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ACID TREATMENTS QUALITY IMPROVING ANALYSIS THROUGH NEW WORKING AGENTS USAGE

Decrease in permeability that occurs during the construction of the well and operation are analyzed. The reasons for the decrease in the permeability of the bottom-hole zone in the reservoir rocks that occur in the process of drilling, cementing, reopening and development of wells are determined. The basic principles of acid treatment for intensification of hydrocarbon raw material extraction of sealed productive strata in the process of their drilling are investigated. The solution for acid treatment is given. Specialized products for stimulation are considered. Acid treatments quality increasing through new working agent's usage and improving the technology analysis is performed: the scientific substantiation of the program realization algorithm of possible influence for concrete geological and physical conditions of a well is presented; systems of geological and technological factors influencing the filtration properties of reservoirs are identified and analyzed; identifying features of development and adaptation types of chemical compositions for specific conditions of the formation; the possibility of conducting experimental research on the development and adaptation the chemical compositions and technologies of influence in the processes of increasing productivity and silencing of wells in relation to specific geological and physical conditions is determined.

Keywords: bottom-hole formation zone, hydrochloric acid treatment, chemical methods, pollution.

Introduction. In recent years, the urgency of maintaining the potential productivity of wells has increased significantly, including due to the involvement in operation in addition to traditionally exploited formations, and the involvement of formations of complex deposits with low permeability properties that have not been used before. In Ukraine, many large deposits have been explored, such as Machuhske, Zagoryanske, Sagaidatske, Semirenkovske, Yablunivske, the main hydrocarbon deposits which are associated with significant depths, and productive strata are represented by reservoirs of different lithological composition. It is known that drilling of exploratory wells is reviving at a slow pace with the growing role of hydrocarbon production in the current crisis conditions. In addition, the main part of the fields has passed into the final stage of development, which is characterized by redistribution of pressure in the reservoirs, restructuring of residual reserves, increasing the share of hard-to-recover oil reserves requires new approaches to their removal.

The efficiency of well construction is directly related to the quality of exposure of productive objects, which in turn depends on maintaining or improving the maximum possible permeability of reservoirs. The quality of exposure of productive objects at oil and gas condensate fields is directly related to the quality of drilling.

Well construction is an expensive and complex process. When drilling wells, high-quality multicomponent drilling fluids are used, but they also sometimes have a negative effect on reservoirs. Therefore, in wells with a long service life, as well as as a result of overhaul, productive horizons are clogged, which significantly reduces the flow and when using poor quality drilling fluids, the flow generally drops to zero. The problem of clogging of reservoirs is quite common - to solve it, leading specialists of Ukraine and the world are developing new methods and technologies to intensify hydrocarbon production.

The latest research and published works analysis. The analysis of a significant number of sources enabled to determine the basic principles of recovery productivity of wells clogged during their drilling and operation by the method of acid treatments [1–6].

The purpose of the study. Determination of the basic principles of acid treatment for intensification of hydrocarbon raw material production of sealed productive strata during their drilling.

Problem statement. Thus, only in the territory of the Dnieper-Donetsk basin about twenty wells in highly promising explored fields do not produce as a result of clogging of productive formations during drilling. At a time when geophysical studies in the well show that the filtration-capacity characteristics of the reservoir are highly effective, the horizons are productive in neighboring wells, but as a result of repression on the reservoir there is a significant penetration of solids into the reservoir, emulsion formation and polymerization. the bottomhole zone of the formation and the well is low in flow or does not produce at all.

The main part. Presentation of the main material. Today, oil and gas deposits are being opened with complex reservoirs in terms of chemical composition, dense, low-permeability and low-porosity. Deterioration of filtration properties of a productive collector can be caused by many reasons, the main of which are:

- absorption of well silencing fluid by the reservoir;
- swelling of the clay material of the rock as a result of contact with the filtrate of the well silencing fluid;
- formation of stable water-oil and gas emulsions in the zone of contact of the well silencing fluid with formation fluids (Jamen effect)
- formation of asphalt-resin-paraffin deposits and sparingly soluble sediments when the thermodynamic parameters of the formation change;

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- reduction of oil permeability of RAM as a result of hydrophilization of the pore space of the reservoir due to its contact with the filtrate of the well shut-off fluid, etc.

Before the productive horizons of an oil and gas field are exposed to wells, the physical parameters of the formation, such as pressure, temperature, distribution of fluids in the reservoirs, are in a constant (stable) state achieved for a long time since the formation of deposits. As soon as the formation is exposed to external influences (primary and secondary opening by drilling, silencing of wells).

The main reasons for clogging of the reservoir are the wrong selection of the solution, the human factor, non-compliance with the technology of preparation, processing and purification of the washing liquid. Highly promising wells do not produce anything and replenish the fund of idle wells. Water-based clay drilling fluids, potassium mortars, stabilized saline-saturated mortars mainly lead to contamination of the bottomhole zone of the formation (PZP) with solid phase and filtrate [7]. Many scientists have studied the issue of well recovery [8]. Successful recovery can lead to excellent results. For example, at the Yablunivske field, well №4 was clogged during drilling and did not produce, but after treatment with an acid solution, the well yielded 800,000 cubic meters of gas per day [9].

To avoid deep penetration of drilling mud filtrate into the formation, additives of various thickeners - polymers - are often used. The following thickeners are used: methyl acrylate, carboxymethylcellulose (CMC), polyacrylamide (PAA), acrylonitrile, GIPAN, cideryl, dc-drill, etc. Also sometimes use auxiliary additives - water repellents and inhibitors. The advantage of polymer-based BR is that during drilling the polymer is partially filtered on the "well-formation" boundary, forming an almost impermeable crust, which protects the formation and reduces the possibility of deep penetration of drilling mud filtrate [10].

When using low-quality polymer-based drilling fluids, the reduction in the permeability of oil and gas formations can occur several times and can even lead to complete clogging.

The main problem of reducing the flow characteristics of oil and gas fields in Ukraine in the process of their overhaul is the use of silencing fluid and other technological reagents in the repression of the reservoir. Thus, according to the statistics of the 80-90s of the XX century, the reduction in well productivity after overhaul was about 30%. The causes of clogging of productive formations and the mechanism of clogging are similar problems that occur during drilling.

Modern technologies indicate the following advantages of opening productive formations in depression: preservation and even improvement of natural FEH of productive formations, thanks to inflow of formation liquid in the course of opening; elimination of negative impact on the productive horizon of drilling and cement mortars used in traditional technologies, as well as excessive pressures during drilling and fastening;

increase in the level of oil recovery due to the increase in the permeability of the ROM (skin effect) increase in the flow rate of wells, resulting in a reduction in the payback period of their construction; involvement in the development of low-profit oil deposits and fields, as well as productive horizons

The development of gas and oil fields can be represented as a complex technological process that takes place under volatile conditions and is not subject to direct (visual) observation. Effective indicators of field development and high final return can be obtained with rational development, as well as with effective regulation of system processes. Means of regulation, for example, can be changes in the rate of fluid sampling and the corresponding distribution of samples in the wells, the density of the wells, increasing the permeability of the bottomhole zone, etc. (Table 1):

Table 1 – General systems analysis of the wells recoil clogged during drilling

№	Analysis system components examples according to the functional scheme
1	Analysis of scientific sources, formulation of goals and objectives of the research system; definition of the theoretical researches program and experiment planning
2	Classifications-identification and analysis of existing production wells and methods for determining flooding, identifying general and individual problems.
3	Scientific part methodology development: systems of dynamic models of the production management process on the basis of selected complex schemes; preparation for tests, numerical modeling, calculation results analysis
4	Determining the hierarchy of components while measurement and methodical part of flooding production of production wells, research of dynamics change of flooding at non-stationary mode of operation at a well.
5	Conducting physical and mathematical experiments; statistical analysis comparing the results of experiments with theoretical data.
6	Development of structure systems, identification-classification of algorithm and mathematical support of information-measuring and control system for intensification of production and determination of flooding the extracted products
7	Development of an innovative method of bringing production wells with different types of depth pumping units to a certain mode of operation using the developed complex processes of the system.
8	Carrying out of industrial experiment on an estimation of accuracy of instrumental definition of flooding of production of wells and effect on intensification of system of the subsequent extraction.
9	Carrying out of industrial experiment on an estimation of quality instrumental definition of flooding of production of wells and effect on intensification of system of the subsequent extraction.
10	Scientifically well-ground conclusions development and analysis.

Some issues of the system of increasing the recoil of wells clogged in the process of drilling in order to determine modern highly effective science-based technologies for their use and some features of possible

solutions, which are based on the analysis of geological and technical measures to intensify inflow to wells and reduce watering, extracted. This approach is one of the most promising for the development of process mechanisms and their scientific justification in the form of objects of technology, in particular to determine the features of the use of acid solutions based on hydrochloric acid in high temperature collectors [1] Despite its obvious advantages, the success of the operations of the application of acid compositions still remains low. The optimal technology of acid treatment provides the maximum effect is first selected taking into account the causes of ROM contamination, taking into account such parameters of the formation as: particle size and mineralogical composition of rocks; filtration-capacity properties; temperature, chemical composition of formation fluids. Properly selected formulation of the acid composition should lead to the desired result - cleaning the ROM from contamination, restoring its permeability and, as a consequence, ensuring the productivity of the well, corresponding to the local capabilities of the formation.

According to the experimental and industrial operation of deposit wells, the productive section of which is composed of reservoir rocks, it can be concluded that with low porosity and permeability, a significant effect can be achieved by intensification, using different variations of acid treatments and anti-clogging. The most effective formulations and highly permeable solvents were used and tested in the treatment of wells. Analyzing the data, it can be noted that with a properly selected solution formulation and the use of decontamination fluids, the flow rates of unproductive wells in productive sediments can be increased several times, and sometimes several orders of magnitude.

Today, to intensify the inflow from the productive strata often resort to the use of hydrochloric acid technology without decontamination. However, based on the fact that the productive strata where these bottomhole treatments are carried out are already flooded or simple hydrochloric acid technology does not give tangible results, it is necessary to use uniquely new compositions of working agents.

New compositions of solutions should solve the following tasks:

- 1) increasing the distance of acid penetration
- 2) decompression of ROM;
- 3) increasing the ability to remove reaction products;
- 4) low corrosion activity in relation to the equipment;
- 5) adaptation to the mineralization of formation water.

Due to its high soluble ability, hydrochloric acid is the most common reagent in the process of conducting KO in reservoirs. There are two risk factors that arise when using hydrochloric acid: the high reaction rate in the formation, which complicates the processing and high corrosion activity. To reduce the level of corrosion

activity, organic acids and inhibitors are added to the acid composition [14]. Various inhibitors are used to reduce corrosion of pipes when transporting acids through them. For example, such as formalin, Uicol PB-5, U-1-A inhibitor

Technical Utropin and BA-6 inhibitor (B-1, D-2). These inhibitors are used in the inhibition of high concentrations of acid and acid solutions for the treatment of wells with high formation temperatures and pressures. The use of these inhibitors is effective. In addition, the low solubility of organic acids reduces the level of non-uniformity of the reaction front of the acid composition in the rock. Given the above description of the properties of organic acids, there is a practice of creating acid compositions based on hydrochloric acid with the addition of organic acids to achieve a moderate level of formation of highly permeable channels in ROM, which has a positive effect on increasing productivity. Organic acids have been used for bottomhole treatment in bottomholes for many years. Experience shows that the use of high-end

Based on the literature review, the use of different solutions for drilling and secondary opening of wells, we can draw the following conclusions: almost always the solutions have a negative impact on the filtration characteristics of the bottomhole zone, the quality of opening depends on the final productivity of production wells. Therefore, before the use of drilling fluids in the field it is necessary to conduct laboratory tests to determine their basic physicochemical parameters, as well as filtration properties in the geological, physical and technological conditions of the operational facility.

Based on the literature review, the direction of research was focused on the development of acid composition for sealed wells. It is also planned to study the main physical and chemical parameters of polymer drilling mud used in drilling wells in difficult mining and geological conditions of Poltava region. It is planned to investigate the effect of the filtrate of inhibited BR of different composition with the addition of different surfactant hydrophilizes. The second part of the experiment is based on the study of the effect of cleaning properties on the clay crust created by the proposed solution of hydrochloric acid with various additives, which will be developed during the experiment, on the FEC of reservoir rocks in clogged wells [15–17].

The application of well restoring technologies and increase of their return is currently carried out without special consideration of individual geological and physical characteristics of productive strata, as well as without taking into account the occurrence of man-made changes in the process of field development. The basic principles of restoring the productivity of wells clogged during drilling can be defined as:

- study of issues and analysis of the scientific substantiation of the rational production organization and the ability to use them in the study and design of the organization of production processes at the enterprises of the industry;

- study of innovative patterns of development and design principles of production organization in the oil and gas industry;

- acquisition of skills of development of projects of the organization based on auxiliary and service processes at the enterprises of branch.

Experimental studies will be conducted in accordance with the basic requirements for drilling fluids and acid compositions.

Conclusions of this study and prospects for further research in this area. Thus, the acid used to treat the formation should not cause the formation of insoluble precipitates. Also, for effective acid treatment, the composition used must have the following properties: slow reaction rate with rock-forming minerals, which is especially important at high formation temperatures; low interfacial tension at the boundary "hydrocarbon - acid composition"; had corrosive activity; compatibility with formation fluids; inhibitory effect on clays; manufacturability at application. Based on the literature review, the use of different solutions for drilling and secondary opening of wells, we can draw the following conclusions: almost always the solutions have a negative impact on the filtration characteristics of the bottomhole zone, the quality of opening depends on the final productivity of production wells. Therefore, before the use of drilling fluids in the field it is necessary to conduct laboratory tests to determine their basic physicochemical parameters, as well as filtration properties in the geological, physical and technological conditions of the operational facility.

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Experimental studies are conducted in accordance with the basic requirements for drilling fluids and acid compositions. The study enables to draw the following conclusions: many wells, as a result of drilling, overhaul of the well after prolonged operation do not give products due to complete or partial clogging. The disadvantage of acid solutions based on hydrochloric acid is the high speed of reaction and the difficulty of getting the acid to the reservoir through the clogging film. It is necessary to model and study the mechanisms of decompression, to develop an effective composition for the restoration of deep wells, to increase the channels, as well as to reduce the corrosive effect. Many acid components and cleaning materials are known, but for specific conditions of depth and composition of the rock

it is necessary to develop an individual formulation of process fluids and technologies for processing PZP and restoring well productivity.

References

1. Rady, A. Iron Precipitation in Calcite, Dolomite and Sandstone Cores [Electronic resource] / A. Rady, H.A. Nasr-El-Din. *SPE Russian Petroleum Technology Conference*. 2015. Access mode: <https://doi.org/10.2118/176574-RU>
2. Saber, Mohamed R. A New Technique to Increase the Performance of Organic Acids to Stimulate Carbonate Reservoirs at High Acid Concentrations [Electronic resource] / Saber Mohamed.R, Ahmed I. Rabie and H.A. Nasr-El-Din//*SPE* 175192. 2015. Режим доступа: <https://doi.org/10.2118/175192-MS>
3. Sarma, D.K. Application of Self-Diverting Acid System for Stimulation of Multilayered Wells in Carbonate Reservoir: A Case Study [electronic resource] / D.K.Sarma., Y.R.L.Rao., B.Mandal and P.K.Bhargava. *SPE 154554, SPE oil and gas India conference and exhibition*. 2012. Access mode: <https://doi.org/10.2118/154554-MS>
4. Sayed, M. A. A New Emulsified Acid to Stimulate Deep Wells in Carbonate Reservoirs: Coreflood and Acid Reaction Studies [Electronic resource] / M. A. Sayed., H. A. Nasr-El-Din., J. Zhou., L.Zhang and S. Holt. *SPE 151062, The North Africa Technical Conference and Exhibition*. 2012. Access mode: <https://doi.org/10.2118/151062-MS>
5. Sayed, M. A. A New Emulsified Acid to Stimulate Deep Wells in Carbonate Reservoirs [Electronic resource] / M. A. Sayed., H. A. Nasr-El-Din., J. Zhou., S. Holt and H. Al-Malki. *SPE 151061, international symposium and exhibition on formation damage control*. 2012. Access mode: <https://doi.org/10.2118/151061-MS>
6. Sayed, M. A. Reaction Rate of Emulsified Acids and Dolomite [Электронный ресурс] / M. A. Sayed and H. A. Nasr-El-Din. *SPE 151815, international symposium and exhibition on formation damage control*. 2012. Access mode: <https://doi.org/10.2118/151815-MS>
7. Kotskulich Ya. S. Analysis of the efficiency of industrial beds for the primary development of productive layers. Scientific Bulletin of the Ivano-Frankivsk National Technical University of Oil and Gas. 2012. No. 1. Access mode: http://nbuv.gov.ua/UJRN/Nvif_2012_1_5..
8. Rudy M.I. Technologies of action on the bottomhole zone of the formation of production wells with the use of surfactants. Oil and gas industry. 2009. № 1. p. 45–48.
9. Dmytrenko, V. I., & Zezekalo, I. H. Influence of ammonium carbon dioxide salts on the filtration properties of rocks in the bottomhole zone of the formation. Prospecting and development of oil and gas fields, (1 (70), 70-76. [https://doi.org/10.31471/1993-9973-2019-1\(70\)-70-76](https://doi.org/10.31471/1993-9973-2019-1(70)-70-76)
10. Rabie, A.I. Sodium Gluconate as a New Environmentally Friendly Iron Controlling Agent for HP/HT Acidizing Treatments [Электронный ресурс] /A.I. Rabie, H.A. N. EIDin. *SPE Middle East Oil & Gas Show and Conference*. 2015. Access mode: <https://doi.org/10.2118/172640-MS>
11. Mikhailov VA Unconventional sources of hydrocarbons of Ukraine. Book VIII. Theoretical substantiation of resources of unconventional hydrocarbons of sedimentary basins of Ukraine. К.: NIKA-CENTER, 2014. 280 p.
12. Nitters, G. Structured Approach to Advanced Candidate Selection and Treatment Design of Stimulation Treatments [Electronic resource] /G.Nitters, L.Roodhart,

- H.Jongma, V.Yeager, M.Buijse, D.Fulton, J.Dahl and E.Jantz. SPE 63179. 2000. Access mode: <https://doi.org/10.2118/63179-MS>
13. Rabie, A.I. Effect of Acid Additives on The Reaction of Stimulating Fluids During Acidizing Treatments [Electronic access] / Ahmed I. Rabie and H.A. Nasr-El-Din. SPE 175827. 2015. Access mode: <https://doi.org/10.2118/175827-MS>
 14. Зеєкало І.Г., Іваницька І.О., Агейчева О.О. Основні принципи відновлення продуктивності свердловин закольматованих у процесах буріння та експлуатації методом кислотних обробок. Вісник НТУ «ХПІ». – Х.: НТУ «ХПІ», 2020. – № 6 (1360). – С. 90–94. doi: 10.20998/2220-4784.2020.06.14
 15. Агейчева О.О., Зеєкало І.Г., Бухкало С.І. Загальні системи аналізу віддачі пластів свердловин. XXIX Міжн. н-практ. конф. «Інформаційні технології: наука, техніка, технологія, освіта, здоров'я» (MicroCAD-2020) 18-20 травня 2021 р.: у 5 ч. Ч. II. / за ред. проф. Сокола Є.І. – Харків: НТУ «ХПІ». С. 103.
 16. Зеєкало І.Г., Бухкало С.І., Агейчева О.О. Деякі задачі з підвищення віддачі пластів свердловини. XXIX Міжн. н-практ. конф. «Інформаційні технології: наука, техніка, технологія, освіта, здоров'я» (MicroCAD-2020) 18-20 травня 2021 р.: у 5 ч. Ч. II. / за ред. проф. Сокола Є.І. – Харків: НТУ «ХПІ». С. 149.
 17. Svitlana BUKHKALO. The systems and models for complex polymer solid waste. XXIX Міжн. н-практ. конф. «Інформаційні технології: наука, техніка, технологія, освіта, здоров'я» (MicroCAD-2020) 18-20 травня 2021 р.: у 5 ч. Ч. II. / за ред. проф. Сокола Є.І. – Харків: НТУ «ХПІ». С. 114.
 6. Sayed, M. A. Reaction Rate of Emulsified Acids and Dolomite [Electronic resource] / M. A. Sayed and H. A. Nasr-El-Din. SPE 151815, international symposium and exhibition on formation damage control. 2012. Access mode: <https://doi.org/10.2118/151815-MS>
 7. Kotskulych Ya. S. Analiz efektyvnosti promyvalnykh ridyn dlia pervynnoho rozkryttia produktyvnykh plastiv. Naukovyi visnyk Ivano-Frankivskoho natsionalnoho tekhnichnoho universytetu nafty i hazu. 2012. № 1. Rezhym dostupu: http://nbuv.gov.ua/UJRN/Nvif_2012_1_5.
 8. Rudyi M.I. Tekhnolohii dii na pry vybiinu zonu plasta vydobuvnykh sverdlolvyn iz vykorystanniam poverkhnivo-aktyvnykh rehovyn. Naftova i hazova promyslovist. 2009. № 1. S. 45-48.
 9. Dmytrenko, V. I., & Zezekalo, I. H. Vplyv vuhlekyslotnykh solei amoniu na filtratsiini vlastyvoli porid pryvybiinoi zony plasta. Prospecting and development of oil and gas fields, (1(70), 70-76. [https://doi.org/10.31471/1993-9973-2019-1\(70\)-70-76](https://doi.org/10.31471/1993-9973-2019-1(70)-70-76)
 10. Rabie, A.I. Sodium Gluconate as a New Environmentally Friendly Iron Controlling Agent for HP/HT Acidizing Treatments [Електронний ресурс] / A.I. Rabie, H.A. N. ElDin. SPE Middle East Oil & Gas Show and Conference. 2015. Режим доступу: <https://doi.org/10.2118/172640-MS>
 11. Mykhailov V. A. Netradytsiini dzhherela vuhlevodniv Ukrainy. Knyha VIII. Teoretychne obgruntuvannia resursiv netradytsiinykh vuhlevodniv osadovykh basiniv Ukrainy. K.: NIKA-TsENTR, 2014. 280 s.
 12. Nitters, G. Structured Approach to Advanced Candidate Selection and Treatment Design of Stimulation Treatments [Electronic resource] /G.Nitters, L.Roodhart, H.Jongma, V.Yeager, M.Buijse, D.Fulton, J.Dahl and E.Jantz. SPE 63179. 2000. Access mode: <https://doi.org/10.2118/63179-MS>
 13. Rabie, A.I. Effect of Acid Additives on The Reaction of Stimulating Fluids During Acidizing Treatments [Electronic mode] / Ahmed I. Rabie and H.A. Nasr-El-Din. SPE 175827. 2015. Access: <https://doi.org/10.2118/175827-MS>
 14. Zezekalo I.G., Ivanic'ka I.O., Agejcheva O.O. Osnovni principii vidnovlennja produktyvnosti sverdlolvyn zakol'matovanih u procesah burinnja ta ekspluatacii metodom kislotnih obrobok. Visnik NTU «KhPI». – Kh.: NTU «KhPI», 2020. – № 6 (1360). – pp. 90–94. doi: 10.20998/2220-4784.2020.06.14
 15. Agejcheva O.O., Zezekalo I.G., Buhkalo S.I. Zagal'ni sistemi analizu viddachi plastiv sverdlolvyn. XXIX Mizhn. n-prakt. konf. «Informacijni tehnologii: nauka, tehnika, tehnologija, osvita, zdorov'ja» (MicroCAD-2021) 18-20 travnja 2021 r.: u 5 ch. Ch. II. / za red. prof. Sokola E.I. – Kharkiv: NTU «KhPI», p. 103.
 16. Zezekalo I.G., Buhkalo S.I., Agejcheva O.O. Dejaki zadachi z pidvishennja viddachi plastiv sverdlolini. XXIX Mizhn. n-prakt. konf. «Informacijni tehnologii: nauka, tehnika, tehnologija, osvita, zdorov'ja» (MicroCAD-2021) 18-20 travnja 2021 r.: u 5 ch. Ch. II. / za red. prof. Sokola E.I. – Kharkiv: NTU «KhPI», p. 149.
 17. Svitlana BUKHKALO. The systems and models for complex polymer solid waste. XXIX Mizhn. n-prakt. konf. «Informacijni tehnologii: nauka, tehnika, tehnologija, osvita, zdorov'ja» (MicroCAD-2021) 18-20 travnja 2021 r.: u 5 ch. Ch. II. / za red. prof. Sokola E.I. – Kharkiv: NTU «KhPI», p. 114.

References (transliterated)

1. Rady, A. Iron Precipitation in Calcite, Dolomite and Sandstone Cores [Electronic resource] / A. Rady, H.A. Nasr-El-Din. SPE Russian Petroleum Technology Conference. 2015. Access mode: <https://doi.org/10.2118/176574-RU>
2. Saber, Mohamed R. A New Technique to Increase the Performance of Organic Acids to Stimulate Carbonate Reservoirs at High Acid Concentrations [Electronic resource] / Saber Mohamed.R, Ahmed I. Rabie and H.A. Nasr-El-Din/SPE 175192. 2015. Access mode: <https://doi.org/10.2118/175192-MS>
3. Sarma, D.K. Application of Self-Diverting Acid System for Stimulation of Multilayered Wells in Carbonate Reservoir: A Case Study [Electronic resource] / D.K.Sarma., Y.R.L.Rao., B.Mandal and P.K.Bhargava. SPE 154554, SPE oil and gas India conference and exhibition. 2012. Access: <https://doi.org/10.2118/154554-MS>
4. Sayed, M. A. A New Emulsified Acid to Stimulate Deep Wells in Carbonate Reservoirs: Coreflood and Acid Reaction Studies [Electronic resource] / M. A. Sayed., H. A. Nasr-El-Din., J. Zhou., L.Zhang and S. Holt. SPE 151062, The North Africa Technical Conference and Exhibition. 2012. Access mode: <https://doi.org/10.2118/151062-MS>
5. Sayed, M. A. A New Emulsified Acid to Stimulate Deep Wells in Carbonate Reservoirs [Electronic resource] / M. A. Sayed., H. A. Nasr-El-Din., J. Zhou., S. Holt and H. Al-Malki. SPE 151061, international symposium and exhibition on formation damage control. 2012. Access mode: <https://doi.org/10.2118/151061-MS>

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АНАЛІЗ ПІДВИЩЕННЯ ЯКОСТІ КИСЛОТНИХ ОБРОБОК ЗА РАХУНОК ВИКОРИСТАННЯ НОВИХ РОБОЧИХ АГЕНТІВ

Проаналізовано причини зниження проникності, що відбувається в процесі спорудження свердловини та її експлуатації. Визначено причини зниження проникності призабійної зони пласта порід-колекторів, що відбуваються під час процесів: буріння, цементування, вторинного розкриття та освоєння свердловин. Досліджено та проаналізовано основні принципи проведення кислотної обробки для інтенсифікації видобутку вуглеводневої сировини закольматованих продуктивних пластів в процесі їх буріння. Наведено рішення для кислотної обробки. Розглянуто спеціалізовані продукти для стимуляції. Проведено аналіз підвищення якості кислотних обробок за рахунок використання нових робочих агентів й удосконалення технології проведення: представлено наукове обґрунтування алгоритму програми реалізації можливого впливу для конкретних геолого-фізичних умов свердловини; визначено та проаналізовано системи геолого-технологічних факторів, що впливають на фільтраційні властивості колекторів; виявленні особливості різновидів розробки і адаптація композицій хімічних реагентів для конкретних умов пласта; визначена можливість проведення експериментальних досліджень по розробці і адаптації композицій хімічних реагентів і технологій впливу в процесах підвищення продуктивності і глушіння свердловин стосовно конкретних геолого-фізичних умов.

Ключові слова: привибійна зона пласта, соляно-кислотна обробка, хімічні методи, забруднення.

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АНАЛИЗ ПОВЫШЕНИЯ КАЧЕСТВА КИСЛОТНЫХ ОБРАБОТОК ЗА СЧЕТ ИСПОЛЬЗОВАНИЯ НОВЫХ РАБОЧИХ АГЕНТОВ

Проанализированы причины снижения проницаемости, что происходит в процессе сооружения скважины и эксплуатации. Определены причины снижения проницаемости призабойной зоны пласта пород-коллекторов, происходящие в процессе бурения, цементирования, вторичного вскрытия и освоения скважин. Исследованы основные принципы проведения кислотной обработки для интенсификации добычи углеводородного сырья закольматированных продуктивных пластов в процессе их бурения. Приведены решения для кислотной обработки. Рассмотрены специализированные продукты для стимуляции. Проведен анализ повышения качества кислотных обработок за счет использования новых рабочих агентов и совершенствование технологии проведения: представлено научное обоснование алгоритма программы реализации возможного влияния для конкретных геолого-физических условий скважины; определены и проанализированы системы геолого-технологических факторов, влияющих на фильтрационные свойства коллекторов выявлении особенности разнородности разработки и адаптация композиций химических реагентов для конкретных условий пласта; определена возможность проведения экспериментальных исследований по разработке и адаптации композиций химических реагентов и технологий воздействия в процессах повышения производительности и глушения скважин применительно к конкретным геолого-физическим условиям.

Ключевые слова: призабойная зона пласта, соляно-кислотная обработка, химические методы, загрязнение.