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Evaluation of the Influence of Oiling of Clay Minerals on their Swellability in Drilling Solutions

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ABSTRACT. An increase in the content of CaO and MgO in clay is accompanied by an increase in the swelling and swelling time of the clay mineral, which should be taken into account when obtaining a multifunctional drilling fluid. The swelling and swelling times of local clay minerals with water were studied depending on CaO and MgO in their composition. A comparative analysis of fresh and spent (oiled) clay mineral was carried out, which allowed to identify distinctive features in their structure and properties. Oily clay minerals can reduce their swelling and oil absorption, which is due to a change in the type of solution from hydrophilic to hydrophobic.

KEYWORDS: montmorillonite, palygorskite,hydromica, surfactants, clay minerals, swelling, moisture capacity, clay drilling fluids, filtration capacity, suspensions, multifunctional drilling fluid

I. INTRODUCTION

At present, clay minerals (montmorillonite, palygorskite,hydromica, etc.) are widely used in various sectors of the economy as adsorbents, fillers, and carriers, etc.

After their repeated use, the loss of reactivity is subjected to regeneration, thereby worsening the air atmosphere and the ecological safety of the environment. In addition, for high-temperature regeneration of spent clays, they consume a large amount of fuel, electricity, etc.

Therefore, today rational ways to utilize the oiling of clays are being sought through their repeated use in detergents (surfactants), drilling fluids and rubber products as plasticizers.

II. SIGNIFICANCE OF THE SYSTEM

An increase in the content of CaO and MgO in clay is accompanied by an increase in the swelling and swelling time of the clay mineral, which should be taken into account when obtaining a multifunctional drilling fluid. The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. METHODOLOGY

A comparative analysis of fresh and spent (oily) clay mineral allows you to identify distinctive features in their structure, properties, etc.

With this in mind, we studied a number of indicators of local montmorillonite (Navbakhardeposit) and palygorskite, (Navbakhar deposit) and hydromica (Shorsu deposits).

The revealed results are presented in table 1

From table 1 it is seen that oily clay minerals after repeated use tend from hydrophilic to hydrophobic, which is confirmed by a significant decrease in their swelling and moisture capacity. According to the data presented in Table 1, the studied minerals before and after oiling are arranged in the following order of decreasing: montmorillonite (NM)>palygorskite (NM)>hydromica (MSN)> ...

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Table 1.
Comparative indices of local clay minerals before and after oiling

View clay mineral	Before oiling			After oiling		
	Swelling %	moisture capacity, %	type of solution	Swelling, %	moisture capacity, %	type of solution pa
Montmorillonite(NM)	90	55	hydrophilic	82	50	hydrophilic
Palygorskite (NM)	70	39	hydrophilic	58	30	hydrophilic
Hydromica (MSW)	64	33	hydrophilic	56	29	hydrophilic

The largest decrease in clay swelling after oiling is observed in palygorskite (NM) -12% and less in montmorillonite (NM) and hydromica (MSW). However, when bleaching vegetable oils, montmorillonite adsorbents are used several times more than palygorskite or hydromica. Therefore, oily bentonite clays are exported to the city landfill, palygorskite or hydromica are mixed in collections where various types of oiled clays come. It is known that increasing the viscosity of drilling fluids due to peptization of clays and cuttings complicates the process of drilling a well. In this case, clay swelling should be studied according to all the requirements of the standard and the conclusions should take into account their role in changing the viscosity of the resulting drilling fluid.

IV. EXPERIMENTAL RESULTS

Table 2 presents the main indicators of swelling of local clays with water before and after their oiling.

Table 2.
The main indicators of swelling of local clays with water before and after oiling

Name of indicators and units of their measurements	Name of local clay		
	Montmorillonite (NM)	Palygorskite (NM)	Hydromica (MSW)
Before oiling the local clay			
Degree of swelling (n), sм^3/g	1,409	1,202	1,354
Degree of swelling (τ), hour	750	675	712
Average swelling rate (W_{cp} *10^{-3}), cм^3 / g* hour	1,57	1,37	1,43
Shear stress (Pm), g*s / sм^2	104	105	107
After oiling local clay			
Degree of swelling (n), sм^3/g	1,357	1,184	1,312
Degree of swelling (τ), hour	745	605	694
Средняя скорость набухания (W_{cp} *10^{-3}), sm^3 / g*hour	1,44	1,26	1,37
Shear stress (Pm), g*s / sм^2	101	93	98

From table 2 it is seen that the oiling of local clay minerals helps to reduce all of their main indicators of swelling. Moreover, palygorskite (NM) and further, hydromica (MSh) and palygorskite (NM) are more resistant to water swelling. This can be explained by the fact that montmorillonite (NM) water is absorbed not only by the outer

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surface, but also by the inner (inter-packet) space, which is not the case with palygorskite.
In practice, the maximum swelling of clays or their compositions (N, sm^3/g) is calculated by the following formula:

$$H = \frac{h \cdot S}{F} \qquad (1)$$

Where, h - the height of the clay swelling with water, cm;
S is the area of the cylinder ring, cm^2;
F is the sample weight, g.

Using this formula, we studied some of the dependencies necessary to assess the degree of swelling of local clay and determine the possibility of its use.

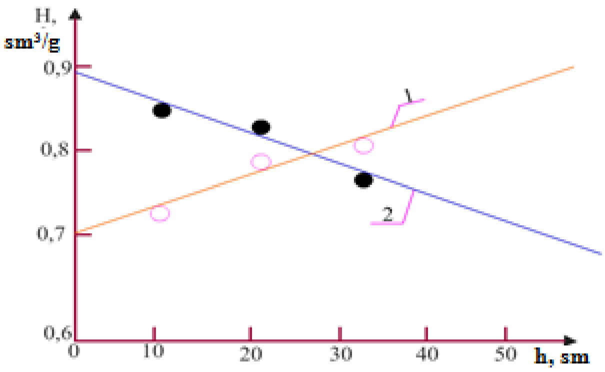

Fig. 1: Change in the maximum swelling of local clay (montmorillonite) depending on the height of the water and its size.

It can be seen from Fig. 1 that with an increase in the height of water in the cylinder (curve 1), the maximum swelling of clay grows linearly and vice versa, with an increase in its weight, this indicator decreases linearly. This is due to the fact that the water necessary for clay swelling must be in such quantity that it completely fills the pores and channels of the clay under study. The height and size of the clay sample depends on the water content in the cylinder. This dependence is directly proportional over the area of the ring, and inversely proportional to the size of the clay sample.

At the request of drillers, for the normal performance of their functions, clay drilling fluids should have a small filtration ability, form strong coagulation structures that have thixotropic (the ability to recover spontaneously after destruction) properties, and be resistant to the coagulating action of electrolytes. This is necessary to keep the cuttings in suspension when the circulation of the mud is stopped, as well as to prevent complications when drilling in saline rocks. Moreover, when drilling in loose, easily collapsing rocks, a prerequisite is the low rate of filtration of the clay suspension i.e. very weak ability of the suspension to give water to the drilled formations.

V. CONCLUSION AND FUTURE WORK

All this to a certain extent depends on the mineralogical and chemical composition of clay minerals. For example, palygorskite, rich in CaO and MgO, as compared with montmorillonite and hydromica, also changes its swelling indices depending on these compounds.

Given this, we studied the swelling and swelling times of local clay minerals with water, depending on the content of the above oxides in their composition.

The results are presented in Fig. 2.

As can be seen from Fig. 2. with increasing contents of CaO (curve 1) and MgO (curve 2), the swelling and swelling time of palygorskite (NM) increases. This is due to the fact that both oxides actively interact with water, absorb it in large quantities and generate heat, which intensifies the swelling time of palygorskite (NM).

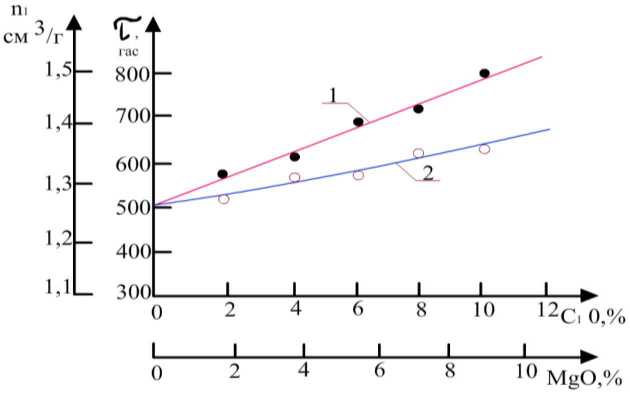

Fig. 2. Change in swelling (curve 1) and swelling time (curve 2) of palygorskite (NM) depending on the content of CaO and MgO in it.

Thus, the conducted studies allow us to draw the following conclusions: - the oiling of clay minerals reduces their swelling and oil absorption, which is due to a change in the type of solution from hydrophilic to hydrophobic. At the same time, the greatest decrease in the swelling and moisture capacity of clay is observed in palygorskite (NM), which differs significantly in mineralogical structure and chemical composition from montmorillonite and hydromica. This also affects the average swelling rate and ultimate shear stress of the studied clays.

As expected after oiling these minerals, the aforementioned indicators are significantly reduced in almost all of the analyzed clays.

It was revealed that the maximum swelling of local clays directly depends on the height of the sorbed water and is inversely proportional to their weight.

It was found that the swelling and swelling time of clay depends directly on the content of CaO and MgO in it. An increase in their content in clay is accompanied by an increase in the swelling and swelling time of this mineral, which should be taken into account when obtaining a multifunctional drilling fluid

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