高等学校教材

DRILLING FLUIDS TECHNOLOGY

钻井液工艺学

杨振杰　刘志坤　张振活　编

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Petroleum Industry Press

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内 容 提 要

本书从石油工程现场应用的角度，介绍了钻井液工艺学的基本概念，钻井液工艺理论，钻井液技术设计，钻井工程日志，钻井液处理剂的使用以及钻井液现场配制、性能测试和维护管理等。选材均为钻井液的原版专著和真实的现场钻井液工程素材，词汇涵盖了钻井液工艺现场常用的基本词汇，使读者能够尽快学会用英语表达相关的钻井液技术问题。

本书可作为石油高校石油工程国际合作班钻井液工艺双语教材，也可供从事国际钻井液工程的现场工程技术人员参考。

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前　　言

随着石油需求的高速增长，我国三大石油公司（中国石油、中国石化、中国海油）大力拓展海外业务，纷纷组建国际公司，建立海外石油生产基地，广泛开展对外技术服务和国际合作。石油工业的国际化对高校提出了培养高素质国际化人才的要求。为了满足对国际化石油工程人才的培养需要，西安石油大学建立了相应的石油工程双语教材体系。本书作为石油工程双语教材体系的一部分，从现场工程应用的角度，介绍了钻井液工艺学相关的基本概念和技术方法，并通过实际的钻井液技术设计、工程日志，使学生能够形象生动地理解钻井液的工艺技术原理和方法，对钻井液工艺的理论、设计、钻井液处理剂的使用以及钻井液现场配制、性能测试和维护管理的全过程有一个比较深入的了解和认识，同时能够尽快学会用英语表达相关的钻井液技术问题。

本书选材均为钻井液的原版专著和真实的现场钻井液工程素材，词汇涵盖了钻井液工艺现场常用的基本词汇。通过两届石油工程国际合作班的教学实践，对教材内容进行完善和修改。本书除作为石油高校石油工程国际合作班钻井液工艺双语教材外，对从事国际钻井液工程的现场工程技术人员也有一定的参考价值。

本书在编写过程中得到了西安石油大学石油工程学院领导和同事们的指导和帮助，也得到了石油工程国际合作班学生的鼓励和支持，在此一并表示衷心的感谢。

限于编者水平，难免存在疏误之处，敬请广大读者不吝赐教，使本书更加完善。

编者

2010.6

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1 Drilling Fluids Conspectus

The successful completion of an oil well and its cost depend to a considerable extent on the properties of the drilling fluid. The cost of the drilling fluid itself is relatively small, but the choice of the right fluid and maintenance of the right properties while drilling profoundly influence total well costs. For example, the number of rig days required to drill to total depth depends on the rate of penetration of the bit, and on the avoidance of delays caused by caving shales, stuck drill pipe, loss of circulation etc., all of which are influenced by the properties of the drilling fluid. In addition, the drilling fluid affects formation evaluation and the subsequent productivity of the well.

It follows that the selection of a suitable drilling fluid and the day-to-day control of its properties are the concern not only of the mud engineer, but also of the drilling supervisor, the drilling foreman, and drilling, logging and production engineers. Drilling and production personnel do not need a detailed knowledge of drilling fluid, but they should understand the basic principles governing their behavior, and the relation of these principles of drilling and production performance. The object of this chapter is, therefore, to provide this knowledge as simple and briefly as possible, and to explain the technical terms so that the information provided by the mud engineer may be comprehensible. Aspiring drilling fluid specialists who have no pervious knowledge of drilling fluids should also read this chapter before going on to the more detailed knowledge of drilling fluid.

1.1 Drilling Fluid Circulating Systems and Auxiliary Equipment

Figure 1 - 1 illustrates the main components of a fluid circulating system for rotary drilling: the pump, hose and swivel, drill string, mud return line, and pits. Accessory equipment also depicted includes the standpipe, chemical tank, mixing hopper, and mud storage. Auxiliaries for mud circulation include the shale shake, agitators-mud guns and mechanical stirrers, desander, desilter, mud centrifuge, mud gas separators, mud handling equipment, and pit instruments.

The mud pump is the primary component of any fluid circulating system. The pressure provided by the mud pump forces the drilling fluid up the standpipe, through the mud hose, swivel, and kelly, and down to the bit through the drill pipe. Completing a cycle of circulation, the mud returns through the annulus to the mud pits at the surface, carrying with it the cuttings from the bit.

The mud pits are an essential part of the drilling fluid circulating system. Their main function is to accumulate mud circulated through the hole and provide a constant supply to the suction of the pump. Secondarily, the pits serve as a reservoir in which the mud stream is allowed to slow down so that the cuttings can settle out, and into which mud materials and chemicals can be added.

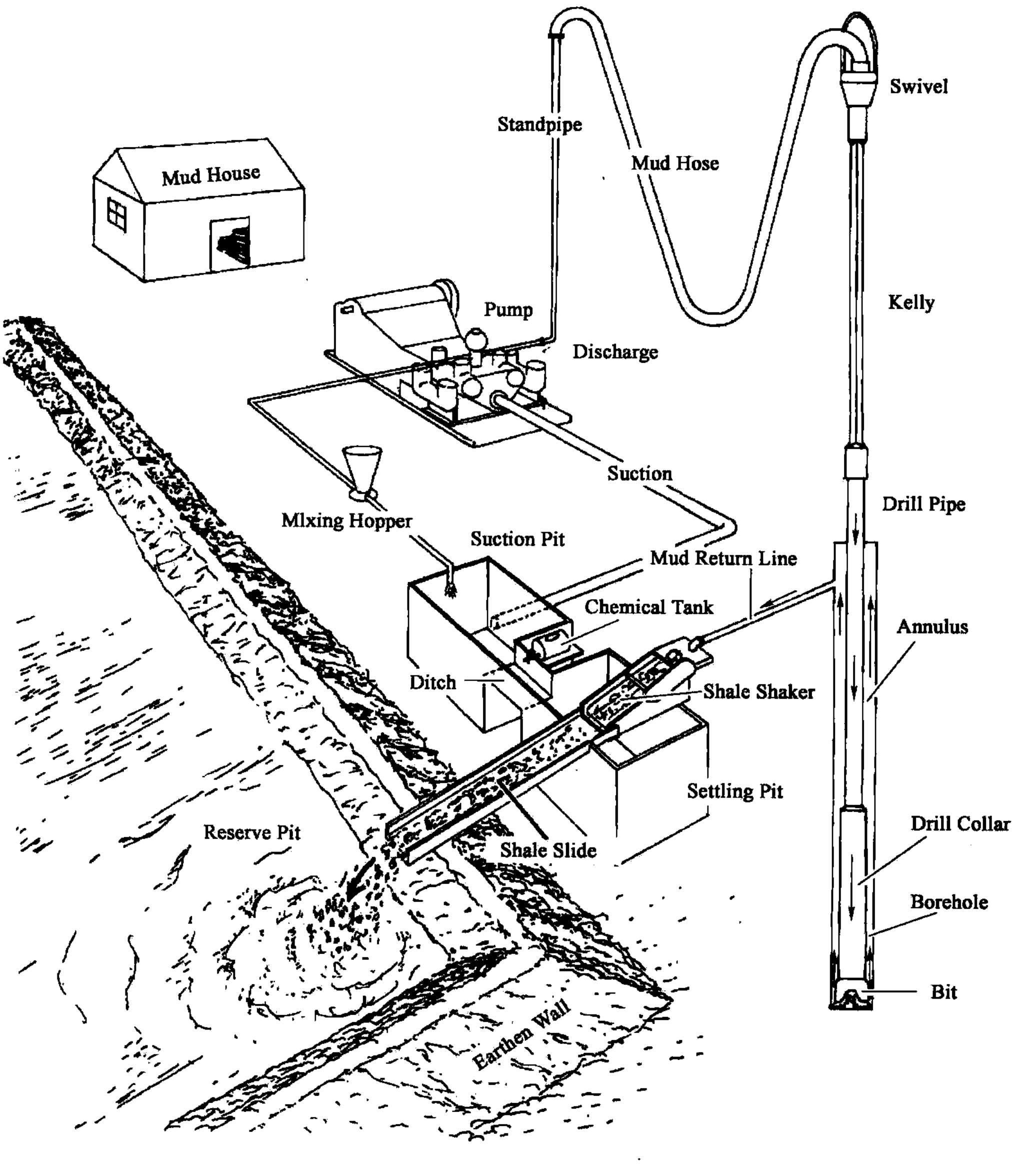

Figure 1 – 1 Drilling fluid circulating system

A standpipe in the derrick may be used to suspend the mud hose so that it is clear of the work on the rig floor. When the hose is suspended in this manner the drill string may be moved vertically nearly twice the length of the hose. A return line from the wellhead to the pit is a neater arrangement than the ditch that is often used, and becomes essential when steel pits are employed, in order to raise the fluid stream to the height of the tanks. A small tank for mixing chemicals with water and feeding them into the mud stream may be an accessory item on some rigs and a necessary one on rigs where the mud must be chemically treated. Likewise, a mud hopper for mixing dry materials with the drilling fluid becomes a requirement when weighted mud is being used. Storage facilities for protecting the dry mud and chemicals from the weather, although accessory, may be required.

Most of the auxiliaries for mud handling become essential when heavy mud is being circulated. The saving of rig time, mud materials and chemicals were made possible by using these devices more than by justifiing their cost. A shale shaker will remove nearly all of the larger particles from the fluid stream, making it possible to use smaller pits than would otherwise be needed. Mud agitators enable mud weight material to be maintained in suspension. A degasser will remove entrained gas from the mud much more quickly than allowing the mud to stand still in a pit. Desanders, desilters and mud centrifuges are useful to separate sand or fine particles from liquid mud, to salvage weight material, and for mud conditioning.

1.2 Functions of Drilling Fluids

1.2.1 Introduction

The objective of a drilling operation is to drill, evaluate and complete a well that will produce oil and/or gas efficiently. Drilling fluids perform numerous functions that help make this possible. The responsibility for performing these functions is held jointly by the mud engineer and those who direct the drilling operation. The duty of those charged with drilling the hole—including the oil company representative, drilling contractor and rig crew—is to make sure correct drilling procedures are conducted. The chief duty of the mud engineer is to assure that mud properties are correct for the specific drilling environment. The mud engineer should also recommend drilling practice changes that will help reach the drilling objectives.

1.2.2 Drilling Fluid Functions

Drilling fluid functions describe tasks which the drilling fluid is capable of performing, although some may not be essential on every well. Removing cuttings from the well and controlling formation pressures are of primary importance on every well. Though the order of importance is determined by well conditions and current operations, the most common drilling fluid functions are as follows.

1.2.2.1 Remove Cuttings from the Well

As drilled cuttings are generated by the bit, they must be removed from the well. To do so, drilling fluid is circulated down the drill string and through the bit, entraining the cuttings and carrying them up the annulus to the surface. Cuttings removal (hole cleaning) is a function of cuttings size, shape and density combined with Rate of Penetration (ROP), drill string rotation, and the viscosity, density and annular velocity of the drilling fluid.

Viscosity. The viscosity and rheological properties of drilling fluids have a significant effect on hole cleaning. Cuttings settle rapidly in low-viscosity fluids (water, for example) and are difficult to circulate out of the well. Generally, higher-viscosity fluids improve cuttings transport.

Most drilling muds are thixotropic, which means they gel under static conditions. This characteristic can suspend cuttings during pipe connections and other situations when the mud is not being circulated. Fluids that are shear-thinning and have elevated viscosities at low annular velocities have proven to be best for efficient hole cleaning.

Velocity. Generally, higher annular velocity improves cuttings removal. Yet, with thinner drilling fluids, high velocities may cause turbulent flow, which helps clean the hole but may cause other drilling or well bore problems.

The rate at which a cutting settles in a fluid is called the slip velocity. The slip velocity of a cutting is a function of its density, size and shape, and the viscosity, density and velocity of the drilling fluid. If the annular velocity of the drilling fluid is greater than the slip velocity of the cutting, the cutting will be transported to the surface.

The net velocity at which a cutting moves up the annulus is called the transport velocity. In a vertical well:

$$\text{Transport velocity} = \text{Annular velocity} - \text{slip velocity}$$

Cuttings transport in high-angle and horizontal wells is more difficult than in vertical wells. The transport velocity as defined for vertical well bores is not relevant for deviated holes, since the cuttings settle to the low side of the hole across the fluid's flow path and not in the direction opposite to the flow of drilling fluid. In horizontal wells, cuttings accumulate along the bottom side of the well bore, forming cuttings beds.

These beds restrict flow, increase torque and are difficult to remove. Two different approaches are used for the difficult hole-cleaning situations found in high-angle and horizontal well bores:

(1) The use of shear-thinning, thixotropic fluids with high Low-Shear-Rate Viscosity (LSRV) and laminar flow conditions. Examples of these fluid types are biopolymer systems, like FLO-PRO, and flocculated bentonite slurries like the Mixed Metal Hydroxide (MMH) system. Such drilling fluid systems provide a high viscosity with a relatively flat annular velocity profile, cleaning a larger portion of the well bore cross section. This approach tends to suspend cut-tings in the mud flow path and prevent cuttings from settling to the low side of the hole. With weighted muds, cuttings transport can be improved by increasing the 3 and 6 RPM Fann dial readings (indications of LSRV) to 1 to 1.5 times the hole size in inches and to use the highest possible laminar flow rate.

(2) The use of a high flow rate and thin fluid to achieve turbulent flow. Turbulent flow will provide good hole cleaning and prevent cuttings from settling while circulating, but cuttings will settle quickly when circulation is stopped. This approach works by keeping the cuttings

suspended with turbulence and high annular velocities. It works best with low-density, unweighted fluids in competent (not easily eroded) formations. The effectiveness of this technique can be limited by a number of factors, including large hole size, low pump capacity, increased depth, insufficient formation integrity, and the use of mud motors and down hole tools that restrict flow rate.

Density. High-density fluids aid hole cleaning by increasing the buoyancy forces acting on the cuttings, helping to remove them from the well. Compared to fluids of lower density, high-density fluids may clean the hole adequately even with lower annular velocities and lower rheological properties. However, mud weight in excess of what is needed to balance formation pressures has a negative impact on the drilling operation; therefore, it should never be increased for hole-cleaning purposes.

Drillstring rotation. Higher rotary speeds also aid hole cleaning by introducing a circular component to the annular flow path. This helical (spiral-or corkscrew-shaped) flow around the drillstring causes drill cuttings near the wall of the hole, where poor hole-cleaning conditions exist, to be moved back into the higher transport regions of the annulus. When possible, drillstring rotation is one of the best methods for removing cuttings beds in high-angle and horizontal wells.

1.2.2.2 Controlling Formation Pressures

As mentioned earlier, a basic drilling fluid function is to control formation pressures to ensure a safe drilling operation. Typically, as formation pressures increase, drilling fluid density is increased with barite to balance pressures and maintain well bore stability. This keeps formation fluids from flowing into the well bore and prevents pressured formation fluids from causing a blowout. The pressure exerted by the drilling fluid column while static (not circulating) is called the hydrostatic pressure and is a function of the density (mud weight) and True Vertical Depth (TVD) of the well. If the hydrostatic pressure of the drilling fluid column is equal to or greater than the formation pressure, formation fluids will not flow into the well bore.

Keeping a well "under control" is often characterized as a set of conditions under which no formation fluid will flow into the wellbore. But it also includes conditions where formation fluids are allowed to flow into the wellbore—under controlled conditions. Well control or pressure control means there is no uncontrollable flow of formation fluids into the well bore.

Hydrostatic pressure also controls stresses adjacent to the well bore other than those exerted by formation fluids. In geologically active regions, tectonic forces impose stresses in formations and may make well bores unstable even when formation fluid pressure is balanced. Well bores in tectonically stressed formations can be stabilized by balancing these stresses with hydrostatic pressure. Similarly, the orientation of the well bore in high-angle and horizontal intervals can cause decreased well bore stability, which can also be controlled with hydrostatic pressure.

Normal formation pressures vary from a pressure gradient of 0.433 psi/ft (equivalent to 8.33

lb/gal freshwater) in inland areas to 0.465 psi/ft (equivalent to 8.95 lb/gal) in marine basins. Elevation, location, and various geological processes and histories create conditions where formation pressures depart considerably from these normal values. The density of drilling fluid may range from that of air (essentially 0 psi/ft), to in excess of 20.0 lb/gal (1.04 psi/ft).

Often, formations with sub-normal pressures are drilled with air, gas, mist, stiff foam, aerated mud or special ultra-low-density fluids (usually oil-base).

The mud weight used to drill a well is limited by the minimum weight needed to control formation pressures and the maximum mud weight that will not fracture the formation. In practice, the mud weight should be limited to the minimum necessary for well control and wellbore stability.

1.2.2.3 Suspend and Release Cuttings

Drilling muds must suspend drill cuttings, weight materials and additives under a wide range of conditions, yet allow the cuttings to be removed by the solids-control equipment. Drill cuttings that settle during static conditions can cause bridges and fill, which in turn can cause stuck pipe or lost circulation. Weight material which settles is referred to as sag and causes a wide variation in the density of the well fluid. Sag occurs most often under dynamic conditions in high-angle wells, where the fluid is being circulated at low annular velocities.

High concentrations of drill solids are detrimental to almost every aspect of the drilling operation, primarily drilling efficiency and ROP. They increase the mud weight and viscosity, which in turn increases maintenance costs and the need for dilution. They also increase the horsepower required to circulate, the thickness of the filter cake, the torque and drag, and the likelihood of differential sticking.

Drilling fluid properties that suspend cuttings must be balanced with those properties that aid in cuttings removal by solids-control equipment. Cuttings suspension requires high-viscosity, shear thinning and thixotropic properties, while solids-removal equipment usually works more efficiently with fluids of lower viscosity. Solids-control equipment is not as effective on non-shear-thinning drilling fluids, which have high solids content and a high plastic viscosity.

For effective solids control, drill solids must be removed from the drilling fluid on the first circulation from the well. If cuttings are recirculated, they break down into smaller particles that are more difficult to remove. One easy way to determine whether drill solids are being removed is to compare the sand content of the mud at the flow line and at the suction pit.

1.2.2.4 Seal Permeable Formations

Permeability refers to the ability of fluids to flow through porous formations; formations must be permeable for hydrocarbons to be produced. When the mud column pressure is greater than formation pressure, mud filtrate will invade the formation, and a filter cake of mud solids will be deposited on the wall of the well bore. Drilling fluid systems should be designed to deposit a thin, low-permeability filter cake on the formation to limit the invasion of mud filtrate. This improves well bore stability and prevents a number of drilling and production problems. Potential problems related to thick filter cake and excessive filtration include "tight" hole conditions, poor log quality, increased torque and drag, stuck pipe, lost circulation, and formation damage.

In highly permeable formations with large pore throats, whole mud may invade the formation, depending on the size of the mud solids. For such situations, bridging agents must be used to block the large openings so the mud solids can form a seal. To be effective, bridging agents must be about one-half the size of the largest opening. Bridging agents include calcium carbonate, ground cellulose and a wide variety of seepage-loss or other fine lost-circulation materials.

Depending on the drilling fluid system in use, a number of additives can be applied to improve the filter cake, thus limiting filtration. These include bentonite, natural and synthetic polymers, asphalt and gilsonite, and organic deflocculating additives.

1.2.2.5 Maintain Wellbore Stability

Well bore stability is a complex balance of mechanical (pressure and stress) and chemical factors. The chemical composition and mud properties must combine to provide a stable wellbore until casing can be run and cemented. Regardless of the chemical composition of the fluid and other factors, the weight of the mud must be within the necessary range to balance the mechanical forces acting on the well bore (formation pressure, well bore stresses related to orientation and tectonics). Well bore instability is most often identified by a sloughing formation, which causes tight hole conditions, bridges and fill on trips. This often makes it necessary to ream back to the original depth (Keep in mind these same symptoms also indicate hole-cleaning problems in high-angle and difficult-to-clean wells).

Well bore stability is greatest when the hole maintains its original size and cylindrical shape. Once the hole is eroded or enlarged in any way, it becomes weaker and more difficult to stabilize. Hole enlargement leads to a host of problems, including low annular velocity, poor hole cleaning, increased solids loading, fill, increased treating costs, poor formation evaluation, higher cementing costs and inadequate cementing.

Hole enlargement through sand and sandstone formations is due largely to mechanical actions, with erosion most often being caused by hydraulic forces and excessive bit nozzle velocities. Hole enlargement through sand sections may be reduced significantly by following a more conservative hydraulics program, particularly with regard to impact force and nozzle velocity. Sands that are poorly consolidated and weak require a slight overbalance to limit well bore enlargement and a good-quality filter cake to limit well bore enlargement.

In shales, if the mud weight is sufficient to balance formation stresses, wells are usually stable—at first. With water-base muds, chemical differences cause interactions between the drilling fluid and shale, and these can lead (over time) to swelling or softening. This causes other problems, such as sloughing and tight hole conditions. Highly fractured, dry, brittle shales, with high dip angles, can be extremely unstable when drilled. The failure of these dry, brittle formations is mostly mechanical and not normally related to water or chemical forces.

Various chemical inhibitors or additives can be added to help control mud/shale interactions. Systems with high levels of calcium, potassium or other chemical inhibitors are best for drilling into water-sensitive formations. Salts, polymers, asphaltic materials, glycols, oils, surfactants and other shale inhibitors can be used in water-base drilling fluids to inhibit shale swelling and prevent sloughing. Shale exhibits such a wide range of composition and sensitivity that no single additive is universally applicable.

Oil-or synthetic-base drilling fluids are often used to drill the most water-sensitive shales in areas with difficult drilling conditions. These fluids provide better shale inhibition than water-base drilling fluids. Clays and shales do not hydrate or swell in the continuous phase, and additional inhibition is provided by the emulsified brine phase (usually calcium chloride) of these fluids. The emulsified brine reduces the water activity and creates osmotic forces that prevent adsorption of water by the shales.

1.2.2.6 Minimize Formation Damage

Protecting the reservoir from damage that could impair production is a big concern. Any reduction in a producing formation's natural porosity or permeability is considered to be formation damage. This can happen as a result of plugging by mud or drill solids or through chemical (mud) and mechanical (drilling assembly) interactions with the formation. Frequently, formation damage is reported as a skin damage value or by the amount of pressure drop that occurs while the well is producing (drawdown pressure).

The type of completion procedure and method will determine which level of formation protection is required. For example, when a well is cased, cemented and perforated, the perforation depth usually allows efficient production, even if near-well bore damage exists. Conversely, when a horizontal well is completed with one of the "open-hole" methods, a "drill-in" fluid —specially designed to minimize damage—is required. consideration should be given to potential formation damage when selecting a fluid for drilling potential reservoir intervals.

Some of the most common mechanisms for formation damage are:

(1) Mud or drill solids invading the formation matrix, plugging pores.

(2) Swelling of formation clays within the reservoir, reducing permeability.

(3) Precipitation of solids as a result of mud filtrate and formation fluids being incompatible.

(4) Precipitation of solids from the mud filtrate with other fluids, such as brines or acids, during completion or stimulation procedures.

(5) Mud filtrate and formation fluids forming an emulsion, restricting permeability.

The possibility of formation damage can be determined from offset well data and studies of formation cores for return permeability. Drilling fluids designed to minimize a particular problem, specially designed drill-in fluids or work over and completion fluids, all can be used to minimize formation damage.

1.2.2.7 Cool, Lubricate and Support the Bit and Drilling Assembly

Considerable frictional heat is generated by mechanical and hydraulic forces at the bit and where the rotating drill string rubs against the casing and well bore. Circulation of the drilling fluid cools the bit and drilling assembly, transferring this heat away from the source, distributing it throughout the well. Drilling fluid circulation cools the drill string to temperatures lower than the bottom-hole temperature. In addition to cooling, drilling fluid lubricates the drill string, further reducing frictional heat. Bits, mud motors and drill string components would fail more rapidly if it were not for the cooling and lubricating effects of drilling fluid.

The lubricity of a particular fluid is measured by its Coefficient of Friction (COF), and some muds do a better job than others at providing lubrication. For example, oil-and synthetic-base muds lubricate better than most water base muds, but lubricants can be added to water-base muds to improve them. On the other hand, water-base muds provide more lubricity and cooling ability than air or gas.

The amount of lubrication provided by a drilling fluid varies widely and depends on the type and quantity of drill solids and weight material, plus the chemical composition of the system—pH, salinity and hardness. Altering mud lubricity is not an exact science. Even after a thorough evaluation, with all relevant factors considered, application of a lubricant may not produce the anticipated reduction in torque and drag.

Indications of poor lubrication are high torque and drag, abnormal wear, and heat checking of drill string components. But be aware that these problems can also be caused by severe doglegs and directional problems, bit balling, key seating, poor hole cleaning and incorrect bottom-hole assembly design. While a lubricant may reduce the symptoms of these problems, the actual cause must be corrected to resolve the problem.

The drilling fluid helps to support a portion of the drill string or casing string weight through buoyancy. If a drill string, liner or casing string is suspended in drilling fluid, it is buoyed by a force equal to the weight of the mud displaced, thereby reducing hook load on the derrick. Buoyancy is directly related to the mud weight, so an 18-lb/gal fluid will provide twice the buoyancy of a 9-lb/gal fluid.

While most rigs have sufficient capacity to handle the drill string weight without buoyancy, it is an important consideration when evaluating the neutral point (where the drill string is in neither tension nor compression). However, when running long, heavy strings of casing, buoyancy can be used to provide a significant benefit. Using buoyancy, it is possible to run casing strings whose weight exceeds a rig's hook load capacity. If the casing is not completely filled with mud as it is lowered into the hole, the void volume inside the casing increases buoyancy, allowing a significant reduction in hook load to be used. This process is referred to as "floating in" the casing.

1.2.2.8 Transmit Hydraulic Energy to Tools and Bit

Hydraulic energy can be used to maximize ROP by improving cuttings removal at the bit. It also provides power for mud motors to rotate the bit and for Measurement While Drilling (MWD) and Logging While Drilling (LWD) tools. Hydraulics programs are based on sizing the bit nozzles properly to use available mud pump horsepower (pressure or energy) to generate a maximized pressure drop at the bit or to optimize jet impact force on the bottom of the well. Hydraulics programs are limited by the available pump horsepower, pressure losses inside the drill string, maximum allowable surface pressure and optimum flow rate. Nozzle sizes are selected to use the available pressure at the bit to maximize the effect of mud impacting the bottom of the hole. This helps remove cuttings from beneath the bit and keep the cutting structure clean.

Drill string pressure losses are higher in fluids with higher densities, plastic viscosities and solids content. The use of small ID drill pipe or tool joints, mud motors and MWD/LWD tools all reduce the amount of pressure available for use at the bit. Low-solids, shear-thinning drilling fluids or those that have drag reducing characteristics, such as polymer fluids, are more efficient at transmitting hydraulic energy to drilling tools and the bit.

In shallow wells, sufficient hydraulic horsepower usually is available to clean the bit efficiently. Because drill string pressure losses increase with well depth, a depth will be reached where there is insufficient pressure for optimum bit cleaning. This depth can be extended by carefully controlling the mud properties.

1.2.2.9 Ensure Adequate Formation Evaluation

Accurate formation evaluation is essential to the success of the drilling operation, particularly during exploration drilling. The chemical and physical properties of the mud affect formation evaluation. The physical and chemical well bore conditions after drilling also influence formation evaluation. During drilling, the circulation of mud and cuttings is monitored for signs of oil and gas by technicians called mud loggers. They examine the cuttings for mineral composition, paleontology and visual signs of hydrocarbons. This information is recorded on a mud log that shows lithology, ROP, gas detection and oil-stained cuttings plus other important geological and drilling parameters.

Electric wire line logging is performed to evaluate the formation in order to obtain additional information. Sidewall cores also may be taken with wire line conveyed tools. Wire line logging includes measuring the electrical, sonic, nuclear and magnetic-resonance properties of the formation to identify lithology and formation fluids. For continuous logging while the well is being drilled, LWD tools are available. Drilling a cylindrical section of the rock (a core) for laboratory evaluation also is done in target production zones to obtain desired information. Potentially productive zones are isolated and evaluated by performing Formation Testing (FT) or Drill-Stem Testing (DST) to obtain pressure and fluid samples.

All of these formation evaluation methods are affected by the drilling fluid. For example, if the cuttings disperse in the mud, there will be nothing for the mud logger to evaluate at the surface. Or, if cuttings transport is poor, it will be difficult for the mud logger to determine the depth at which the cuttings originated. Oil muds, lubricants, asphalts and other additives will mask indications of hydrocarbons on cuttings. Certain electrical logs work in conductive fluids, while others work in non-conductive fluids. Drilling fluid properties will affect the measurement of rock properties by electrical wire line tools. Excessive mud filtrate can flush oil and gas from the near-well bore region, adversely affecting logs and FT or DST samples. Muds that contain high potassium ion concentrations interfere with the logging of natural formation radioactivity. High or variable filtrate salinity can make electrical logs difficult or impossible to interpret.

Wire line logging tools must be run from the surface to bottom, with the actual measurement of rock properties being performed as the tools are pulled up the hole. For optimum wire line logging, the mud must not be too thick, it must keep the well bore stable and it must suspend any cuttings or cavings. In addition, the well bore must be near-gauge from top to bottom, since excessive bore enlargement and/or thick filter cakes can produce varying logging responses and increase the possibility of sticking the logging tool.

Mud for drilling a core is selected based on the type of evaluation to be performed. If a core is being taken only for lithology (mineral analysis), mud type is not a concern. If the core will be used for water flood and/or wettability studies, a "bland", neutral-pH, water-base mud without surfactants or thinners will be needed. If the core will be used for measuring reservoir water saturation, a bland oil mud with minimal surfactants and no water or salt is often recommended. Many coring operations specify a bland mud with a minimum of additives.

1.2.2.10 Control Corrosion

Drill string and casing components that are in continual contact with the drilling fluid are susceptible to various forms of corrosion. Dissolved gasses such as oxygen, carbon dioxide and hydrogen sulfide can cause serious corrosion problems, both at the surface and down hole. Generally, low pH aggravates corrosion. Therefore, an important drilling fluid function is to keep corrosion to an acceptable level. In addition to providing corrosion protection for metal surfaces, drilling fluid should not damage rubber or elastomer goods. Corrosion coupons should be used during all drilling operations to monitor corrosion types and rates.

Mud aeration, foaming and other trapped-oxygen conditions can cause severe corrosion damage in a short period of time. Chemical inhibitors and scavengers are used when the corrosion threat is significant. Chemical inhibitors must be applied properly. Corrosion coupons should be evaluated to tell whether the correct chemical inhibitor is being used and if the amount is sufficient. This will keep the corrosion rate at an acceptable level.

Hydrogen sulfide can cause rapid, catastrophic drillstring failure. It is also deadly to humans after even short periods of exposure and in low concentrations. When drilling in high hydrogen sulfide environments, elevated pH fluids, combined with a sulfide-scavenging chemical like zinc, should be used.