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Issue Article

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THE METHOD OF DRILLING MUD TREATMENT WITH THE INHIBITED COMPLEX ADDITIVE «PACS» AND THE RESULTS OF FIELD TESTS

Abstract: *In this article, the method of drilling mud processing using the PACS and PACS-T (thermally stabilized) systems, as well as the results of their field tests, are highlighted and considered in detail. Inhibited solutions after prolonged stoppages (for the period of geophysical research and others) restoration of the circulation of the solution is carried out intermittently after the drilling tool is lowered into the cased part of the borehole (casing shoe). This causes the sedimentation stability of the solution for a long time and reduces the likelihood of the drill string being seized due to the retention of the suspended state of barite particles and drilled rock.*

When using the PACS and PACS-T (thermostabilized) systems on the oil and gas areas of Turkmenistan, in sections containing clay rocks, the narrowing of the borehole, collapses and tacks of drilling tools stopped.

(translated article)

Key words: *inhibitor, collapse, plastic viscosity, water loss, chemisorption. sludge, inhibitory additives, reagent, cavern formation, heat stabilizer, filtration property, viscosity.*

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Introduction

Inhibited solutions have increased clay capacity, fastening properties of the filtration crust, thereby increasing the stability of the borehole zone of the well. Therefore, the solutions transferred to the inhibited system can withstand large values of water yield by 1.5-2.0 times in comparison with the required values laid down in the geological and technical order (GTO) and at the same time are able to maintain the stability of the wellbore for a long time.

One of the properties of inhibited solutions is a set of structural strength over time. Therefore, after long stops (for the period of geophysical research and others) restoration of the circulation of the solution is carried out intermittently after the drilling tool is lowered into the cased part of the borehole (casing shoe). This causes the sedimentation stability of the solution for a long time and reduces the likelihood of the drill string being seized due to the retention of barite particles and drilled rock.

When drilling in unstable deposits of clay rocks in the zone of moderate and elevated temperatures, it is necessary to use inhibited drilling fluids for successful trouble-free wiring of wells.

The ability of clay rocks to spontaneously disperse and swell complicates the whole process of drilling wells. Inhibited solutions are used where the use of conventional clay solutions causes complications when drilling wells. Complications are expressed in the form of scree and landslides, narrowing of boreholes, cavern formation caused by swelling of clay rocks and their transition into solution. Clay sludge undergoes peptization and dispersion, which leads to thickening of the solution and deterioration of its parameters.

Inhibited solutions reflecting domestic and foreign experience of drilling wells are known [1, 2].

Salts of NaCl, KCl, $CaSO_4$, $CaCl_2$, silicates, fatty acid soaps, lime are used as inhibitory additives in these solutions. However, when using them, the inhibition effect is lower, since inhibitors neutralize, as a rule, only one of the two lyophilic sections of the mosaic surface of clay particles: either along the planes – negatively charged areas, or along positively charged faces and fractures. Since clays are diphilic and rigidly amphoteric, unilateral inhibition will be much less effective than multilateral. There is a known method of processing clay solution with a combined reagent [3], including, by weight %:

Cement 10,0 – 25,00
Clay 10,0 – 25,00
Caustic soda 0,20 – 0,40
Viscosity
reducing agent: Sulfite-alcohol bard (SAB) or its derivatives 4,00 – 8,00
Water (the rest)

Cement is included in the reagent as a supplier of inhibitory components, and after its introduction, the preparation time of the inhibited reagent is 20-30 hours.

However, the inhibited system containing the above reagent has disadvantages, which are that clay (10-25%) is additionally introduced into the reagent, which accordingly increases the content of the clay phase in the solution to 40-45%. Such concentration thickening causes an additional load on the clay capacity of the solution and the solution cleaning system. In addition, sulfite-alcohol bard or its derivatives cause strong foaming, which affects the parameters of the inhibited solution: the solution "swells", its volume increases, density decreases and viscosity increases. The disadvantage of the inhibited reagent also includes a long time of its preparation [3, 4].

The technical task of successful drilling operations is to develop a method for processing drilling mud with an inhibited complex additive, and to determine the qualitative and quantitative composition of its constituent components. This will increase the efficiency of inhibition of drilling mud and reduce the preparation time of the inhibited complex additive.

The technical problem is solved when drilling mud is treated with a combined reagent consisting of cement, caustic soda, a viscosity reducing agent (lignosulfonates), a surfactant and potassium chloride (KCL) and water, with the following component ratio, weight %:

Portland cement 10,0 – 12,0
Lignosulfonates 10,0 – 15,0
Caustic soda 4 – 5
Surfactants 1-2
Potassium chloride 10 – 15
Sea water
Technical, reservoir - the rest.

If there is a shortage in some systems, then in moderate (from +61°C to +100°C) and elevated (+101°C and more) zones, the temperature loses the mobility of the drilling fluid and lowers the protective properties of the reagents, which are reflected in the inhibited solution parameter: density increases, structural-mechanical, rheological and filtration properties.

The technical task of the invention is due to an increase in the inhibition efficiency and stability of the drilling fluid in the zone of moderate and elevated temperatures.

The solution of the technical problem is achieved by the fact that when carrying out the possibility of processing drilling mud, including the introduction into the drilling mud of a complex ingested supply of "PACS", consisting of portland cement, potassium chloride, caustic soda, lignosulfonates, powerfully active substances (surfactants) and water, which include additional sources: sodium bichromate ($Na_2Cr_2O_7$) or potassium ($K_2Cr_2O_7$) with the subsequent joint component, weight %

Portland Cement - 10 - 12
Potassium chloride - 10 - 15
Lignosulfonates - 10 - 15
Caustic soda- 4 - 5
Sodium or potassium bichromate- 3 - 4
Surfactants - 1 - 2
Sea water, technical, reservoir- the rest.

The specified composition is called a complex inhibited thermostabilized supply "PACS-T" (Calcium-potassium-Aluminate Inhibited Solution - Thermostabilized). It is a conciliatory composition consisting of inhibitors, stabilizers, thermostabilizers, caustic soda, powerfully active news and water.

As stabilizers and humbling substances, lignosulfonates are used-salts of lignosulfonic acids, which impose an additional hydrophobic force. Although lignosulfonates tolerate foaming in drilling fluids and are not amenable to aesthetic degassing [5, 6, 7].

Combined surfactants (HT-48) are soy nitrogenous surfactants in a mixture of block polymers of polyoxyalkyl - ethylene and propylene oxides, and also have an active defoamer. The defoaming mechanism is involved in the fact that HT-48 binds the hydrophobic part of the lignosulfonate molecule. Chrome is also due to the adsorption of HT-48 on clay genera that adsorbed HT-48 molecules, active substances are produced on the secrecy of clay, flattening them into interdependence with hydrogen.

The roll of the heat stabilizer will perform salts of chromic acid-sodium bichromate ($Na_2Cr_2O_7$) or potassium ($Na_2Cr_2O_7$).

Rolling inhibitors produce potassium chloride and slotted hydrolysates of Portland cement, forming acid-potassium chloride and acid-slotted hydrolysates with sodium or potassium bichromates, which

anticipate hydration, swelling and disintegration of clay genera in the zone of moderate and elevated temperatures. The increase in immersion in water occurs due to the transition to water, consisting of potassium and calcium compounds present in potassium chloride and Portland cement-in the form of potassium and calcium monochromate.

Acid-base hydrolysates of Portland cement contain water-soluble and insoluble compounds, the mineralogical composition of which contains:

tricalcium silicate-58.0-62.0%; - $3CaO\text{-}SiO_2+H_2O+K_2Cr_2O_7$;

bicalcium silicate-14.5-18.5%; - $2CaO\text{-}SiO_2+H_2O+ K_2Cr_2O_7$;

tricalcium aluminate-4.0 - 6.0% - $Ca_3Al_2O_6\text{-}SiO_2+ H_2O + K_2Cr_2O_7$;

four-calcium aluminoferrite -13.0 - 15.0%; - $Ca_4(Al_2O_6)(Fe_2O_5) + H_2O + K_2Cr_2O_7$.

Water-soluble compounds of calcium, aluminum, silicates, iron are in dissociated form and are effective anionic-active inhibitors of clays.

Acid-potassium chloride (KCl) enhances the inhibitory effect of the complex additive due to the unique properties of the potassium ion. The potassium ion is not hydrated and, therefore, has a minimum size in an aqueous medium. This allows it to penetrate into the interplane space of clays, preventing their hydration and swelling.

The combination of essential features provides a new technical result. This is explained by the fact that the developed system provides a multi-sided, more effective inhibition of clay particles due to water-soluble acid and alkaline hydrolysates of Portland cement containing both cationic and anionic forms of mineral inhibitors enhanced by the inhibitory action of potassium ions and chromic acid salts capable of penetrating into the inter-pack distance of clays, and the hydrophobic action of combined surfactants based on their chemisorption on hydrophilic and hydrophobic exposed clay particles. This makes it possible to obtain a combination of inhibitors: calcium, potassium, aluminate, silicate, polymineral. The anions and cations released as a result of acid and alkaline hydrolysis under the action of surfactants actively affect the state of the drilling mud, clay rocks composing the walls of wells, due to the filtrate of the drilling mud, and the clay rock being drilled itself. In addition, the complex surfactant in hydrocarbons completely degasses the foam and prevents its formation.

The inhibited thermally stabilized complex additive "PACS-T" can be treated with various types of drilling fluids, including clay ones.

A comparative analysis of the technical solution with the prototype shows that a significant difference between the claimed invention is an increase in the inhibitory effect in the zone of moderate (+61 ° C to +100 °C) and elevated (+101 °C and more) temperatures, which affects the parameters of the solution - a decrease in viscosity (due to a decrease in the swelling of clay particles) and static shear stress in one and ten minutes.

When viewing other technical solutions known in this field, the proposed set of essential features that allows achieving a technical result is not found.

The method is carried out as follows.

The implementation of the method is shown by the example of processing clay drilling mud in field conditions. First, a complex inhibitory thermostabilized additive "PACS-T" is prepared. To do this, pour 2 - 2,5 m^3 of seawater into a 4 m^3 clay mixer, load 120 kg - 160 kg of chrome powder and mix for 15-20 minutes, add 400 kg - 500 kg of Portland cement - mix for 1-2 hours, then add 160 kg - 200 kg of caustic soda - mix for 20-30 minutes, add 400 kg - 600 kg of lignosulfonate and 40 liters - 80 liters of HT-48. After that, with continuous stirring, 400 kg - 600 kg of potassium chloride is loaded, mixed for 1-2 hours. Sea water is added to the clay mixer to the full level. All this is mixed for 1-1.5 hours. After preparation, the complex inhibitory thermostabilized additive "PACS-T" is released into a circulating clay drilling mud for one cycle. Injected into clay drilling mud in an amount of 8% - 15% by volume of the solution. The cooking time is 3-4 hours.

The effectiveness of the complex inhibitory thermostabilized additive "PACS-T" has been proven by laboratory studies at room temperature (+24 °C) and under thermostatic conditions (+80 °C and +105 °C).

The viscosity values of the solutions studied at a temperature of +24 °C. after the introduction of the additives "PACS" and "PACS-T" (solutions 3, 4) practically do not differ. To study solutions at a temperature of +80 °C and +105 °C, samples of solutions weighted with barite up to a density of 2020 g/cm^3 were used. The viscosity values of solutions 6 (+80 °C) and 7 (+105 °C) with the addition of "PACS-T" were 48 s and 41 s, respectively, and solutions of the prototype "PACS" - 71 s and 112 s. That is, with increasing temperature, the viscosity of solutions with the addition of "PACS-T" decreases.

Static shear stress for 1 min and 10 minutes also tends to decrease, and in the prototype (samples 6 and 7), with increasing temperature, the values of viscosity and static shear stress of drilling fluids increase.

Thus, a new method for processing drilling mud with an inhibited thermally stabilized complex additive "PACS-T", with the following component content (weight %):

Portland Cement- 10 - 12
Potassium chloride- 10 - 15
Lignosulfonates - 10 - 15
Caustic soda- 4 - 5
Sodium or potassium bichromate - 3 - 4
Surfactants - 1 - 2
Sea water, technical, reservoir - the rest.

To conduct field tests on drilling rigs, a working program was drawn up for acceptance tests of complex inhibited additives "PACS" at the Southern Gamyshlydzha, Akpatlavuk and Northern Goturdepe fields.

Inhibited system "PACS-T" (thermostabilized) this is a multi-sided highly effective inhibited system, the level of inhibition of which is Ca+2=900-1500mg/l, K+=3000-8000mg/l and aluminates 3500-4000mg/l.

Inhibited system "PACS-T" (calcium – potassium aluminate inhibited solution) this is a multi-sided inhibited system, its application ensures a reduction in the consumption of chemicals and materials, increases the stability of the wall of the borehole zone of the borehole and increases the relief of the trunk, bringing it closer to the nominal diameter.

In connection with the successful field tests, the inhibited system "PACS-T" (calcium – potassium aluminate inhibited solution) was patented by the author and registered with the State Intellectual Property Service of the Ministry of Economy and Development of Turkmenistan for № 604 dated 06.06.2014.

As a preventive measure in these conditions, inhibitory additives are used in solution using salts of NaCl, KC1, CaC_{12}, $CaSO_4$, silicates, fatty acid soaps, lime, etc. However, when using them, the inhibition effect is lower, since inhibitors neutralize, as a rule, only one of the two lyophilic sections of the mosaic surface of clay particles: either along the planes – negatively charged areas, or along positively charged faces and fractures. Since clays are diphilic and rigidly amphoteric, unilateral inhibition will be much less effective than multilateral inhibition [8].

The developed inhibited additives PACS and PACS-T prevent hydration swelling and disintegration of clay rocks.

PACS – provides multilateral inhibition of clay particles due to hydrolysates of Portland cement and potassium chloride containing both cationic and anionic forms of mineral inhibitors enhanced by the inhibitory action of potassium ions capable of penetrating into the interplane space of clays, and the hydrophobic action of combined surfactants based on their chemisorption on hydrophilic and hydrophobic exposed clay particles. In addition, the complex surfactant in lignosulfonate solutions completely degasses the foam and prevents its formation.

PACS-T (thermally stabilized) is one of the homologues of the general additive of inhibited calcium-potassium solutions of PACS. PACS-T differs from PACS by a high level of inhibition and a large temperature range. These advantages are achieved by converting the calcium compounds present in Portland cement and potassium chloride into a water-soluble state in the form of calcium and potassium monochromate [9, 10].

The solubility of this compound is two orders of magnitude higher than the solubility of lime and is 16%. Due to the increased solubility and subsequent conversion of calcium and potassium chromates into mixed lignosulfonate salts, the content of water–dissolved Ca^{+2} and K^{+} inhibitors in PACS-T filtrates is Ca^{+2} –900–1500mg/l and K^{+}–1000–2000mg/l, against calcareous 400-600mg/l drilling mud systems. Therefore, in the system of the inhibited additive PACS, the positive effect of inhibition is manifested up to a temperature of +70 °C, and in PACS–T due to the use of chromates, the positive effect of inhibition is already manifested at a temperature of +30 °C, and not at a temperature of +70 °C and above, which usually occurs in other types of solutions where chromates they are used only as a thermally stabilizing additive [11].

Drilling of well № 19 of Altyguyi field is due to the high content of clay rocks along the entire section of the well, reaching 70% or more. These clays during drilling present certain difficulties associated with the complication caused by narrowing and collapses of the walls of the borehole. All this is due to unstable rocks composing colloidal clays.

For the successful opening of the clay, a solution was chosen with a complex inhibited additive of the PACS system to a temperature of +70 °C and the thermally stabilized PACS-T system over +70°C drilling to a projected depth of 3950 m.

Drilling of the well from a depth of 655 m was carried out with a bit Ø393.7mm, the temperature at the bottom was +35 °C. Due to the fact that the temperature in the well increases intermittently and reaches the limits of +70 °C in the interval of 2500m, it was decided to transfer the drilling fluid to the inhibited solutions of the PACS system. The transfer was carried out without stopping during the drilling of the well in the range of 655–700m.

The main materials for the transfer of drilling mud with a complex inhibited additive PACS: Portland cement PCT1–100, potassium chloride (KS1), KSSB-2, caustic soda (NOH), surfactant HT-48 [12].

Drilling mud parameters before translation: density - ρ =1.47g/cm^3; viscosity – T = 63sec; water output – V = 3 cm^3; thickness of clay crust – K = 1mm; static shear stress in 1min. – Q_1 =48dPa; in 10min. – Q_{10} = 96dPa; plastic viscosity – η_{res} =34sPz; dynamic shear stress – τ_0 = 45dPa.

Parameters of drilling mud after conversion to inhibited PACS: specific gravity ρ = 1.45g/cm^3; viscosity T = 30sec; water output B = 2 cm^3; thickness of clay crust K = 0.5 mm; static shear stress in 1min. Q_1= 6dPa; in 10min. Q_{10} = 9dPa; plastic viscosity η_{res} = 15sPz; dynamic shear stress τ_0 = 21dPa.

Drilling of the well from a depth of 2187m was carried out with a bit Ø295.3 mm, the temperature at the bottom was +65 °C. Due to the fact that the temperature in the well increases intermittently and reaches the limits of +96 °C at the design depth of

3950 m, it was decided to transfer the drilling fluid to the thermally stabilized inhibited PACS-T system. The transfer was carried out without stopping during the drilling of the well in the interval 2187 – 2234m.

The main materials for the transfer of drilling mud with a complex inhibited thermally stabilized additive PACS-T: Portland cement PCT1–100; potassium chloride (KCl); FHLS; Chrompik ($Na_2Cr_2O_7$ or $K_2Cr_2O_7$), caustic soda, surfactant HT-48 [13].

Drilling mud parameters before translation: density – ρ = 1.45g/cm^3; viscosity – T = 71sec; water output – V = 3 cm^3; thickness of clay crust – K = 1mm; static shear stress in 1min. - Q_1 = 51dPa; in 10min. - Q_{10} = 108dPa; plastic viscosity – η_{res} = 42sPz; dynamic shear stress - τ_0 = 57dPa.

Parameters of drilling mud after conversion to the inhibited thermally stabilized PACS-T system: specific gravity ρ = 1.45g/cm^3; viscosity T = 32sec; water output B = 2 cm^3; thickness of clay crust K = 0.5 mm; static shear stress in 1min. Q_1= 3dPa; in 10min. Q_{10}=9dPa; plastic viscosity η_{res} = 12sPz; dynamic shear stress τ_0 =18dPa.

As the well deepened, complex inhibited solutions of the PACS system and thermally stabilized PACS-T to maintain their properties were carried out by injecting PACS and PACS-T inhibitors into the solutions. The oil was well emulsified in solutions, having lubricating properties. The values of the hydrogen pH of the solutions were maintained to the limits of 10-12, with caustic soda additives. The decrease in water output was achieved by treating the solution with KSSB-2 and FHLS reagents. The decrease in viscosity was achieved by treating the solution with water or water reagents KSSB-2 and FHLS. With an increase in the structural and mechanical properties of the solutions, the solutions were inhibited to.

Drilling of the well on the inhibited solution of the PACS system in the range of 655 - 2187m and on the thermally stabilized PACS-T system in the range of 2187m and up to the actual depth of 3922m was completed without complications, the casing strings Ø324mm, Ø245mm and Ø140mm were lowered without planting and cemented.

Drilling of well № 156 Northern Goturdepe field in the range of occurrence of the Akchagyl tier there are 2 stratigraphic bundles of the same black clay: the first bundle is in the range 2368-2485m (117m); the second bundle is lower in the range 2545-2625m (80m). These black clays during drilling present certain difficulties associated with the complication caused by narrowing and collapses of the walls of the borehole. All this is due to unstable rocks composing high-columnar plastic black clays.

It was recommended to open packs of black clays with solutions of a complex inhibited additive PACS to a temperature of +60 °C and PACS-T above +60 °C and below by drilling to a projected depth of 4300m.

The tests were carried out to confirm the technological and economic efficiency of PACS and PACS-T solutions.

Drilling of the well from a depth of 2000 m was carried out with a bit Ø295.3 mm, the temperature at the bottom was +60 °C. Due to the fact that the temperature in the well increases intermittently and reaches +104 °C at a depth of 4300m, it was decided to convert the drilling mud into a complex-inhibited PACS-T solution. The transfer was carried out without stopping during the drilling of the well [14].

The main materials for the transfer of drilling mud with a complex inhibited additive PACS-T: Portland cement PCT 1-100; potassium chloride (KCL); FHLS; Chrompik ($Na_2Cr_2O_7$ or $K_2Cr_2O_7$), caustic soda (NOH), surfactant HT-48.

Drilling mud parameters before translation: density ρ = 1.48g/cm^3; viscosity T = 45sec; water output B = 3 cm^3; thickness of clay crust K = 1mm; static shear stress in 1min. Q_1 = 27dPa; in 10min. Q_{10} = 56dPa; plastic viscosity η_{res} = 27sPz; dynamic shear stress τ_0 = 36dPa.

Parameters of drilling mud after conversion to inhibited PACS-T: density ρ = 1.45g / cm^3; viscosity T = 30sec; water output B = 2 cm^3; thickness of clay crust K = 0.5 mm; static shear stress in 1min. Q_1 = ZdPa; for 10min. Q_{10}=6dPa; plastic viscosity η_{res} = 10sPz; dynamic shear stress τ_0 = 15dPa.

As the well deepened, the inhibited thermally stabilized drilling fluid of the PACS-T system was maintained by injecting the PACS-T inhibitor into the solution. The oil was well emulsified in solution, having lubricating properties. The values of the hydrogen pH of the solution were maintained in the range of 10-12, with caustic soda additives. The reduction of water loss was achieved by treating the solution with the FHLS reagent. The decrease in viscosity was achieved by treating the solution with water or an aqueous FHLS reagent. With an increase in the structural and mechanical properties of the solution, the solution was inhibited by the addition of PACS-T by entering into the circulating solution during well drilling.

The interval 2000-4300m was passed without complications, the casing columns Ø 245mm and Ø 178mm were lowered without planting and cemented.

Drilling of well №. 202 field Northern Goturdepe in the interval of occurrence of the Akchagyl tier there are 2 stratigraphic bundles of identical black clay: the first bundle is in the range 2364-2482m (118m); the second bundle is lower in the range 2552-2632m (80m). These black clays during drilling present certain difficulties associated with the complication caused by narrowing and collapses of the walls of the borehole. All this is due to unstable rocks composing high-columnar plastic black clays.

In this regard, the black clays were opened with

solutions of a complex inhibited additive PACS to a temperature of +60 °C and PACS-T above +60 °C and below by drilling to a projected depth of 5100m.

The tests were carried out to confirm the technological and economic efficiency of PACS and PACS-T solutions.

Drilling of the well from a depth of 2224m was carried out with a bit Ø393.7mm, the temperature at the bottom was +60 °C. Due to the fact that the temperature in the well increases intermittently and reaches +119 °C at a depth of 5100 m according to the project, it was decided to convert the drilling mud into a complex-inhibited solution of PACS-T. The transfer was carried out without stopping during the drilling of the well.

The main materials for the transfer of drilling mud with a complex inhibited additive PACS-T: Portland cement PCT 1-100; potassium chloride (KCL); PHLS; Chrompik ($Na_2Cr_2O_7$ or $K_2Cr_2O_7$), caustic soda (NaOH), surfactant HT-48.

Parameters of drilling mud before translation: density ρ = 1.35g/cm^3; viscosity T = 58sec; water output B = 3 cm^3; thickness of clay crust K = 1 mm; static shear stress in 1min. Q_1 = 32dPa; in 10min. Q_{10} = 65dPa; plastic viscosity η_{res} = 27sPz; dynamic shear stress τ_0 = 36dPa; hydrogen pH = 8,7; temperature at the mouth 30 °C.

Parameters of drilling mud after conversion to inhibited PACS-T: density ρ = 1.45g / cm^3; viscosity T = 40sec; water output B = 2 cm^3; thickness of clay crust K = 0.5 mm; static shear stress in 1 min. Q_1 = 15dPa; in 10min. Q_{10} = 21dPa; plastic viscosity η_{res} = 11sPz; dynamic shear stress τ_0 = 18dPa; hydrogen pH = 11.

Parameters of the inhibited PACS-T drilling mud when opening productive formations in the drilling interval of 5012 m: density p = 1.86g/cm^3; viscosity T = 40-50sec; water output B = 2 cm^3; thickness of clay crust K = 0.5 mm; static shear stress in 1min. Q_1 = 15dPa; in 10min. Q_{10} = 21-33dPa; plastic viscosity η_{res} = 11-15sPz; dynamic shear stress τ_0 = 18-21dPa; hydrogen pH = 10-11; temperature at the mouth 45-50 °C.

As the well deepened, the inhibited thermally stabilized drilling fluid of the PACS-T system was maintained by injecting the PACS-T inhibitor into the solution. The oil was well emulsified in solution, having lubricating properties. The values of the hydrogen pH of the solution were maintained in the range of 10-12, with caustic soda additives. The reduction of water loss was achieved by treating the solution with the FHLS reagent. The decrease in viscosity was achieved by treating the solution with water or an aqueous FHLS reagent. With an increase in the structural and mechanical properties of the solution, the solution was further inhibited by the addition of PACS-T by entering into the circulating solution during well drilling.

The drilling interval from 2224m to 5012m was passed without complications, the casing strings Ø324mm, Ø245mm and Ø139.7mm were lowered without planting and cemented.

Drilling of well № 30 field Nebitlidje This is also due to the high content of clay rocks throughout the well section reaching 70% or more. These clays during drilling present certain difficulties associated with the complication caused by narrowing and collapses of the walls of the borehole. All this is due to unstable rocks composing colloidal clays.

In this regard, it was proposed to open the clays with solutions of a complex inhibited additive PACS to a temperature of +70 °C and PACS-T above +70 C° and below drilling to the projected depth of 3550m.

The tests were carried out to confirm the technological and economic efficiency of PACS and PACS-T solutions.

Drilling of the well from a depth of 1600 m was carried out with a bit Ø295.3 mm, the temperature at the bottom was within +55 °C. Due to the fact that the temperature in the well increases intermittently and reaches within +90 °C at the design depth of 3550 m, it was decided to convert the drilling mud into a complex inhibited solution of PACS-T. The transfer was carried out without stopping during the drilling of the well [15]

The main materials for the transfer of drilling mud with a complex inhibited additive PACS-T: Portland cement PCT 1-100; potassium chloride (KCL); PHLS; Chrompik ($Na_2Cr_2O_7$ or $K_2Cr_2O_7$), caustic soda (NOH), surfactant HT-48.

Drilling mud parameters before translation: density – ρ = 1.47g/cm^3; viscosity – T = 63sec; water output - B= 3 cm^3; thickness of clay crust – K = 1mm; static shear stress in 1min. - Q_1 = 48dPa; in 10min. - Q_{10} = 96dPa; plastic viscosity – η_{res} = 34sPz; dynamic shear stress - τ_0 = 45dPa.

Parameters of drilling mud after conversion to inhibited PACS-T: specific gravity – p = 1.45g / cm^3; viscosity T = 30sec; water output B = 2 cm^3; thickness of clay crust K = 0.5 mm; static shear stress in 1min. Q_1 = 6dPa; in 10min. Q_{10} = 9dPa; plastic viscosity η_{res} =15sPz; dynamic shear stress τ_0 = 21dPa.

As the well deepened, the inhibited thermally stabilized drilling mud of the PACS-T system was maintained by injecting the PACS-T inhibitor into the solution. The oil was well emulsified in solution, having lubricating properties [6]. The values of the hydrogen index of the pH of the solution were maintained in the range of 10-12, with caustic soda additives. The reduction of water loss was achieved by treating the solution with the FHLS reagent. The decrease in viscosity was achieved by treating the solution with water or an aqueous FHLS reagent. With an increase in the structural and mechanical properties of the solution, the solution was inhibited.

The interval 1600-3550m was passed without complications, the casing columns Ø245mm and the

shank Ø140mm were lowered without planting and cemented.

Conclusions:

1. Inhibited solutions with PACS and PACS-T additives are economical and technological. Their use in sealed sections provides an increase in the mechanical drilling speed due to the suppression of colloidal clays.

2. Inhibited solutions with PACS and PACS-T additives prevent the rapid moistening of clay minerals due to water-soluble alkaline hydrolysates of Portland cement and potassium ions, which are able to bind water into very resistant hydrates.

3. PACS-T, due to the unique action of the chromic acid salt, provides a higher inhibition of the solution at reservoir temperatures reaching +100 °C and more.

4. With the use of complex inhibited solutions of the PACS and PACS-T system (thermostabilized), the narrowing of the borehole, collapses and tacks of drilling tools stopped in the oil and gas areas of Turkmenistan in sections containing clay rocks. All casing columns are lowered without planting and cemented.

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