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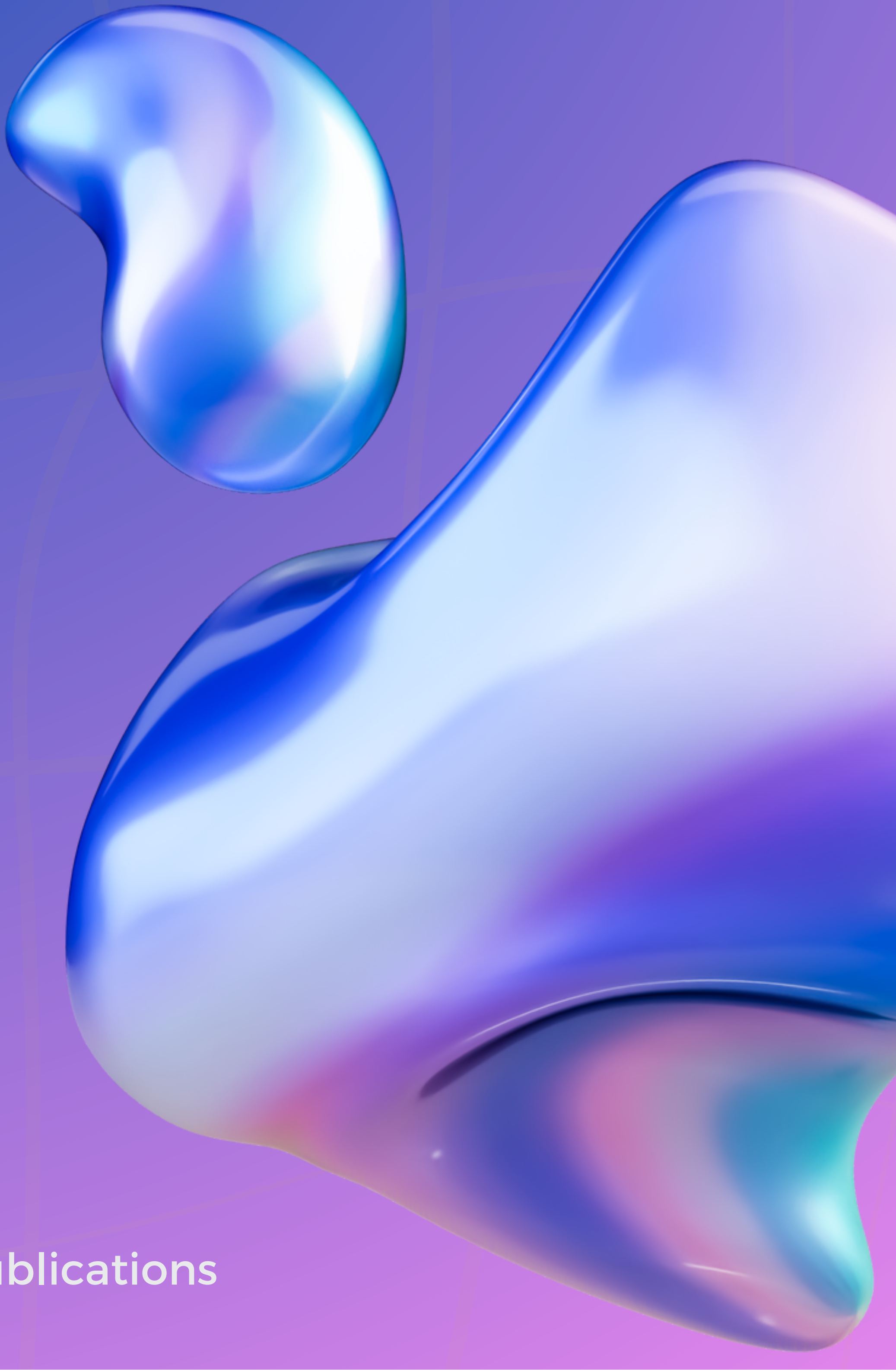
THEORY OF DRILLING FLUIDS

EDITED BY
Dr. Kalpajit Hazarika



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Preface

The technique and mechanical techniques for controlling drilled solids in drilling fluids used in oil well drilling is described in this book. System specifics enable rapid and useful application during both the planning and design phases as well as throughout operations. Because fundamental concepts are not understood, effective solids-control programmes are frequently disregarded. The foundations of effective solids control are explained in this book. Following these straightforward fundamental concepts will pay off financially. The book can be used to build and develop a system for handling drilling fluids, as well as to troubleshoot existing systems and enhance rig operations. The concept of this handbook is that drilled solids are evil. The economics of drilling a well are slightly impacted by drilled solids. On a drilling rig, an increase in drilled-solids content does not instantly spell calamity. A driller understands right away that it's time to pull the bit when it stops drilling and torque increases. The negative consequences of a rise in drilled solids are not always obvious.

Drilled-solids management has changed as drilling has gotten harder and environmental concerns have taken the stage. The need to treat more and more expensive drilling fluids has led to equipment modifications and advancements. The understanding that polymers can provide considerably superior drilling fluids than those used previously, despite the fact that they are expensive, has arguably had the most impact on the drilling sector. Superior solids removal systems were created in response to the decreased drilled-solids concentration requirements of polymer drilling fluids.

An accurate and comprehensive historical overview of drilling-fluid management, specifications, solids control, and auxiliary operations paints a picture of how modern equipment has developed. Mid-1800s cable tool (percussion) drilling employed drilling fluid to suspend the cuttings until they were bailed from the drilled hole. (History of Oil Well Drilling by J. E. Brantley discusses cable tool drilling.) Drilling fluid's functions as a coolant for the drill bit and a means of holding drilled cuttings until they could be removed from the well bore became well recognized with the introduction of rotary drilling in the water-well drilling business. By the 1890s, clays were being added to the drilling fluid. When Spindletop, near Beaumont, Texas, was found in 1901, suspended particles (clay) in the drilling fluid were thought to be required to hold the borehole's walls. At Spindletop, cuttings had to be carried to the surface with the introduction of rotary drilling. Lacking water, mud from mud puddles was circulated downhole to raise rock shavings to the surface. The sludge was spiked with some hay. The majority of the solids in the circulating system (mostly clays) came from the drill bit's so-called "disaggregation" of the formations it drilled through. The process that occurred to the drilled clays was known as disaggregation. Clays would make the circulating fluid thicker, raising the fluid's viscosity. Some of the drilled formation would not spread but instead would stay in the form of small rock fragments known as cuttings.

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CHAPTER - 1

INTRODUCTION TO DRILLING FLUID

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Well-draining is often facilitated by drilling fluid, sometimes known as drilling mud. Drilling fluids are often used while drilling for natural gas and oil wells, and chemicals are also used in the exploration sector for much lesser boreholes, including water wells. Three types of drilling fluid exist Water-based mud that may or cannot spread. Different gases may be present in non-aqueous mud, sometimes referred to as hydrocarbon and gaseous drilling mud. They are used in the excavation of different oil and gas deposits, together with the proper clay and polymer additives for moulding. In addition to preventing development fluids from entering the good bore, drilling fluids also convey drill cuttings, keep the drill bit cool and clean throughout drilling, and suspend drill clippings when drilling is halted and the drilling assembly is carried in and out of the hole. The drilling fluid used for a particular project is selected to minimise corrosion and minimise formation damage [1]–[3].

Types of Drilling Fluids

WBM, or water-based mud the majority of water-based fracturing fluids starts off tasting like a hybrid amongst chocolate milk and malt before adding clays and other chemical components depending on viscosity. The clay is often a mixture of natural clays floating in the drilling fluid or a particular kind of clay that has been gathered and offered as a supplement for the WBM system. Bentonite, known as "gel" in the oilfield, is the most typical addition and is also the most often used. When a fluid is being pumped, it may be very thin and free streaming like chocolate milk, but once the pump is switched off, the static fluid congeals into a "gel" structure that hinders flow. When sufficient pumping force is applied to "break the gel," flow resumes, and the fluid returns to its initial condition of unrestricted flow [4]–[6].

Various advantages, such as viscosity control, shale stability, enhanced drilling depth of penetration, and equipment cooling and lubrication, are produced when additives (such as potassium formate) are introduced to a WBM system. An oil-based mud (OBM) utilises an oil-based base fluid, such as diesel fuel. Oil-based muds are used for a variety of reasons, including increased lubricity, shale inhibiting, and cleaning abilities with decreased viscosity. Muds made with oil are more heat resistant as well. Cost, environmental concerns, such as where to dispose of cuttings, and the exploratory disadvantages of using oil-based mud, particularly in wildcat groundwater, are all things to take into account. Because it is impossible to distinguish between base fluid and oil extracted from the formation, cuttings, and cores are subjected to geochemical analysis using hydrocarbon mud, and API gravity is computed. Fluid with a synthetic basis (SBM): A mud that uses synthetic oil as its foundation fluid is known as a synthetic-based fluid. Even though the fluid fumes are far less toxic than an oil-based fluid, it is often used on offshore rigs since it has the characteristics of an oil-based mud. This is essential when the drilling crew is handling fluid in a small space, such as an offshore drilling rig. The environmental and analytical problems with oil-based fluid are the same as those with synthetic-based fluid.

The makeup of drilling fluid

The most common elements of water-based drilling mud are bentonite clay (gel) and additives like barium sulphate (Barite), calcium carbonate (chalk), or hematite. The viscosity of the fluid may be changed by adding thickeners such guar gum, starch, glycol, or xanthan gum. Lubricants, shale accelerators, and apparent viscosity additives are a few more often used additives.

To increase the overall density of the water-based drilling, a weighing agent like dolomite is used. It is possible to maintain adequate bottom hole pressure to prevent an unanticipated (and possibly fatal) entrance of formation fluids. Invert emulsion-based muds are made possible by the use of high-pressure, slightly elevated silica and clay nanoparticles, as well as by the monitoring of their beneficial effects on the rheological properties of drilling mud.

Water-based drilling fluid composition

The quantity of water used in the production and maintenance of water-based mud has an impact on the effectiveness of mud additives. Clay minerals function quite well when combined with fresh water. Clay performs less well in salty and harsh waters.

Potato muds Depending on the drilling techniques utilised across the globe, different types of mud are often used to spud wells. In certain instances, the owner only utilises water that is available locally, such as from a spring, stream, or lake. The ideal conditions are when the underlying water is soft and thus the surface formations create excellent natural mud. If not, the operator may amend the mud by adding clay, lime, or soda ash.

Organic muds

If there is sufficient clay present, it may be combined with water to create fantastic natural mud. Since natural muds either do not hydrate well or need a lot of water to keep them at a low weight and viscosity, they are useful in deeper water, such as for surface drilling and generating holes just under the conductor casing. Since shallow holes often have normal formation pressures, heavy mud is not necessary to prevent kicks.

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CHAPTER - 2

OIL-BASED DRILLING FLUID'S COMPOSITION

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Oil, often synthetic or diesel oil, makes up the liquid part of oil muds instead of water. Compared to water-based muds, oil-based muds are more expensive, more challenging to handle, and more challenging to dispose of, but they are simpler to make and maintain. Because of the cost and environmental implications, operators only employ them when downhole conditions demand it [1]–[3].

Operators often utilise oil muds for the following purposes:

Drilling water-soluble formations, drilling deep, slightly elevated holes, salvaging casing (when used as a casing pack), preventing severe drill string corrosion, preventing gas entrainment, protecting productive formations, protecting difficult shales, and more are just a few of the benefits.

Drilling fluid made of synthetic materials

The basis fluids in SBMs are synthetic organic compounds that function like petroleum-derived oils in terms of oil exploration but, according to the manufacturer, biodegrade quickly in saltwater. This contrasts with the base oils in OBMs (diesel and mineral oil), which are refined from crude oil. Similar to most OBMs, SBMs are implosion emulsions in which a brine serves as the inner phase and a synthetic fluid serves as the external, or continuous, phase [4]–[6].

In recent years, several synthetic fluids, all in the C18-C24 size range, have just been introduced to the market. Produced when a fatty acid and an alcohol combine. Considering the ester as a synthetic vegetable oilDi-Ether: Di-ether was created by the precipitation and steam reforming of alcohols; it was preceded by a mono-ether (lower molecular weight). Di-ethers are utilized as flavouring, perfumery, cosmetics, and solvents.

Drilling fluid's function

Cuttings are produced during drilling, but they are often not a problem until the drilling is stopped because a drillbit broke or for some other reason. The cuttings re-fill the hole when this happens without the use of drilling fluids. To prevent this, drilling fluids are utilised as a suspending mechanism. Drilling fluid's total viscosity rises when movement slows, enabling it to provide a form of qualitative while drilling and change into a more solid substance once drilling is complete. Up until the drill is reinserted, the cuttings are then hung in the well. The gel-like material changes back to a liquid state when drilling is restarted. By managing chemical and rock wellbore stability, drilling fluids also aid in reducing bore stress. Weighting components are found in drilling fluids, which improve fluid flow while simultaneously increasing pressure on the good walls. Hydrocarbons also have an essential feature called rock stability. To prevent the drilling mud from being evacuated by the well's rock formation while simultaneously preventing the holes from being plugged, certain additives are employed. A greater drill pipe is used when a well is dug deeper. Due to the weight of the heavy drill pipe, drilling mud improves stability and reduces stress. Drilling mud also greatly lowers the temperature by lowering friction only with the rock formation. Greasing and freezing a drillbit both increase its lifespan.

System for Drilling Fluid

In drilling fluid systems, there is a continuous working fluid stage as well as an intermittent particulate stage. These sometimes get vaporised, either as a result of building work or spontaneous produce vapour entrainment. Drilling mud may be divided into three categories using continuous phases: gaseous, aqueous, and non-aqueous substances. Each of the semisolid particles that make up these compounds may be used to alter the viscosity or density of the drilling fluid.

Aqueous drilling fluids, sometimes known as "drilling fluids," are among the three types of drilling fluids that are most prevalent and diverse. These drilling fluid systems may range from basic inhibitive, or silt stabilised, systems with a few components to complicated inhibitive, or water mixed silt, systems. To defeat non-aqueous fluids, which are routinely utilised in challenging pumping settings, scientists and engineers have been working hard over the last several decades to improve both the thermal and inhibitive efficiency of water solutions. The continuous phase of non-aqueous drilling fluids, sometimes referred to as synthetic-base muds, contains a variety of substances, including mineral oils, recyclable esters, olefins, and others. These systems have greater subsurface control, barrier properties, lubricity, and penetration rates than aqueous drilling fluids, which may help the operator save money in the long run. In fractured rock or situations where the borehole cannot retain a column of water without significant fluid loss to the formation, drillers use air, mist, or foam systems to help remove trimmings from the hole and maintain wellbore integrity.

Drilling fluids' purposes

Thixotropic drilling fluids are perhaps the most common kind of viscosity increase during static conditions. When the fluid is not flowing, the aforementioned appropriately completed those stationary cuts, mostly for maintenance. Drilling operations appear to benefit greatly from fluids with considerable shear weakening and varied densities. Cutting effectiveness is improved by increasing annulus speed. It is advised to keep the transfer rate carrying speed and minimum annular speed at a suitable half. Highly dense fluids may effectively clean pores even at a slow annulus speed (by increasing the buoyancy force acting on cuttings). However, mud weight has a negative effect if it exceeds the amount required to equalise this pressure with nearby rock formation pressure. For this reason, the soil moisture content is often raised for an appropriate well wash.

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CHAPTER - 3

RELEASE AND SUSPEND CLIPPINGS

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In a variety of circumstances, substances, weight materials, and additives should be hung. Drill cuttings that settle have the potential to build dams, fill them, obstruct pipelines, and impede flow. Sag is the progressive sinking of weight material, which causes a considerable fluctuation in density, mostly affecting well fluids. This is more common in hot wells and bigger angles. Drilling debris should be eliminated from fluid during the well's first rotation to guarantee effective sediment management. Cuttings become more difficult to get rid of when they are cycled over and again. Compare the sand content in the clay, primarily in the pipeline system and in the suction pits to determine whether cuttings are being removed [1]–[3].

Regulate the Formation of Pressure

When formation pressure rises, mud thickness may also increase to control pressure and maintain borehole stability. Barite represents one of the most often used weighing components. A kick, or sudden rush of formation fluids into the borehole due to unbalanced formation pressures, might result in a blowout through compressed formation fluids. Gravitational acceleration is accelerated by drilling fluid density time's real vertical depth. Atmospheric pressure and hydrostatic pressure are equivalent.

Fluids from the formation will never enter the borehole when hydrostatic pressure is greater than or equal to the formation pressure. Well, control describes the unrestricted flow of formation fluid into a wellbore. Although development fluid pressure is equal, hydrostatic pressure controls the weights imposed by earthquakes and volcanoes, which may potentially cause wellbores to become unstable. If the formation pressure is too low for whatever reason, you should utilise oxygen, mist, fog, stiff foam, or low-density mud (oil base).

Structures that Can Be Sealed

Mud filtrate infiltrates into the formation and forms a filter cake of mud on the bottom of the borehole if mud chamber pressure raises formation pressure. Mud forms a thin, moderate filter cake that is largely on the surface to deter attackers. When a thick filter cake forms, it results in formation damage, tight hole circumstances, poor log quality, clogged pipelines, and delayed flow.

Depending on the size of the mud particles, whole mud may penetrate very porous strata with large bore mouths; use bridging agents to cover up large holes before adding mud particles. Bridging chemicals must be at least one-half the size of such pore gaps or fractures to be useful [4]–[6]. Calcium carbonate, cellulose in powder form, and various binders are some examples of different bridging substances. A variety of additives, including bentonite, natural and synthetic polymers, asphalt, and gilsonite, may enhance the filter cake depending on the drilling mud.

Keep the wellbore stable.

The chemical makeup and mud properties should contribute to a stable borehole. To sustain the mechanical load, the amount of mud must stay within a predetermined range. Sloughing formations, which may result in tight hole circumstances, bridges, and fill on excursions, are an indication of wellbore instability same symptoms indicate hole cleaning problems. When a borehole is stable, its size and form remain consistent. A bigger hole weakens and becomes more unstable, leading to issues including low annulus velocities, inadequate hole washing, fragment loading, and subpar formation assessment. To lessen mud/shale interactions, chemical inhibitors excellent for water-sensitive deposits might be utilised, such as calcium, magnesium, salt, polymerization, asphalt, glycols, and oil [7], [8]. Emulsified brine phase calcium chloride drilling fluids are used to reduce moisture content and create osmotic pressures, which inhibit water adsorption in shale formations.

Reduction of Formation Damage

Formation damage refers to any reduction in the porosity and permeability of a natural formation (washout). When residuals build up on holes and induce a reduction in pressure through them, skin injury results.

- The most frequent locations for damage are as follows:
- Drill mud or solids penetrate the formation matrix, irritating the skin and decreasing porosity.
- Less permeability as a result of the reservoir's formation of clays swelling.
- Insoluble salts precipitate when formation fluids and mud filtrate are combined.
- A mud filtrate and formation fluid-produced emulsion lower the reservoir's porosity.
- Careful consideration has gone into the design of drilling fluids, work-over fluids, and finishing fluids to minimise formation damage.

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CHAPTER - 4

SUPPORT, COOL, AND LUBRICATE THE BIT AND DRILLING ASSEMBLY

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When the drill string revolves and rubs even against the casing and borehole, mechanical and hydraulic forces produce heat. Reduce the heat source and keep the temperature below the bottom of the hole. If this weren't the case, drill bits, boring strings, and mud engines would typically wear out sooner. The friction coefficient is used to provide lubrication. "Coefficient of friction" is the term used to describe the degree of resistance on the wellbore portion and the collar or pneumatic cylinder size required to free stuck pipe. Water-based mud lubricates more effectively than oil- or synthetic-based mud but the latter can be improved by the addition of lubricants. The amount of lubricating drilling fluid provided depends on the kind, weight, and density of drill cuttings as well as on the chemical makeup of the system [1]–[3].

Proper lubrication reduces heat measurement of the drill string and increases torque and drag, although these issues may also be brought on by improper key seating improper bottom hole installation design and insufficient hole washing. A portion of the buoyancy of the drill string but rather casing is also included in drilling fluids. Derrick hook loads should be suspended in drilling fluid with a force equivalent to the density and weight of the mud. The maximum weight that a derrick can sustain is determined by its mechanical strength; as depth increases, so does the pressure of the drill string and casing. When using lengthy, heavyweight thread or casing, buoyancy may be used to transport strings made of casing that are stronger than the rig's hook load limit.

Transmit Hydraulic Power to the Bit and Tools

Hydraulic energy powers the MWD and LWD (measurement and logging while drilling) equipment as well as the mud engine, which rotates the bit. Hydraulic programmes enhance jet impact at the bottom well by designing bit nozzles for current mud pump horsepower restricted to:

- Increase power,
- Reduce pressure loss in the drill string,
- Apply the highest possible surface pressure,
- Increase flow rate,
- Fluids with higher densities, plastic viscosities, and particles result in increased drilling string pressure losses.

Polymer fluids and other drilling fluids with fewer particulate and less shear thinning are better at carrying hydraulic energy. Managing mud characteristics might enable you to get farther. Pressure pulses are used to transmit data from MWD and LWD to the surface.

Ensure proper formation assessment

The evaluation of a formation is impacted by the physical, chemical, and borehole conditions that exist after drilling. Mud loggers look for a variety of things in cuttings, including mineral content, visible signs of hydrocarbons, rock characteristics, ROP, gas detection, and geological features. Several methods, including wiring, acoustic, nuclear, and magnetic resonance, are used in wireline logging. The potential producing zone is the topic of drill stem and formation analysis. Mud helps mud loggers in identifying the depth of the cuts by preventing cuttings from dispersing and boosting cutting transit. Bitumen, lubricating lubricants, and soil with an oil content will all mask hydrocarbon signs. As a result, the sort of assessment to be performed determines which drilling core is chosen many coring operations specify a blend mud with minimum of additives.

Control Corrosion

If the drill string and casing are regularly exposed to drilling fluid, corrosion might happen. Dissolved gases increase the corrosion of oxygen, carbon dioxide, and hydrogen sulphide. In a short period, bring about a catastrophic collapse. Probably, it won't take long for people to die from it. Use corrosion coupons to keep track of the kind, pace, and amount of chemical inhibitors used as low pH (acidic) makes corroded worse [4], [5]. A corrosion discount is a little piece of metal that has been subjected to corrosive conditions to see how it affects machines with comparable compositions. In a relatively short period, corrosion issues are brought on by mud aeration, foaming, and other O_2-trapped circumstances. Sulphide scavenging chemicals and higher pH fluids were employed during drilling in high H_2S settings (zinc).

Help With Cementing and Finishing

For a zone and a well to be completed, cementing is necessary. To avoid fracture-induced lost circulation, the mud must stay fluid during the casing run, and pressure rises must be kept to a minimum. The cementing fluid's temperature is within the cementers' tolerance, which is often 70 degrees, particularly in cold areas. All of these desired qualities in mud include a thin, homogeneous filter cake with few impurities, a wellbore with minimal cuts, and no caves or bridging to hinder a good casing run to the bottom. Circulate until there are no more impediments in the bore. Mud is removed by flushes as well as cement to properly cement and complete the procedure. To be effective, we try to guarantee:

- When drilling close to gauges, clean the holes properly by pushing sweeps at TD and wiping trips to the shoe.

Low viscosity mud, mud characteristics that are tolerant of the drilling fluid composition and the deposits being drilled, turbulent flow with constant viscosity and high pump rate, pipe flow with high viscosity and high pump rate, low viscosity mud and low pump rate, and mud whose gel strength does not change over time are all desirable.

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CHAPTER - 5

MINIMISE ENVIRONMENTAL EFFECT

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Mud may be dangerous in several different ways. Additionally, getting rid of garbage in an eco-friendly way is complicated and costly. The biggest oil field in Ecuador, Lago Agrio, has almost unregulated drilling operations, according to Vanity Fair. Water, bentonite, and barite, all clay products of mining operations, are the three main components of water-based drilling fluid, which is often found in Colorado and Telemark. Hydrochloric acid, for instance, is caustic and hazardous when used alone with surface drilling fluids. Hydrochloric acid simply brings down the pH of water-based drilling fluids to a more tolerable level. The most frequently used ingredients in surface drilling fluids include bitter (sodium hydroxide), desiccated lime, soda ash, metakaolin, barite, and polymers.

A. Benzene and other compounds are present in substantial quantities in synthetic drilling fluids and oil base mud.
B. The compounds used most often in OBM Muds.
C. Barite, bentonite, diesel, emulsifiers, and water are just a few examples.

Elements that affect drilling fluids

Several factors may affect the performance of drilling fluids, such as: a) fluid rheology; b) drilling fluid viscosity; c) drilling fluid density; d) mud pH; e) drill string corrosion or fatigue; f) drilling fluid thermal stability; and g) differential sticking.

The life cycle of drilling fluid

Surface and downhole factors drive iterative drilling fluid design and maintenance processes. These circumstances vary when the well is drilled further into the formation and experiences consecutive increases in temperature and pressure in addition to chemical changes brought on by various kinds of rock and formation fluids. To adjust the drilling fluid in reaction to shifting borehole circumstances, on-site fluid experts and staff engineers utilise continuous process engineering. After analysing fluid performance, they then modify fluid parameters repeatedly [1]–[3].

First conception Fluid experts choose the kind and layout of the mud system for each drill segment during the planning stage. The systems are made to satisfy a variety of needs, such as those related to logistics, density, borehole stability, temperature gradients, and environmental issues. A simple fluid system may be used to start drilling. When drilling to the first casing point, water is often employed. Higher mechanical wellbore control and hole cleaning capability are required as the borehole deepen due to increased formation pressure, rising temperatures, and more complicated formations. Simple fluid systems are capable of being replaced or transformed into lightweight water-base inhibitive mud, which is then followed at further depths by non-aqueous drilling fluids.

Circulation: Over time, the drilling fluid's chemical makeup varies. The fluid wastes energy in a single cycle of circulation by raising cuttings, chilling the bit and hole, and then depositing waste to the surface. The system must be regularly assessed by engineers and fluid experts, who must also replenish it with new fluids and additives [4]–[6].

Evaluation and redesign of the mud that has been returned are evaluated by a drilling fluids expert. A few of the variables analysed include density, surface tension, filtration rate, interfacial tension content and ratios, solids content and categorization, and they vary depending on the fluid type. Measurements are made of the pH, hardness, alkalinity, hydroxide, acid vapour pressure, and other fluid-specific characteristics. The doctor will next come up with a 12- to the 24-hour treatment schedule. To adjust the mud as necessary for the hole and drilling circumstances, the driller, derrickman, and fluids expert keep a close eye on the conditions of the borehole and the characteristics of the returning fluid.

Classification of drilling fluid

These materials are divided into several categories based on their fluid phase, alkalinity, dispersing, and chemical composition.

Dispersed system

Colloid-treated organic mud. For instance, alkaline tannate-treated muds have a pH level exceeding 9.5. Four different kinds of water-based drilling muds high pH lime mud, low pH plasterboard mud, seawater, and saturated salt water muds resist clay hydration and dispersion.

Non-dispersed system

- Low Solids Mud: Low solids mud weighs less than 9.5 pounds per gallon and has a solids percentage of 3-6% by volume. These muds mostly consist of water, with varying amounts of hydroxide and a polymer.
- Emulsions are employed. There are two forms of emulsions: water in oil and oil in water also known as oil emulsion muds invert oil emulsion muds.
- Oil-Based Muds: In oil-based muds, oil is the continuous phase, and water is a hazard rather than a design element. Typically, they have less than 5% water (by volume). Although they may also be formed from crude oil and mud, asphalt and diesel fuel are often used in the production of oil-based mud.

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CHAPTER - 6

CONTROLLING DRILLING FLUID

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Each well faces a different set of difficulties. Possible problem areas include the kind of rock in the formation, well-pressure gradients, and impurities that alter the fluid. The drilling programme is customised by the mud engineer for each well to extract the petroleum as cheaply and effectively as feasible while ensuring formation pressure management. Unfortunately, the mud engineer runs into issues when trying to attain the greatest moment for all of the tasks that a drilling fluid must fulfill. For instance, weighing mud to encourage the best cuttings conveyance puts the deposit in danger of fracture. The advantages and disadvantages of switching a drilling fluid are continually being considered by drilling professionals [1]–[3].

In-Shale Formation Drilling

Shale is a porous rock yet has a limited permeability. However, the pore spaces often include salt water as well as other liquids like hydrocarbons. Connate water, which was present in the formation when it formed, is what makes the salt water. Hydrocarbons may sometimes be found in impermeable shale. For instance, vast amounts of shale in the western United States contain compounds that can't be exploited by drilling. When the time is right, these deposits will then be mined or used in some way. In any case, the fluid must be treated very carefully when shale that contains salt water is exposed to it via a wellbore.

Testing of drilling fluids using a water base

The derrick hand checks the mud on land drilling rigs for weight, viscosity, temperature variations, adjustments in cutting size, the volume of water, and mud concentration in the tanks. An expert in mud engineering conducts more thorough testing. The derrick hand typically checks the mud's density, viscosity, gel strength, membrane processes and wall-building capabilities, and sand content. The pH, liquid and solid contents, pollutants, and electrolytic characteristics of the mud may all be examined by the mud engineer. Mud that passes an electromotive speeds up the corrosion of the metal parts in the hole. Somebody tests your mud and also records the findings in a mud diary [2], [4], [5].

Making ready mud sample

Most studies mimic part or all of the good conditions because the samples must accurately and meaningfully represent the mud downhole to produce accurate and meaningful mud test findings. For instance, some tests need for the mud to be stirred up or otherwise agitated to mimic circulation, while others demand that the temperature of the mud sample be quite near to that of the borehole.

Drilling fluid treatment

To determine if and when the mud has to be treated, the crew and mud engineer test the mud. The weight or composition of the drilling mud may need to be changed depending on the drilling circumstances.

In many drilling operations, switching mud chemistry from one kind to another is crucial. The precise name for such a shift is a conversion, which is sometimes referred to as a breaker. Breakover is the moment at which the mud's characteristics change. Breakers between different types of mud often entail a major alteration in the chemistry of the mud as well as large "viscosity humps." Salt may be added to a conventional bentonite-based mud system to produce a salt-saturated mud system. The viscosity will increase noticeably and reach incredibly high levels as you add salt, but ultimately you will hit a break-over point when the viscosity will start to decrease as you continue to add salt. You are changing the mud system that you are using.

There are several reasons why breakers are performed, including the following:

- Maintaining a stable wellbore, providing mud that can support more weight, drilling salt formations, and reducing clogging in the producing zones are all examples of good drilling practices.
- Due to the often encountered high viscosities, breaking over mud in an open hole might be risky in certain circumstances. A breaker is often carried out in a cased hole before drilling the next hole section.

Selection of drilling fluid for a formation

Drilling fluid rheology affects how well it drills. The effectiveness or performance of a drilling fluid is determined by how well it completes its task. The primary function of the drilling fluid is to drain formation cuttings from the well. The cuttings should be carried and suspended in the recommended fluid while in circulation, and they should be safely transferred through the annulus with the least amount of loss and environmental damage possible.

The mud engineer chooses the necessary viscosity, density, fluid loss control, chemical composition, and many other components of the fluid during the selection and formulation phase. The kind of drilling fluid used depends on several critical aspects, including cost, functionality, and environmental influence on the formation. The success of the drilling operation depends on the choice of the best-fitting kind. In recent years, scientists have concentrated their efforts on creating a biodegradable alkyd that would lower disposal costs while also having a less negative environmental effect.

Drilling fluid is the waste products that are expelled from the body via the blood vessels, the fluid pump is the heart, and the kidney and lungs are the mud-cleaning systems. Drilling operations are anticipated to cover between 50 and 80 percent of exploration expenditures and between 30 and 70 percent of other field development expenses in the oil exploration and extraction sector.

Particles floating in water or oil are referred to as drilling fluids, and they might include additives to improve their performance.

The following are the main functions of drilling fluids:

- Move cuttings up the annulus and separate them at the surface by carrying them from below the bit.
- Make a thin, low-permeable filter cake to cover pores and other openings in bit-penetrated formations to reduce friction between the drilling string and the hole's side,

maintain the stability of the borehole's uncased areas, and prevent fluid intrusion from permeable rocks penetrated. 2. Cool and clean the drilling bits.

- Assist in the gathering and analysis of information from electrical logs, drilling cores, and cuttings.

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CHAPTER - 7

THE EFFECT OF DRILLING FLUIDS ON THE ENVIRONMENT

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Muds, or specialised drilling fluids, are used to assist maintain well control and remove drill cuttings from the drill hole while drilling exploration and production oil and gas wells. The drilling industry has lately created a variety of synthetic-based fluids in response to current environmental issues throughout the world as well as stringent local and international restrictions on drilling waste disposal standards. These fluids combine the advantageous operating characteristics of drilling fluids with an oil basis with the less poisonous and less damaging to the environment characteristics of drilling fluids based on water [1]–[3].

Oil-based fluids are helpful in locations where shale swelling is a problem, but when they are released and subsequently moved into the sea, they destroy the ecology. Fish and other aquatic vegetation suffer significant damage. In the long term, this will be bad for the ecosystem. In addition, eating fish poses a risk to people since they are poisonous. Additionally, the chemicals released during onshore drilling may have a substantial effect on soil quality, altering the chemical composition of the soil and, thus, altering the habitat of humans and animals. Cuttings from fluids with an oil basis spread less readily underwater than cuttings from fluids with a water base. Parts of the seafloor will be covered by cutting piles that will be built. Around the rig, this situation can affect animals that live on the bottom [4]–[6].

A new kind of drilling mud that is particularly helpful for drilling in deep water and deviated holes is synthetic-based drilling fluid. They are a cutting-edge material type that may be utilised to effectively and safely drill oil and gas wells. Their improved drilling efficiency reduces drilling time in half and, in certain situations, beats diesel oil fluids in terms of environmental protection, safety, and public health. They were created as a more sustainable substitute for drilling fluids that are based on oil.

The fundamental characteristics of a material may corrode and disappear due to chemical, electrochemistry, and other processes between the exposed surface and the environment. Corrosion is a consequence of increased air contact on the surfaces of both metals and nonmetals. This interaction has an impact on the buildings and infrastructure made of various materials. Even moist, oxygen-rich ambient air may initiate the rusting process on steel surfaces.

Corrosion is the electrochemical oxidation of a metal when it occurs in the presence of an oxidant like oxygen, hydrogen, or hydroxide. One well-known instance of electrochemical corrosion is rusting, in which iron oxides develop. The development of oxides or solutions of the workpiece as a consequence of this kind of corrosion is what gives the material its unique orange colour. Although other materials like ceramics or polymers may also experience corrosion, the word "degradation" is more often used in this context. The strength, resilience, and transparency of both materials and structures to liquids and vapours are all impacted by corrosion [7]–[9].

Drilling fluid corrosion

The integrity of steel base installations, oil and gas pipelines, and other infrastructure is increasingly at risk from corrosion, which might result in both monetary losses and international pollution. Pipelines, platforms, vessels (such as storage tanks), drill pipes, and well casings are examples of this sort of infrastructure. Environmental hazards include pollution, spills, flora/fauna damage, fire breakouts, and fatalities, while economic losses included absenteeism, productivity losses, taint, and equipment failures. The petroleum industry, particularly the drilling sector, makes extensive use of drilling mud. Granules and chemicals stuck in either of these fluids, as well as solid components floating in water or oil, make up drilling mud. These compounds are composed of clays and organic colloids.

There are three kinds of drilling mud: water-based, oil-based, and gas-based. To create water base mud, solid particles are retained in fresh or salt water. As a consequence, we obtain both fresh and saltwater mud depending on the kind of water. Oil is the only ingredient of oil base mud, a coring fluid. Oil base mud soaks from the deposit, therefore no extra water or brine is provided. Oil base mud systems are unique drilling muds that were created to overcome some of the drawbacks of water base mud, mainly due to water's capacity to dissolve salts, obstruct the movement of oil and gas thru all the rock layers, encourage clay, implosion, and dispersion, and result in steel corrosion. Drilling mud is used to support the wellhead walls, control pressure, stabilise the wellbore, transport, lift, and drop off cuttings, and lubricate the drill string to reduce friction.

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CHAPTER - 8
SYSTEMS FOR DRILLING FLUIDS

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Every fluid that is circulated in the hollow to help with the execution of a productive drilling operation that produces a stable and gauged borehole to the target depth with the least amount of harm to promising formations as is practicable is known as drilling fluid. Drilling fluids serve a variety of purposes, including regulating formation pressures, extracting cuttings from the wellbore, sealing permeable structure commonly faced during drilling, lubricating and cooling the bit, transferring hydraulic pressure to downhole methods and the bit, and, perhaps most importantly, preserving wellbore stability and well control. Mud sometimes referred to as drilling fluid, was first created in 1913 to control ground pressure [1]–[3].

Depending on wellbore requirements, rig capacities, and environmental considerations, drilling fluid composition varies. Drilling fluids are made to enhance the effect of machining parameters including the market share and hole cleaning as well as to control subsurface pressures, decrease formation damage, lower the danger of lost circulation, avoid borehole erosion, and minimise formation damage. Furthermore, drilling fluid systems are required to help with entire cleaning and stability difficulties specific to these wells since many current wellbores significantly deviate.

Systems for Drilling Fluids

There are two phases in drilling fluid systems: a continuous liquid phase and a fragmentary solids phase. They sometimes include a gas phase, either on purpose or as a consequence of formation gas entrainment. Using the continuous phase, drilling fluid types may be categorised as gas, aqueous solutions, or non-aqueous systems. Each of the liquid and solid components that make up these fluids is intended to alter a particular characteristic of the drilling fluid, also including viscosity or density [4], [5].

Drilling Mud Types

The creation of different drilling fluids has been prompted by the challenges faced during oil exploration in the petroleum sector. According to their continuous phase, drilling muds are divided into the following categories:

Muds with a Water Base (WBM) It is also referred to as hydrodynamic drilling fluid and contains a mixture of dissolved substances, with fresh water constituting the continuous phase, in amounts ranging from 90 to 95 percent. Due to both its environmental friendliness and the fact that it is very affordable to run, it is frequently used in the industry. WBM drilling mud will be the kind that this project focuses on and uses.

Dispersed Muds: These muds are often used in challenging whole conditions or at deeper depths when larger densities are needed when extra treatments are required. To give the mud system certain properties, specified additives would be dispersed throughout it, such as thinners or dispersants. Muds that are not dispersed are often employed in shallow aquifers or top whole regions. Clear or native water may be found, for example, in spud muds, natural muds, and other poorly treated systems. Drilled solids and clay particles don't need to be spread out using thinners or dispersants; instead, water is allowed to interact with formations that include shales and clays, causing the mud to spontaneously develop a solids content and density.

A seawater system with a chloride content of 10,000 to 190,000 mg/l or a saturated salt system with a chloride concentration of around 190,000 mg/l is suitable for salt formation drilling to prevent dissolving.

Polymer Muds: By serving as encapsulating agents for drilled materials, long-chain polymers like cellulose and acrylamide are used in mud systems to improve viscosity, minimise fluid loss, restrict dispersion, and inhibit or prevent shale sloughing via coating. For instance, inhibited salts like KCl/NaCl muds keep shale formations in place.

Low solids Mud: It is a kind of mud that is often used to reduce or increase penetration rates. These are tightly controlled solid systems, with a clay percentage of no more than 3% and the volume of a total solid ranging from 6 to 10%. They are non-dispersed and often utilise viscosifiers made of polymer additives.

Calcium Muds: The inclusion of calcium or magnesium in freshwater drilling muds inhibits the swelling and hydration of clays and shales, whereas higher concentrations of dissolved calcium significantly limit shale sloughing and whole growth. Muds that have been treated with calcium are anti-contamination and perfect for drilling gypsum/anhydrite lithologies. However, at high temperatures, they are prone to gelling and hardening.

Oil Base Muds (OBM): These muds contain oil as their continuous phase, often diesel oil, mineral oil, or low toxicity mineral oil, and even though they may absorb formation water, no more water or brine is added to them. Because they contain substances that emulsify water. This technology, which uses less than 5% water than WBM, has several benefits but also some serious drawbacks.

Emulsion Muds: In these muds, oil makes up the dispersed phase, which normally varies from 5 to 10%, while water is the major continuous phase. Environmental problems and expenses are minimised when water serves as the primary phase, but the addition of oil offers the advantages of oil-based systems, such as enhanced lubrication, an accelerated rate of penetration, less torque and drag effects, and lower filter loss.

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CHAPTER - 9

DRILLING FLUIDS' FUNCTIONS

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These water-in-oil emulsions have an emulsifier phase that contains up to 50% brine and a continuous phase of base oil or fuel. They are used in 10–20% of all drilling operations and are particularly beneficial in inclined boreholes and stable, water-sensitive rocks. They have good thermal stability and excellent corrosion resistance. They do, however, have several disadvantages, such as a high cost, a high risk of drilling into gas sources, and substantial environmental problems. An example of an emulsifier used in these systems is calcium chloride brine [1]–[3].

Muds with synthetic bases in response to a rising need to reduce the environmental impact of offshore drilling operations while retaining the economic viability of oil-based systems, synthetic-base muds were developed. Many of the performance advantages of hydrocarbon oil systems are also provided by them (synthetic and mineral oils) but without the environmental dangers. SBMs, like OBMs, may be utilised to improve lubrication in directional and horizontal wells, increase penetration rate, and lessen wellbore stability problems brought on by reactive shales. Synthetic mud systems include, for instance, esters, ethers, and polymerized or isomerized alpha olefins. These base fluids perform well in terms of the environment due to their high biodegradability and low toxicity. Drilling fluids are designed to perform a variety of tasks. Key performance traits include the following, even if the list is extensive and diverse:

Management of Formation Pressures

A well needs drilling fluid to stay under control. The mud is poured up the annulus, past the bit, and down the drill string. The hydrostatic pressure of the mud column is used in an open hole to offset increases in formation pressure that would otherwise push formation fluids into the borehole and perhaps result in well control loss. However, the pressure of the drilling fluid must not be greater than the pressure at which the rock fractures; otherwise, the mud would escape into the formation and cause a condition known as lost circulation [4]–[6].

Cuttings Removing From the Borehole

Circulating drilling fluid moves cuttings (rock fragments produced by the bit) out of the borehole and up to the surface. To successfully drill and prevent stopped pipes, it's essential to maintain the fluid's carrying capacity, or its capability to convey these heavy bits up the hole. Drilling fluid experts collaborate with the driller to balance mud rheology and flow rate to change carrying capacity and prevent high equivalent circulating density (ECD), which is the sum of the mud density and the pressure drop in the annulus above a certain place in the borehole. If high ECD is not treated, circulation may be lost.

Hydraulic Energy Transfer to the Bit and Downhole Tools

As drilling fluid moves through and around the revolving drilling assembly, it cools and lubricates the bit. The heat energy is absorbed by the drilling fluid, which then transports it to the surface. In very hot drilling conditions, heat exchangers may be used near the surface to cool the drilling mud. Hydraulic energy is transmitted to the bit and downhole equipment by the discharge of drilling fluid through nozzles at the bit's face. The hydraulic force exerted against the rock causes cuttings to become loose and rise away from it. This energy is also used to operate downhole motors and other hardware that guide the bit and continuously collect drilling or formation data. Mud pulse telemetry, a technique that transmits data to the surface by delivering pressure pulses down the mud column, is often used to transmit data acquired downhole to the surface.

Wellbore Stability Maintenance

Among other things, maintaining wellbore stability requires modifying density, preventing hydraulic erosion, and managing clays. To keep the density constant, the mud column's weight is only slightly overbalanced against the pore pressure of the formation. To minimise hydraulic erosion, engineers balance hole form against cleaning needs, fluid carrying capacity, and annular flow velocity. Controlling clay is a challenging task. Some clay constructions expand in the presence of water, whereas others spread out. A portion of these impacts may be controlled by altering the drilling fluid's properties. Regardless of the technique used, reducing the fluid's impact on the formation helps to retain cuttings integrity, regulate the borehole, and provide a cleaner, easier-to-manage drilling fluid. In fractured rock or other situations when the borehole cannot support a column of water without suffering considerable fluid loss to the formation, drillers use air, mist, or foam systems to assist remove cuttings from the hole and preserve wellbore integrity.

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CHAPTER - 10

MUD FOR DRILLING: RHEOLOGY

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The study of fluid deformation and material flow is known as rheology. Its importance is recognised in the investigation of fluid flow velocity profiles, fluid viscosity such as plastic, apparent, and marsh funnel viscosity, friction pressure depletion, and annular borehole cleaning. The effectiveness of the mud system and all wellbore hydraulics studies are evaluated using rheological metrics. Additionally, the drilling mud's yield point and gel strength are rheological factors. Rheological properties such as density, viscosity, and gel strength are monitored at various stages of the drilling process. Controlling and conserving rheological properties is essential since refusal to do so may lead to time and money losses, as well as, in severe cases, the cancellation of well. During the drilling procedure, in addition to rheological testing, filtration tests, pH, chemical analysis (alkalinity and lime content, chloride, calcium, etc.), and resistivity are all performed.

Viscosity: A hand crank viscometer is the most common piece of field equipment used to assess mud rheological properties. In a viscometer, mud is sheared at a constant pace between someone's inner bobbed and an outside rotating sleeve. With the use of this device, mud properties such as mechanical velocity, yield point or yield stress, and 10-second to 10-minute gel strengths may be measured numerically. This machine has six speeds that may be selected (600, 300, 200, 100, 6, and 3 rpm). The rotor and bob dimensions are designed at a rotor speed of 300 rpm such that the dial reading is equal to the seeming Newtonian resistance [1]–[3].

Plastic Viscosity (PV): Using two readings from Fann metres, the plastic viscosity is determined (600 and 300 rpm). The low plastic viscosity is preferred because the dispersion of the mud close to the bit speeds up the drilling operation. High values are a sign of too many particulates or a viscous base fluid. By dilution, we can lower the value of rheological properties (Negm et al. 2014). Where 600 and 300 represent the viscometer's reading at 600 and 300 revolutions per minute, respectively. PV = 600 300 centipoises

AV, or apparent viscosity

A fluid's viscosity is assessed at a set temperature and shear rate. It is necessary to specify or define the shear rate for a viscosity measurement to be useful. It is a rheological parameter calculated from drilling fluid viscometer observations made by a mud engineer. The usual abbreviation is AV. The mud engineer uses these calculations and tests to create and keep the drilling fluid's properties within the required parameters. The gel strength in lb./100 ft2 is calculated from the maximum dial deflection when the spinning viscometer is operated at low engine speed (i.e. 3 rpm) after the mud has remained static for a while, often 10 seconds or 10 minutes.

AV = 1/2 600 (in centipoises)

YP, or yield point:

The term "yield point" describes the tension needed to start a fluid movement or the fluids' first resistance to flowing. In comparison to a fluid with the same density but a lower yield point, drilling mud with a greater yield point has superior cuttings carrying capacity. Where PV is for plastic viscosity in centipoise and AV represents apparent viscosity. The mineral content, their electrostatic attraction, and the surface properties of the mud all have an impact on the actual yield point (YP) [4]–[6].

Gel Hardness:

The minimum shear stress required to transport mud is measured by the gel strength. The cuttings were kept suspended thanks in large part to the gel's durability. In addition to other problems, excessive gel strength may cause blocked pipes.

Loss of Fluid

Fluid loss avoidance is a crucial part of drilling fluid performance. Drilling fluid properties, such as thickness and rheology, may alter irreversibly when a significant size of water or fluid from a rain liquid phase is lost in the formation. This can cause borehole instability. A common procedure for analysing drilling fluids is used in the laboratory to assess the control of fluid loss.

This is the process through which the liquid phase of both a drilling fluid, slurry, and treatment fluid introduces solid particles into the formation matrix. Both the resulting filter cake or solid material buildup and the filtrate's penetration of the formation may be undesirable. The permeability is seriously threatened by the liquid loss to reservoir formation.

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CHAPTER - 11

FILTRATE LOSSES

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Filtrate losses in wet formations, which leave dense particles in the mud in the crack, are the main mechanism. The main drawback of water-based drilling is that they react with clays and result in time-dependent borehole issues. In shale, the hole often becomes bigger over time. Fluid loss control is the act or method of controlling usually reducing the amount of filtrate that passes through a filter media. There are many techniques to regulate fluid loss for mud, one of which is by adding fluid loss-control components to the filter media. To enhance the performance of the materials already present, another approach is to change the chemistry of the mud. Usually, adding clay de-flocculants to freshwater mud improves fluid loss management. The oil and gas sector now uses fluid loss controllers such as polyacrylamide, polyethene amines, carboxymethyl hydroxyethyl cellulose (CMHEC), and hydroxyethyl cellulose (HEC), as well as LV-PAC and CMC.

Operators can maintain capillary pressure and overall drilling speed while cutting down on their HSE footprint thanks to fluid loss control additives, which are adapted to specific applications. There are several additives for fluid loss on the market. There are many classes of fluid loss control additives, including LGT, MGT, and HGT. These additives provide effective filtrate control in drilling fluid systems based on oil because they have low hydrocarbon solubility and low plastic flow in all grades [1]–[3].

It has become critical to focus on producing environmentally friendly drilling fluids due to the increased environmental risks associated with drilling for natural gas wells on both land and at sea, especially when an accident happens, and due to tightening environmental limitations. The goal of the present research is to examine and identify environmentally safe additives that might be added to drilling fluid to enhance both the rates of fluid loss and the rheological characteristics, which are two of the most significant elements impacting leakage and environmental contamination. Environmentally friendly fluid loss suppression additives have become essential due to environmental demands in the oil and gas sector to stop the degradation of coastal habitats and marine resources.

A key benefit of using biodegradable drilling fluids is that any leftover fluids will safely and spontaneously biodegrade to their component molecules once the water or finishing mud has been cleansed. This is only one advantage of using biodegradable fluids rather than fluids made of petroleum. Another benefit is that nanoparticle fluids outperform petroleum-based fluids in drilling operations, if not better. Second, there are many ways they might save costs on drilling operations. By allowing for quicker drilling through rock and keeping the drill bit cooler, bio-based fluids with greater lubricating properties may save drilling time. Additionally, the improved lubricity lessens the wear on drilling equipment. Additionally, hundreds of gallons of drilling fluid are used during the process, and the consequences of a leak might be devastating. Bio-based and biodegradable drilling fluids may lessen the negative effects of fluid spills and leaks on the environment. Their discharge will result in far less environmental harm and enable speedier cleanup.

The key properties of drilling fluid may be improved by combining two or more bio-products. By working together, these bio-products may successfully improve the quality of drilling fluids while also reducing costs and preventing environmental degradation [4]–[7]. The benefits of employing bioproducts in drilling fluid include their availability, similarity to commercial addictive qualities, and most importantly high cost-effectiveness.

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CHAPTER - 12

BASICS OF CONTAMINANTS

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The mud is considered to be contaminated when a foreign object enters the mud system and results in unintended changes to mud properties such as density, viscosity, and filtration. In general, water-based mud systems are the most susceptible to contamination. Contamination may result from excessive mud system treatment with additives or drilling fluid contamination. Materials that are drilled and added to a mud system are referred to as solids (bentonite, barite) (active and inert). Excess solids of any type are the contamination that causes the greatest damage to drilling fluids. They affect all mud characteristics. If they are not a necessary component of the mud mix, fine particles, micron and submicron in size, be the most detrimental to overall drilling performance and must be eliminated [1]–[3]. Drilling salt sections or formation saltwater flow introduces the ions Na+Cl- into the mud system, which results in the mud with high yield strength, significant fluid loss, and low ph. Sources of contaminated ions (CO_3, HCO_3) include drilling a CO_2 bearing deposit, thermal decomposition of organics in mud, and overtreatment with soda ash and bicarbonate. The mud has a lower pH and a higher yield due to these impurities, as well as a higher gel strength [4], [5].

- Putting a recently agitated fluid sample in an appropriate container ensures that there is sufficient free space in the cup to accommodate the displacement of the rotor and bob (approximately 100 mL). You must conduct the measurements as soon as you can after retrieving the sample since timing is crucial.
- Immersing the rotor precisely along the drawn line, then tightening the leg lock nut to keep it there.
- Rotating the crank for around 15 seconds after shifting the shift cam to the "Stir" position completely anticlockwise. Place a thermometer into the sample while it is being stirred, then note the temperature.
- Adjusting the gear to the middle 600 RPM level and turning the engine until the dial reading stabilises. The properties of the mud will determine how long it takes.
- Setting the shift cam all the way clockwise to 300 RPM and cranking the engine until the dial reading stabilises. Note the reading on the dial. To calculate the gel's strength
- Rotating the crank quickly for around 10 seconds while completely turning the shift cam anticlockwise to stir the sample.
- Detaining the fluid for 10 seconds without moving it. Turning the gel knob clockwise slowly and steadily while recording the highest dial reading before the gel splits. Making a note of this reading as "Initial Gel Strength (10-Second Gel)" in pounds per square foot
- Giving the liquid another vigorous stir for 10 seconds at high speed, followed by 10 minutes of leaving it alone. Turning the gel knob clockwise slowly and steadily while recording the highest dial reading before the gel splits recording this value as "10-Minute Gel" in pounds per square foot. Re-stirring the solution and waiting 10 minutes

before measuring the maximum dial deflection are the procedures for the 10-minute gel strength.

- Verifying the circular gauze frame is inserted properly at the base of the filter press mud chamber, checking the rubber gasket's position there, and placing Whatman No. 50 filter paper on top of the gauze frame.
- Installing a rubber gasket on top of the filter paper, aligning the mud chamber's cylindrical body's pins with the chamber's base's slots, and tightly twisting to lock the assembly in place.
- Saturating the mud chamber with mud while minimising the air gap at the top.
- Installing the mud chamber in the filter press frame, ensuring the rubber gasket is properly inserted in the mud chamber lid, and covering the mud chamber's cylindrical body.
- Locking and tightening the lid of the mud chamber by turning the screw in the filter press frame.
- Setting up a graduated measuring cylinder on the height-adjustable platform underneath the mud chamber so that filtrate may be collected from the discharge tube in the mud chamber's base.
- Replacing the CO_2 cartridge in the pressure assembly on the mud chamber's lid.
- Changing the pressure regulator to pressurise the mud chamber to 80 psi and timing the commencement.

As long as additives are not supplied in excess, some pollutants, such as cement and salt, may be kept from polluting the mud system. The qualities of the mud may be harmed by excessive additions, some of which are unexpected and unanticipated as the number of pollutants steadily increases. Therefore, any substance that when added to the mud system unfavourably alters the mud's characteristics is considered to be a source of contamination. The most prevalent kind of contamination is solid. Furthermore, the formation's rheological qualities have high values and the pace of drilling is reduced when there are too many solids coming from the formation. Some contaminants are chemical, necessitating a specific chemical treatment to return the mud's properties to their original state with a certain degree of engineering tolerance. Although it is not always possible to completely remove the contaminant(s) from the mud system, it is possible to do so with the least amount of error possible.

The objective of this study is to assess and create environmentally responsible additives that might be added to drilling fluid to enhance its rheological properties and fluid loss rate. Comparing the environmentally friendly mud to mud with industry-grade fluid loss additives, we also tried to determine how the environmentally friendly mud responded to pollutants.

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CHAPTER - 13

VISCOMETER AND HAND CRANK

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The Rheometer is a manually controlled rotating viscometer with direct indication. The spindle is driven by a hand crank that travels through a precise gearing system that is powered by the instrument. The shift cam rotates between set speeds of 300 and 600 RPM. On the shift hub, a knob controls the gel strength. During operation, fluid is kept in the annular gap between two concentric cylinders. The outer cylinder, or rotor, is turned by the hand crank. The inner cylinder, or bob, is held in position by a torsion spring. A dial connected to the compression spring displays the displacement caused by friction in the bob. The instrument constants have been adjusted to allow for the computation of plastic viscosity and yield points using the 300 and 600 RPM values.

For calculating liquid loss just with water-based liquid, the low-temperature API channel press is used. It operates at room temperature and low pressure. Simply put, the API channel press test approach involves compressing a mud sample in a chamber while estimating the amount of filtrate that passes across channel paper during a specified period. Once the device has been destroyed for cleaning, the quality and thickness of the channel cake preserved on the channel paper are also examined [1], [2].

Sieve Analysis for the API Filter Press

We can determine the size of the particles utilised in the experiment with the use of this apparatus. This is how we get particles of a consistent size. This has a micron-sized mesh inside that only enables particles of a certain grain size to pass through it, holding the rest particles back that is larger than the mesh of the trays.

Hot Air Oven

The tools are used to remove any materials' remaining moisture content. We can maintain things at the proper temperature for the needed amount of time thanks to this equipment. It is a closed container with trays that enables us to hold the things in place while giving them the necessary amount of time to dry out and remove moisture from the material. It is often employed when we don't require any moisture of any type or additional water contents that might have an impact on the experiment. With the help of this machinery, we can reduce the raw materials to their ideal grain sizes. A motor turns the blades in this piece of equipment, which also has a cover on top and within it. The blades begin revolving [3]–[6].

Food Processor

As soon as we load it with the raw materials and turn it on, breaking down the ingredients as they do so. The viscosity of the mud is produced by bentonite. Bentonite also has a colloidal solid that may aid filter cakes in newly formed muds to perform better. Since bentonite thickens with time, API bentonite is favoured because it improves mud performance. It is a cellulose ether derivative produced chemically from natural cellulose that is water-soluble. It has exceptional salt tolerance, antibacterial activity, and heat resistance. The slurry or fluid created from the product is superior at lowering fluid loss, rejecting materials, and tolerating temperature. Freshwater, saltwater, and saturated saltwater water-base mud are all favourable environments for polyanionic cellulose.

Powder for Jackfruit Peel

Around 200–500 fruits are produced yearly by mature jackfruit plants. When fully grown, each fruit weighs between 23 and 50 kilogrammes. The fruit's outer peel is mostly made up of fibre, which is somewhat high in calcium and pectin. JF peel has high levels of protein (6.27% 0.03%), carbohydrate (4%) and cellulose (27.75%).

Sugarcane Peel Powder

JPP is a fibrous substance with cellulose as its primary constituent. It is made in great numbers throughout the globe. It is a kind of waste product that is produced by the sugar industry. Although researchers have proposed that various mechanical and chemical processes may aid in the extraction of cellulosic fibres, pure cellulose, cellulose nanofibers, and cellulose nanocrystals, they are most often utilised in the paper industry. The manufacturing of composite materials and regenerated cellulosic fibers utilises a variety of these extracted components.

Compares Sodium Chloride with Sugarcane Peel Powder (NaCl)

Many different things may cause salt contamination, such as drilling salt formations, formation water intrusion, and using salty makeup water. Salt contamination may be easily identified by a spike in the filtrate's chloride content. Possible signs include a higher yield point, greater fluid loss, and maybe decreased pH and alkalinities. The density of the mud may decrease if the source of the salt is a flow of saltwater. As a consequence, we should emphasise that although freshwater mud does not include salt, salt does in saltwater mud when it is used to drill vast amounts of salt formations.

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