WELL DRILLING

Lubricating additives in drilling and methods of their research

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The paper presents an analysis of the properties of various lubricating additives, which are used for treatment of drilling fluids to reduce the consumption of crude oil and methods of research.

A supply shortfall of high quality chemicals including lubricants became an actual problem of drilling companies in 2010-2012. During the past 10 years in the market of lubricants for drilling fluids and process liquids, in addition to traditional chemicals, oil and graphite, lubricant additives are distributed based on the modifying oil and fat production processing waste (*phosphatide concentrate, hydrofuse*): labrykol, wells of small diameter (WSD), SMZh, burol and others in Ukraine and FC-2000 in Russia. The use of such additives for drilling made it possible to reduce the cost of oil for reduction of the coefficient of coating friction (CCF).

It is known that oil as a component of drilling additives has the following functional properties: inhibition of clay swelling, inhibition of thermal degradation, hydrophobizated, anti-foam, anti-oxidant and anti-friction properties. In addition, oil is a quality lubricating component and kolmatant during productive horizons exposure. The use of oil as a part of the liquid for the development of productive horizons reduces interfacial tension and facilitate the inflows of fluid from the reservoir [1]. During drilling of wells with depth of 2000 m the hydrophobizated particles of formation cuttings facilitates solution cleaning and increases drilling speed.

Useful properties of oil are determined by its chemical composition: asphaltenes (0.2-0.7 %), resinous substances (0.4 - 25.5 %), naphthenic acids (0,6-2,4 %), bituminous substances (up to 10 %) [2]. We know that foreign companies use pure asphaltic reagents under various brand names (Soltex, Sulphoneted Asphalt, etc.).

The versatility of oil makes it possible to build wells, even in the absence of reagents of special purpose. The recommended concentration of oil in drilling fluids is traditionally up to 10 %, but there are some restrictions on the use of oil while drilling. According to [3], the use of oil as part of the drilling fluid in the range of drilling from 0 to 2000 m is prohibited, requiring the use of lubricating additives of other origin.

An important factor affecting the occurrence of friction during well drilling, is the degree of lubrication properties of the drilling fluid [4]. So, the timely determination of the quality of lubricating additives in the composition of drilling fluids is important. The authors of the article compared the current available methods for determining of lubrication (anti-friction) properties of drilling fluids.

It is generally accepted a method of determining the lubricating properties by measuring CCF using the CCF-1 device. The use of CCF-1 allows measuring of the displacement angle of the objects (indenter) with clay coating in degrees. Note that this parameter as the CCF considered to be less informative because it does not allow to express the coefficient of friction in conventional terms, namely in H and Pa.

It is also known a method by the standard of the American Petroleum Institute (API), in which the lubricating properties of drilling fluids are determined by measuring the friction coefficient of the pair "metal- metal" when metal ring is rotating towards relatively fixed metal block. It allows you to simulate the rotation of the drill pipe in the well. The result of research is to establish the coefficient of the lubricating properties of the drilling fluid. The use of techniques and devices proposed by API helps to determine the degree of lubrication properties of the drilling fluid, but does not allow simulation of the real conditions encountered in the well during friction of drilling pipes.

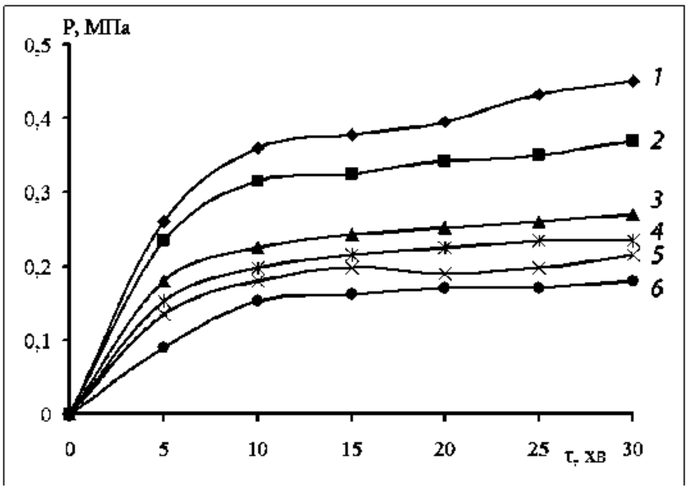

Fig. 1. The dependence of static stress of indenter shift: from a clay coating of their contact time: *1* - clay model solution T = 20-25 s, F = 15 cm^3, *2* - model solution+1 % of graphite, *3* - model solution+3 % of labrykol, *4* - model solution+3 % SMZh, *5* - model solution+3 % WSD, *6* - model solution+10 % of oil

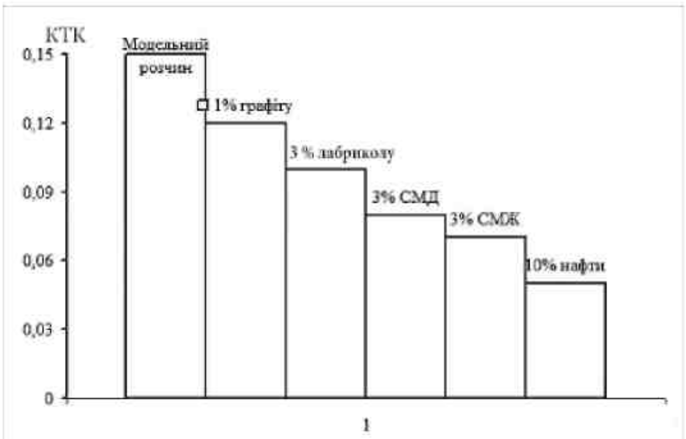

Fig. 2. The dependence of the coefficient of coating friction from lubricating additives

In order to study the anti-friction properties of the drilling fluid the authors used the method for determining the shift stress in the clay coating by pressure changes at the mount NK-1, developed by the Instrument Engineering Plant of Baku. The setting enables to measure the shift stress of indenter with clay coating formed by the differential pressure of 5 MPa, which makes it possible to simulate the conditions that occur during differential friction. The use of NK-1 enables to measure the static filtration of drilling solution and fluids that can be used in the form of "baths" in case of frictions, under pressure up to 50 atm. In addition, the thickness of the clay coating formed within a specified time can be measured with NK-1, and be varied with the pressure and time at which indenter sticks to the clay coating. Thus, the use of mount NK-1 allows to approach the conditions of experiment to the real conditions of well drilling.

It should be noted that the mount NK-1 has drawbacks: low performance of filter working solution, due to the lack of perforations in the filter node. This deficiency prevents the formation of clay coating to be thick enough for indenter sticking. The drawback was removed by cutting auxiliary cylindrical grooves (for example BM-6) on the filter node, which doubled filtration rate and helped to form a coating.

The work technique with the mount of NK-1 goes as follows: 1) a model solution with volume of 550-600 cm3 is prepared, and lubricant additive is added there in a predetermined ratio 2) the mount casing is filled with work solution and working pressure up to 5 MPa is applied to form clay coating and 3) clay coating and indenter are brought into the contact 4) after a fixed period of time the indenter is displaced from the clay coating.

The use of the mount NK-1 made it possible to vary the filtration pressure, pressure and time at which the indenter is sticked and pressure at which the displosal of the indenter with clay coating is performed. Ultimately, the breakdown point of indenter is fixed by the counter the readings of which are multiplied by a spring factor (in this case the actual value of the spring constant K = 0.009 MPa/h), which enables you to get the value of a static shift stress (*Pss*) in MPa. During the research the pressure in the working chamber of the mount (*Pw*) was maintained between 0.5 and 4 MPa for 30 min to form a clay cover, time of indenter and the clay coating being in contact (Tcont) ranged from 5 to 30 minutes, the pressure at which there was a shift of indenter (Pshift) ranged from 0 to 4 MPa.

Conducted research at the mount NK- 1 helped to identify the main criteria that affect the static shift stress of indenter of clay coating, namely the composition of the solution and contact time of indenter and clay coating. The received dependences are shown on the Fig. 1.

Analyzing the above dependencies it can be concluded that the adhesive interaction between the metal surface and indenter and clay coating occurs most actively during the first five minutes of contact, subsequently strengthening of the connection of the metal surface and the cover is not going so fast that appears as a flat section of described dependencies.

Thus, a flat interval is observed in the case of lubricating additives on the fat base or oil due to their specific adsorption on the metal surface as well as on the active surface area of the clay phase. In contrast to the above additives, the presence of graphite in the model solution does not allow to get dependency with low static shift stress, indicating the inability to form graphite adsorption bonds with the metal surface. Thus, graphite is an inert lubricating additive, lubricity of which explains the decrease of the friction force due to sliding metal surface on the edges of the crystal lattice of graphite. A wide range of oil chemical composition is shown in the best performance of anti-freezing properties with relation to all of the above lubricating additives. Thus, the specific absorption which is inherent to lubricant additives on the fat base and oil makes it possible to increase the lubricity of drilling fluid for a long time compared with inert lubricants additives like graphite.

If these circumstances apply to the drilling conditions, it is fair to conclude on the need of quick overcoming of frictions because sometimes it is necessary to put more shift stress to displace drill pipes.

In parallel with the measurement of static shift stress of indenter from the clay coating the measuring of the coefficient of coating friction was performed. The base liquid was a model clay solution with the following parameters: T = 30 s, F = 11-12 cm3.

The received results are shown in the histogram on the Fig. 2.

The comparison of the results obtained for the installation NK-1 and CCF-1 device, allows them to detect a clear correlation. Thus, the test lubricants and anti-freezing additives for gear

CCF can be recommended as an express method in an industrial environment with a high reliability of the results.

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NEWS

Perspectives of gas imports from Israel to Jordan

Since Israel plans to export 40 % of its energy from the Mediterranean Sea, Jordan is considering a draft agreement for the procurement of natural gas. Though, because of geopolitical considerations the final decision is not taken, several variants of gas supplies from Israel to Jordan are studied. Among them are the extension of gas pipeline from gas-chemical complex of Israel which is on the shore of the Dead Sea, to the Soda Factory in Jordan, the construction of a new pipeline from the Mediterranean Sea through Jezzerel Valley to Beit Shean and on to Jordan and so on.

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