

DOI: <https://doi.org/10.25689/NP.2023.4.1-10>

EDN ALZNHU

УДК 550.834

## Seismic data processing for spectral decomposition

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**Abstract.** Currently available seismic processing flows provide for application of numerous multichannel filtering procedures aimed at improvement of the signal-to-noise ratio to substantially enhance reflector traceability. On the other hand, these procedures can result in smoothed small-scale wavefield anomalies. The present paper considers the effect of filtering procedures on the wavefield and subsequent spectral decomposition results.

**Keywords:** *spatial filtering, lateral resolution, spectral decomposition*

**For citation:** N.V. Klimova, N.A. Evdokimov, D.A. Shchetinin, R.B. Yanevits Podgotovka seismicheskikh dannykh na etape obrabotki dlya spektral'noy dekompozitsii [Seismic data processing for spectral decomposition]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 1-10. DOI <https://doi.org/10.25689/NP.2023.4.1-10>. EDN ALZNHU (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.11-38>

EDN CNFAKF

УДК 550.834

## Connection of dynamic characteristics of the wave field of 3D seismic data (seismophations, attributes) and lithofacial types of sections according to borehole data

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**Abstract.** Correctly constructed lithofacial models of productive deposits, which confirm the distribution of effective thicknesses calculated through the dynamic parameters of the seismic field, significantly reduce investment risks during exploration drilling. The main information used to construct lithofacial models is based on a qualitative analysis of the dynamic parameters of the seismic field – seismofacial analysis and analysis of dynamic attributes (amplitude, frequency, etc.). The article shows the experience of combining facies types of well sections with the results of interpretation of dynamic parameters of the seismic field using the example of continental sediments of one of the layers of the Tyumen formation. These materials show how the selected seismic classes with a certain shape of the route correlate with the facies types of core sections and GIS (geophysical well survey). It is shown that each facies type of section, consisting of genetically different facies-collectors and non-collectors, in the field of dynamic parameters of the seismic field is characterized by certain anomalies of amplitude and frequency attributes. This is also reflected in the area distribution of sections dominated by sandy, clay or carbonaceous lithotypes of rocks on cubes of synchronous acoustic inversion (Pimp, Simp, Vp/Vs).

**Keywords:** *seismofacial analysis, attributes of the seismic field of the MOGT 3D, lithofacial zoning of terrigenous sections, geological interpretation of seismic attributes*

**For citation:** O.V. Elisheva, N.A. Ushatinskaya, O.A. Gibaeva, A.V. Shahov, N.V. Silnyagina, A.A. Mikhailov Svyaz' dinamicheskikh kharakteristik volnovogo polya seysmicheskikh dannykh MOGT 3D (seysmofatsii, atributy) i litofatsial'nykh tipov razrezov po skvazhinnym dannym [Connection of dynamic characteristics of the wave field of 3D seismic data (seismophations, attributes) and lithofacial types of sections according to borehole data]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 11-38. DOI <https://doi.org/10.25689/NP.2023.4.11-38>. EDN CNFAKF (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.39-52>

EDN CWRHUF

УДК 550.834

## Forecast of the boundaries of reservoirs of the Neocomian complex based on seismic facies modeling

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**Abstract.** The article is devoted to seismic geological modeling of sequences of the Neocomian complex in order to improve the efficiency of seismic facies analysis. The work was performed for one of the fields in Western Siberia.

The priority task was to increase the efficiency of reservoir localization in the systemic tracts of the Lower Cretaceous clinofolds. The purpose is to increase the success of exploratory drilling.

The relevance of the work is due to the fact that the oil and gas potential of the north of Western Siberia is associated mainly with Lower Cretaceous clinofolds, where there is uncertainty in the forecast of reservoirs. The results of the work will improve the efficiency of geological exploration in fields where there is a lack of well information.

**Key words:** *seismic facies analysis, classification, sequence stratigraphy, modeling, attribute analysis*

**For citation:** K.A. Senkina, M.V. Lebedev, I.V. Musatov Prognoz perspektivnykh ob'yektov neokomskogo kompleksa na osnove seysmofatsial'nogo modelirovaniya [Forecast of the boundaries of reservoirs of the Neocomian complex based on seismic facies modeling]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 39-52. DOI <https://doi.org/10.25689/NP.2023.4.39-52>. EDN CWRHUF (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.53-63>

EDN CYNBAF

УДК 553.98(571.1)

## Forecasting the distribution zones of the accretionary complex of meandering rivers in the section of the PK1 formation of the Kharampu deposit

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**Abstract.** The Cenomanian deposits of the north of the West Siberian Plate are important targets for the gas industry, and effective development in these deposits requires preliminary analysis and identification of potential risks. The accumulated experience in the development of the deposits under consideration has determined that the greatest danger for the development of the deposit at the first stages is the early abandonment of wells caused by uneven, local rise of the gas-water contact (GWC), associated with lithological heterogeneity and the presence of gas-water "merge windows" in the contact zone.

The article presents the results of studies, including the collection and analysis of data on the geological structure of the PK1 object of the Kharampur field, the lithological properties of the formation, and the facies characteristics of the section of the productive formation. Methods of forecasting and modeling are applied, which determine the risk zones for the appearance of confluence windows in the accretionary complexes of meandering rivers.

The results obtained can be used in the decision-making process when designing wells, and taking them into account will reduce the risks of early retirement of wells associated with the development of the accretionary complex of rivers.

**Materials and methods.** Results of geophysical and seismic studies. Electrofacial analysis. Analysis of the dependence of linear anomalies of the seismic section with actual data on wells. Forecasting zones of riverbed development.

**Keywords:** *Western Siberia, productive Cenomanian deposits, Pokurskaya suite, drilling risks, facies model, gas deposit*

**For citation:** K.B. Kuziv, A.A. Alexandrov Prognozirovaniye zon razvitiya akkretsiionnogo kompleksa meandriruyushchikh rek v razreze plasta PK1 Kharampurskogo mestorozhdeniya [Forecasting the distribution zones of the accretionary complex of meandering rivers in the section of the PK1 formation of the Kharampu deposit]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 53-63. DOI <https://doi.org/10.25689/NP.2023.4.53-63>. EDN CYNBAF (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.64-82>

EDN DMYOEU

УДК 622.276.031.011.43(571.51)

## **Petrophysical modeling based on lithological analysis of Nizhnekhetskaya depositions in the fields of northern part of Krasnoyarsk Krai**

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**Abstract.** This paper presents features of petrophysical modeling of Nizhnekhetskaya depositions (lower Cretaceous) in northern part of West Siberia. Rock typing was done based on the results of complex sedimentological and petrophysical analysis of core material and petrotypes were predicted based on logging data. This paper aims to predict porosity and permeability properties before development activities will be underway. Reservoir rock typing has helped to improve predicting properties of geologic models.

**Keywords:** *Nizhnekhetskaya formation, sedimentological analysis, petrophysical model, petrotypes, porosity and permeability properties*

**For citation:** Sosnin M.A., Shagimardanova O.I., Samsonov N.E., Zarai E.A. Petrofizicheskoye modelirovaniye na osnove litologicheskogo analiza nizhnekhetskikh otlozheniy mestorozhdeniy severa Krasnoyarskogo kraya [Petrophysical modeling based on lithological analysis of Nizhnekhetskaya depositions in the fields of northern part of Krasnoyarsk Krai]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 64-82. DOI <https://doi.org/10.25689/NP.2023.4.64-82>. EDN DMYOEU (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.83-100>

EDN EQTPKP

УДК 622.276.1/4.001.57

## **Evaluation of the factors affecting the results of modeling of complex hard-to-recover oil reservoir development**

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**Abstract.** The paper considers the primary uncertainties associated with oil viscosity, relative permeabilities and grid size, that have the most pronounced effect on reservoir production performance. The analysis is based on the results of reservoir simulations using a sector model. Variations of input data have been found to influence more heavily the initial stage of reservoir development: variations in estimated production performance data can reach as high as 30%.

**Keywords:** *hard-to-recover reserves, ultralow permeability, low degree of certainty, relative permeability, PVT model, decline rates, decline curve analysis (DCA), reservoir simulation modeling*

**For citation:** A.V. Zavozina, A.A. Ankudinov, E.A. Gromova, G.V. Ulybyshev, M.V. Naruta, V.N. Arkhipov Otsenka faktorov, vliyayushchikh na rezul'taty modelirovaniya razrabotki slozhno postroyennoy zalezhi TrIZ [Evaluation of the factors affecting the results of modeling of complex hard-to-recover oil reservoir development]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 83-100. DOI <https://doi.org/10.25689/NP.2023.4.83-100>. EDN EQTPKP (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.101-112>

EDN FVXMFY

УДК 622.276.66

## **Preparation of geomechanical rock properties library for reservoir optimization of hydraulic fracturing design at the sites of JSC Samotlorneftegaz**

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**Abstract.** This paper contains 1D geomechanical models of vertical evaluation wells which were developed based on full-wave sonic and density logging data. It also contains a ready database of uniform and physically based data on elastic properties and stresses for different lithofacies and stratigraphic units which later can be used in hydraulic fracturing design and improvement of fracturing efficiency during field development at vertical, directional and horizontal wells of JSC Samotlorneftegaz.

**Keywords:** *geomechanical modeling, reservoir fracturing, full-wave sonic logging, clustering*

**For citation:** M.I. Samoilov, A.N. Sovranenko, V.A. Moreva, V.S. Kuleshov, N.A. Pavlyukov, P.A. Kurkin Podgotovka biblioteki geomekhanicheskikh svoystv dlya optimizatsii dizaynov GRP na ob"yektakh AO «Samotlorneftegaz» [Preparation of geomechanical rock properties library for reservoir optimization of hydraulic fracturing design at the sites of JSC Samotlorneftegaz]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 101-112. DOI <https://doi.org/10.25689/NP.2023.4.101-112>. EDN FVXMFY (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.113-122>

EDN KEOIJU

УДК 622.276.1/4.001.57+622.276.432

## Determination of the optimal working time of injection wells of an oil reservoir using hydrodynamic modeling

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**Abstract.** The optimal working time of injection wells is determined by calculations based on a synthetic hydrodynamic model. The formation under study is divided into three zones due to geological conditions: mixed sandstone (ZA), mixed sandstone in the transition zone (ZB), low-permeability reservoir (ZC).

The determination of the working time of injection wells in the zone «ZB» is considered. With the averaged technological parameters of wells and geological conditions, the optimal time for working out injection wells in the «ZB» zone was 4 months with an increase in oil production by element 1154.5 tons, and an increase in net present value of 1.29 % over 20 years. When geological and technological conditions changed, the optimal working time varied from 2 to 8 months. In order to maximize oil production and economic effect, it is necessary to take into account the geological and technological parameters when determining the optimal time for working out injection wells.

**Materials and methods.** The results of calculations based on a synthetic hydrodynamic model (multivariate modeling). Analysis of the influence of geological and technological parameters on the optimal working time of injection wells.

**Keywords:** *oil reservoir, development of injection wells, increase in oil production, hydrodynamic modeling*

**For citation:** D.N. Zolnikov Opredeleniye optimal'nogo vremeni otrabotki nagnetatel'nykh skvazhin neftyanogo plasta s pomoshch'yu gidrodinamicheskogo modelirovaniya [Determination of the optimal working time of injection wells of an oil reservoir using hydrodynamic modeling]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 113-122. DOI <https://doi.org/10.25689/NP.2023.4.113-122>. EDN KEOIJU (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.123-140>

EDN LFOUPU

УДК 622.276.432

## **Optimization of injection well operation based on the analysis of flow paths and drainage matrix implemented in reservoir simulator**

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**Abstract.** The paper describes an algorithm for optimization of injection well operation parameters based on drainage matrix and flow paths. Modification of injection well operation parameters enables adjustment of water injection rates and injectivity of injection wells to increase waterflood sweep efficiency and improve conformance of oil-water displacement front. Timely monitoring of waterflood performance and modification of injection well operation parameters will prevent premature flooding of production wells, increase oil productivity and oil recovery factor.

**Keywords:** *optimization of well operation, waterflood grid element, sweep efficiency, nonuniform depletion, bypassed oil zones, modification of water injection strategy, injection wells, production wells, drainage matrix, increase of injection rates*

**For citation:** A.R. Kopnysheva, A.S. Romanov, A.T. Zhubanov, Ya.V. Puritskis Optimizatsiya rezhimov raboty nagnetatel'nykh skvazhin na osnove analiza liniy toka i matritsy drenirovaniya, realizovannykh v gidrodinamicheskom simulyatore [Optimization of injection well operation based on the analysis of flow paths and drainage matrix implemented in reservoir simulator]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 123-140. DOI <https://doi.org/10.25689/NP.2023.4.123-140>. EDN LFOUPU (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.141-152>

EDN LQLLUB

УДК 338.45:622.276

## **Possibilities of well stock management based on cost-benefit assessment using the example of one of large fields**

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**Abstract.** This paper presents possibilities to optimize existing operations on marginal well stock in order to stabilize production and profits from mature fields

Shut down of marginal wells is significant to resources saving and production optimization. It allows to focus efforts and resources on more productive wells. Emergence of subeconomic and marginal wells can be attributed to various reasons including low productivity and high operation costs. Moreover, shut down of marginal wells could be necessary not only due to economic reasons but to legal reasons as well.

**Keywords:** *well stock, oil, gas and condensate field, marginal well, subeconomic well, well shut down, oil and gas reservoirs, stabilization of production, stock of marginal wells*

**For citation:** M.N. Ufimtseva Vozmozhnosti upravleniya fondom skvazhin na osnove otsenki rentabel'nosti na primere odnogo iz krupnykh mestorozhdeniy [Possibilities of well stock management based on cost-benefit assessment using the example of one of large fields]. Neftyanaya Provintsiya, No. 4(36), 2023. pp.141-152. DOI <https://doi.org/10.25689/NP.2023.4.141-152>. EDN LQLLUB (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.153-165>

EDN MSFAAW

УДК 622.276.1/4.001.57

## **Risk assessment during planning of T reservoir development based on uncertainty analysis and multivariate estimations**

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**Abstract.** The present research paper focuses on the planning of hard-to-recover gas reservoir development under conditions of geological uncertainty. An approach to drilling risk mitigation at the stage of geological and reservoir simulation modeling is described. Matrix of uncertainty parameters is generated, the properties that have the largest effect on reserves volume and gas production profile are identified based on sensitivity analysis, reliability of forecast production profile is assessed. The work performed resulted in a proposed plan of actions to reduce geological and technological uncertainties.

**Keywords:** *multivariate estimates, optimization of gas reservoir development strategy, uncertainty analysis of geological and fluid flow parameters, Turonian sediments, hard-to-recover reserves*

**For citation:** D.V. Ponomareva, Z.R. Usmanova, D.E. Barabanov Otsenka riskov pri planirovanii razrabotki plasta T na osnove analiza neopredelennostey i mnogovariantnykh raschotov [Risk assessment during planning of T reservoir development based on uncertainty analysis and multivariate estimations]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 153-165. DOI <https://doi.org/10.25689/NP.2023.4.153-165>. EDN MSFAAW (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.166-176>

EDN OMHQW

УДК 661.97

## CCUS technology from theory to practice

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**Abstract.** The paper discusses comprehensive assessment of CO<sub>2</sub>-EOR method based on CO<sub>2</sub> injection into a low-permeability reservoir to enhance oil recovery. It involves a number of laboratory experiments, including slim-tube test, swell and VIT tests, as well as a suite of core flow studies; generation of prerequisites for a compositional reservoir simulation model with history matching using laboratory test results; selection of optimum pilot project program and commercial field development strategy with application of CO<sub>2</sub>-EOR technology based on feasibility study.

**Key words:** *carbon capture use and storage (CCUS), gas-based EOR methods, simulation of gas-based EOR methods, decarbonization*

**For citation:** V.N. Arkhipov, A.A. Ankudinov, A.A. Mochalova, S.A. Yashchenko, G.V Ulybyshev Tekhnologiya CCUS ot teorii k praktike [CCUS technology from theory to practice]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 166-176. DOI <https://doi.org/10.25689/NP.2023.4.166-176>. EDN OMHQW (in Russian) CCUS technology from theory to practice

DOI: <https://doi.org/10.25689/NP.2023.4.177-193>

EDN OXNWFC

УДК 661.97

## CO<sub>2</sub> storage potential of the Russian petroleum sector

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**Abstract.** The international “net zero” policy remains a key focus in the energy transition process of the Russian petroleum industry which offers the highest capacity of carbon dioxide (CO<sub>2</sub>) storage in the world. Out of the CCS (Carbon Capture and Storage) process chain, we have selected a less expensive stage, i.e. the geological storage of CO<sub>2</sub>. The paper describes the CO<sub>2</sub> storage potential of the Russian petroleum sector. We introduced the main aspects of the reservoirs’ availability for long-term and safe storage of CO<sub>2</sub>. The paper also presents an analysis of the risks and uncertainties of CO<sub>2</sub> storage in various geological formations. The risks and uncertainties were assessed using the matrix method and quantitative analysis based on the estimated risk index. We concluded that the most effective way for the petroleum industry to reduce emissions is to store CO<sub>2</sub> in depleted oil and gas reservoirs of West Siberia.

**Key words:** *sequestration, energy transition, CO<sub>2</sub> emissions, geological storage of CO<sub>2</sub>, decarbonization, greenhouse gas emissions, carbon dioxide capture and storage (CCS) technology, geological formation, probability matrix, occurrence of risk, impact on the environment*

**For citation:** A.S. Kholodionova, R.Y. Khmelevskiy, B.A. Yerka Potentsial khraneniya TSO<sub>2</sub> neftegazovogo sektora Rossii [CO<sub>2</sub> storage potential of the Russian petroleum sector]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 177-193. DOI <https://doi.org/10.25689/NP.2023.4.177-193>. EDN OXNWFC (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.194-207>

EDN QIGQKL

УДК 622.276.8(571.1)

## **Analytical procedure of associated and dissolved gas separation at large field of Western Siberia**

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**Abstract.** From the experience of oil fields development, it is known that besides natural gas cap in formations, during field development there can be secondary processes of dissolved gas break out with technogenic formation of free gas containment areas. This, among other things, causes gas to breakthrough into bottomhole and drastically increase field gas-oil ratio (as opposed to approved gas content). Consequently, estimation of dissolved gas recovery based on approved gas content cannot be considered correct.

Initial reservoir pressure virtually corresponds to bubble-point pressure in gas and oil reservoirs. Current reservoir pressure over production history often lower than bubble-point pressure even with on-time implementation of reservoir pressure maintenance system so gas breaks out directly within the reservoir which results in increase of field oil-gas ration relative to approved gas content. In such case it is not sufficient to use gas content determined from deep oil samples under laboratory conditions to calculate historical dissolved gas production data. It is also necessary to take into account field oil-gas ration measurements taken directly at the well using mobile multiphase metering unit (MPMU) as well as gas measurement at gathering points (BPS, gathering station). Utilization of all available field information will allow the most reliable estimation of dissolved gas recovery [1, 2].

Therefore, there is a practical need for an analytical tool that can quickly solve the problem of separating historical and current production data.

**Keywords:** *redistribution of production, oil, gas and condensate field, current reserves containment areas, gas and oil reservoirs, gas content, oil-gas ration, bubble-point pressure, reservoir pressure, regression analysis*

**For citation:** M.N. Ufimtseva, A.V. Bochkarev, O.A. Bondarenko, D.V. Grandov Analiticheskaya metodika razdeleniya poputnogo i rastvorennogo gaza na krupnom mestorozhdenii Zapadnoy Sibiri [Analytical procedure of associated and dissolved gas separation at large field of Western Siberia]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 194-207. DOI <https://doi.org/10.25689/NP.2023.4.194-207>. EDN QIGQKL (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.208-225>

EDN QSGVKH

УДК 622.279.5

## Energy efficiency assessment of “formation-wells-gas collecting system” natural gas production system

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**Abstract.** Energy conservation and efficiency increase of its utilization are key tasks for oil and gas production enterprises. This paper presents several approaches to energy efficiency assessment of gas production process in “formation-wells-gas collecting system” chain. It proposes energy efficiency measure which is based on the quantity of specific gas production at the field per reservoir energy cost unit. This paper also includes correlations for calculation of absolute, standardized and relative interpretations of abovementioned measure as well as review of factors influencing their value.

In order to analyze the reasons for changes in energy efficiency this paper proposes three-level control methodology which includes calculation of hydraulic pressure losses for whole “formation-wells-GCS” system first and then for its individual elements (formation, wells, chokes) ending with each well. This approach allows to identify first flawed elements of the system and then wells which negatively affect energy efficiency.

The methodology was used at the Beregovoye and Kharampurskoye fields (Cenomanian) and the results of its practical evaluation generally confirm its efficiency.

**Keywords:** *energy efficiency, energy, productive formation, gas collecting system; booster pumping station; complex gas processing plant; integrated model, specific gas production, reservoir pressure, hydraulic pressure losses, pressure drawdown, optimization of well operation, declining production*

**For citation:** A.N. Kharitonov Otsenka energoeffektivnosti sistemy dobychi prirodnogo gaza «plast-skvazhiny-gazosbornaya set'» [Energy efficiency assessment of “formation-wells-gas collecting system” natural gas production system]. *Neftyanaya Provintsiya*, No. 4(36), 2023. pp. 208-225. DOI <https://doi.org/10.25689/NP.2023.4.208-225>. EDN QSGVKH (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.226-238>

EDN SBYGIC

УДК 622.24(571.51)

## **New approach to well drilling and completion in multiple-contact continental-genesis reservoirs of a large field in the Krasnoyarsk Region**

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**Abstract.** The paper considers an innovative approach to implementation of individual development systems involving horizontal and multilateral wells for each production target under conditions of complex geological structure: non-confirmation of reservoir rock at a short distance from wellbores (50-100m), substantial variability of fluid contacts.

New approach to the design of drilling program enables minimization and exclusion of the risks associated with absence of the target reservoir or unconfirmed fluid saturation at the initial drilling stage and at subsequent stages, respectively.

**Keywords:** *field development strategy, multilateral well, discontinuous continental- genesis reservoir, project wells, development phase, well pad, confident drilling zone*

**For citation:** A.V. Nazarov, YA.V. Utusikov, D.E. Barabanov Novyy podkhod k razburivaniyu i zakanchivaniyu skvazhin v usloviyakh mnogokontaknykh zalezhey kontinental'nogo genezisa krupnogo mestorozhdeniya Krasnoyarskogo kraya [New approach to well drilling and completion in multiple-contact continental-genesis reservoirs of a large field in the Krasnoyarsk Region]. *Neftyanaya Provintsiya*, No. 4(36), 2023. pp. 226-238. DOI <https://doi.org/10.25689/NP.2023.4.226-238>. EDN SBYGIC (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.239-243>

EDN TONCMU

УДК 004.9:622.276

## **Improvement of research and academic process in Tyumen Industrial University based on interaction with Tyumen Petroleum Research Center and application of digital technologies**

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**Abstract.** The paper presents a unique experience of interaction between Tyumen Petroleum Research Center and Tyumen Industrial University in education of highly qualified engineers according to Master's Degree program in Petroleum Engineering. The Research Center provides the university with well-proven original research and instruction materials, including corporate software packages. The university engages specialists and subject matter experts in vocational training and supervision of students' research and graduation thesis writing. During the period of learning, master's students solidify their knowledge at workplaces. This approach not only increases the level of students' competence, but also reduces the onboarding period at an enterprise.

**Keywords:** *personnel training, young specialists, petroleum engineering, research center, competencies, skills, digital technologies, in-house software packages, Tyumen Petroleum Research Center, Tyumen Industrial University*

**For citation:** S.K. Gracheva Sovershenstvovaniye nauchno-obrazovatel'nogo protsessa v TIU na osnove vzaimodeystviya s TNNTS i primeneniya tsifrovyykh tekhnologiy [Improvement of research and academic process in Tyumen Industrial University based on interaction with Tyumen Petroleum Research Center and application of digital technologies]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 239-243. DOI <https://doi.org/10.25689/NP.2023.4.239-243>. EDN TONCMU (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.244-261>

EDN TUUTZK

УДК 551.24+51-7:55(571.1)

**Paleo-tectonic features of sedimentary deposits structure in  
Surgutsky Arch of Severo-Vartovsky megaterrace, Western-  
Siberian platform.**

**(LUKOIL-Western Siberia Company's fields)**

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**Abstract.** The paper presents some geologic aspects of Upper Jurassic and Lower Cretaceous sedimentary sequences, as well as their correlation with oil-bearing areas within the territory under consideration. 2D/3D CDP seismic data interpretation (amplitude analysis) and probabilistic-and-statistical analysis techniques have been used.

**Key words:** *seismic survey, 3D CDP, amplitude analysis, trend-analysis, formations, seismic stratigraphy, faults, flexural folds*

**For citation:** E.R. Kiseleva, A.V. Lyalin Paleotektonicheskiye osobennosti stroyeniya otlozheniy osadochnogo chekhla Surgutskogo svoda - Severo-Vartovskoy megaterrassy Zapadno-Sibirskoy plity (mestorozhdeniya OOO «LUKOYL – Zapadnaya Sibir'») [Paleo-tectonic features of sedimentary deposits structure in Surgutsky Arch of Severo-Vartovsky megaterrace, Western-Siberian platform. (LUKOIL-Western Siberia Company's fields)]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 244-261. DOI <https://doi.org/10.25689/NP.2023.4.244-261>. EDN TUUTZK (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.262-274>

EDN VJFSUK

УДК 622.279.23/4(571.64)

## Updated model of an offshore gas-condensate field on Sakhalin

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**Аннотация.** The paper describes the correlation problem of the Darginskaya (Dagi) Series of Lower-Middle Miocene productive formations on a case study of a large offshore gas-condensate field on Sakhalin, which has not yet entered the operational phase. The field has included to the list of the main deposits forming the mineral resource base of the Sakhalin region [1]. The reservoir structure is significantly complicated by high-amplitude faults. When building the author's model of the field, the specialists of the corporate scientific center managed to justify a more correct and logical correlation of productive deposits in comparison with the previous one. The maximum adjustment of the formation markers that was required reached 70 m. within the reservoir height of about 300 m. This led to the reinterpretation of 3D seismic data over the entire area of the field ( $>100 \text{ km}^2$ ). The main reason is the large-scale erosion of the Upper-Dagi sediments (more than 100 m.), but it was a local event, related to the southern part of the “B” field. As a result, the sand bodies formed in the conditions of the Amur paleodelta in the new model gained greater lateral consistency, the discontinuity of reservoirs was significantly reduced, a 14 % increase in reserves was obtained, and the characteristics of forecast production profiles were improved.

The paper shows paleotectonic and geodynamic processes that led to erosion and redeposition of sediments. The prospects of additional lateral and vertical exploration of the field by are described.

**Keywords:** *Darginskaya Series, correlation of sediments, parasequence, sedimentation cycles, rifting, sediment erosion*

**For citation:** V.A. Vanin, T.M. Malysheva Utochnonnaya model' gazokondensatnogo mestorozhdeniya na shel'fe Sakhalina [Updated model of an offshore gas-condensate field on Sakhalin]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 262-274. DOI <https://doi.org/10.25689/NP.2023.4.262-274>. EDN VJFSUK (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.275-281>

EDN VF SRVV

УДК 622.276.031:532.5

## On downhole pressure correction in modeling of "intelligent" wells

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**Abstract.** Pressure losses in a horizontal intellectual well due to operation of electro-valves are estimated. Analytical dependence linking bottomhole pressure at the well with pressure in tubing is obtained. Calculations illustrating the pressure losses when the fluid flows through the orifices of the electro-valve have been performed.

**Keywords:** *smart well, bottomhole pressure, electro-valve*

**For citation:** G.A. Nikiforov, V.V. Baushin, A.I. Nikiforov O popravke na zaboynoye davleniye pri modelirovanii «intellektual'nykh» skvazhin [On downhole pressure correction in modeling of "intelligent" wells]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 275-281. DOI <https://doi.org/10.25689/NP.2023.4.275-281>. EDN VF SRVV (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.282-298>

EDN VKLNRN

УДК 004.9:622.276.1/4

## **Application of machine-learning algorithms to substitute for some components of integrated oilfield model**

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**Abstract.** The paper discusses a technique for replacing part of an integrated oil and gas field model with a machine learning model. This will reduce the calculation time of this model and increase its response. Four most suitable algorithms were identified, test training and prediction of calculation parameters of one of the components of the integrated model were performed. As an example, we consider an integrated model of an oil and gas field, built on the basis of Petroleum Experts software. Synthetic models and models of real deposits were created and prepared. The degree of influence of operational parameters on the calculation of the integrated model is assessed. Methods have been developed to take into account the influence of these parameters without building an integrated model. The possibility of using machine learning to replace components of an integrated model is assessed. The machine learning algorithm is written in the Python programming language using the scikit-learn library. The integration of the machine learning model with the integrated model was carried out in the Petroleum Experts Resolve software product.

**Keywords:** *integrated modeling, plant model, artificial intelligence, machine learning, regression*

**For citation:** Z.F. Ismagilova, M.A. Priestov, R.I. Shaikhetdinov *Primeneniye algoritmov mashinnogo obucheniya dlya zameny komponentov integrirovannoy modeli neftegazovogo mestorozhdeniya* [Application of machine learning algorithms to replace components of the integrated oil and gas field model]. *Neftyanaya Provintsiya*, No. 4(36), 2023. pp. 282-298. DOI <https://doi.org/10.25689/NP.2023.4.282-298>. EDN VKLNRN (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.299-318>

EDN WBRVCM

УДК 51-7:622.276

## To the 100th anniversary of the main analytical formulas of the decline curves

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**Annotation.** The article provides overview materials on the use of formulas for the decline curves analysis, many of which are more than 100 years old, but they have not lost their relevance.

A comparison of historical and modern dependencies is given, some of which, in fact, give a close result. The history of the development of the decline curves analysis, the features of their application and justification, a practical example, trends and current status are shown.

The true discoverers of modern formulas, which we know for another - later authorship, are revealed.

The material will be useful for engineers and researchers of many competencies.

**Key words:** decline curve analysis, Lejbenzon, Arps, depletion, CRM, Stretched Exponent, exponent

**For citation:** A.A. Ruchkin K 100-letiyu osnovnykh analiticheskikh formul krivyykh padeniya debita [To the 100th anniversary of the main analytical formulas of the decline curves]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 299-318. DOI <https://doi.org/10.25689/NP.2023.4.299-318>. EDN WBRVCM (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.319-346>

EDN WWOGOG

УДК 622.276.42:662.613.5

## Literature analysis of methods of flue gas injection with steam

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**Abstract.** Reducing the negative impact of industrial emissions into the Earth's atmosphere, as well as increasing the period of utilization of fossil resources in our time are among the most urgent tasks of the fuel and energy complex of Russia and the world. In this connection with this problem, injection of flue gases with steam at oil fields to increase oil recovery can be considered as an environmentally safe and economically feasible way to reduce harmful emissions and beneficial use of greenhouse gases.

Flue gases generated by power plants or other industrial facilities burning fossil fuels such as natural gas, fuel oil, coal, etc. can be used for injection using thermal recovery methods.

Thermal recovery methods have received much attention in laboratories to better understand their mechanisms of application. Among the methods used to intensify and enhance heavy oil production, steam injection is the most well-known and used worldwide.

All thermal recovery methods can be thought of as injecting energy (in the form of heat) into the reservoir, which heats the oil, reducing its viscosity and improving its mobility, facilitating displacement. Other mechanisms are also activated by heat, such as rock expansion, in which oil is displaced from rock pores, and oil distillation, in which light fractions vaporize to form a miscible front ahead of the steam. A number of researchers (Harding et al. 1983) (Nasr et al. 1987) and more recently (Goit 1999), (Yee 2002), (Simangunsong 2005), (Laboisière 2009) and (Rios 2011) have presented in their papers a number of experimental studies on steam and steam injection combined with additives such as propane, nitrogen, carbon dioxide, air and flue gases.

Thermal methods achieve high recovery rates, but often have operational efficiency issues. Operational efficiency is related to the high costs of steam generation and produced water treatment. A problem arises when these costs become unprofitable in a particular project. The problem can be translated into the need to reduce the rate of steam injection per unit volume of oil produced. Recent studies show that steam injection with inert gases allows to reduce this indicator ("Laboisière", 2009; "Rios", 2011).

The article analyzes the world experience of research of oil displacement efficiency using steam and flue gases.

**Key words:** *enhanced oil recovery, flue gases, enhanced oil recovery method, oil displacement, oil core*

**For citation:** E.A. Burlutsky, R.Kh. Sadreeva, A.A. Zalyatdinov, D.S. Beloklokov, I.V. Valiullin Literaturnyy analiz sposobov zakachki dymovogo gaza s parom [Literature analysis of methods of flue gas injection with steam]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 319-346. DOI <https://doi.org/10.25689/NP.2023.4.319-346>. EDN WWOGOG (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.347-358>

EDN XFCQWW

УДК 543.4

## Methorological characteristics of the method for determining oil in industry wastewater

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**Abstract.** The paper presents the results of experimental tests of a method for determining oil in industrial wastewater using a three-component solvent consisting of n-hexane, isooctane and xylene as an extractant. In order to determine the metrological characteristics of the method, an analysis of the causes of uncertainty was carried out. Taking into account the results of the analysis and the requirements of RMG 61-2010, a program has been developed that establishes the procedure, organization and scope of research for assessing accuracy indicators. In preparation for the measurements, an analysis of the initial data was carried out, the conditions for performing the measurements were selected, the measuring instrument (model solutions), the measurement result of which was used as the accepted reference value. A series of tests was carried out to determine the optical density of model solutions using the photocolorimetric method (12 results, 4 measurements in three laboratories) at two points in each measurement range, followed by calculation of the mass concentration of oil. As a result of assessing the accuracy indicators during certification of the measurement technique, the values of the reproducibility limit and the expanded uncertainty of the measurement result were established.

**Keywords:** *oil in water, analysis, extraction, organic solvents, photocolorimetry method, metrological characteristics, standard and expanded uncertainty*

**For citation:** D.A. Miftahutdinov, R.G. Romanova, A.R. Sadriev Meteorologicheskiye kharakteristiki metoda opredeleniya nefi v promyslovykh stochnykh vodakh [Methorological characteristics of the method for determining oil in industry wastewater]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 347-358. DOI <https://doi.org/10.25689/NP.2023.4.347-358>. EDN XFCQWW (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.359-368>

EDN XITFZG

УДК 622.24.051.55

## **Applicability of roller cone bits for drilling through interbedded rocks**

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**Abstract.** The efficiency of well construction is largely determined by the efficiency of the rock-breaking tool, the resource of which largely depends on the mining and geological conditions in the intervals of its use. The service life of a drilling tool largely depends on the conditions of its use. Despite the widespread use of PDC bits, in certain conditions of drilling wells, it is effective to use ball bits. The proposed improvements, methods of exploitation, make it possible to achieve a high mechanical penetration rate.

**Key words:** *BURINTEKH R&D Company, oil, gas, drilling, roller cone bit, rock-cutting tool, drilling practice, axial load, rate of penetration*

**For citation:** K.R. Valyamov, G.G. Ishbayev Aktual'nost' adaptatsii primeneniya sharoshechnykh dolot pri burenii v pereslaivayushchikhsya gornyykh porodakh [Applicability of roller cone bits for drilling through interbedded rocks]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 359-368. DOI <https://doi.org/10.25689/NP.2023.4.359-368>. EDN XITFZG (in Russian)

DOI: <https://doi.org/10.25689/NP.2023.4.369-383>

EDN ZJJHBQ

УДК 622.245.422

## Effect of Zeolite Nano Particle Powder on the Durability of Class G Well Cement

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**Abstract.** To provide structural support of the casing and isolate different wellbore zones during well cementing, early strength development of the cement stone is necessary. This paper presents experimental results of the influence of nano zeolite (particle size  $\leq 100$  nm) on the compressive strength to enhance early strength of class G cement. Cubic samples were prepared with three different nano zeolite additives 0,5 %, 1 %, and 1,5 % BWOC (By Weight of Cement). The samples were cured in the water bath at atmospheric pressure and heating temperature of 60° C (140° F) for 8 hours. Compressive strength was determined by compressing the samples in a press (destructive method) according to the standard of American Petroleum Institute (API). The results showed that the addition of 1,5 % nano zeolite leads to enhances early strength in rate of 32,4 %. Nano zeolite indicated the pozzolanic behavior with high free space and high cation exchange capacity. They are capable of absorbing molecules at a slow, medium and fast rate. These properties help increase the strength of cement mixtures.

**Key words:** *Portland cement, well cementing, cement mortar, nano-zeolite, class G cement, compressive strength, mechanical properties, water bath, calcium silicate hydrate (C-S-H), pozzolanic reaction*

**For citation:** A.I.M. Mohammedameen Vliyaniye poroshka nano-chastits tseolita na dolgovechnost' skvazhinnogo tsementa klassa G [Effect of Zeolite Nano Particle Powder on the Durability of Class G Well Cement]. Neftyanaya Provintsiya, No. 4(36), 2023. pp. 369-383. DOI <https://doi.org/10.25689/NP.2023.4.369-383>. EDN ZJJHBQ (in Russian)