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Lithological and mineralogical heterogeneity of Lower Berezovskian subseries of Medvezhye and Kharampurskoye fields

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Abstract. The content of opal-cristobalite-tridymite (opal-CT phase), quartz, montmorillonite, and glauconite in Lower Berezovskian subseries of the Kharampurskoye and Medvezhye field differ substantially. Studies conducted in different laboratories revealed the general trend. Relationships between mineral composition (opal-CT phase and quartz) and amplitude of tectonic movements, as well as between quartz and clay content were established. In Lower Berezovskian subseries of Kharampurskoe field lithogenetic and tectonic fractures were encountered. NB1 formation exhibited the largest intensity of tectonic fracturing. Clay content in NB formation was observed to increase from 19% in Kharampurskoye field to 30% in Medvezhye field. This increase in clay content was assumed to be related to the effect of other Coniacian-Santonian marine sediments carried over to Upper Cretaceous West Siberian basin.

Key words: *Kharampurskoye field, Medvezhye field, Lower Berezovskian subseries, argillaceous-siliceous reservoir, opal-cristobalite-tridymite phase, quartz, X-ray diffraction analysis, microfracture clusters, tectonic processes, Transeuropean shift*

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Effect of horizontal fault structures on geology of upper Jurassic sediments in Kharampurskoye and Festivalnoye fields

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Abstract. The paper presents results of study of the horizontal fault structures in the sedimentary mantle of the Upper Jurassic formations by the examples of the Kharampurskoye and Festivalnoye fields. The horizontal fault structures' effect on the geologic setting and production potential was analyzed; sweet spots, as well as drilling-risk zones, were identified. Recommendations regarding development of fields with horizontal fault structures are offered.

Key words: *subhorizontal fault; horizontal fault structures; en echelon faults*

For citation: K.K. Zinchenko, A.P. Popruzhuik Vliyanie struktur gorizontal'nogo sdviga na geologicheskoe stroenie verhnjejurskih otlozhenij Harampurskogo i Festival'nogo mestorozhdenij [Effect of horizontal fault structures on geology of upper Jurassic sediments in Kharampurskoye and Festivalnoye fields]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 22-34. DOI <https://doi.org/10.25689/NP.2021.4.22-34> (in Russian)

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Specific aspects of scattered carbonaceous matter in Yu_0 and Yu_1 intervals of Em-Yogovsky field in Krasnoleninsky Arch

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Abstract. Micro-component organic matter composition has been analyzed, as well as its catagenetic maturity in the Upper Jurassic sediments of Em-Yogovsky field in the Krasnoleninsky Arch, West-Siberian petroleum basin.

A micro-component composition of concentrated (carbonaceous) organic matter in the Upper Jurassic sediments of Tutleimsky and Abalaksy formations has been studied for the first time using 304 samples from 11 Em-Yogovsky wells. Vitrinite reflectance has been measured and depositional environment has been specified. The most probable directions of hydrocarbon migration have been defined.

Key words: carbon matter, micro-component composition, depositional environment, vitrinite reflectance, catagenetic maturity, coal grades, hydrocarbon generation

For citation: T.A. Ryazanova, R.R. Khasanov Svoeobrazie rassejannogo ugleficirovannogo veshhestva plastov Ju_0 i Ju_1 Em-Egovskoj ploshhadi Krasnoleninskogo svoda [Specific aspects of scattered carbonaceous matter in Yu_0 and Yu_1 intervals of Em-Yogovsky field in Krasnoleninsky Arch]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 35-54. DOI <https://doi.org/10.25689/NP.2021.4.35-54> (in Russian)

Special considerations in identification of fluid barriers to localize remaining oil reserves and enhance production: A case study of Samotlor field (AB4-5 formations)

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Abstract. AB4-5 production target of Samotlor oil-gas-condensate field is marked by presence of clearly identified highly productive solid block section, as well as the presence of low-permeability thinly-laminated reservoirs exhibiting both vertical and horizontal heterogeneity. Reserves in non-compartmentalized reservoir section have almost been depleted, while their localized distribution pattern interferes with the planning of production enhancement operations.

The authors conducted an in-depth analysis of geological structure and completion quality, and evaluated the efficiency of production enhancement operations conducted recently. Most of the reserves were found to be localized in the top section of poor reservoir quality, as well as in the bottom section in presence of shale barrier, more than 1 m thick, isolating the highly productive non-compartmentalized reservoir section.

The present research effort is a comprehensive study of the current status of development of AB4-5 production formations for efficient planning of production enhancement operations, reinterpretation of geological structure, completion strategy and consequently, planning of recorrelation for individual units of production target.

Key words: *Samotlor field; shale barrier; coning; AB4-5 production target; non-compartmentalized production target; division of section into units; recorrelation; production performance analysis; analysis of completion quality; late stage of field development; localization of residual reserves; planning of production enhancement operations*

For citation: D.S. Smirnov, A.A. Shkitin, I.A. Likhoded, E.L. Arkhipova, D.Yu. Pisarev Osobennosti vydeleniya fljuidouporov v razreze s cel'ju lokalizacii i dovyrabotki ostatocnyh zasov nefi na primere gruppy plastov AV4-5 Samotlorskogo mestorozhdenija [Special considerations in identification of fluid barriers to localize remaining oil reserves and enhance production: A case study of Samotlor field (AB4-5 formations)]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 55-69. DOI <https://doi.org/10.25689/NP.2021.4.55-69> (in Russian)

Real-time oil and gas production control and optimization technology

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Abstract. The development of the oil and gas companies at the present stage is directly related to their digital transformation, including the use of emerging technologies that modify business processes by replacing or supplementing a person. According to the authors' opinion, an important component of this process, which should ensure a significant increase in the efficiency of hydrocarbon production, is the intellectualization of oil and gas fields.

To solve this problem specialists of Rosneft Oil Company proposed oil and gas production control and optimization technology (RN-TRON). The technology consider the creation of a distributed gas (gas condensate) field control system consisting of:

- Automatic Field Control System (SAUP) - software and hardware complex for optimizing the operation of the entire fishery;
- Distributed Control Systems (SAR) - software and hardware appliance for maintaining the well regimes specified by the SAUP;
- Automatic Process Control System (APCS) providing remote control and regulation of gas production and treatment.

SAUP is physically located in the UKPG control room, SAR of wells - in the automation units of well pads.

The core of the SAUP is a fast-acting dynamic gas field digital twin, which works together with validation, auto-adaptation and optimization modules to select a reasonable optimal control scenario. The technology envisages sequential implementation of the following main functions:

- Automatic validation (control) of actual incoming data and rejection of false information;
- Automatic adaptation (digital twin) real-time adjustment to valid actual data;
- Automatic optimization oil and gas real-time production control scenarios using the digital twin.

Target parameters set by SAUP are transmitted through APCS and are automatically supported by local automation systems, including SAR on well pads. At the same time, the SAUP works under UKPG dispatcher control, who, if necessary, can take over the operation control of individual equipment or the whole field.

Software for basic version of SAUP mathematical apparatus in stationary non-isothermal two-phase definition has been currently developed. The paper presents the

approaches used in solving multiphase fluids flow distribution and thermodynamic equilibrium problem in the system "Reservoir – Wells – Gas gathering system – UKPG – Gas booster station".

Today, the basic principles and algorithms of the RN-TRON technology have been developed and achieved the first results of its application. The SAUP core basic version successful testing was carried out using the example of the onshore gas field digital twin. The results of testing are given in the article.

Key words: *gas field, gas production, digital transformation, digitalization, automatic control system, real-time control, digital twin, adaptation, validation, optimization, flow distribution task, system of nonlinear equations*

For citation: A.V. Arzhilovskiy, T.A. Pospelova, A.N. Kharitonov, A.V. Strekalov, D.E. Deryushev, R.R. Lopatin, D.N. Trushnikov, O.A. Loznyuk, Y.A. Arkhipov Tehnologija regulirovanija i optimizacii neftegazodobychi v rezhime real'nogo vremeni [Real-time oil and gas production control and optimization technology]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 70-93. DOI <https://doi.org/10.25689/NP.2021.4.70-93> (in Russian)

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Analysis of the applicability of WAG at the facilities of the Tyumen sweet

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Abstract. This article is devoted to the assessment of the applicability of water alternating gas (WAG) in the conditions of the objects of the Tyumen sweet. To assess the applicability of water-gas exposure, various experiences of using this technology on low-permeability objects are considered. Field experience shows that the efficiency of WAG use depends primarily on the reservoir permeability. Simulation of various methods of stimulation (waterflooding, gas injection, WAG) on objects with low permeability indicates that gas and water-gas methods are more effective than classical waterflooding. Field experience and simulation results are supported by core studies showing high efficiency of gas stimulation techniques. The author has developed an automated utility for determining the effectiveness of the implementation of various methods based on the geological and physical characteristics of the reservoir. The results of the utility's work confirm the high potential efficiency of gas and water-gas methods at the facilities of the Tyumen sweet.

Key words: *water alternating gass, Tyumen sweet, waterflooding, low-permeability reservoir*

For citation: P.A. Tsitser Analiz primenimosti vodogazovogo vozdejstviya na ob#ektah Tjumenskoj svity [Analysis of the applicability of WAG at the facilities of the Tyumen sweet]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 94-108. DOI <https://doi.org/10.25689/NP.2021.4.94-108> (in Russian)

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Effects of self-induced hydraulic fractures on oil recovery factor and recovery prediction

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Abstract. Current experience in waterflood development of low-permeability production zones suggests that existing process approaches to operation of injection wells cannot prevent formation of self-induced hydraulic fractures.

Self-induced fracture growth interferes with waterflooding process and affects both current oil production and oil recovery factor. In this paper actual field data are used to study the effects of self-induced fractures on predicted oil recovery factors. A new approach to production forecast is proposed in view of presence of production-induced fractures.

Key words: *self-induced hydraulic fracturing, hard-to-recover reserves, water flooding, displacement efficiency*

For citation: A.A. Izotov, D.G. Afonin Vlijanie treshhin avto-GRP na koeficient nefteizvlechenija i ego prognozirovanie [Effects of self-induced hydraulic fractures on oil recovery factor and recovery prediction]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 109-121. DOI <https://doi.org/10.25689/NP.2021.4.109-121> (in Russian)

**Influence of the temperature of the injected water on the filtration
properties of the productive deposits of carbonate rocks of the fields of
Eastern Siberia**

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Abstract. The paper represents the results of filtration studies on fresh water injection into a reservoir model under conditions of low temperatures. The experiments were carried out on the core material of a dolomite-type carbonate bed of the Eastern Siberia field with the simulation of reservoir conditions. It was found that the water permeability of the reservoir model at residual oil saturation decreases significantly with a decrease in temperature from 20 to 5 °C. The performed set of laboratory studies showed that the results obtained are mainly induced by the deposition of heavy oil components in the pore space and the possible formation of stable low-mobile water-oil mixtures that impede the movement of water, which in practice is accompanied by a decrease in the intake capacity of injection wells.

Key words: *dolomites, asphalt-resin-paraffin components, phase permeability, filtration, organic solvent, bottomhole formation zone, waterflooding, phase equilibrium, saturation pressure, clogging of pore space*

For citation: N.A. Cherepanova, A.A. Zagorovskiy, V.V. Mazaev Vliyanie temperatury zakachivaemoj vody na fil'tracionnye svoystva produktivnyh otlozhenij karbonatnyh porod mestorozhdenij Vostochnoj Sibiri [Influence of the temperature of the injected water on the filtration properties of the productive deposits of carbonate rocks of the fields of Eastern Siberia]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 122-135. DOI <https://doi.org/10.25689/NP.2021.4.122-135> (in Russian)

Efficiency of water-alternating-gas process in water-wet and oil-wet reservoirs by results of core flooding experiments on long core samples

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Abstract. Considering the ever-increasing deterioration of the hydrocarbon reserves' structure as well as decline of the number and, more to the point, the quality (in terms of the recoverable reserves' amount) of new discoveries, enhanced oil recovery (EOR) methods have acquired great importance. Worthy of separate attention are gas injection EOR technologies, for they do not just increase recovery, but also improve the gas utilization factor.

The efficiency of water-alternating-gas (WAG) process depends on various factors associated with properties of reservoir rocks and fluids. Still, the wettability being responsible for phases' distribution in the porous space and the reservoir fluid flow, is one of the most important factors. The paper analyzes the effect of wettability on increase of displacement efficiency in WAG processes.

The comparative analysis of results of core flooding experiments on long core samples in water-wet (Suzunskoye oil field) and oil-wet (North-Danilovskoye and Verkhnechonskoye oil fields) conditions is presented.

Key words: *wettability, displacement efficiency, water-wet, oil-wet, core sample, core flooding experiment*

For citation: V.A. Zakharenko, A.V. Kobyashev, A.A. Pyatkov, K.M. Fedorov, I.A. Dolgov *Jefferktivnost' vodogazovogo vozdejstviya v uslovijah gidrofil'nyh i gidrofobnyh sred po dannym laboratornyh jeksperimentov na sostavnyh kernovyh kolonkah* [Efficiency of water-alternating-gas process in water-wet and oil-wet reservoirs by results of core flooding experiments on long core samples]. *Neftyanaya Provintsiya*, No. 4(28), Part 1, Special issue, 2021. pp. 136-154. DOI <https://doi.org/10.25689/NP.2021.4.136-154> (in Russian)

Ways to solve production problems of gas wells in West Siberia's mature fields

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Abstract. A considerable number of West Siberia's gas fields have reached the maturity stage characterized by pressure depletion, ever-increasing watercut, and severe sand production. The paper focuses on comprehensive analysis of reservoir and operational challenges including liquid loading, damage of near-bottomhole zone, aging and abrasive wear of equipment. Factors contributing to these processes and ways to address the issues are discussed. The paper presents methods to calculate minimum necessary gas production rates in watered and non-watered wells, as well as a procedure to evaluate the erosion rate.

The paper also discusses methods to control water breakthrough. They include hydrochemical and electrochemical methods, in that number, use of a mineralization detector in the wellhead equipment to signal beginning of water breakthrough to production wells.

The generally used sand detectors have a high measurement error, so to improve the erosion control, the sand detection system can be backed up by erosion signaling indicators, which are activated as soon as their control elements installed in the gas flow are destructed.

Common technologies to improve production of marginal gas wells including free-piston pumping, concentric tubing, gas-lift, surfactant flooding are discussed, and case studies are presented. Results of well tests allowed a comparative analysis of available technologies and selection of the most effective methods to improve the performance of maturing gas assets. The industry efforts must be aimed at search of advanced technologies to control water production. This problem is particularly acute in low-thickness gas reservoirs, and the authors offer some possible ways to address this issue.

Key words: *reservoir pressure, declining production, marginal gas well, liquid loading, water breakthrough, minimum necessary gas production rate, formation damage, sand production, erosion rate, sand detection system, hydrochemical reservoir control, concentric tubing, gas-lift, free-piston pumping, surfactant flooding*

For citation: A.N. Kharitonov Problemy jekspluatatsii gazovyh skvazhin zrelyh mestorozhdenij Zapadnoj Sibiri i puti ih reshenija [Ways to solve production problems of gas wells in West Siberia's mature fields]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 155-185. DOI <https://doi.org/10.25689/NP.2021.4.155-185> (in Russian)

Hydraulic fracturing in highly permeable and weakly cemented reservoir

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Abstract. The development of the Pokurskaya suite of the Russkoye field is complicated by a number of factors: poorly cemented reservoir, high-viscosity oil, high lateral and vertical heterogeneity of reservoir properties, the presence of a gas cap and an underlying aquifer.

To improve the efficiency of developing the reserves of this object, hydraulic fracturing in horizontal wells is being considered.

The main goal of hydraulic fracturing operations in the Pokurskaya suite is to increase the volume of oil reserves drained by the well due to the union of additional productive intervals by the hydraulic fracture, separated by clay interlayers. Hydraulic fracturing also has the potential to improve the efficiency of low-productivity wells with a high fraction of non-reservoir along the wellbore.

Based on the results of evaluating the hydraulic fracturing technology effectiveness, the geological conditions for the applicability of hydraulic fracturing were substantiated, well completion layouts were recommended, an optimal scheme for the implementation of pilot operations was developed, candidate wells were selected, and designs of hydraulic fracturing operations were calculated.

Key words: *Hydraulic fracturing, multistage hydraulic fracturing, well completion, highly permeable reservoir, unconsolidated reservoir, pilot work*

For citation: N.A. Pavlyukov, V.A. Pavlov, K.G. Lapin, E.R. Volgin, K.V. Toropov Tehnologija provedenija GRP v vysokopronicaemyh i slaboscementirovannyh otlozhenijah [Hydraulic fracturing in highly permeable and weakly cemented reservoir]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 186-203. DOI <https://doi.org/10.25689/NP.2021.4.186-203> (in Russian)

Experience in CRM model application to optimize waterflooding in Samotlorskoye field

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Abstract. A continuous search for new technologies to produce the remaining oil from low-productive reservoirs is under way in the Samotlorskoye oil, gas and condensate field. Advances in multi-stage fracturing technology allow producing from the low-productivity zone of BV8(0) horizon which was in commingled production with the underlying highly productive BV8(1-3) horizon 10 years ago. Infill horizontal drilling has been started in BV8(0) horizon which in fact means production with an individual well pattern. The inherent water injection system designed for a good-quality BV8(1-3) reservoir requires some optimization to produce from BV8(0).

Ariadne Software has been developed by OOO Tyumen Oil Research Center to make on-line decisions when optimizing the water injection system. The software execution is based on a group of CRMP (Capacitance resistance) models. To test the Ariadne software for the Samotlorskoye field conditions, a pilot test area has been selected and model calculations have been made.

The authors analyze the results of work based on well performance monitoring and identify errors and limitations.

Key words: *Samotlorskoye field, mature fields, water injection optimization, water flooding, CRM model, interference factors, incremental oil production, infrastructural limitations of water injection system*

For citation: M.L. Babaev, I.V. Savchenko, D.G. Rudikov, A.D. Bekman, D.S. Smirnov, Opyt primeneniya modeli CRM dlja optimizacii zavodneniya na Samotlorskom mestorozhdenii [Experience in CRM model application to optimize waterflooding in Samotlorskoye field]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 204-220. DOI <https://doi.org/10.25689/NP.2021.4.204-220> (in Russian)

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Optimization of planned well pattern in VK1 formation based on seismic facies simulation

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Abstract. The paper presents one of the possible procedures for identification and simulation of prospect features. Based on the integrated analysis of geological and geophysical data, range of the river paleo-system distributing canal has been delineated, 3D refined model has been generated and several possible options of planned well pattern have been proposed.

Key words: *seismic attribute analysis, seismic facies ranking, better-quality reservoir areas, Vikulovsky formation, Ai-Torsky High, Krasnoleninsky Arch*

For citation: E.V. Ilzit, E.A. Morozova, D.A. Batmanov Optimizacija razmeshhenija proektnogo fonda skvazhin dlja plastov VK1 na osnove sejsmo-facial'nogo modelirovanija [Optimization of planned well pattern in VK1 formation based on seismic facies simulation]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 221-236. DOI <https://doi.org/10.25689/NP.2021.4.221-236> (in Russian)

Optimizing field development and construction strategy based on integrated simulation

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Abstract. The paper discusses the experience of integrated simulation application as a tool for a comprehensive analysis of field development scenarios with regard to interference of integrated model components. The work is aimed at improving the economic efficiency of field development due to optimization of surface infrastructure based on integrated simulation results. Application of the proposed approach at the initial planning stages enables the surface infrastructure to be improved and optimized considering its impact on production data, as well as taking justified engineering solutions, thus increasing accuracy of the project economic benefit estimation. Based on the integrated model calculations, the authors provide recommendations on pipeline size optimization and additional loop laying. Planned booster pump stations have been recommended to be commissioned at a later period. All the recommendations have been taken into consideration while preparing design documentation for field facilities construction.

Key words: *gas field, integrated simulation, field facilities construction*

For citation: E.V. Raudanen, D.A. Konev, V.P. Pavlov, R.R. Shakirov, R.M. Yusupov Optimizacija strategii razrabotki i obustrojstva gruppy mestorozhdenij na osnove integrirovannogo modelirovanija [Optimizing field development and construction strategy based on integrated simulation]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 237-245. DOI <https://doi.org/10.25689/NP.2021.4.237-245> (in Russian)

Digital supervising

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Abstract. The work is aimed at elaboration of mining algorithms for HSE (Health, safety and environmental protection) rules violations based on video content both at industrial facilities and in office premises.

The results are the following:

- 1) mining algorithms have been developed;
- 2) dataset for model training has been generated;
- 3) neural network type has been selected;
- 4) models have been trained;
- 5) accuracy of the algorithms has been estimated;
- 6) supplement testing has been performed using video footage from Taas-Yuryakh Neftegazodobycha.

Key words: *video content analysis, HSE, data science*

For citation: V.A. Grinchenko, N.A. Popova, P.I. Chermynanin, M.B. Koshelev, A.F. Khabibullin, D.V. Polyakov Cifrovoj supervajzing [Digital supervising]. Neftyanaya Provintsiya, No. 4(28), Part 1, Special issue, 2021. pp. 246-259. DOI <https://doi.org/10.25689/NP.2021.4.246-259> (in Russian)

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**Results of international research-to-practice conference
“Decarbonization in the European Union and New Paradigm for the
Development of Fuel and Energy Complex in Russia” held
on August 31 – September 1, 2021, in Kazan**

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Abstract. The Tatarstan International Conference gathered a large number of participants who presented 130 papers for discussions, including 65 poster presentations. Twenty-six per cent of all presentations touched on the decarbonization issues, which was due to the broadness of the conference program and novelty of the decarbonization topic for the wide public, including both scientists and operators. As for the operators, they had but a general idea of decarbonization and relied on getting off with some activities to reduce carbonization at the cost of cutting down energy expenditures of oil companies.

The paper presents arguments of both advocates and opponents of global transition to green energy. The author analyzes some speakers' opinion that decarbonization for Russia is an evil necessity needed to mitigate the issues of energy transition. Broad oil and gas community suggests that hydrocarbon generation should be developed in accordance with the prior development strategy and the new paradigm of Russia's oil industry development discussed at the 2021 and 2020 Tatarstan forums.

Discussion of the program of Russia's fuel and energy complex development did not yield any new insights as compared to the last-year's discussions of the new paradigm of Russia's oil industry development offered by the Academy Fellow A.E. Kontorovich.

Key words: *Paris Climate Agreement, climate agenda, global warming, carbon neutrality, green energy, renewable energy sources, decarbonization, paradigm of development of energy sector, main energy sources*

For citation: R.Kh. Muslimov Itogi provedennoj 31 avgusta – 1 sentjabrja v g. Kazani mezhdunarodnoj nauchno-prakticheskoj konferencii «Reshenie Evropejskogo sojuza o dekarbonizacii i novaja paradigma razvitija top-livno-jenergeticheskogo kompleksa Rossii» [Results of international research-to-practice conference «Decarbonization in the European Union and New Paradigm for the Development of Fuel and Energy Complex in Russia» held on August 31 – September 1, 2021, in Kazan]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 260-292. DOI <https://doi.org/10.25689/NP.2021.3.260-292> (in Russian)

Synthetic water-hydrocarbon inclusions in quartz, as evidence of the possibility of oil and gas formation in the process of interaction of bituminous rocks with hydrothermal solutions

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Annotation. The article provides experimental data on the phase composition, state and transformations of liquid and gas hydrocarbons (HC), based on the use of synthetic fluid inclusions in quartz. The experimental novelty of the research was that the growth of quartz with trapped inclusions was carried out in the same experiments in which the interaction of bituminous and carbonaceous rocks with hydrothermal solutions took place in the temperature range 240 - 550 °C and pressures of 7 - 150 MPa. As a result, it was proved that bituminous and carbonaceous rocks are an almost inexhaustible source of liquid and gaseous hydrocarbons and, upon reaching certain temperatures and pressures, are capable of active migration in the Earth's interior in the form of homogeneous supercritical fluids.

Key words: *synthetic fluid inclusions, quartz, oil, methane, experiment, oil metamorphism, hydrothermal solutions, hydrocarbons*

For citation: V.S. Balitsky, I.N. Plotnikova, E.D. Balitskaya, J. Pironon, O. Barres, S.V. Penteley, T.V. Setkova, M.A. Golunova, T.M. Bublikova, L.V. Balitskaya, S.M. Petrov, A.I. Lakhova Sinteticheskie vodno-uglevodorodnye vkljuchenija v kvarce, kak svidetel'stvo vozmozhnosti obrazovaniya nefti i gaza v processe vzaimodejstvija bituminoznych porod s gidrotermal'nymi rastvorami [Synthetic water-hydrocarbon inclusions in quartz, as evidence of the possibility of oil and gas formation in the process of interaction of bituminous rocks with hydrothermal solutions]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 293-326. DOI <https://doi.org/10.25689/NP.2021.3.293-326> (in Russian)

Study of the organic-scales formation in heavy oil of the Western Siberia field

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Abstract. The efficiency of operation of wells with abnormal operating conditions - the formation of asphalt-resinous paraffin deposits of hydrocarbons (ARPD), can be achieved only with constant monitoring and control of complications development.

To form an approach when working with a complicated fund, laboratory experiments were conducted to determine the conditions for the organic-scales formation in a wellhead oil sample at pressures of 17 and 34 atm. The studies were carried out by high-pressure microscopy with software granulometric analysis.

Analysis of data from the results of experiments made it possible to determine the rate of formation of organic-scales particles. Temperature dependence of average particle area at two pressures is obtained. It is shown that the temperature of formation of organic-scales particles in oil increases with increasing pressure, and the rate of their formation decreases.

Based on the forecast model of ARPD formation in the program module, it is proved that there is no risk of ARPD formation in oil-well tubing regardless of well flow rate at current watering in conditions of the field under consideration.

Key words: *paraffin saturation point, organic deposits, heavy oil, visual method of investigation, complicated stock*

For citation: I.A. Stetsyuk, M.I. Korolev, P.V. Roschin, I.A. Struchkov Izuchenie uslovij obrazovaniya chastic tverdoj fazy v tjazheloj vysokovjazkoj nefi mestorozhdenij Zapadnoj Sibiri [Study of the organic-scales formation in heavy oil of the Western Siberia field]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 327-342. DOI <https://doi.org/10.25689/NP.2021.3.327-342> (in Russian)

**Advancements in flow zone indicator method based
on piecewise-linear approximation of FZI distribution function
under conditions of complex geological structure**

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Abstract. The paper considers an automated approach to selection of hydraulic flow units within the lower part of the carboniferous system in one of oil fields in the Republic of Tatarstan. Based on piecewise-linear approximation of distribution function of flow zone indicator FZI, constructed using laboratory core study data, permeability - porosity correlations for each of 4 identified groups of reservoirs were obtained.

Key words: *heterogeneity, permeability, core, HFU, FZI*

For citation: A.A. Makhmutov, V.K. Mukhutdinov, R.Kh. Gilmanova, R.M. Insafov Sovershenstvovanie metoda gidravlicheskih edinic potoka na osnove kusochno-linejnoj approksimacii funkicii raspredelenija FZI v usloviyah slozhnogo geologicheskogo stroenija [Advancements in flow zone indicator method based on piecewise-linear approximation of FZI distribution function under conditions of complex geological structure]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 343-352. DOI <https://doi.org/10.25689/NP.2021.3.343-352> (in Russian)

The investigation of oil reservoirs using the tracer method

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Abstract. The article deals with the problem of increasing the reservoir fluid conductivity and changing its hydrogeological structure through the use of waterflooding technology. This is especially true at a later stage of development. To solve this problem, the article describes tracer (indicator) studies of one of the oil fields of the Bashkir object of the Udmurt Republic. Based on tracer research methods, it is possible to obtain reliable information about the presence of high-permeability filtration channels (super reservoirs) between the injection well and the nearest production wells of the Bashkir object, as well as about the distribution of injected water flows and determining the filtration rate of the injected agent in the reservoir. The obtained results of these studies will make it possible to develop a program for the application of flow diverting technologies and refine the technology of impact on the source of an injection well of an oil field. These studies were carried out at the section of the injection well of the Bashkirian stage of the oil field by injecting the fluid labeled with the Uranin A indicator into the A_{4-3} , A_{4-4} , A_{4-5} interlayers and the Eosin H-labeled fluid into the A_{4-6} interlayer. The choice of the indicator is due to the fact that the geological and physical conditions of the field (composition of rocks, composition of reservoir oil, fresh water injection, salinity of reservoir water, pH of the medium, and reservoir temperature) are most suitable for use as tracers of fluorescein derivatives. According to the results of indicator studies, it was revealed that the filtration parameters of the tracer flow along the dissected and monolithic parts of the productive formation are quite close and reliably correlate. This confirms the presence of a hydrodynamic connection between all interlayers in the source of the injection well, that is, the Bashkirian stage of the studied field as a whole is a single hydrodynamic connected natural reservoir both vertically and horizontally.

Key words: *indicator, tracer studies, Uranin A, Eosin N, field, oil, productive formation*

For citation: S.A. Krasnoperova Issledovanie neftjanyh plastov pri pomoshhi trassernogo metoda [The investigation of oil reservoirs using the tracer method]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 353-365. DOI <https://doi.org/10.25689/NP.2021.3.353-365> (in Russian)

DOI: <https://doi.org/10.25689/NP.2021.4.366-374>

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Simulation experiments to determine optimal reservoir parameters for creating stable in-situ combustion front simultaneously with air injection

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Abstract. The paper summarizes results of reservoir modeling studies aimed to determine optimal geological and reservoir conditions for creating a stable burning front in heavy and extra-heavy oil accumulations developed by in-situ combustion (ISC) process. Reservoir depths and oil viscosities are the main factors that control the ISC process. The relationship between the oil viscosity and the reservoir depth corresponding to the conditions of creating a high-temperature combustion zone in the vicinity of the injection well simultaneously with air injection into the reservoir has been obtained.

Key words: *heavy oil accumulation, extra-heavy oil accumulation, in-situ combustion, reservoir flow model, reservoir depth, original oil viscosity, air injection, in-situ combustion front*

For citation: R.Kh. Nizaev, G.V. Aleksandrov, Yu.L. Yegorova, A.A. Stolyarov Vychislitel'nye jeksperimenty po opredeleniju parametrov plasta dlja uslovij vzniknovenija ustojchivogo fronta vnutriplastovogo gorenija s nachalom zakachki vozduha v zalezhi [Simulation experiments to determine optimal reservoir parameters for creating stable in-situ combustion front simultaneously with air injection]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 366-374. DOI <https://doi.org/10.25689/NP.2021.3.366-374> (in Russian)

Establishment of criteria for creating in-situ combustion front following air injection into oil reservoir

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Abstract. The paper presents and summarizes results of reservoir modeling studies aimed to determine geological and reservoir conditions for creating a stable burning front resulting from air injection into heavy and extra-heavy oil accumulations (known as in-situ combustion (ISC) process). A numerical reservoir model was built to determine reservoir depths and oil viscosities at these reservoir depths. Based on the results of calculations, the relationship between the reservoir depth and the oil viscosity in original reservoir conditions corresponding to the conditions of creating a combustion zone in the vicinity of the injection well within three days once air injection was started, has been obtained. Using this analytical dependence, the distinct line based on reservoir depths and original oil viscosities was constructed dividing oil reservoirs into zones with and without oil self-ignition within three days once air injection was started at BHP equal to hydrostatic pressure at the given reservoir depth. Case histories of other ISC projects in which self-ignition of oil was observed reported in the literature are mentioned. To calculate performance of the in-situ combustion-developed fields, reservoir characteristics of the Moco zone reservoir of the Midway-Sunset oil field and the Brea-Olinda field, California, were used as input data. The analysis of the calculation results demonstrated good history matching.

Key words: *heavy or extra-heavy oil accumulation, in-situ combustion, reservoir depth, original oil viscosity, in-situ combustion front, self-ignition of oil, hydrostatic pressure*

For citation: G.V. Aleksandrov, R.Kh. Nizaev, Yu.L. Egorova, A.A. Gizzatullina Opređenje kriteriev vzniknovenija fronta vnutriplastovogo gorenija pri zakachke vozduha v neftenosnuju zalezh' [Establishment of criteria for creating in-situ combustion front following air injection into oil reservoir]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 375-392. DOI <https://doi.org/10.25689/NP.2021.3.375-392> (in Russian)

Integrated experimental technique to select a scale inhibitor

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Abstract. The paper discusses an urgent issue of developing an integrated experimental technique for scale inhibitor selection in terms of targeted selection of chemicals and taking into account composition and properties of fluids produced. The authors suggested a technique for determining a set of performance indicators that characterize the influence of a scale inhibitor on adjacent processes. To define an integrated criterion of scale inhibitor effectiveness it is necessary to assess scale inhibitors in terms of their impact on water-and-oil emulsion stability, pH index change of separated water and light absorption coefficient of oil.

Scale inhibitors being used in sub-surface and injection systems of PJSC TATNEFT have undergone laboratory testing to evaluate their effectiveness, and confirmed that the effect of the chemicals on the formation of emulsions and their stability depends on the watercut value. The authors have established the watercut ranges where this impact is the most significant. The watercut interval when the emulsion stability is increasing depends on the type of a scale inhibitor used. It has been found that, when using different scale inhibitors, water-oil emulsions' ability to disperse grows and improves the emulsion resistance to break down. The paper shows that the scale inhibitor type and watercut value might increase the emulsion stability. There were inhibitor groups distinguished having both positive and negative impact on the formation of an emulsion. It has been observed that the integrated experimental technique in selecting an optimal scale inhibitor makes it possible to perform an integrated assessment of chemical agents considering their inhibitory potential and risk assessment done with the aim of obtaining a long-term systemic effect for extracting crude oil from residual reserves at the late stage of their development.

Key words: *scale inhibitor, watercut, emulsion, stability, pH index, kinetic stability, methodology*

For citation: I.A. Guskova, D.R. Khayarova, R.R. Zakirov Kompleksnaja jeksperimental'naja metodika vybora ingibitora soleotlozhenij [Integrated experimental technique to select a scale inhibitor]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 393-405. DOI <https://doi.org/10.25689/NP.2021.3.393-405> (in Russian)

Advantages of underwater development of fields

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Abstract. The present study aims to show the advantage of underwater vehicles compared to traditional platforms in terms of material consumption, size and loads. For this purpose, the analysis of existing gravity structures operated in ice conditions and on the shelf of the Norwegian Sea was carried out. Based on the performed analysis, the modeling of gravity bases for depths from 20 to 260 m was carried out, taking into account external loads and the fulfillment of the condition of stability of the soil base. The modeling of the hull of an underwater drilling rig was carried out and the strength calculation of the hull of the structure from the action of hydrostatic pressure at a depth of 200 m was performed. The obtained results of the wall thicknesses of the underwater vehicle hull set indicate the possibility of manufacturing such a structure. The data obtained as a result of modeling made it possible to compare the mass, dimensions and loads on underwater and surface structures. The findings suggest that the use of underwater vehicles for the development of deep-sea deposits in the Arctic is preferable to traditional offshore platforms.

Key words: *underwater drilling rig; advantages of underwater development; comparison of different types of development; GBS modeling; modeling of underwater drilling unit.*

For citation: D.G. Bobov, Ch.S. Guseynov Preimushhestva podvodnogo osvoenija mestorozhdenij [Advantages of underwater development of fields]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 406-422. DOI <https://doi.org/10.25689/NP.2021.3.406-422> (in Russian)

Monitoring technological processes and assessment of technical condition of pump units (ASKiR-Expert)

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Abstract. Remote monitoring of pumping equipment operation in real time is widely implemented in the oil and gas industry. The controllers used in this case allow to prevent "avalanche" destruction of equipment and emergency failures, to implement automatic control of the operation of the units. The current information collected by them flows to the servers of the enterprise and makes it possible to effectively set and solve various problems of equipment maintenance. However, there are still few services for solving the problems of operating pumping equipment. The presented work is aimed at resource-saving operation of equipment by obtaining on-line information about both the current and the predicted technical condition of the equipment.

During the operation of the pumps, a decrease in the main characteristics of the pump occurs, which is accompanied by an increase in the specific consumption of electricity for injection (with a constant characteristic of the collector). Economic losses due to pump wear are determined by the price of electricity and the cost of overhaul. The introduction of the developed monitoring system will automatically make it possible to make a decision about the unprofitability of further operation of the pump and the need to take it out for overhaul. Based on the analysis of the trend in unit costs, when the trend reaches a minimum, the pump unit is promptly taken out for overhaul, which will allow to obtain an average annual economic effect of up to 4,000,000 rubles per pump unit.

Key words: *monitoring, technical condition, pumping units, diagnostics*

For citation: A.S. Galeev, G.I. Bikbulatova, Yu.A. Boltneva, R.N. Suleimanov, S.L. Sabanov Monitoring tehnologicheskikh processov i ocenka tehnicheskogo sostojaniya nasosnyh agregatov ("ASKiR-Jekspert") [Monitoring technological processes and assessment of technical condition of pump units (ASKiR-Expert)]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 423-434. DOI <https://doi.org/10.25689/NP.2021.3.423-434> (in Russian)

DOI: <https://doi.org/10.25689/NP.2021.4.435-453>

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The primary gas-bearing horizon opening experience With afron-containing drilling fluid in the well construction on shelf

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Abstract. The article presents the experimental work results of chemical reagents selection the development of an afron-containing drilling fluid composition for the primary gas productive horizon opening with abnormally low reservoir pressures (ALPP). As the world practice has shown, aphron systems of drilling fluids allow at the lowest cost, in comparison with traditional technologies, to solve such problems as: circulation losses, the occurrence of sticking, irreversible clogging and damage to filtration channels by deeply penetrating particles of drilling mud and its filtrate.

The descriptions of aphrons behavior mechanism, the composition and based on aphrons fluids properties, as well as the results of field work on the use of drilling fluids based on aphrons are given.

Key words: *aphrons, aphron-containing drilling mud, bottomhole formation zone, colmatation screen, inhibition, destruction of biopolymers, rheological parameters, bactericides, geological complication*

For citation: R.U. Rabaev Opyt pervichnogo vskrytija gazonosnogo gorizonta s afronsoderzhashhim burovym rastvorom pri stroitel'stve skvazhiny na shel'fe [The primary gas-bearing horizon opening experience With afron-containing drilling fluid in the well construction on shelf]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 435-453. DOI <https://doi.org/10.25689/NP.2021.3.435-453> (in Russian)

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УДК 622.24.063

Mathematical modeling of the composition and properties of anhydrous flushing fluids using Devon-2L lubricant reagent

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Abstract. In recent years, the use of drilling emulsion inhibition fluids in wells has increased. These make it possible to maximally preserve the reservoir properties of the formation zone at the bottom of the wellbore, prevent jamming and sticking of the tool used, ensure the stability of the wellbore and the removal of cuttings to the surface, as well as provide high lubricity, which increases the technical and economic indicators for the construction of horizontal wells. In this work, experimental studies were carried out, which also supported the choice of the optimal formulation of emulsion drilling mud with the addition of Devon-2L lubricating reagent in order to improve the tribotechnical properties.

Keywords: drill pipe stiking, rheological properties, lubricant, mathematical model, optimal formulations of drilling fluids

For citation: G.L. Gaymaletdinova, R.A. Ismakov, R.A. Mulyukov Matematicheskoe modelirovanie sostava i svoystv promyvochnykh zhidkostey na bezvodnoj osnove s primeneniem smazochnogo reagenta Devon-2L [Mathematical modeling of the composition and properties of anhydrous flushing fluids using Devon-2L lubricant reagent]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 454-467. DOI <https://doi.org/10.25689/NP.2021.3.454-467> (in Russian)

Application of polyelectrolyte reagents for regulation of the properties of grouting solution

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Abstract. To obtain a high quality of well fastening, it is necessary to regulate the basic properties of cement mortars using various chemical reagents. One of the most interesting reagents in this regard is polyelectrolyte VPK-402, which belongs to the class of cationic polymers.

The results of studies of the VPK-402 and the experience of its application in the fixation of wells showed the effectiveness of this reagent. A disadvantage of this reagent is that it is released only in liquid form. One of the analogues of VPK-402 is powdered cationic polyelectrolyte (PAC), manufactured under the brand name Praestol.

It was shown that when using the PAC reagent in a concentration of 0.1%, the water supply of the solution did not exceed 50 cm³/30 minutes. The mobility of the solutions, both from cement PCT1-50 and cement PCT I-G, with the addition of PAC decreases, therefore, plasticizers are needed, the best results were obtained with ReoTeck. To accelerate the solubility of PAC in water, the possibility of its additional dispersion together with cement in a disintegrator is considered.

The article presents the results of changing the hydrostatic pressure of the cement mortar to a "gas formation", showing that the highest rate of reduction in hydrostatic pressure was observed in non-addition cements, and solutions with polyelectrolytes (VPK-402 and PAC) retained pressure on the formation longer and prevented gas from breaking through the cement mortar, while through solutions from non-collection cements gas breakthrough occurred after 15-45 minutes.

The mechanism of action of polyelectrolytes on cement mortars is that the reagents can inhibit the hydration reaction of C₃A in the cement mortar and prevent the growth of the static shear stress of the solution, which causes a drop in the hydrostatic pressure of the cement mortar column, contributing to the gas breakthrough.

Keywords: *gas occurrence, waiting for cement hardening, pressure on the formation, structuring of cement mortar, polyelectrolytes, gas blockers*

For citation: F.A. Agzamov, E.F. Tokunova, S.F. Komleva, A.A. Kabdushev *Primenenie polielektrolitnykh reagentov dlja regulirovaniya svoystv tamponazhnykh rastvorov* [Application of polyelectrolyte reagents for regulation of the properties of grouting solution]. *Neftyanaya Provintsiya*, No. 4(28), Part 2, 2021. pp. 468-491. DOI <https://doi.org/10.25689/NP.2021.4.468-491> (in Russian)

DOI: <https://doi.org/10.25689/NP.2021.4.492-507>

УДК 622.245.422

Development and selection of optimal cement designs for water shutoff jobs

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Abstract. Considering high watercut of the wellstream, the development and selection of efficient cement slurry designs for water shutoff jobs is one of the priorities in oil industry. The cost efficiency of water shutoff depends on the strength properties of the injected cement systems. The paper focuses on gypsum binder-based compositions comprising hemihydrate of calcium sulfate or anhydrite. The authors present description and production process of the compositions, analysis of the temperature effect on the change of properties, results of laboratory studies aimed to determine time of setting of the compositions' constituents, the effect of water- and hemihydrate of calcium sulfate-based retarders.

Key words: *cement slurry, hemihydrate of calcium sulfate, calcium sulfate dihydrate, anhydrite, optimal cement design, water shutoff jobs, filler-binding cement, time of setting*

For citation: I.G. Fattakhov, Z.A. Garifullina, A.S. Zhirkeev, A.K. Sakhapova, R.R. Khusnutdinova Razrabotka i podbor optimal'nyh receptur tamponazhnogo sostava dlja provedenija remontno-izoljacionnyh rabot [Development and selection of optimal cement designs for water shutoff jobs]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 492-507. DOI <https://doi.org/10.25689/NP.2021.4.492-507> (in Russian)

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УДК 622.276.1/4:553.98

**Academician A.A. Trofimuk and his contribution to the effective
development of oil fields in the Ural-Volga region**

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Abstract. In an article devoted to the 110th anniversary of the great scientist and geologist, his achievements in the oilfields development of Ural-Volga region are discussed.

Key words: *Outstanding Scientist, Anniversary, Oil Field, Development, Carbonate Reservoir, Productive Strata, Hydrochloric Acid Treatment, Fracture Capacity, Devonian Highly Productive Reservoir, Development, Waterflooding*

For citation: R.Z. Mukhametshin Akademik A.A. Trofimuk i ego vklad v jeffektivnoe osvoenie neftjanyh mestorozhdenij Uralo-Povolzh'ja [Academician A.A. Trofimuk and his contribution to the effective development of oil fields in the Ural-Volga region]. Neftyanaya Provintsiya, No. 4(28), Part 2, 2021. pp. 508-520. DOI <https://doi.org/10.25689/NP.2021.4.508-520> (in Russian)

DOI: <https://doi.org/10.25689/NP.2021.4.521-533>

УДК: 550.8

The role of V.P. Stepanov in the formation of a new paradigm for the development of oil and gas geology

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Abstract. In connection with the 90th anniversary of his birth, the scientific and industrial activities of the Doctor of Geological and Mineralogical Sciences, an outstanding representative of the Kazan Geological School, Honored Geologist of the Republic of Tatarstan, geophysicist Vladimir Pavlovich Stepanov were highlighted.

The role of V.P. Stepanov in the formation of a new paradigm for the development of oil and gas geology is evaluated. It is noted that all the developments of the scientist were aimed at improving the efficiency of studying the features of the geological and geophysical structure, identifying migration channels of oil and gas-containing fluids (inflow zones, recharge) and searching for small and minute objects promising for hydrocarbons. The necessity of high-precision gravimetric and magnetic surveys is shown. Criteria for the identification of various manifestations of diastrophism of the Earth's crust are given. Attention is focused on historical faults in the sedimentary column.

Key words: *paradigm, oil-prospective objects, migration zones, tectonic disturbances, criteria for identifying manifestations of diastrophism, ring faults, accuracy of anomalies, high-precision geophysical surveys, gravity exploration, magnetic exploration*

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