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An Overview of Drilling Fluids Used in Oil and Gas Drilling

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Abstract - *Drilling fluids are mixtures of natural and synthetic chemical compounds used in the drilling of oil and gas. They provide protection to the drill bit as well as helps in carrying out the drilling operations smoothly. Drilling fluids are mainly classified as water based muds (WBM) and oil based muds (OBM).Each type needs special additives and their selection depends on various factors. A drilling mud can be disposed of in an environmental friendly manner by mixing the mud with a cross linkable polymer and a crosslinking agent to form a composition that solidifies at a predetermined time*

Key Words: **WBM, OBM, reducing agents. Sequestering agents, pH modifying agents**

1. INTRODUCTION

Drilling fluids or drilling muds are a class of high density and high viscous fluid mixture used in drilling of oil and gas wells to carry the rock cuttings to the surface, to cool and lubricate the drill bit, clean the hole bottom etc [1]

1.1 Factors affecting the selection of drilling fluid

Drilling fluids are crucial to the success of the operations and the safety of the operators. The factors that affect the amount of fluid used are the fluid composition, density, viscosity etc. These factors vary from one field to the next and even from one borehole to another in the same field. In addition to this, the factors which influence the composition and consumption of a formulated drilling fluid include geographic location, direction of drilling, pressure and temperature of the down hole, depth of the hole to be drilled etc. These fluid contain chemicals and they should be compatible with the rock that it is drilling through which could include limestone, sand stone, granite, dolomite or a composite. These chemicals can protect the expensive drill shaft and bits by providing lubrication, cooling and corrosion control [1]

1.2 Types of drilling fluids

Drilling muds are divided into two general types: water-based drilling muds (WBM) and oil-based drilling muds (OBM) depending upon the continuous phase of the mud. The classification of drilling muds is based on their fluid phase alkalinity, dispersion, and the type of chemicals used in their formulation. However, water based drilling muds (WBMs) may contain oil and oil-based drilling muds (OBMs) may contain water [1]. Each type needs special additives. The type of fluid base used depends on drilling and formation needs, as well as the requirements for disposition of the fluid after it is no longer needed. OBMs generally use hydrocarbon oil as the main liquid component, with other materials such as clays or colloidal asphalts being added to provide the desired viscosity together with emulsifiers, polymers, and other additives including weighting agents. Water may also be present, but in an amount not usually greater than 50% by volume of the entire composition. If more than about 5% of water is present, the mud is often referred to as an invert emulsion. WBMs conventionally contain viscosifiers, , weighting agents, corrosion inhibitors, lubricants, emulsifiers, salts, and pH control agents. Water makes up the continuous phase of the mud, and is usually present as at least 50 volume percent of the entire composition. Oil is also usually present in small amounts, but will typically not exceed the amount of the water, so that the mud will retain its character as a water-continuous-phase material [1]

2. Disposal of drilling muds

In the case of *water-based muds,* the base fluid in these muds is water, and they are considered to be the most environmentally favorable mud systems. Water based muds are typically used when drilling the top sections of the well. On the other hand, in the *oil-based muds* the base fluid in these muds is oil and is subject to the release of hydrocarbons to the environment (Hird and Tibbetts, 1995). Diesel was used until 1984 when it was banned as a base fluid and replaced more refined oils, the *low toxicity oils.* The discharge of oil-based muds has been phased out in the 1990s, and they have been replaced by pseudo-oil based muds

(POBM). In the POBM, the base fluids for these muds are synthesized from a variety of non-petroleum-related products. However, these muds are also being phased out.

No precise, standard formulation exists for drilling fluids. Their composition depends on the needs of the particular situations. These differ considerably in different regions and may even radically change during each drilling process while drilling rocks of very different structure (from solid granite formations to salt and slate strata). At present, two main types of drilling fluids are used in offshore drilling. They are based either on crude oil, oil products, and other mixtures of organic substances (diesel, paraffin oils, and so on) or on water (freshwater or seawater with bentonite, barite, and other components added). During the last 10 years, the preference is given to using the less-toxic water-based drilling fluids [3]. However, in some cases, for example during drilling of deviated wells through hard rock, using oil-based fluids is still inevitable. The oil-based fluids, in contrast with the water-based ones, are usually not discharged overboard after a single application. Instead, they are regenerated and included in the technological circle again.

The environmental hazard of drilling muds is connected, in particular, with the presence of lubricating materials in their composition. These lubricating substances usually have a hydrocarbon base. They are needed for effective drilling, especially in case of slant holes or drilling through solid rock. The lubricants are added into the drilling fluids either from the very beginning as a part of the original formulations or in the process of drilling when the operational need emerges. In both cases, the discharges of spent drilling muds and cuttings coated by these muds contain considerable amounts of relatively stable and toxic hydrocarbon compounds and a wide spectrum of many other substances [2]

Drilling mud is an expensive material, which requires costly and tedious disposal and remediation mechanisms. As a result, reuse of mud is one of the best options in waste management. For reuse, mud cuttings must be separated. For further separation of the drill cuttings, additional mechanical processing is often used in the mud pit system. According to NETL (2005), three types of mechanical equipment are used:

1. Hydro cyclone-type desilters and desanders
2. Mud cleaners (hydrocyclone discharging on a fine screened shaker
3. Rotary bowl decanting centrifuges.

The present waste management guidelines restrict the disposal of drill cuttings coated with mud. In order to comply with these guidelines, the solids are further treated with drying shakers using high gravitational separation, vertical or horizontal rotary cuttings dryers, screw-type squeeze presses, or centrifuges (NETL 2005). The cuttings dryers recover additional mud and produce dry, powdery cuttings. Different drying methods are used for drying the cuttings [2]

A drilling mud can be disposed of in an environmentally sound manner by mixing the mud with a crosslinkable polymer and a crosslinking agent to form a composition that solidifies at a predetermined time. Before curing, the composition is injected into a subterranean formation, preferably into an abandoned well and when solidified, the compositions are substantially immobilized within the formation. Compounds suitable as crosslinking agents are aldehydes, ethers, phenols etc.

To control the solidifying time of the drilling mud, a crosslinking reaction regulator is optionally also added to the drilling mud. Exemplary crosslinking reaction regulators include reducing agents that are capable of activating the crosslinking agent, sequestering agents that are capable of inhibiting the activity of the crosslinking agent and are releasing the crosslinking agent at the desired conditions, or pH modifiers that are degrading at the desired conditions to adjust the pH so that the crosslinking agent goes in action. Typical sulphur containing reducing agents are sodium sulphide, hydrogen sulphide, sodium thiosulphate etc and sulphur free reducing agents are potassium iodide, manganese nitrate etc. Sequestering agents are citrate, propionate, and acetate salts of polyvalent metal ions such as aluminum, chromium, and iron. pH modifying agents, are acid precursors and base precursors, which generally either hydrolyze or thermally decompose to form an acid or a base, respectively.

Typical classes of acid precursors include hydrolyzable esters, acid anhydrides, sulfonates, organic halides, and salts of a strong acid and a weak base.

After the crosslinkable polymer, the crosslinking agent, and the ingredients are mixed with the drilling mud, the resulting solidifiable, disposable drilling mud composition is injected into the interior bore of the well. After some time, the composition solidifies and occupies a substantially fixed portion of the formation. Because the drilling mud is immobilized in the formation, adverse potential environmental risks due to the migration of the mud into other parts of the formation, such as potable water aquifers, is substantially reduced [4]

3. CONCLUSION

Importance of drilling fluids, their types and how drilling mud is disposed after its usage is discussed in this paper. Considering the importance of drilling fluids in oil and gas drilling operation, it is an area where considerable research work has to be carried out.

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