**Lubricating Additives for Drilling Oil and Gas Wells and Their Significance**

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**Abstract.** This article presents the significance of lubricating additives in the composition of drilling fluids. The efficiency, safety, and stability of oil and gas well drilling processes largely depend on the proper selection and control of drilling fluid parameters. Drilling fluids not only serve as a working medium between drilling tools and the wellbore but also perform key functions such as wellbore stabilization, cuttings removal, lubrication of drilling equipment, and pressure balancing. The study highlights different types of lubricating additives, their characteristics, properties and limitations. Furthermore, the technical, economic, and environmental importance of these lubricating additives in improving drilling efficiency under complex geological conditions is discussed. The comparison of developed MBR with other lubricants and their advantages and disadvantages were shown.

**Keywords:** drilling fluids, lubricating additives, MBR, barit, viscosity, stability, wellbore protection, oil and gas drilling, environmental safety.

**INTRODUCTION**

The oil and gas industry occupies a particularly important place in the development of Uzbekistan’s economy. To maintain the current level of hydrocarbon production, an increasing amount of drilling operations is required. Therefore, efficient drilling fluids are also necessary, since they are used under the complex geological and mining conditions of oil and gas fields located in various regions of Uzbekistan. Here, within certain short intervals, the geological conditions of the drilled formations (strata, pressure, and pore pressure) change rather frequently.

The process of drilling oil and gas wells is considered a complex technology. In this process, the stability, safety, and efficiency of the well largely depend on the drilling fluid. A drilling fluid is a specially prepared liquid that serves as the working medium between the drilling tools and the wellbore wall [1].

The development of modern rapid drilling technology can only be achieved by strengthening the requirements for maintaining a small predetermined amount of solid phase in the drilling fluids.

The solid phase of the drilling fluids in use mainly consists of finely dispersed clay particles smaller than 50–80 μm and drill cuttings (from fractions of a millimeter up to 3–5 mm). Therefore, it is very difficult to completely remove all of them from the drilling fluid using the existing mechanical means [2].

In this regard, it is necessary to use chemical reagents and special fluid systems during drilling. They prevent the spontaneous disintegration of the drilled rock and the excessive dispersion of clay and clay-like systems. At the same time, they provide the possibility of controlling the concentration of the solid phase, ensuring the effective operation of the rock-destroying tool. This is achieved through cleaning agents – drilling fluids [3].

Drilling fluid is understood as a complex multicomponent dispersed system of suspension, emulsion, and aerated fluids used for well flushing during the drilling process.

The drilling fluid performs a number of functions, which become more diverse as the drilling process becomes more complex: the deeper the well, the less stable its walls, and the higher the gas and oil pressure in the drilled formations [4].

The type and properties of the drilling fluid, together with technological measures and technical equipment, must ensure safe drilling conditions with high technical and economic performance, as well as quality exposure of productive horizons [5].

A drilling fluid is a composite system used in the well-drilling process, possessing specific physical and chemical properties. It may consist of aqueous, oil-based, emulsion-based, or specially formulated additives [6].

The main functions of drilling fluids are as follows:

1. Removal of drill cuttings – carries fine and coarse particles generated during drilling to the surface.

2. Stabilization of the wellbore wall – prevents collapse and fracturing through hydrostatic pressure.

3. Balancing formation pressure – prevents fluid or gas inflow into the well.

4. Lubrication and cooling of drilling tools – reduces friction and extends the bit’s service life.

5. Filtration control – limits fluid loss into the wellbore walls and forms a protective filter cake.

6. Serving as a diagnostic medium – based on the fluid’s properties, conclusions about geological conditions in the well can be drawn.

Drilling reagents are substances added to drilling fluids that serve to maintain and control the physical, chemical, and technological properties of the fluid at the required level. The following reagents are used in the preparation of drilling fluids [7]:

1. Dispersants – break down the solid phase into fine particles and create a stable suspension in the fluid.

Examples: lignosulfonates (LST, LSTM), tannin sulfonates.

2. Inhibitors – prevent clay minerals from swelling and protect the wellbore wall.

Examples: NaCl, KCl, CaCl₂, silicates (Na₂SiO₃), polyamines.

3. Weighting agents – increase the density of the fluid.

Examples: barite (BaSO₄), hematite (Fe₂O₃), dolomite (CaMg(CO₃)₂), calcite (CaCO₃).

4. Fluid loss reducers – restrict fluid loss through the wellbore wall and form a protective filter cake.

Examples: starch, CMC (carboxymethylcellulose), polyacrylamides, asphaltene-containing substances.

5. Thixotropic and rheology modifiers – maintain the viscosity and gel strength of the fluid at the required level.

Examples: bentonite, attapulgite, polymers.

6. pH and chemical stability regulators – maintain an alkaline medium and bind calcium and magnesium.

Examples: caustic soda (NaOH), soda ash (Na₂CO₃), phosphates.

7. Antibacterial and preservative additives – prevent the biodegradation of organic substances in the fluid [8].

Examples: formalin, glutaraldehyde, biocidal additives.

The importance of drilling fluids is very high: they control density, viscosity, and filtration of the fluid; stabilize the wellbore wall; facilitate the removal of cuttings; ensure lubrication of drilling tools; and maintain well safety (by balancing formation pressure).

**MATERIALS AND METHODS**

Investigations of drilling fluids properties are carried out according to the API (API RP 13-b1, 2017) standards. As with all laboratory procedures involving potentially hazardous chemicals and equipment, users are expected to have appropriate training and knowledge regarding the use and disposal of such materials [9]. Users are also responsible for compliance with all applicable local, regional, and national health, safety, and environmental regulations [10].

Lubricating additive MBR for water-based drilling fluids for improvement tribological and technological properties of drilling fluids for drilling oil and gas wells. The process of obtaining the MBR lubricant is based on the modification of gossypol resin and oil sludge using solutions of caustic alkali and calcined soda at a temperature of 70–80°C. All reagents are then mixed for 30–40 minutes until a homogeneous mass is obtained. This technology enables complete recycling of the aforementioned industrial wastes [11]. In addition to the lubricant MBR, SMAD, SET-1, Lubrimol, Ecolub, Lubra, Bitulub, and graphite-based additive are currently used for drilling oil and gas wells [12].

The SMAD-1M lubricant is designed to refine clay solutions in order to reduce the gravity and ethno-sized friction in wells, as well as improving the working capacity of the chisel. It is used as a structural former in salted solutions, a solid phase hydrophobized and a stabilizer in oil -based solutions [13]. The stabilizer emulsifier Thermal-resistant “SET-1” emulsifier, designed to obtain inverted emulsions with a high-water content, which are used for drilling wells in moistened unstable clay rocks, salts of polymineral composition, when opening productive layers and stupor of the wells [14, 15].

**RESULTS AND DISCUSSION**

Several types of lubricating additives are known for drilling fluids. Examples include, MBR, SMAD, Lubrimol, Ecolub, Lubra, Bitulub, and graphite-based additives.

**TABLE 1.** Known lubricating additives and their properties

|  |  |
| --- | --- |
| **Lubricating additive** | **Main properties / functions** |
| MBR | Improves lubricity of drilling fluids, reduces torque and drag, enhances wellbore stability |
| SMAD | Improves lubricity of drilling fluids, reduces torque and drag, enhances wellbore stability |
| Lubrimol | Synthetic additive; reduces friction, increases ROP (rate of penetration) |
| Ecolub | Environmentally friendly additive; decreases wear of drilling tools, biodegradable |
| Lubra | Provides stable lubrication under high temperature and pressure |
| Bitulub | Bitumen-based additive; enhances film formation on wellbore walls, prevents sticking |
| Graphite-based additives | Natural solid lubricant; reduces friction coefficient, resistant to high temperatures |

Lubricating additives play a crucial role in improving the performance of drilling fluids under various geological and technological conditions. Among the classical lubricants, SMAD is mainly applied in water-based drilling fluids. Its primary functions are lubricating the wellbore wall, slightly reducing viscosity, and decreasing friction between metals, sand, and cuttings. However, SMAD is not stable at high temperatures, and its efficiency decreases in formations rich in organic matter.

Modern polymer-based lubricants such as Lubrimol provide significant advantages. They remain stable in high-temperature and saline environments, reduce the friction coefficient to as low as 0.15–0.20, distribute evenly over tool surfaces without coagulation, and are more environmentally safe. Compared with SMAD, Lubrimol demonstrates higher efficiency and can be used in a wide range of media, including water-based, saline, and polymer-based fluids.

Another promising additive is Ecolub, which is biodegradable and environmentally friendly, decomposing naturally without harming the ecosystem. It is widely applied in Europe and Asia, mixes well with water, and, due to its organic emulsifier base, effectively reduces friction while enhancing tool lubrication. Its main advantage over SMAD and Lubrimol is ecological safety, combined with high performance.

In addition to these, other lubricants such as Lubra (cost-effective and adaptable to different environments), Bitulub (asphaltene–bitumen-based, effective under harsh drilling conditions), and graphite-based additives (solid lubricants with strong antifriction effects and high thermal resistance) are also employed in modern drilling practices.

**TABLE 2.** Characteristics of Different Lubricating Additives

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of Lubricant** | **Advantages** | **Disadvantages** | **Main Application** |
| MBR | Low-cost, lubricates in water-based fluids | - | Drilling under salt anhydrite layer, deep wells |
| SMAD | Low-cost, lubricates in water-based fluids | Not stable at high temperature, limited efficiency | Drilling under normal conditions |
| Lubrimol | Resistant to high temperature and mineralized water, low friction | More expensive | Deep wells, harsh conditions |
| Ecolub | Environmentally safe, biodegradable | High cost, not widely available in all markets | Regions with high environmental standards |
| Bitulub | Asphalt-based, effective in hard geological formations | Difficult to clean, affects filtration | Hard rock intervals |
| Graphite-based | High mechanical lubrication effect | Does not fully dissolve in water | Drilling under severe and challenging conditions |

Efficiency criteria are technical characteristics such as the heat transfer of the solution, its density and viscosity, static shift voltage, the degree of structural homogeneity and purification of the drilling solution.

**TABLE 3.** Physical and mechanical characteristics of the lubricants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Indicators** | **MBR** | **SMAD** | **Lubrimol** | **Ecolub** |
| Friction coefficient (µ) | 0,12 | 0,35 | 0,15 | 0,18 |
| Temperature stability, °C | 80-180 | 80–100 | 180–200 | 150–170 |
| Environmental Security, 1-3 points | 1 | 1 | 2 | 3 |

The preparation of drilling fluids with lubricating additives is carried out in the following stages:

1. Preparation of the base fluid. Freshwater or saline water (NaCl, CaCl₂ solution) is used as the base. A clay component such as bentonite or palygorskite is added. Bentonite provides thixotropy and stability to the fluid.

2. Addition of stabilizers and auxiliary agents. Carboxymethylcellulose (CMC) is introduced to increase viscosity. Soda (Na₂CO₃) or NaOH is used to regulate pH. Barite or hematite is applied to increase density when necessary.

3. Addition of lubricants.

SMAD: 1.5–3% under normal drilling conditions.

Lubrimol: 2–5% in deep and high-temperature wells.

Ecolub: 2–4% in environmentally sensitive operations.

Lubricants are added after the base mud is prepared. They are first dissolved separately in water, then introduced into the main system using a pump. Mixing is performed with a mixer or circulation pump for 20–30 minutes to ensure homogeneity.

Example of material consumption for preparing 1 m³ of drilling fluid:

Water – 800 L

Bentonite – 40–60 kg

Barite – 200 kg (if required)

CMC – 2–3 kg

NaOH – 0.5–1 kg

Lubricant (e.g., MBR) – 25–30 kg

**TABLE 4.** Technological parameters of the burden solution

|  |  |
| --- | --- |
| **Indicators** | **Value** |
| The viscosity is | 45-55 sec |
| Filtration | ≤ 10 ml |
| pH | 9–10 |
| Density | 1.3-1.4 g/cm³ |
| The mower is | high |

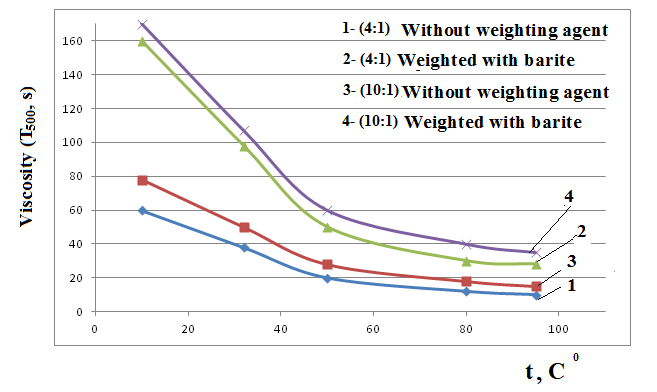
Technical, Economic, Environmental, and Safety Significance of Drilling Fluids.

Technical significance – drilling fluids protect the wellbore walls, remove cuttings, and lubricate drilling tools.

Economic significance – 20–30% of drilling costs account for drilling fluids. Properly selected mud reduces both time and expenses.

Environmental significance – specially formulated fluids minimize the impact on the environment.

Safety significance – drilling fluids help prevent accidents and major risks in the well.



**FIGURE 1.** Dependence of viscosity of fluids on temperature, 0C

**TABLE 5.** Technological parameters of stable hydrophobic emulsions with MBR

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| № | MBR, % | Electrostis, V | Technology Parameters | | | |
| Т500, s | SS, mg/sm2 | Stability, g/cm3 | W, cm3/30min |
| Hydrocarbon phase - Aquilic phase = 1:1 | | | | | | |
| 1 | 1 | 10 | 15 | 3/5 | 0,16 | 7 |
| 2 | 2 | 35 | 19 | 5/7 | 0,11 | 6 |
| 3 | 3 | 205 | 27 | 9/15 | 0,08 | 4 |
| 4 | 4 | 245 | 31 | 18/28 | 0,06 | 3 |
| 5 | 5 | 250 | 37 | 23/32 | 0,03 | 2 |

High-stability thixotropic systems with specific static shear stress values depend on the component composition of invert hydrophobic emulsions and their preparation technology [4, 5].

The difficulties of maintaining the required properties of such systems during drilling are mainly associated with external factors: well temperature, intrusion of fine-dispersed rock particles with hydrophilic surfaces, salts, and other impurities.

The obtained data show that the plastic viscosity of emulsion-based drilling fluids—both weighted and unweighted—tends to decrease with heating. In particular, within the range of 10–95 °C, viscosity decreases by several degrees. This behavior of emulsion drilling fluids is related to the interfacial properties of the phases and is typical for highly concentrated emulsions. Such a characteristic of emulsions does not hinder either rotary or turbine drilling operations and allows for the preparation of highly stable weighted drilling fluids.

Thus, the role of drilling solutions in the drilling of deep wells is reduced to ensuring the optimal conditions of flushing and working on the bottom of the drill chin, upbringing engines, drilling tools, cleaning the slaughter from the broken breed and removing it from the well of the well. Worm solutions create a gas pressure on layers containing oil, gas, plastic waters, unstable rocks. By changing the composition and properties of drilling solutions, you can increase the drilling rate, improve the conditions of opening and mastering oil and gas strata, reduce or prevent complications, increase the technical and economic indicators of drilling wells.

**CONCLUSION**

Drilling fluids are one of the most essential technological tools in the well construction process. They perform key functions such as stabilizing the wellbore wall, removing cuttings, balancing formation pressure, and protecting drilling tools. There are shown importance to develop lubricant and use them for drilling oil and gas wells to improve tribological, technological properties of drilling fluids as well as to improve safety, improve environmental friendliness. Therefore, proper selection of drilling fluid composition and careful control of its parameters are of great importance for each well. Existing drilling reagents provide different properties to drilling fluids. Depending on the geological conditions of each reservoir, various reagents are selected, and their proper application determines the efficiency of drilling operations. There were shown advantages of developed lubricant MBR comparing other lubricating additives and recommended for drilling oil and gas wells.

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