerted by the mud column.

$$\mathbf{Hp} = \frac{\rho}{8.33} \mathbf{x\ 0.433\ x\ L = 0.052\ \rho\ L}$$

Where:

Hp : Hydrostatic pressure, psi.

ρ : Density of drilling fluid, lb/gal.

L: depth, ft.

8.33: Density of water, lb/gal

0.433: pressure gradient for water, psi/ft

How was this number obtained? (0.433 psi/ft)

Pressure gradient for water = 62.4 lb/ft^3 x 1 ft^2 / 144in^2

Where:

62.4 lb/ft3 : water density.

1 ft = 12 in , 1ft^2 = 144 in^2

Lb/in^2 = psi

Notes:

- Barite is the standard solid used to increase mud density.
- For reduction in density, weighted muds are usually chemically treated.
- When chemicals no longer work, water can be added to reduce mud density.
- Centrifuges can also be used to remove excessive solid particles from the mud.

2-Mud Viscosity:

Mud viscosity measures the drilling mud's resistance to flow.

The greater resistance is the higher viscosity.

It must be high enough for the mud to keep the bottom hole clean and carry cuttings to the surface.

A simple measure of viscosity, the funnel viscosity, is made by the derrickman using a Marsh Funnel.

The measurement is simply the number of seconds required for the fluid to flow through a calibrated orifice **(Marsh Funnel)** .

3-Gel Strength:

Gel strength measures the attractive forces of suspended particles when the fluid is static.

Determines the ability of the drilling fluid to develop a gel structure as soon as it stops moving.

Its purpose is to hold cutting and mud solids in suspension when circulation is stopped.

4-Mud PH Level:

The PH level of drilling mud should be monitored in order to maintain sufficient alkalinity and reduce pipe corrosion.

Caustic soda is often added to increase and/or maintain the PH level.

The PH : It is the negative decimal logarithm of the concentration of hydrogen in a solution

$PH = - Log (H^+)$

Notes:

- Less than 7 acidic.
- greater than 7 alkaline solution.
- Ordinary drilling fluids have a pH range of 7 to 8.
- As for chemically treated drilling fluids, it ranges from approximately 8 to 12.5.
- As it rises, the viscosity decreases.

5-Sand Content :

It is the volume percentage of solid particles present in the drilling fluid, with a diameter ranging from: 0.074 to 4 mm; Because less than this range will be dispersed in the liquid like clay, while the largest of it will be trapped on the surface by the shale shaker, and this percentage should not exceed 3% in the liquid because if it increases, it will affect all the properties and processes of drilling and drilling means where it causes problems Numerous such as Valves erosion, drill pipe and even nozzles.

6-Filtration :

It is the penetration of a part of the free liquid phase into the permeable layers due to the pressure difference between the pressure of the drilling fluid column and the pressure of the formations.

We always try to choose a drilling fluid whose filter is small, because if its filtering is high, it will cause many problems during drilling.

High filtration problems:

1- When drilling in shale or clay layers, the high filtration causes the clay or shale to swell, which leads to a narrowing of the diameter of the well, which causes problems in Inserting and take out the drill pipes.

Mudcake: It is the narrowing of the diameter of the well due to the bulge of the clay or shale that occurs as a result of the high filtration of drilling fluid.

2- It causes problems in fishing of drilling equipment, for example, when the Bit or part of the drill pipe falls. If there is thick mudcake, part of the pipe will get stuck in it and it will be difficult to get it out.

3- If we dig into a salt bed and the filtration is high, the water will cause the salt to dissolve and cause caving in the formation.

7-Stability:

The stability of the drilling fluid means that the fluid maintains its homogeneity, that is, it does not separate into its components during stopping rotation or stagnation.

If the drilling fluid is not stable, the solid parts will settle at the bottom, so the density will increase at the bottom and decrease at the top .If there are gas pockets in the layers, this will lead to the entry of layers fluids into the well and an blowout will occur.

Also, when the separation occurs, the solid parts will accumulate at the bottom on the Bit, which makes the drilling process difficult.