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Analysis And Estimation of The Efficiency of The Current State of Application of Drilling Fluids and Chemicals to Them

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Annotation: The article reflects the results of the analysis of the current state and assessment of the current efficiency of the use of drilling fluids when drilling vertical and horizontal wells in the conditions of productive horizons in the territory of the Republic of Uzbekistan. On the basis of the revealed results of the analytical study, recommendations are given for increasing the technological efficiency of the used drilling fluids and chemical additives to them.

Keywords: Well, drilling, drilling mud, chemicals, formation, inhibitor, lubricant, density, heat resistance.

Introduction

At present, on the territory of the Republic of Uzbekistan, the productive horizons from which hydrocarbons are extracted, mainly lie at a depth of 3000 and more meters. Consequently, the expansion of the fund of operational, i.e. oil and gas producing wells are carried out by drilling wells, the bottom of which is at a depth of at least 3000 meters. It is known that when drilling wells with the above-mentioned depth marks, the bit and other downhole-moving parts of the drilling equipment, as well as the drilling fluid, are exposed to high temperatures, the values of which otherwise exceed 90-100 °C. Under such high-temperature operating conditions, it is necessary to select a drilling fluid that is capable of providing lubrication to the moving parts of the drilling rig in order to prevent bit sticking and other complications that contribute to stopping the drilling process.

Currently, countries such as Saudi Arabia, Kuwait, the United Arab Emirates and other Arab countries located in the strait, as well as the Persian Gulf states (Iran, Iraq, Syria, etc.) where they produce oil and gas, little attention is paid to issues lubricants, because Productive formations of recoverable hydrocarbons are located at a relatively close depth and are easily pumpable. On the contrary, in the CIS countries, the production of oil and gas from year to year forces to increase the depth of extraction of hydrocarbons. For example, today in Russia, Kazakhstan, Azerbaijan and Turkmenistan, dozens of wells have already been commissioned with depths ranging from 4 to 8 km. These countries spend significant costs on oil and gas production in the process of drilling deep wells, or rather on lubricating additives to drilling fluids, due to which the temperature in the current intervals of drilling a bit is reduced in order to prevent stuck rock-destructive tools and other complications.

Discussion

Due to the increase in the average drilling depth of oil and gas wells, today scientists and technologists of the oil and gas industry have developed special requirements for drilling fluids used in individual wells.

Drilling fluids are prepared based on well depth, reservoir depth, temperature, etc.

If the pressure abnormality (rock pressure) coefficient is significantly lower than one, then under such conditions it is advisable to use hydrocarbon-based solutions, i.e. solutions of an emulsion nature, which have a (minimum) density in the range of 0.88-1.0 g/cm^3, which makes it possible to use them in conditions of ANPD. Application experience shows that hydrocarbon solutions have a number of useful technological properties: lubricating properties, very low filtration rates and excellent inhibiting properties. If the coverage area of ANPD has a local character, i.e. is located in a narrow interval between areas with normal pressure

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(rock pressure), it is impractical to drill the entire interval of the productive stratum of the productive formation. Such zones are often located in the strata of the development of depleted productive horizons. In order to avoid technical and technological complications in such cases, a water-based drilling fluid is used, which must contain the required amount of colmatant, i.e. marble chips with a specially selected particle size distribution.

In the case of drilling operations in the intervals of the productive horizon with AHPP (the coefficient indicating the abnormality of the rock pressure should be more than one), fluids with a higher density are used. Traditionally, the density of a polymer-clay solution does not exceed 1.16-1.18 g/cm^3. Solutions for drilling oil and gas wells based on brines of various salts (sodium formates, sodium chloride, potassium, etc.) have a density in the range of 1.18-1.6 g/cm^3. When using various inert weighting agents in the solid phase, we obtain drilling fluids with a density of 2 g/cm^3 and higher. At the same time, limestone and dolomite provide an opportunity to obtain weighted flushing fluids with a density of up to 1.25-1.35 g/cm^3. Such weighting agents dissolve in an acidic medium, therefore, it is recommended to use them in the work during the initial opening of productive strata [1]. Barite, hematite, galena (lead sulfide), magnetite, siderite (iron carbonate) are considered heavier and slightly soluble salts, which is why they are used to create solutions with a density of 1.4-2.3 g/cm^3 and higher. [2].

When drilling shallow and horizontal wellbores (angle of inclination from the vertical axis 65-900), low-clay and clayless drilling fluids are used, which have a pseudo-plastic flow character. This is due to strict requirements for the ability to transport drilling mud, which is determined by the efficiency of the removal of cuttings (drilled particles) to the day surface. Systems of this type should have minimal plastic viscosity, high dynamic shear stress, and an inverse relationship between effective (or structural) viscosity and shear rate. Biopolymer flushing fluids containing xanthanum CS-polymer as the main structure-forming agent meet these rheological requirements [3]. It is also known that a biopolymer flushing fluid (system), as a rule, contains an inert filler of the solid phase, as well as an additive that can serve as an inhibitor that prevents the dispersion of cuttings (i.e. system from effective pseudoplastic rheology.

Practice shows several types of halogenated rocks [4]:

1. Rock salt. The drilling fluid must be salted to prevent salt dissolution and cavernous formation, which in turn can lead to talus and collapse of the overlying terrigenous rocks. Drilling operations can be carried out with brine flushing if the required density does not exceed 1.2 g/cm^3.

2. Rock salt with layers of bischofite and other salts. It is necessary to drill these rocks using brine or mud containing salt with greater solubility;

3. Rock salt with interlayers of terrigenous rocks. For their drilling, it is necessary to use salt-saturated drilling fluids, the chemical treatment of which allows to obtain low fluid loss values;

4. Rock salt with interlayers of bischofite and terrigenous rocks. They should be drilled with flushing with solutions treated with chemical reagents with low fluid loss, saline with magnesium chloride [5].

Here, the presence of salt interlayers is often confined to the AORP zones, when drilling through which the use of saline solutions with a density of 1.18 g/cm^3 and higher leads to catastrophic complications (losses) due to the excessive difference between the formation and bottomhole pressures (repression). In this regard, in such cases, it is required to use oil-based emulsion drilling fluids with a density of 0.9-1.06 g/cm^3, in which rock salt does not dissolve.

The greatest danger during drilling in permafrost zones (permafrost), which is a high ice content, is created by rock splitting, which leads to dumping, destruction of the wellhead and borehole, and the development of caverns. Therefore, when driving a bit through permeable intervals, high-viscosity polymer clay systems with a nominal viscosity of more than 100 s are used. In the composition of the solution, an increased amount of polymer-type reagents is traditionally used, which can bind excess water and slow down heat transfer between the solution and the wellbore walls. When drilling, where elevated bottomhole temperatures (over 120 °C), drilling fluids are used containing heat-resistant polymeric reagents of the polyacrylic and polymethacrylic series, for example, Seurvey FL, Seurvey D1, etc.

Drilling operations at high temperatures, as a rule, are accompanied by sharp thickening of the solution, an increase in the filtration rate. Another difficult task is the calcination of the thickened bottomhole mortar unit after a long absence of circulation. Because of this, in addition to heat-resistant polymers, the proposed solutions in their composition contain effective liquefiers based on chromium-containing compounds.

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It is known that in wells, most of all, attention is paid to the technical and technological quality of the primary opening of productive formations, developing and using drilling fluids (or systems), which should ensure maximum preservation of the initial permeability of productive reservoirs and reduce the liquid-phase recovery of hydrocarbon-bearing horizons.

Drilling fluids for the primary opening of a productive formation must necessarily contain compositions of highly effective non-ionic surfactants, polyalkylene glycols. The surfactant indicators significantly effectively reduce the interfacial tension at the boundary of the solution filtrate with the hydrocarbon phase, hydrophobic the capillary walls of the productive reservoir, and maximally reduce the liquid-phase formation of productive horizons.

As you can see, a large assortment of drilling fluids is required when drilling wells in geologically complicated regions. Powerful salt deposits, for example, in the areas of the Bukharo-Khiva and Ustyurt regions, are located at a relatively great depth and at high temperatures, where, in addition to salt and temperature aggression, hydrogen sulfide is also found. It is possible to drill such wells only when using high-quality solutions treated with appropriate chemicals and materials.

The use of functional drilling fluids is considered promising, which, along with simplifying the process of drilling wells, can increase the mechanical strength of their walls, reduce foaming and fluid loss, and also reduce the thickness of crust formation. Such solutions can serve as hydrocarbon emulsions, which are very different in composition and properties from aqueous emulsions.

The analysis of the indicators of existing hydrocarbon systems does not create full-fledged conditions for revealing the advantages of a particular solution in terms of a dispersion medium. It should be noted here that in scientific works on hydrocarbon solutions there is no information about the chemical properties of the dispersion medium of these systems, the forces of interaction between its molecules, the control of the indicators of these solutions by changing the properties of the medium, etc.

The dispersed phase of solutions based on hydrocarbons can be solid and liquid. The following are used as a solid phase in the composition of hydrocarbon solutions: structure-forming agents - hydrophobized asbestos, organophilic bentonite (active ingredients); weighting agents - carbonate materials, magnetite, hematite and barite (inactive, inert components). Moreover, the chemical composition of bitumen has a significant effect on the properties of hydrocarbon bitumen solutions. Bitumen, which is the residue after the process of distillation of oil fractions from fuel oil, is a certain amount of oils and asphalt-resinous substances, consisting of a neutral resin, the main component of which is asphaltenes, as well as asphaltogenic acids, carbenes and carbides [6].

To bring the technological properties of hydrocarbon solutions to this or that value, various surfactants are used. The use of surfactants has a specific purpose: some of them increase the structural and rheological parameters of the drilling fluid, while others, on the contrary, decrease it. This conclusion is due to the results of the analysis of hydrocarbon solutions. The mechanism of action of surfactants does not fully disclose itself.

This usually manifests itself as follows: "The introduction of stabilizing reagents and active fillers ensures the kinetic stability of bituminous hydrocarbon drilling fluids." Soaps of alkaline, alkaline earth and heavy metals, naphthenates and sulfonaphthenates, cationic surfactants, nonionic fatty acid esters, etc., which act as water repellents for weighting agents and fillers, enhance the aggregative stability of asphaltenes, protect the system from the action of water falling into it.

Conclusion

Based on the foregoing, it is practically impossible to find out the role and mechanism of influence of stabilizers on the technological parameters of hydrocarbon drilling fluids.

Consequently, the analysis of materials on existing hydrocarbon drilling fluids deduces the fact that there is no scientific information on the regulation of their properties. There are practically no published works of both domestic and foreign specialists devoted to the regulation of the technological properties of hydrocarbon drilling fluids. The known compositions of hydrocarbon drilling fluids and technologies for their preparation do not meet the complicated mining and geological conditions when drilling wells at the present stage of the development of this industry. Drilling oil and gas wells in complicated mining and geological conditions requires the development of hydrocarbon drilling fluids, which should be distinguished by ease of use in the drilling process and manufacturability in preparation.

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Therefore, today it is advisable to create thermo- and salt-resistant clay drilling fluids in accordance with the following directions:

- creation of high-quality compositions of dispersed systems based on thermo- and salt-resistant natural mineral raw materials;
- based on thermo- and salt-resistant stabilizers reagents obtained by chemical-technological methods.

Of course, the priority development of the first direction is considered promising and economically justified. Moreover, this does not exclude the need for work in the second direction.

As noted earlier, palygorskite minerals showed high resistance to the aggression of electrolytes of formation waters and salt deposits than montmorillonite minerals. This made it possible to significantly reduce the cost of expensive chemical reagents while obtaining stable drilling fluids.

Unfortunately, it is not always rational to use drilling fluids obtained on the basis of palygorskite clays. they, having a solid structure, accelerate the wear of drilling equipment. Therefore, more often drilling fluids are prepared on the basis of compositions obtained from bentonites and palygorskite clays.

This approach is considered to be effective especially when drilling deep wells at relatively high temperatures.

Known heat-resistant stabilizing reagents (polyelectrolytes) obtained by hydrolysis of polyacrylonitrile and polyacrylamide or their copolymers greatly overestimate the cost of the obtained drilling fluids and hydrocarbon production in general.

In practice, the following stabilizing reagents are used to protect clay solutions from the coagulating action of electrolytes: condensed sulfite-alcohol stillage (KSSB), Na-carboxymethylcellulose (CMC), starch reagent (CR), cellulose sulfoesters, etc. [7, 8].

A common disadvantage of these stabilizers is their susceptibility to temperature effects [9].

On the contrary, reagents such as GIPAN, RS-2, RS-3, K-4 and others are more resistant to thermal effects on clay solutions.

Instead of the known stabilizing reagents such as KMC-600, K-4 and K-9 clay drilling muds in [9] proposed a composite polymer reagent, which consists mainly of caustic and soda ash and nitrogen fertilizer production waste, which contains polyacrylamide.

Analysis of methods for increasing the thermal and salt resistance of clay drilling fluids shows that there are still many unsolved issues and problems in this area of the industry.

There is little or no scientific evidence for local clays used in powder form or their compositions in drilling fluids. In this aspect, of scientific and practical interest are the clays of the Navbakhor field (Navoi region), which have good prospects for use in the oil and gas industry.

Thus, the specificity of drilling new oil and gas wells requires the use of new, highly effective, lubricating drilling fluids that function stably at high temperatures in the wells.

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