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PROSPECTS FOR THE DEVELOPMENT OF PRODUCTION OF REAGENTS FOR DRILLING SOLUTIONS BASED ON SECONDARY RESOURCES

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Abstract. The article discusses the prospects for the development of production of reagents for drilling fluids based on secondary resources. Currently, the big problem is the creation of new, highly efficient and affordable drilling fluids and they are essential for successful drilling, to increase productivity and reduce the amount of time. To solve these problems, the article considers the possibilities of synthesis and practical application of new stabilizers for drilling fluids based on waste from chemical enterprises of our republic. The basic physicochemical, rheological and applied properties of the developed stabilizer-reagents are investigated. Specific areas of practical application of the developed new stabilizers are given.

Key words: waste, processing, utilization, ecology, toxicity, viscosity, density, dispersion, drilling, reservoir, well.

Gas and oil wells in Western Uzbekistan are subsalt and inter-salt deposits. Therefore, the big problem is the regulation of the structural-mechanical, rheological and filtration properties of drilling fluids used in drilling oil and gas wells [1]. Currently, in the oil and gas industry of our republic there is an acute problem of creating new, highly effective and affordable drilling fluids, because used drilling fluids are difficult to access, expensive, multicomponent, and in some cases toxic and harmful to the environmental ecosystem as a whole. Drilling deep, longer and more complex wells has become possible due to improved drilling technology, including more efficient and effective drilling fluids. Drilling fluids, also known as "drilling mud" are added to the wellbore to facilitate drilling by suspending sludge, controlling pressure, stabilizing exposed rock, providing buoyancy, cooling and lubrication. As early as the third century BC, the Chinese used drilling mud, in the form of water, to help penetrate the earth, while drilling for hydrocarbons. The term "dirt" was coined when drillers drove herds of cattle through fields saturated with rainwater to Spindletop in the USA, and the resulting mud was used to lubricate the drill bit [2].

Although the technology and chemistry of drilling fluids has become much more complex, the concept remains the same. Drilling fluids are essential for successful drilling, to increase productivity and reduce the amount of time it takes to reach the oil.

The main function of the drilling fluid is also to clean the bottom of the rock destroyed by the bit and the removal of sludge from the well. The faster fragments of rock are removed from the bottom with a drilling fluid stream, the more efficient the chisel works. The requirement to remove sludge from the bottom is mandatory, because otherwise it is impossible to provide a deepening of the wellbore. To improve the cleaning of the face, in practice, increase the viscosity of the drilling fluid or its supply to the face through the nozzles of the bit. The second method is most preferred, since an increase in the viscosity of the solution is accompanied by a decrease in the drilling speed and an increase in energy costs. However, the second method in each case requires a feasibility study, since with an increase in the circulation rate, the erosion of the walls of the barrel is intensified, as a result of which the amount of cuttings in the drilling fluid increases, and the cavernousness of the trunk increases. These negative phenomena lead to a decrease in the efficiency of equipment for cleaning drilling fluids, an increase in the cost of repairing pumps and swivels, an overspending of materials for the preparation and processing of drilling fluids, excessive energy costs, and a deterioration in the quality of well attachment [3].

Thus, the flow rate of the drilling fluid to the bottom of the well must have a feasibility study in accordance with the specific geological and technical conditions of drilling and be selected within optimal limits. A mandatory requirement for the flushing process of wells is to perform the function of transporting sludge to the surface. Obviously, the higher the circulation speed, density and viscosity of the drilling fluid, the more intensively is the hydrotransport of the sludge from the bottom to the surface. Therefore, it is possible to control the rate of removal of sludge from the well by changing the flow of pumps, the density and viscosity of the drilling fluid. But with an increase in viscosity and density of the fluid, the working conditions of the bit deteriorate, hydrostatic and hydrodynamic pressure on the reservoirs increases, which can lead to absorption of the drilling fluid, other complications and even accidents.

Practical data on the speed and cost of drilling wells show that there is some optimal value for the circulation speed at which the given solution satisfactorily removes sludge to the surface and does not accumulate in the well to concentrations that impede the drilling process. Thus, for satisfactory cleaning of the wellbore from sludge, the optimal ratio between the supply of mud pumps, the density and the rheological properties of the solution should be selected. The main parameter that provides compensation for reservoir pressure at the boundary with the well is the density of the drilling fluid, with an increase in which the safety of penetration tends to increase. At the same time, with increasing density, the differential pressure at the bottom increases, the concentration of the solid phase in the drilling fluid increases, which can lead to a noticeable decrease in the mechanical speed of drilling and contamination of productive horizons. Therefore, the density of the drilling fluid must be such that, together with other technological factors and techniques, it is possible to provide sufficient back pressure on the passable formations, but at the same time it should not significantly worsen the working conditions of the bit and the operational characteristics of productive horizons. In other words, in each case, the optimal value of the density of the drilling fluid should be selected. Density is also one of the main factors ensuring the stability of well walls. With its increase, the intensity of scree and landslides of the trunk, as a rule, decreases, but at the same time, another type of complication becomes more dangerous - mud absorption. Therefore, in practice, in order to increase the stability of the borehole walls, the density, the filtration rate, and the salinity of the drilling fluid are simultaneously regulated in order to reduce the degree of penetration of the drilling fluid filtrate into the pores of the rock due to filtration, osmosis, etc. However, talus is a type of complication that usually develops slowly and does not always noticeably hinder the drilling process [4]. In this regard, in some cases it is economically feasible to abandon complex chemical treatments and weighting the drilling fluid to the detriment of the stability of the barrel. At the same time, high penetration rates are maintained, and a lot of time is not spent on auxiliary work. Therefore, in order to prevent scree and collapse of the walls of the well, taking into account the possibility of other types of complications and ensuring high rates of penetration of the barrel, it is necessary to comprehensively approach the choice of the optimal density value. An important technological quality of the drilling fluid is the retention of particles in it in suspension, especially during breaks in circulation. With the improvement of the rheological characteristics of the drilling fluid, its holding capacity is increased. However, this increases energy costs and time spent on circulation, there are significant pressure fluctuations in the well during tripping, which can cause various complications. During washing, separation and discharge of sludge should be ensured on vibrating screens, in hydraulics about cyclones, settling tanks, and so on. Otherwise, the sludge will enter the well, clog it and worsen the working conditions of the bit. To satisfactorily separate the sludge from the drilling fluid, one should strive to minimize the rheological properties of the drilling fluid, however, its holding ability should not be impaired. Otherwise, there are problems associated with the loss of barite in the circulation system and, consequently, a decrease in the density of the drilling fluid [5]. Thus, the success of a well flushing process depends on the rheological properties of the drilling fluid, primarily shear stress and viscosity. Drilling fluid must be lubricating. Lubricating the surface of pipes, chisel supports, hydraulic equipment, the solution would help to reduce energy costs for drilling, to reduce accidents with drill strings, which is especially important for rotary drilling. Therefore, it is desirable to increase the content of lubricant additives in the drilling fluid. However, with a high content of these additives, the mechanical penetration rate is noticeably reduced, especially when drilling with abrasive bits. Perhaps this is due to the negative effect of lubrication on the introduction of the cutting edges of the bit cutters into the face. Therefore, the content of lubricant additives in the drilling fluid should also be optimal. The cooling of chisels, drill pipes, hydraulic equipment increases their durability and is therefore also an important flushing function. It is known that cooling of the washed parts is better, the greater the circulation speed, the lower the viscosity of the drilling fluid and the higher its heat capacity and thermal conductivity. However, the regulation of these indicators in order to improve the cooling conditions of drilling tools and equipment is limited by the need to perform the previous, sometimes more important, functions of flushing the well [6]. Drilling fluids, according to the appropriateness of use, can be arranged in the following series: aerated water, water-based drilling mud, hydrocarbon-based drilling mud. However, the type of drilling fluid is chosen, as a rule, not to ensure better working conditions of the rock cutting tool, but taking into account the prevention of complications and accidents during drilling. Let us consider the most general requirements that must be imposed on drilling fluids of all types and, first of all, on water-based fluids, with which the bulk of deep oil and gas wells are drilled. The fulfillment of these requirements largely depends on the geological and technical conditions of drilling. However, they allow you to choose from the range of solutions exactly the one that not only eliminates complications and accidents in the well, but also ensures high speeds for its drilling. In each specific case, it is necessary to solve the complex problem of the advisability of using this or that solution, taking into account the technical equipment of the drilling rig, the speed of supplying its materials, the skills of workers, the geographical location of the well, and so on.

To obtain high-quality drilling fluids based on them, special treatment is required with a large number of various scarce and expensive active chemicals. In this regard, at present, for the preparation of drilling fluids, mainly fresh water is used, imported from sources from afar to the objects of work. A sharp increase in transportation costs for the delivery of industrial water to facilities leads to an increase in the cost of drilling operations. This situation is typical for the Ustyurt and Bukhara-Khiva oil and gas regions, in which almost all formation waters are highly mineralized and unsuitable for the preparation of high-quality clay solutions. The practice of drilling wells in these regions urgently necessitates the development of new compositions of drilling fluids prepared on the basis of highly mineralized formation water with the addition of new salt-resistant reagents that preserve the rheological and technological properties of the latter in aggressive environments. The selection of effective clay materials and chemicals, rational types and formulations of drilling fluids in accordance with the geological and technical conditions of drilling, as well as control over their quality during the construction of wells is an important urgent task and the basis for the prevention of the prevention of complications and accidents. The stabilization of salt-based drilling fluids is much more difficult than the stabilization of solutions prepared with fresh water. Giving the mineralized solution technological properties that meet the requirements of drilling for salt deposits requires special chemicals [7].

Currently, there are many organic and synthetic reagents for stabilizing the technological properties of drilling fluids. However, only a few of them are effective under the influence of temperature and salt aggression.

Mineralized drilling fluids are subdivided into weakly mineralized with a NaCl content of up to 5% and highly mineralized with a NaCl content of more than 10% of the solution volume [8].

Due to the coagulating effect of salts, the yield of mineralized clay solutions usually reaches very high values (20-30 cm^3/30 minutes) and often causes many complications when drilling wells.

Reducing water loss (up to 6-10 cm^3/30 minutes) of mineralized drilling fluids is achieved by treating them with stabilizing agents such as SAB (Sulphite-alcohol bard), CSAB (Condensed sulphite-alcohol bard), CMC (Carboxymethylcellulose), starch, polyacrylonitrile, polyacrylamide and others. [9].

The introduction of starch or HIPAN (Hydrolyzed Polyacrylonitrile) reagents into the drilling fluid leads to an increase in viscosity and static shear stress. The use of these reagents in combination with the CMC reagent gives favorable results. Under these conditions, CMC plays the role of a viscosity reducer. Sunil reagent can also thin mineralized solutions. In mineralized drilling fluids, the dose of CMC is 1%, Sunil - 2-3%. The effectiveness of these reagents is greatly influenced by the pH of the solution. For the successful action of CMC and CSAB, the pH should be 8-9.

The viscosity reducers of the saline solutions are SAB (3 - 5%), oxyl (up to 10%), alkaline dextrin chips (up to 6% by volume). Adding clay to increase the structural parameters of mineralized solutions usually does not give results. Viscosity increases, and SSS (Static shear stress) hardly increases. The best results are achieved by adding clay paste prepared in fresh water. The addition of 8-10% salt-resistant clay - palygorskite directly to the solution turned out to be more effective.

With low water recovery requirements, highly mineralized clay solutions prepared from one palygorskite clay without chemical treatment can be used. With the content of this clay in an amount of 20-25%, the water loss is 25-30 cm^3. The fluid loss reducers of these solutions are: at temperatures up to 130°C - modified and food starch (up to 3-4%), CMC (up to 1.5 - 2.0%), HIPAN, metas (up to 1.5%); at temperatures up to 150°C - CMC - 500, CMC - 600 (up to 2%), HIPAN, metas (up to 2%); at temperatures up to 200°C - metas, carbofen, carbonyl.

With a combination of reagents, their consumption is halved by the author of [10], studying the properties of saline clay solutions, found that an increase in their quality can be achieved by using special reagents. The researcher recommended using starch, CMC, and acid tar to stabilize the properties of saline clay solutions. Along with this, it was also revealed that the treatment of SAB with a clay solution saturated with sodium chloride gives good results even without the addition of sodium hydroxide. The addition of 10% SAB in relation to the volume of drilling fluid saturated with sodium chloride reduces the water loss of the latter to 12 cm^3, and when the concentration of SAB in the solution is increased to 20%, the water loss is up to 7 cm^3. This is due to the strength of the adsorption films formed by the SAB on clay particles.

According to the author of [11], the fluid loss of a drilling fluid is effectively reduced when treated with high molecular weight reagents, although the viscosity of the fluid increases.

Weakly mineralized solutions can be treated with CAR (Carbon-alkaline reagent) with a caustic soda to coal ratio of 1:5, but when it contains 6% sodium chloride in the solution, it begins to coagulate, losing its stabilizing properties. The presence of Ca in the medium leads to the formation of insoluble humates, and to reduce the effect of CAR to nothing. With the addition of soda ash, a cationic exchange occurs, resulting in the restoration of sodium humate and the formation of insoluble chalk. First, soda ash is added to bind Ca ions, and then the solution is treated with CAR.

According to the data of S.Yu.Kapustin [12], for treating a drilling fluid in the presence of a small amount of salts, CAR and SAB are the most rational; The disadvantage of SAB is a large consumption - 30-40% and foaming. With a high saturation of the clay solution with salt, a reagent from SAB that does not contain caustic soda is effective.

For the treatment of saline solutions, starch is also used and its consumption is less than SAB. However, since starch is a food product, its use for processing a solution is considered not rational. In addition, starch is susceptible to fermentation and decomposition, requires frequent processing and antifermentators. Starch is soluble in caustic soda (10% NaOH solution).

CMC is a water loss reducer in low saline clay solutions. When the salinity of the water exceeds 4%, the CMC is degraded. CMC preparations are effective in neutral and slightly alkaline environments and ineffective in acidic environments where a sparingly soluble hydrogen form is formed.

To stabilize mineralized drilling fluids, polymeric acrylic reagents of type “K” and HIPAN are used. The reagent K-4, which is a product of incomplete saponification of polyacrylonitrile in an alkaline solution, has been widely used in well drilling in Uzbekistan. Reagent K-4 is a viscous mass containing 10% of the active substance. Reagent K-4 reduces the fluid loss of the drilling fluid, even if it is saturated with sodium chloride. However, K-4 is not resistant to the action of polyvalent ions [13].

In the future, by changing the conditions of saponification of polyacrylonitrile and waste products of nitrofiber, various modifications of the polymer reagents of the K series (K-5, K-7, K-9, K-21), DPP (deep polymerization polyacrylonitrile) were obtained and applied.

To reduce the water loss of mineralized drilling fluids from synthetic polymer reagents, HIPAN is used, which is obtained by saponification of polyacrylonitrile and an equimolar amount of caustic soda at a temperature of 90-100^{o}C. However, HIPAN, like K-4, K-9, is not resistant to the action of calcium chloride and other water-soluble salts, as well as polyvalent metals, which limits its scope [14].

One of the modifications of polymer acrylic reagents is DPP (deep polymerization polyacrylonitrile), sponsored by U.M.Mamadzhanov and R.D.Pulatov. This reagent is sootherm-resistant due to deep polymerization, it is able to stabilize the drilling fluid when it is saturated with NaCl, $CaCl_2$, $MgCl_2$ and other salts. However, its preparation requires polyacrylonitrile (PAN). The authors provide data on the properties of the reagent KAP (calcined alkaline polymer), which is resistant to sodium and calcium aggression and can withstand temperatures above 200°C. It turns out that this reagent is universal, can be used for the treatment of clay, chalk and lime solutions. KAP prevents blocking of pores of collectors. With its help, lime solutions can reach a density of up to 1700 kg/m^3 if the solution is saturated with salt without the use of a weighting agent.

The study of the effect of KAP on stabilization of the solution under the influence of electrolytes showed that when 2% $CaCl_2$ was introduced into the solution, the water loss remained within 6 cm^3, the rest of the indicators were in accordance with the technology requirement.

For sinking sediments and aquifers with high salinity, it is recommended to use drilling mud prepared from palygorskite clay, which is slightly sensitive to aggressive components contained in salts and formation waters.

The Ferghana Furan Compounds Plant produced CMC based on cotton cellulose and conducted industrial testing at the Kokdumalak oil and gas condensate field [15].

The addition of new CMC from cotton in an amount of 0.5% (dry matter) to a fresh clay solution reduced the water yield of the solution from 28 to 7 cm^3, and the addition of 1% to 4 cm^3. When 20% sodium chloride was introduced into this solution, the water loss increased to 10 cm^3, and when the solution was heated to 150°C, it reached 15 cm^3. All this testifies to the salt-heat resistance of the new CMC obtained from cotton cellulose in local conditions. The presence of spent fatty clay in the solution reduces the consumption of chemicals used in its processing. By creating compositions from local bentonites, palygorskites and spent greasy clays to produce drilling mud, it is possible to improve their quality and reduce the cost of their production. An objective assessment of the quality of clay solutions for drilling takes into account all the most important colloidal-chemical and structural-mechanical properties, which include density, viscosity, ultimate static shear stress, water loss, pH, others. [15].

Drilling with high water loss in these deposits, consisting of 70-80% clay, causes a violation of the stability of the walls of the well and the formation of thick clay crusts. This leads to accidents, sticking of the drilling tool, and loss of the wellbore.

Drilling rigs for technical needs use water extracted from water wells drilled near the rig. The depth of aquifers ranges from 30 to 300 m. However, this water cannot be used for the preparation of drilling fluids, since it is highly mineralized, bitter-salty, its density varies from 1050 to 1070 kg/m^3.

Water is slightly metamorphosed, highly sulfated, the reaction of the medium is neutral (pH=7.0), density - 1072 kg/m^3. The high salt content of Mg (4.645 g/l) and SO_4 (18.31 g/l) was found in the ion-salt composition. In a percentage equivalent ratio, the content of cations Na + K + (35.31) and anion (36.85), as well as Mg ++ (12.41) and SO_4 (12.45) are very close. Mineralization of water is increased (90.67 g/l) with weak metamorphization (0.96) and high sulfate content (0.34).

The prepared clay solution on the water extracted from the well did not respond to processing with the then known reagents - CAR, CMC, K-4. The fluid yield of the solution could not be reduced below 15-17 cm^3/30min. For this reason, to prepare the drilling fluid, they were forced to bring technical water in tankers. Water had to be transported from the Akchalak compressor station, located at a distance of 60-90 km from the rig. Often did not have time to deliver water on time to the rigs, which were forced to stand idle. At the same time, the wells were complicated by downtime.

The drilling fluid was treated with chemicals: CAR, SAB, CMC-350, soda ash. The results of processing the solution were satisfactory. Added CAR in an amount of 5% reduced the fluid loss of the solution to 13-15 cm^3/30 min. The introduction of the same amount of SAB into the drilling fluid could reduce the water loss to 10-12 cm^3/30 min. The nominal viscosity of such a solution was 35-40 s, but during circulation it increased to 50-60 s. The use of SAB caused foaming of the drilling fluid, which disrupted the process. To combat foaming, soap stock was introduced into the drilling fluid, which is a waste of refined cottonseed oil. Soap stock with cotton was well soluble in water, forming very stable systems. Its consumption during the processing of clay solutions is 0.3-0.5% of the amount of the SAB reagent. To process the clay solution in the areas of Ustyurt, CMC-350 was used. The fluid loss of the solution decreased to 10 - 12 cm^3/30 min, but to a certain temperature. Already at a bottomhole temperature of more than 1100°C, thermal oxidative degradation of the CMC-350 occurred, and the fluid loss of the drilling fluid increased to 18-20 cm^3/30 min. To stabilize the properties of the solution, SAB was added to it in an amount of 2-3% of the volume of the circulating solution. It turned out that combinations of SAB and CMC are more effective than their use separately. A synergistic effect appears to be manifested. The consumption of CMC - 350 increased at high temperatures, especially with a decrease in the pH value. Later, the Namangan Chemical Plant began producing CMC of a higher grade - CMC-500, which in its composition was characterized by heat resistance. This type of CMC can withstand 140-150^{o}C and the consumption compared to CMC-350 is 2 times less [16].

CMC-500 was added to the solution in liquid form from 5 to 10% of the volume of the circulating solution (in dry terms, 0.5-1.0%). With increasing depth of drilling, the consumption of CMC increases. To maintain the stability of the properties of the solution, the hydrogen index should be 8.5-9.5. To do this, caustic and soda ash were introduced into the solution. To regulate the rheological properties of the solution, CAR, nitrolignin, sunil were used. Reagent K-4 - an analogue of HIPAN - is an effective reducer in the yield of fresh and low-mineralized drilling fluids.

A drilling fluid prepared from Nefteabad clay and fresh water, treated with CAR and K-4, had the following indicators: density (ρ) - 1250 kg/m^3; conditional viscosity (T) - 50 s; water loss (B) - 8cm^3/30 min; the thickness of the peel (K) -1.5 mm; static shear stress after 1 min and 10 min ($\Theta_{1/10}$) - 15/25 ∂Pa; plastic viscosity (η) - 0.09 Pa·s; ultimate dynamic shear stress (τ_0) - 4.2 ∂Pa. After adding 0.4% nitrolignin to this solution, its nominal viscosity decreased to 30 s, τ_0=0.7 ∂Pa, η=0.05 Pa·s; $\Theta_{1/10}$=7/15 ∂Pa. Ustyurt formation water was used to prepare the drilling fluid from the bentonite clay powder of the Navbahor deposit. To process such a solution, K-4, CMC, caustic soda, soda ash were used. Wells were drilled with such solutions in the Urginskoye field, in the areas of Northern Urga, Northern Aral, Kabanbay, Muinak, Uchsai and others.

Drilling fluids used in these areas had the following indicators: density - 1240-1280 kg/m^3; nominal viscosity - 40-60 s: water loss - 17-25 cm^3/30min; peel thickness - 2 mm; static shear stress after 1 min - 15 ∂Pa, 10 min - 20 ∂Pa. To achieve such indicators, reagents were consumed 2-4 times more than for a solution prepared on imported fresh water. So, for example, the Ustyurt Directorate of Exploratory Drilling spent 40 kg on 1 meter of K-4 reagent penetration, while K-4 consumption amounted to 10-12 kg per 1 meter of penetration to achieve identical performance of a solution prepared in fresh water. When drilling wells during the circulation of the solution had to constantly introduce a reagent. Water loss did not decrease, remaining at the level of 20-25 cm^3/30min. This was associated with risk, at any time it was possible to get a stick of the drill string, a collapse of the borehole wall. It is no coincidence that accidents caused by loss of mobility of a drilling tool often occurred. It is shown that the use of new reagents creates favorable conditions for the emergence of bonds between macromolecules, which enhances their mutual orientation and lead to the formation of fibrils. Heating has the same effect on structure formation in copolymer solutions as storage. Thus, when the 10% freshly prepared solution of the HIPAN - lignophosphate copolymer is heated for half an hour at 60°C, the same acceleration of fibrillation is observed as during the aging of the solution; this phenomenon is absent when the solutions of the HIPAN copolymers with quaternary salts are heated. This, apparently, is explained by the coordination structure of the latter, as well as by the presence of a supramolecular structure. The attractive forces of molecules located on the interface between the two phases are stably balanced [17]. As a result of the excess of attractive forces from the liquid side, molecules from the interface tend to be drawn inward, therefore, the interface tends to decrease. In this regard, surface molecules at the phase separation have some uncompensated excess energy, called surface energy.

Thus, our studies on the use of chemical industry waste as stabilizers for drilling fluids showed that the new reagents based on waste and secondary resources that we developed to a large extent create favorable conditions for ensuring the stability of the well walls. The main applied, physicochemical and rheological properties of drilling fluids are revealed. The practical application of development can, will solve many of the economic and technological problems of the industry.

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