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Theory and Methodological Basis for the Application of Various Drilling Fluids for Drilling Oil and Gas Wells

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ABSTRACT
The article reveals the theoretical and scientific-methodological basis of application of various drilling fluids for drilling oil and gas wells

KEYWORDS: Drilling fluids, oil and gas fields

Drilling Fluid.

As is known from the theoretical literature **(eng. *drilling fluid, drilling mud*; ger. *Spülung, Bohrschlamm, Spülflüssigkeit*)** — complex multicomponent system dispersed suspension, emulsion and aerated liquids used for cleaning the wells during drilling. The use of drilling fluids for drilling first proposed in 1833 by the French engineer Flovil who has being watched cable drilling operation in which the drilling unit came across the water, noticed that the gushing water is very effective in removing cuttings from the well. He invented apparatus, which was supposed to pump water at the drill rod, where the drill cuttings are washed out with water to the surface between the drill rod and the wellbore. The principle has remained unchanged ever since.

Function

The main functions of a *drilling mud* can be summarized as follows:

- Remove cuttings from well
- Suspend and release cuttings
- Control formation pressures
- Seal permeable formations
- Maintain wellbore stability
- Minimizing formation damage
- Cool, lubricate, and support the bit and drilling assembly
- Transmit hydraulic energy to tools and bit
- Ensure adequate formation evaluation
- Control corrosion (in acceptable level)
- Facilitate cementing and completion
- Minimize impact on environment

Composition of drilling mud

Water-based drilling mud most commonly consists of bentonite clay (gel) with additives such as barium sulfate (barite), calcium carbonate (chalk) or hematite. Various thickeners are used to influence the viscosity of the fluid, e.g. xanthan gum, guar gum, glycol, carboxymethylcellulose, polyanionic cellulose (PAC), or starch. In turn, deflocculants are used to reduce viscosity of clay-based muds; anionic polyelectrolytes (e.g. acrylates, polyphosphates, lignosulfonates (Lig) or tannic acid derivates such as Quebracho) are frequently used. Red mud was the name for a Quebracho-based mixture, named after the color of the red tannic acid salts; it was commonly used in 1940s to 1950s, then was made obsolete when lignosulfonates became available. Other components are added to provide various specific functional characteristics as listed above. Some other common additives include lubricants, shale inhibitors and fluid loss additives (to control loss of drilling fluids into permeable formations). A weighting agent such as barite is added to increase the overall density of the drilling fluid so that sufficient bottom hole pressure can be maintained thereby preventing an unwanted (and often dangerous) influx of formation fluids.

Properties of drilling fluids and its regulation

Efficiency of application of the drilling fluids depends on its properties, which include the density, viscosity, fluid loss, gel strength, structural homogeneity, gas content, sand content; thixotropic, the content of ions of Na, K, Mg.

The fluid loss of the drilling mud is characterized by mud filtrate volume of (2 to 10 cm^3) separated from the mud through a filter surface (filter press) with a standard pressure differential ~ 120 PSI for 30 minutes. The thickness of the filter cake (filter cake) which is formed by determining the water loss varies in a range of 1-5 mm.

The solids content of the mud characterizes the concentration of clay (3-15%) and weighting agent (20-60%). To ensure that the drilling efficiency (depending on the specific geotechnical conditions) mud properties controlled by changing the content ratio of the dispersed phase and the dispersion medium and introducing it's to special materials and chemicals. To prevent the kick at abnormally high formation pressures its necessary increase the density of the drilling fluid through the introduction of special weighting agents (such as chalk up to 1500 kg / m³, barite and hematite up to 2500 kg / m or higher), or reduce it to 1000 kg / m³ by aeration mud or adding to it blowing agents (sulfanol, lignosulfonate). The solids content of the drilling fluid system is regulated by three-stage cleaning system on shale shakers; gaseous agents separated in degassers. In addition, for adjusting the solids content of the solution adding selective flocculants.

A special class of reagents are using for controlling the properties of oil-based solutions. They include emulsifiers (fatty acid soaps, and other emultal…), repellents (sulfanol, quaternary amines and organosilicon compounds), filtration reducer (organogumaty).

The mixing / preparing of the drilling fluids are performing prior starting drilling and while drilling process.

The raw material composition of drilling fluids

For prepare/mix drilling fluids are used fine, plastic clay with a minimum content of sand which can form a viscous, long settled suspension with water. The best properties have a significant alkaline (sodium) varieties montmorillonite (bentonite clays), clay powders, which are mainly used in drilling oil and gas wells and for the preparation of drilling fluids with low density.

The harmful impurities in the clays, deteriorates the stability of the mud are gypsum, soluble salt, limestone.

According to the specifications (TU U 39-688-81 [1]), the main indicator of the quality of raw clay and clay powder intended for the preparation of drilling fluids is to reach a solution - the number of cubic meters of solution (suspension) of a given viscosity, obtained from 1 ton of raw clay. In addition are regulated by the density of the solution and sand content.

Circulation of drilling fluids in the hole

Most drilling fluids in drilling operations are recycling to the following cycle:

- Drilling fluids are mixed and kept in special tanks
- Mud pumps pump the drilling fluid from the tanks into the wellbore through drill string
- Drilling fluid reach to the bottom through drill string where the drill bit break the formation
- Then, drilling fluid returns to the surface, carrying out drill cuttings, which were separated chisel.

The drilling fluid moves through annulus - the space between the walls of the hole and the drill pipe. The typical diameter of the drill pipe about 12.7 sm. The bottom of the deep hole, its diameter may be about 20 sm.

At the surface the drilling fluid passes through the return line - a pipe that leads to a vibrating sieve (shale shaker).

The sieve consists of a series of vibrating grids of metal, which are used for separating cuttings from the fluid. The fluid flows through the grate and back to the sump.

The particles of the cuttings fall into the trough for remove. Before release, they can be purified starting from environmental and other considerations. Some of the cuttings are taken by geologists to study the condition of the wellbore.

Variety of drilling fluids

Lignite alkaline drilling fluid - drilling mud into which adding a certain amount of lignite with alkaline in nature.

Lime-bitumen drilling fluid - oil-based mud dispersion medium which is a diesel fuel or oil, and the dispersed phase - highly oxidized bitumen, calcium oxide, barite, and a small amount of water required for slaking.

Lightened drilling fluid - drilling fluid, reduced in weight, light, which has a lower density. Thus is used for drilling and well killing in formations with low formation pressure.

Polymer drilling fluid – water based mud which has high molecular polymers of the linear structure; usually used for drilling hard rock.

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