NEW COMPOSITE LUBRICANTS AND WEIGHTINGS FOR DRILLING OIL AND GAS WELL

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Abstract. The article presents the ways of improvement and development new weighted mud receipt based on composite lubricant from local raw materials and industrial wastes for drilling oil and gas wells. In the process of building oil and gas wells to maintain the stability of the walls, to prevent the flow of salts, and to prevent the penetration of formation fluids into the well, it becomes necessary to increase the density of the drilling fluid, which can be accomplished by introducing components with increased density.

Key words*. Chemical reagent, composite, gossypol resin, weighting agent, barite, drilling fluids, viscosity, density, stabilization, oil and gas.*

Introduction. As the demand for energy increases, harsh and extreme environments are explored for hydrocarbon; and deeper wells have been drilled to reach targets in formations with very high temperatures and pressures [1]. The successful completion of an oil well depends to a considerable extent on the properties of the drilling fluid. Drilling fluids serve several fundamental functions: (i) to remove the cuttings generated by the drill bit from the borehole, (ii) to control the downhole formation pressures, (iii) to overcome the fluid pressure of the formation, (iv) to avoid damage to the producing formation and (v) to cool and lubricate the drill bit, etc [2,3,4].

The cost of the drilling fluid itself is relatively small in comparison to the overall cost of drilling a well, but the choice of the right fluid and maintenance of its properties while drilling profoundly influence the total well costs. For example, the number of rig days required to drill to total depth depends on the rate of penetration of the bit, and on the avoidance of delays caused by caving shales, stuck drill pipe, loss of circulation, etc., all of which are influenced by the properties of the drilling fluid. In the case of some critical wells, such as deepwater operations, these excess costs can run into the millions of dollars. In addition, the drilling fluid affects formation evaluation and the subsequent productivity of the well. The fluid also needs to be environmentally benign and generate minimal waste [5].

Present time for obtaining and development of drilling fluids for drilling oil and gas wells use more than 3000 kind of chemicals in the world. Such as Carboxymethylcellulose, polyacrylamide, hydrolyzed polyacrylonitrile, ferrochrome-lignosulphonate, grafite, chrompick, NaOH, Na_2CO_3 and others. In the Republic of Uzbekistan for drilling oil and gas wells use about 3,5-4 thousand ton chemical reagents every year [6]. Domestic chemicals are not fully meet the requirements of geological and technical conditions of wells. The quality of the construction of oil and gas wells, and the quality of the opening of the productive formation, largely depends on the used drilling mud because the drilling fluid is a technological fluid that interacts with the newly opened rock. Based on the analysis of basic research in the field of chemistry and biochemistry of carbohydrates, generalizing the practice of drilling wells, polysaccharides are used as polymer reagents for regulating the filtration and rheological properties of lighted and weighted drilling fluids. The main reason for the choice of polysaccharides is their ability to chemical and biological destruction, due to which is possible to destroy and remove the formed clogging layer during the drilling process, and almost complete recovery of reservoir properties [7,8,9].

Most of global drilling operations use water-based drilling fluids, because of their lower environmental impact and lower costs. However, water-based drilling fluids are limited by their abilities of dissolving salts and interfering with the flow of oil and gas through porous rocks. Oil-based drilling fluids, owing to their excellent lubricity, high rate of penetration, shale inhibition, wellbore stability, high lubricity, high thermal stability, are expected to be used to drill difficult wells [8].

In all cotton producing countries and factories proceeding cotton seeds gossypol resin is formed as a final product, which has a viscous-fluid consistency, and now find its effective implementation. The transformation of the viscous fluid gossypol resin into a powdered material by modification of the various

ingredients of the organic and inorganic origin can bring to the commercial introduction of the products and to expand the field of efficient use in large-tonnage quantities.

A successful oil well drilling depends largely on a good mud Program. During drilling, mud provides sufficient hydrostatic pressure, removes drill cuttings and cools drill bits. Mud additives are always required to provide sufficient hydrostatic pressure to ensure borehole stability. Barium Sulphate (BaSO4) also known as barite is the prevalent weighting material but there is need to develop local materials to augment the use of Barite. This study was aimed at assessing the suitability of galena, a lead sulfide (PbS), as an alternative weighting material in drilling fluids [10]. Expected increase in drilling activities, has necessitated the search for alternative sources of drilling mud additives so as to minimize or stop the importation of weighting materials such as barite. There are many local materials which could be investigated to know their suitability for use as weighting material.

Methods and materials

The American Petroleum Institute (API) publishes documents relating to oilfield standards, including drilling fluids testing procedures. As with any laboratory procedure requiring the use of potentially hazardous chemicals and equipment, the user is expected to have received proper training and knowledge in the use and disposal of these potentially hazardous materials. The user is responsible for compliance with all applicable local, regional, and national requirements for worker and local health, safety, and environmental liability [11]. In order to develop effective composite chemical reagents based on existing reagents, organomineral ingredients from local raw materials and industrial wastes, the physicochemical properties of the selected materials were investigated.

The structure, composition and physicochemical properties of the domestic composite chemical reagent for drilling fluids, the waste of "Ferganazot" JSC— carbonate-polymer sludge, soda ash and caustic soda, and Na-carboxymethylcellulose "Carbonam" with 500 polymerization degree were studied.

Next, the physicochemical properties of mineral weighting agents were investigated - red clay, marble flour, dolomite, scale, hematite and barite (table 1).

Table 1 shows comparative data on the results of studies of the physicochemical properties of the studied organomineral raw materials as weighting agents for drilling fluids.

New compositions of Lubricants and technology of obtaining for production of composite polymer lubricants by using of low molecular weight sodium carboxymethylcellulose, alkali, water-soluble modified powdered gossypol resins and organic-mineral additives of various ratios to improve the physical and chemical properties of drilling fluids have been developed. Water-soluble modified powdery resin contains hydrophobic additives based on sodium salt of fatty acids and ionic surfactants. The use of these reagents for drilling fluids used in drilling oil and gas wells ensures the preservation of the regulated rheological and filtration properties of polymer systems at 80-190 ° C for 30-40 hours. Method of obtaining new composite lubricants based on physical and chemical modification of initial materials on various ratios, environment and regime. All the physical, chemical and technological parameters of drilling fluids based on composite chemical reagents have been tested in accordance with API standards. [12].

In the development of new composite chemical reagents for stabilization drilling fluids for drilling oil and gas wells we used mainly waste of oil and fat production-gossypol resin, as well as low mass carboxymethylcellulose. Gossypol resin consists of 52 to 64 of free fatty acids and their derivatives, and the rest-a product of condensation and polymerization of gossypol and its transformation, resulting from extraction of cottonseed oil, mainly in the process of distillation of fatty acids from soapstok. In the gossypol resin found 12% of the nitrogen containing compounds, 36% of the transformation products of gossypol fatty and oxide fatty acids. It is a homogenous fluid mass from dark brown to black color [13]. This reagent plays main lubricant for drilling fluids. Polymers are used heavily in the oil industry for controlling the drilling fluid properties or for enhanced oil recovery applications to extract the heavy oil. Polymer flooding is a very important technique to extract the heavy oil from thin and heterogeneous reservoirs. Screening criteria and screening algorithms should be developed for enhanced oil recovery techniques. Artificial intelligence and data mining can be used to manage the reservoir for polymer flooding, especially in case of thin and heterogeneous heavy oil reservoirs.

Minerals are used as drilling mud weights and, in rare cases, chemical and metallurgical wastes. Weighting compounds from natural minerals are distinguished by the method of their production. Thus, the barite weighting agent can be divided into gravity and flotation. Depending on the base of the mineral, weighting agents from natural ores are divided into several types: barite, ferrous, carbonate and galenic. Formation of weighted drilling fluids realize by adding special weighting agents as a barite or hematite.

Result and discussion.

Developed composite chemical reagents for drilling in salt and chemical corrosive environments, as they are stable to cations of polyvalent salts (Mg^{++}, Ca^{++}, Na^{+}, K^{+}). Composite chemical reagent (CCR) is mainly about 60-65% gossypol resin and has a high lubricity due to the content in its composition of about 35-40% of polymerized fatty acids, pigment, glycerin and other components. These reagents as a surfactants serve to emulsify oil with water, increase drilling speed because of low coefficient of friction, play role as lubricant and corrosion inhibitor.

The way obtaining and modification of powder water soluble gossypol resin as a lubricant with mineral ingredients chemicals were investigated and developed their new method. Next, physico-chemical properties of weighting materials also were investigated. Results of analyses were given in the table 1

Table 1

Physico-chemical properties of weighting materials

Name of weightings	Physical chemical properties				
	Density, g/sm^3	Mohs hardness	Sieve residue, 0071, %	Humidity, %	pH
Clay (Navbahor bentonite)	2,55-2,65	2-2,5	5	2	7,5
Marble flour	2,6-2,70	2,5-3,0	6	1,5	7-8
CPS	2,7-2,75	2,5-3,0	6	1,8	11-12
Dolomite	2,8-2,9	2,5-3,0	6,5	1,2	7-8
Barite (Uz)	3,85-4,1	3,0-3,5	10	1,9	7-7,5
Barite (Kz)	4,1-4,2	3,0-3,5	8	1,3	7
Barite (Ru)	4,15-4,25	3,0-3,5	7	1,1	7-8
Okalina	4,3-4,5	5-6	8	0,9	7-7,5
Hematite	4,4-4,6	5-7	9	0,8	7-7,5

Barite weighting agent $BaSO_4$ (barium sulfate) is a mineral containing 65,7% BaO and 34,3% SO_3, as well as impurities: Sr, Ca, Pb, Ra, Fe_2O_3. It can be white, gray, red and yellow. Its density is 4,2- 4,7 g/cm^3; Mohs hardness is 2,5-3,5. According to the geological condition of wells and needed density of drilling fluids regulate weighting agent concentration. Ferruginous weighting compounds. Hematite is a mineral containing 70% Fe_2O_3. Color from iron black to steel - gray; earthy and bright red. Its density is 5,0-5,3 g/cm^3, Mohs hardness is 5-6. It is produced in the form of a powder with a density of 4,15-4,20 g/cm^3. Magnetite or magnetic iron is a mineral of iron ores. Its chemical composition: 31% FeO, 69% Fe_2O_3. Carbonate weighting. Dolomite is a mineral of Ca, Mg $(CO_3)_2$. Its density is 2,8-2,9 g/cm^3, Mohs hardness is 3,5-4,0. It is used limited to weighting drilling fluids with a density of up to 1,5-1,7 g/cm^3. Limestone - sedimentary rocks, consisting mainly of calcite, silica, its density is 2,70 g/cm^3. Galena weighting compounds. Galena - PbS, or lead shine, contains 86,6% Pb and 13,4% S. Copper, silver, zinc, sometimes selenium, bismuth, iron, etc. are found as impurities in galena. The density is 7,4-7,6 g/cm^3.

Conclusion:

Developed new composite lubricant based on local raw materials give to drilling fluids high lubricity. It can be seen that developed composite chemical reagents have a multifunction. As a result of research and study

of the physical and chemical properties of the developed composite chemical reagents base on local and raw materials, wastes as well as weighting agents have been proposed new compositions of drilling fluids. New receipt of drilling fluids based on developed composite lubricant and weighting agent were recommended for use in drilling oil and gas wells with abnormally high reservoir pressure (AHRP).

References

1. Emmanuel U.A., Godpower C.E., Ghasem N., Aminu A.Y.,Abdullahi A.A., Bello S., 2019. Water based drilling fluids for high temperature applications and water sensitive and dispersible shale formations. J. Petrol. Sci. Eng. 175 .1028-1038. http:/doi.org/10.1016/j.petrol.2019.01.002.
2. Melbouci, M., Sau, A.C., 2008. Water-based drillingfluids. US Patent 7384892
3. Menezes, R., Marques, L., Campos, L., Ferreira, H., Santana, L., Neves, G., 2010.Use of statistical design to study the influence of CMC on the rheological properties of bentonite dispersions for water-based drillingfluids. Appl. Clay Sci. 49, 13–20.
4. Brazzel, R.L., 2009. Multi-component drilling fluid additive, and drilling fluid system incorporating the additive. US Patents 7635667
5. Reyn Caenn., HCH Darley., George R. Gray. 2017. Composition and properties of drilling and completion fluids. Seventh edition. Elsevier. Amsterdam
6. Kobilov N. S., Negmatova K.S., Sharifov G'.N., Rakhimov X.Y. 2016. Composite chemical reagent for stabilization heavy mud for drilling salt-anhydrite layer of oil and gas wells// European applied science. II. Germany, pp 50-52.
7. Kobilov N.S., 2016. New compositions of weighted drilling fluids based on composite chemical reagents // Composite materials. Tashkent,. №2. p.10-12
8. Hai Bu, Chengbiao Wang, Jinsheng Sun, Long Li, Lili Yan. 2012. Influence and Mechanism for the Particle Size of Weighting Material on the Rheological Properties of High-Density Drilling Fluids // International Conference on Pipelines and Trenchless Technology- Wuhan, American Society of Civil Engineers. China. -http://ascelibrary.org.
9. Negmatova K.S., Kobilov N.S et all. , 2015. Method obtaining modyficated powder gossypol resin for drilling fluids. Uz Patent IAP 05046
10. Etim IO, Developing drilling mud weighting material with local galena. BSc. Project of the Department of Chemical and Petroleum Engineering, University of Uyo, Akwa Ibom State Nigeria; 2010.
11. Bob DeWolfe, Leon Robinson., Fred Growcock., Tim Harvey., Bob Barret., Brian Carr. 2005. Drilling fluids processing handbook. Elsevier. USA.666 p
12. ANSI/API 13b-1. 2017. Fifth edition Recommended Practice for Field Testing Water-based Drilling Fluids. USA
13. Negmatova K.S., Negmatov S.S., Salimsakov Yu.A., Rakhimov H.Y., Negmatov J.N., Isakov S.S., Kobilov N.S., 2012. Structure And Properties of Viscous Gossypol Resin Powder. AIP Conference Proceedings **1459**, USA, 300 (2012); pp. 300-302. https://doi.org/10.1063/1.4738476