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A study of the properties of an oil-based drilling fluid with using emulsifier EM-4

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Abstract

The issue of maintaining the potential productivity of the well is one of the most urgent tasks of the oil and gas industry nowadays. Due to the development of deposits with complex deposits and low-permeability productive layers, the issues of increasing the flow rate of wells due to the qualitative opening of reservoirs were of fundamental importance. The drilling fluid with an oil base (OBM) does not adversely affect the properties of oil and gas collectors, also it has good lubricating properties, reducing the wear of drill bits and bits. This paper is devoted to comparing the properties of drilling muds prepared using the industrial emulsifier Cleave FM and the new synthesized emulsifier EM-4. Emulsifier EM-4 is a solution of N- (2-hydroxyethyl) amides of fatty acids in a mixture of mono- and diglycerides of fatty acids.

Keywords: oil-based drilling fluid, electrostability, emulsifier, plastic viscosity, static shear stress;

1. Introduction

The issue of maintaining the potential productivity of the well is one of the most urgent tasks of the oil and gas industry nowadays. Due to the development of deposits with complex deposits and low-permeability productive layers, the issues of increasing the flow rate of wells due to the qualitative opening of reservoirs were of fundamental importance. The drilling fluid with an oil base (OBM) does not adversely affect the properties of oil and gas collectors, also it has good lubricating properties, reducing the wear of drill bits and bits. [4]

Nomenclature
Oil-based mud – an emulsion system consisting of an aqueous phase and an oil phase
Electrostability of the mud – a parameter characterizing the degree of dispersion of emulsified water and the strength of the stabilizing layer of the emulsifier
Plastic viscosity – one of the parameters of the plastic rheological model of Bingham that characterizes the slope of the "shear stress / shear rate" line over the dynamic shear stress
Static shear stress – the value characterizing the strength resistance of the drilling fluid that is at rest for a given time.
The filtration rate – a parameter characterizing the ability of drilling fluids to disperse the dispersion component into a porous permeable medium

2. Experimental considerations

2.1. Rationale for the use of surfactants

The stability of this system is provided by emulsifiers, which are surfactants. The presence of a surfactant emulsifier in the emulsion leads to a decrease in the interfacial tension at the water-oil interface and thereby ensures the formation of a stable microemulsion. The technological properties of the emulsion drilling mud are significantly influenced by the phase ratio, emulsifier concentration and conditions of preparation. [6]

2.2. Study of parameters

The properties of these emulsifiers were studied by estimating the parameters of the model OBM containing these reagents. The OBM formulation was as follows:

- Oil base (diesel fuel) - 330 g;
- Water - 270 g;
- $CaCl_2$ (anhydrous) - 90 g;
- Emulsifier - 13 g;
- $CaCO_3$ - 107 g;
- Lime - 16 g;
- Organophilic clay - 7.2 g.

The ratio of the aqueous and oil phases in this OBM is 55:45.
The results of comparative tests of model emulsion drilling fluids are presented in Table 1.

Table 1. Results of laboratory studies of emulsifiers EM-4 and Cleave FM

		PV,	DSS,	SSS			Filtration, ml	
Emulsifier	ES, V	cP	cP	10 s	10 m	Efflux time, s	7,5 min	30 min
Cleave FM	147,4	26	19	8	8	67,91	3,4	5
EM-4	106,4	23	18	7	7	54,23	3,3	4,5

3. Results and discussions

3.1. Correlation of stability and electrostability of OBM

The electrical stability of the drilling mud characterizes the degree of dispersion of emulsified water and the strength of the stabilizing layer of the emulsifier and is an indirect parameter, characterizing the aggregative stability of emulsions. It is determined by the magnitude of the voltage of the electric current required for the electrical breakdown of the OBM layer placed between the electrodes. [5]

Drilling emulsion, prepared with the use of an industrial emulsifier, shows better electrostability in the model mud, which should indicate greater resistance to phase rotation of such a drilling mud. However the daily sludge of emulsions obtained on the basis of emulsifiers EM-4 and Cleave FM, showed that at a temperature of 80°C, complete destruction of the emulsion using an industrial emulsifier is observed after 5 hours and the EM-4 laboratory emulsifier stratification is observed for 6 hours. Hence, the study of the phase rotation of the drilling mud on the basis of the

electrostability does not give an objective assessment of its stability, and along with the electrical stability, one should consider the index of the daily settling of the drilling mud.

3.2. Comparison of rheological parameters and filtration rates

In practice, the PV is used for assessment the drilling mud to remove the sludge from the well. [1] The lower values of the plastic viscosity of the drilling mud based on the EM-4 emulsifier give it a distinct advantage: a change in the ratio of the phases in the emulsion towards the aqueous increases its viscosity, which means that the drilling emulsion using the Cleave FM emulsifier will reach the viscosity threshold more quickly. An increase in the aqueous phase in an oil-based solution significantly reduces its cost and gives a greater range for the regulation of parameters, at a lower cost, which is undoubtedly an important plus in drilling practice.

The increase in filtration contributes to caver formation, screes and collapse of the walls of the well, increasing the viscosity of the solution, deteriorating the reservoir properties of reservoirs. [2] During the tests, in 7.5 minutes the differences in the filtration rates of the drilling fluids were practically not observed, however, at a filtration time of 30 minutes it was shown that the drilling mud with the EM-4 emulsifier provided a smaller filtration. In practice, the use of a drilling emulsion with EM-4 emulsifier will preserve the natural permeability coefficient for the oil phase and provide a larger debit of the well.

4. Environmental problems and cleaning methods

When oil-based mud are used, there is a risk of environmental pollution by the components. The most dangerous of it is hydrocarbons. There are constant sources of pollution: filtration and leakage of liquid waste drilling from sludge barns, which contain a wide range of contaminants of mineral and organic nature. Temporary sources of impact are:

- The absorption of drilling mud during drilling;
- Outbreak of formation fluid to the surface;
- Seal failure of cemented borehole annulus;
- Flooding of the drilling compound due to slurry barns spilling causes by flooding or intensive snow melting.

The direct negative impact of drilling waste is on the soil, disrupting the its composition, properties and fertility. First of all, the contaminant toxicity affects the soil biota and fertile soil properties. [3]

The basis of drilling fluids can be both water and organic solvents, but today's environmental protection requirements and technological features of drilling processes determine the use in most cases of drilling muds on a water basis. Since PAC is a water-soluble polymer, it is used in drilling fluids as an additive. By the degree of exposure to the body PAC is classified as a hazard class 3 - a moderately hazardous substance.

In soil, which is contaminated with OBM, the ratio between carbon and nitrogen sharply changes, which worsens the nitrogen mode of soils and disturbs the root nutrition of plants. The soil loses its productivity and the fertile layer is not restored for a long time. Self-cleaning of soils is very slow.

According to experts, the most promising methods of cleaning the soil cover from oil spills and drilling mud are electrical methods of remediation, as well as phytoremediation and microbiological treatment of contaminated soils. [7]

5. Conclusion

Based on the obtained results, it can be concluded that the model drilling mud using EM-4 emulsifier shows the best properties of stability, filtration, plastic viscosity, static shear stress, compared with the OBM on the industrial emulsifier Cleave FM. In the future, it is necessary to conduct field tests of EM-4 emulsifier, as well as to conduct laboratory studies of the properties of the model drilling mud at high temperatures close to bottom of borehole. Based on the data obtained, it is necessary to draw conclusions on the feasibility of the industrial release of the EM-4 emulsifier.

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