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LABORATORY TESTS NEWLY DRAWN UP NON-CLAY, GLYCOL-POTASSIUM DRILLING MUD WITH THE NEW POLYMER PT-52 INTENDED TO DRILL CLAY ROCKS***

1. INTRODUCTION

Drilling through clays and shales stratums can make a huge difficulties, which are causes by effects like hydration, swelling and dispersion of clays. Those effects can lead to complications such as loosing a stability of well, flaking of rocks and decreasing of well diameter.

Clay minerals usually conists of hydrated silicated aluminium, sometimes magnesium, it is very characteristic because of its layered or layer-ribboned structure. Structure of clay minerals is considered by parallel layers in shape of tetrahedrons or octahedrons. Every single silicon layer consist of tetrahedron of silicon oxide. They are connected together by oxygen atoms, placed in corners of tetrahedron. Such tetrahedrons are negotiating so that their means of the symmetry create rings about the hexagonal symmetry. Such layer is regarded as the complete anion and is being named tetrahedric. Layers metal-oxygen-hydroxide comprise from octahedrons, inside which are being found cation of metal. Such octahedrons connected with oneself are called octahedral layer octahedral.

For damaging the wall of the hole by the drilling mud on water warp a hydration of clay minerals is an affecting main factor.

On clay minerals it is possible to divide the adsorption of water in two stages: the surface hydration and the osmotic hydration.

The surface hydration consists in the adsorption of water through middle-packages cations and siliceous packages (Fig. 1). Amount of adsorpted water and increase associated

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with it in the distance middle-packages depends on the chemical structure of clay. Minerals containing sodium cations are characterized by a much higher adsorption of water than potassium, calcium or magnesium clays (Fig. 2). The surface hydration is being hindered as a result of the ion exchange. Potassium K^+ ions are acting as the inhibitor of the hydration, such as calcium Ca^{2+} and ammonium NH^{4+}.

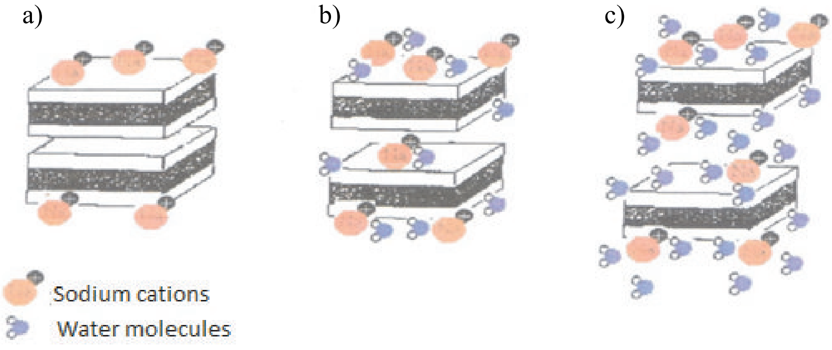

Fig. 1. Hydration of clay minerals: a) non hydrated molecules of clay; b) surface hydration; c) osmotic hydration

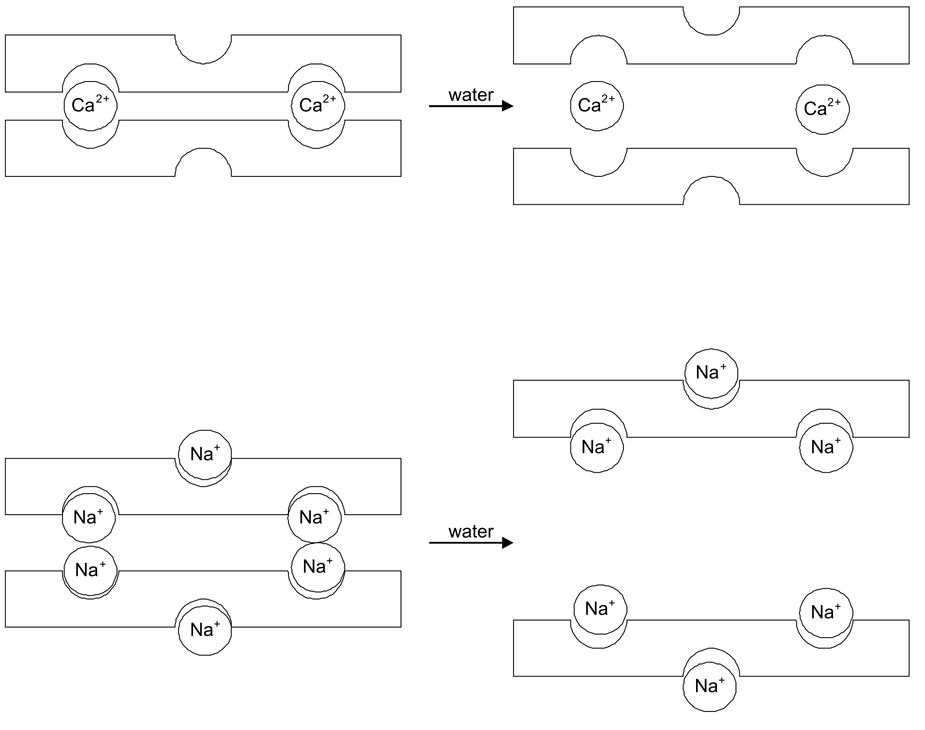

Fig. 2. Hydration of soda and calcium clays

The osmotic hydration is a result of the lack of the balance between the activity of ions in middle-packages spaces of clay, but them with activity in the mud and relies on the flow of particles of solvent than lower to a high concentration of electrolytes, in order to balance the osmotic pressure. Limiting the osmotic hydration is being achieved by applying mud about the high concentration of electrolytes.

Industrial and laboratory studies lead to elaborate a new kind of drilling mud called inhibitated mud, which cause less hydration in clays. Representatives of this kind of mud is glycol-potassium mud.

Effectiveness of inhabitation action of glycol-potassium mud with reference to the hydration of clay rocks is very high and comparable with the effectiveness of dispersion-oil mud. Mechanism of action polyglycol exactly wasn't still examined. According to one of theories inhibition action is following: polyglycol is acting as the penetrating glue which penetrating into leeks of the clay rock, is hardening it, in addition in this process hydrogen bonds are decisive. Penetrating into rock, polyglycol is driving water from it on account of the stronger affinity of clay to glycol than to water.

Other theory is telling, that primary importance in the inhibition process of clay rocks is driving water from the surface of rock and creating long-lasting clay-polyglycol complexes. Important meaning has a phenomenon of the separation of phases, consisting in knocking microdroplets out in this case polyglycol from the drilling fluid in the increased temperature, i.e. above the point of cloudiness. Bevel separating from the mud polyglycol on the wall of well is being planted, creating hydrophobic layer sticky, similar to oil which isn't surrendering to diffusing by the drilling fluid (Fig. 3) [1, 2].

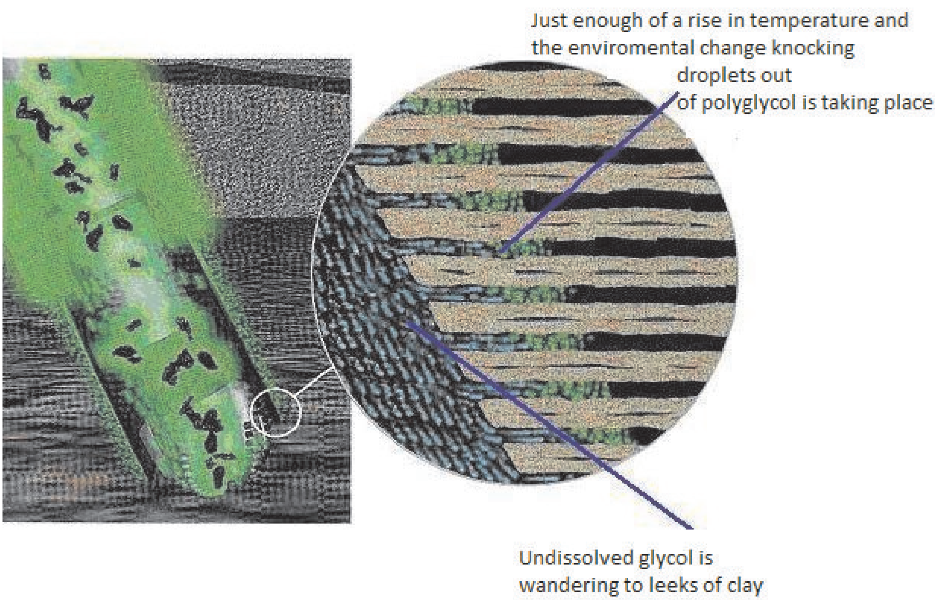

Fig. 3. Inhibitation system of glycol-potassium mud

2. EXPERIMENTAL PART

The first step of studies was to elaborate a composition of mud based on glycol and new polymer PT-52. The studies were guided in accordance with API standards [3] and polish branch standards [4]. The results are showed in the table 1. The main active component is polymer PT-52, which is supposed to decrease filtration and hydration of clays minerals, as well as is glycol with point of turbidity 63 ^{o}C. In the results of tests we have also noticed influence of polymer PT-52 on the rheological parameters of drilling mud. We also have made studies to check the impact of loading material on rheological parameters. The results imposed very satisfactory, we did not noticed any negative changes in rheology, even with 5% concentration of chalk. No influence of chalk on rheological parameters will allow to use it in the conditions of higher reservoir pressure.

Table 1

Composition and technological parameters of glycol-potassium drilling mud

Composition	Technological parameters	
Polyglycol – 4% Rotomag – 2% Polymer PT-52 – 0.5% K_2CO_3 – 3%	Density, g/cm^3	1.02
	Plastic Viscosity, mPa·s	14.5
	Apparent Viscosity, mPa·s	33.5
	Yield Point, Pa	25
	Structural Strength, Pa	7.9
	Filtration, ml	6
	pH, –	13.5
	Lubricity, –	0.29

In the results of the studies we have noticed beneficial influence of polymer PT-52 on rheological parameters of drilling mud. In the next issue we studied the influence of loading material on the rheological parameters. We decided to use a chalk because of less abrasive properties then the other loading materials. The results are showed in table 2.

Table 2

Composition and technological parameters of drilling mud with addition of chalk

Composition	Technological parameters	
Polyglycol – 4% Rotomag – 2% Polymer PT-52 – 0.5% K_2CO_3 – 3% $CaCO_3$ – 5%	Density, g/cm^3	1.04
	Plastic Viscosity, mPa·s	13.5
	Apparent Viscosity, mPa·s	34.5
	Yield Point, Pa	26.5
	Structural Strength, Pa	8.7
	Filtration, ml	5
	pH, –	13.5
	Lubricity, –	0.27

Next step of studies was to test of clay beams "QSE Pellets" in the drilling mud and in the filtrate. We observed the disintegration of the clay beams, it forced us to reduce ion inhibitor in the mud. Decision was to reduce concentration of K_2CO_3 to 2%. We have noticed a improvement in next clay beam test, which confirmed the decision we had made.

In the next modification potassium carbonate was replaced by potassium chloride, which is more common in industry practice.

Table 3

Composition and technological parameters with potassium chloride

Composition	Technological parameters	
Polyglycol – 4% Rotomag – 2% Polymer PT-52 – 0.5% KCl – 2% $CaCO_3$ – 5%	Density, g/cm^3	1.04
	Plastic Viscosity, mPa·s	12
	Apparent Viscosity, mPa·s	29.5
	Yield Point, Pa	16.5
	Structural Strength, Pa	7.5
	Filtration, ml	5
	pH, –	11
	Lubricity, –	0.25

Comparison of results showed advantage in using potassium carbonate. Potassium chloride cause complete disintegration of clay beams which in well conditions could let to swelling or dispersion of clays. Next studies were conducted only with use of potassium carbonate.

3. LABORATORY TESTS OF THERMAL RESISTANCE

In order to prove mud thermal resistance we put it into the tests in higher temperature of 20÷80 ^{o}C. Tests showed us that increasing temperature has a low influence on technology parameters (Fig. 4).

4. INFLUENCE OF MONOVALENT IONS ON RHEOLOGICAL PARAMETERS OF DRILLING MUD

We have made four tests with concentration of sodium chloride as follow 5%, 10%, 15%, 30% to examine the influence of single-valued ions on mud technological parameters (Fig. 5).

Tests proved us, that the influence of sodium chloride is extremely low. Technological parameters did not change even in the condition of full saturation with salt, moreover we have observed an advantage in form of decreasing filtration. Such results allows to use a drilling mud with new polymer PT-52 in saline environment, which actually occurs very often in form of interbedinggs of salt layers with clay stratums.

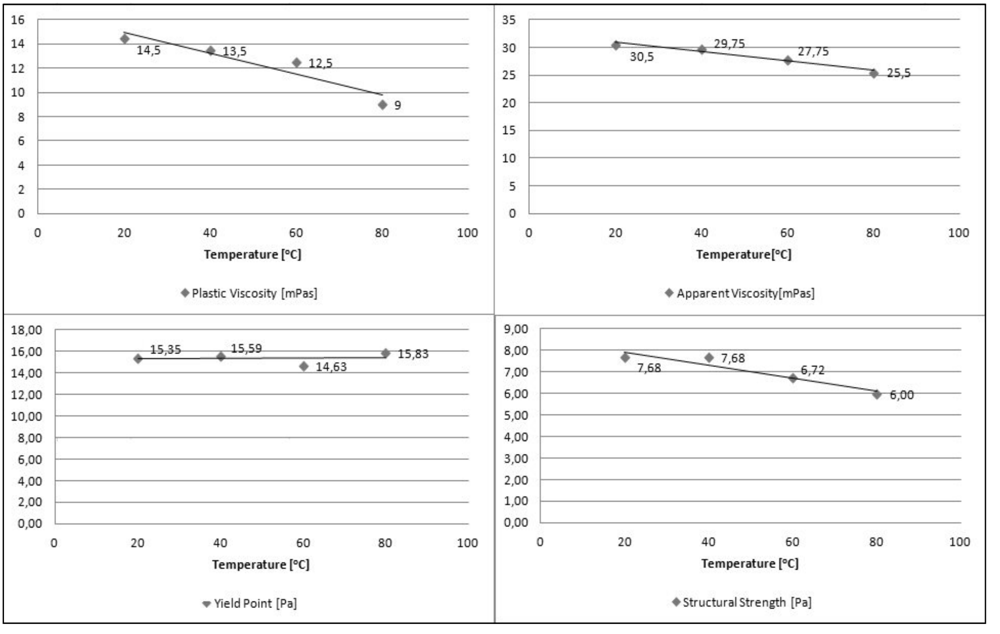

Fig. 4. Mud rheology in function of temperature

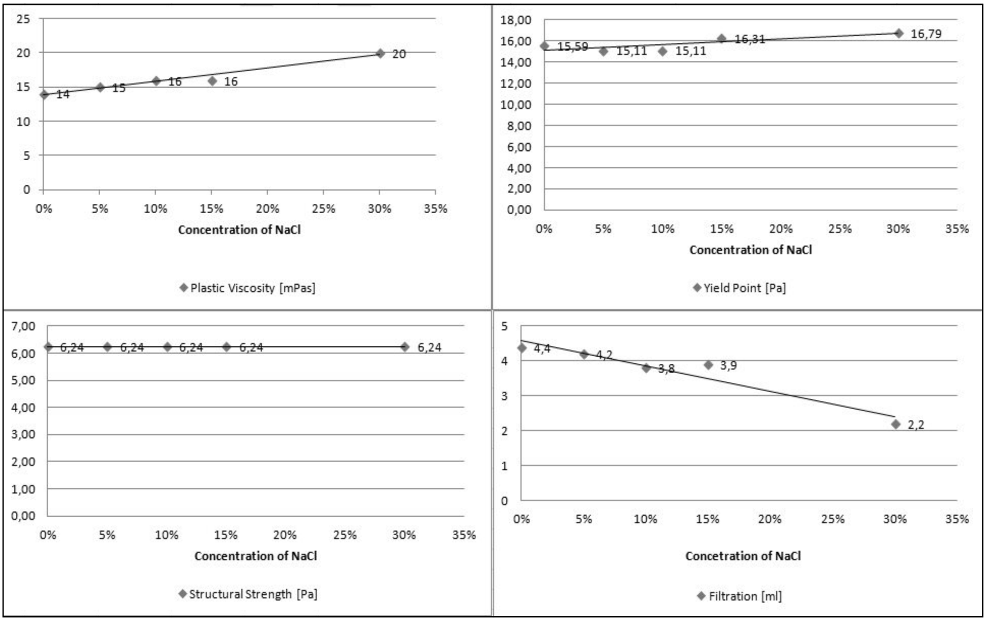

Fig. 5. Influence of NaCl on rheological parameters and filtration of new drilling fluid with polymer PT-52

5. INFLUENCE OF DIVALENT IONS Mg^{2+} AND Ca^{2+} ON TECHNOLOGICAL PARAMETERS OF DRILLING MUD

To research influence of divalent ions on drilling mud we made couple tests with concentration 0.5% of Mg^{2+} i Ca^{2+}. The results are matched in figure 6.

Tests showed that, the infulence of divalen ions is very low, so we did not notice any changes in rheological parameters. It confirms, that elaborated drilling mud resist divalent ions. Like as in the earlier tests we have observed an advantage in form of decreasing filtration.

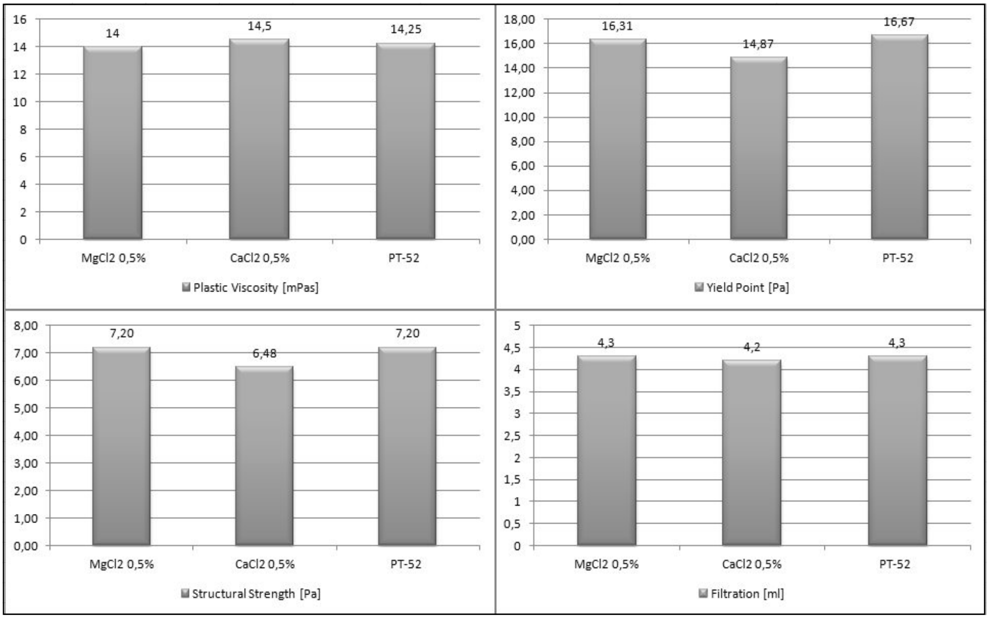

Fig. 6. Influence of divalent ions Mg^{2+} and Ca^{2+} on technological parameters of drilling mud

6. CONCLUSION

The tests we have made showed us, that elaborated glycol-potassium drilling mud characterized with very good inhibition of clay minerals. We have a proof in results we have obtained after the tests of clay beams QSE Pellets. During our researches we have noticed very good technological parameters of mud. What is more created glycol-potassium drilling mud with polymer PT-52 resists temperature changes and influence of single-valued ions as well as it resists influence of divalent ions. Based on test results we are able to ascertain, that there is no negative influence of loading material in form of chalk on technological parameters. This is especially important in deep drilling.

LITERATURE

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