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On new concept of Russian oil and gas sector development suggested by A.E. Kontorovich

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Abstract. During a long history of oil industry development, a wide experience has been gained in exploration and development of various oil fields, from small to supergiant. Ways to improve field development have been found. The most efficient oil prospecting and field extension technologies have been elaborated, as well as advanced secondary recovery techniques for active and unconventional reserves. Enhanced oil recovery (EOR) methods have become widely used in various geologic conditions, including production of residual reserves from mature fields. An extensive experience has also been gained in development of small complex reservoirs containing hard-to-recover reserves.

R&D and pilot projects are under way aimed at search for optimal methods of unconventional reserves development (including high-viscosity and heavy oils, natural bitumen in tight reservoirs), as well as studying the phenomenon of reservoir charging with abyssal hydrocarbons via the crystalline basement.

All these aspects require further conceptualization and development. In view of this, a new concept of Russian oil and gas sector development proposed by A.E. Kontorovich should be considered.

Key words: *concept, improved field development, unconventional reserves, secondary recovery, enhance oil recovery (EOR), recoverable oil-in-place, hydrocarbons, renewable power sources, primary energy sources, fuel and energy industry, energy resources, oil and gas sector, prospecting, heavy oil and bitumen reservoirs, oil recovery factor, shelf, heavy oils, tight rocks, mineral reserves replacement*

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Geological structure and depositional environment of Bazhenov formation in East-Urengoi license block

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Abstract. Surveys of the Bazhenov formation have been concentrated, primarily, in the central part of West Siberia. The paper discusses the lithology of the Bazhenov Shale in the northern part of West Siberia, in the East-Urengoi license block. For the first time in the history of investigations, the geological section of the Bazhenov formation was divided into five lithological units based on the results of lithological and mineralogical studies and well logging surveys. Concise characteristic of all units is presented. Correlation of lithological units allowed tracing of thickness changes within the territory of the license block.

Key words: *Bazhenov formation, Bazhenov formation anomalous section, Urengoi megaswell, West Siberia, Upper Jurassic*

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Lithological and facies analysis of producing terrigenous Devonian reservoirs of the Alekseevskoye field

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Abstract. This paper presents results of analysis of geological, well log and seismic data obtained for terrigenous Devonian reservoirs of the Alekseevskoye field. The geological structure has been refined and facies analysis of the Pashian, Mullinskian and Ardatovskian horizons has been conducted to further improve the performance of production enhancement operations with account of depositional environment and peculiar characteristics of the deposition of terrigenous sediments within the field.

Key words: *heterogeneity, facies, oil deposit, South-Tatarian arch*

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Influence of collector deformations on the development of Western Siberia

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Abstract. In the process of developing exploration and development of deposits, as well as in the process of developing the equilibrium state of rocks, it is not constant - it undergoes any changes all the time. The processes and phenomena that cause deformation of the earth's crust, its surface and mountain ranges at various stages of development of oil and gas fields are quite popular in world practice, especially in countries involved in the extraction of hydrocarbons and other minerals. The ranges and scales of manifestation of all kinds of deformation processes have rather wide boundaries: subsidence of the earth's plane is possible from a few millimeters to several tens of meters. This problem is relevant throughout Russia, especially in Western Siberia, where most of the country's fields are being developed.

This article presents the main causes and factors of the occurrence of rock deformation, methods of their determination, the tasks achieved by solving this problem. It also evaluates the baseline data for the validity of the studies.

As examples of the influence of reservoir deformations on the development of fields, calculations are given that were carried out in laboratory conditions on rock samples and cores from layers J1-1 - JV6 of the Khokhryakovskoye, Permyakovskoye and Koshilskoye fields. In particular, the dependences of the influence of stress and effective pressure on the rock on the reservoir properties, namely, the porosity and permeability of the rock, have been determined and built.

Research data shows that reservoir deformation should be actively studied and ways to reduce it should be sought. The solution to this problem is relevant in the formation and construction of development systems.

Key words: *deformation, rock reservoir, effective pressure, shear of rocks, permeability, saturated core.*

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Permeability alteration of carbonate reservoir rock under cyclic geomechanical treatment

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Abstract. The paper presents integral analysis of experimental data from laboratory studies on carbonate reservoir rocks of the Bashkir and Turney formations aimed at the measurement of rock permeability alteration under changing pore pressure and constant outer stresses. The dependencies obtained have been related to geomechanical treatment and initial reservoir properties of rock samples. Characteristic hysteretic effects of permeability alteration under cyclic changes of pore pressure on samples with different saturation have been revealed, and it was shown that cyclic geomechanical treatment can promote significant improvements of the flow characteristics of a carbonate reservoir. The published results were obtained in the research study on the topic “Justification of the mechanism of geomechanical treatment in carbonate reservoirs (Bashkir and Turney formations)” carried out by the Almetevsk State Oil Institute for PJSC Tatneft in 2019, and in the State Research Contract study of OGRI RAS on the topic AAAA-A19-119022090096-5.

Key words: *carbonate reservoir, cyclic geomechanical treatment, permeability alteration, hysteresis, laboratory studies, natural and induced fractures, porous media, fracture permeability*

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On separation of EOR /well stimulation effects with consideration of injection effect

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Abstract. This work discusses the problem of separation of effects from different EOR and well stimulation operations performed in the producing well and in the surrounding injection wells in the waterflooded development. Because of interference of effects, the true value of the main treatment might easily be overestimated, or on the contrary, underestimated. In such situations, estimate of base oil production comes to the forefront, however conventionally used draw-down curves and decline curve analysis (DCA) ignore effects from changes in bottomhole pressure before and after treatment and water injection rates.

Model studies to calculate base oil production might be a good solution, however, because of the too long run time and rapid aging of data, prompt estimate is challenging and so are the responsive remedial in-field operations.

Conventional approach to assess efficiency of stimulation treatment based on DCA is compared with the results of the numerical experiment using reservoir simulator. It has been shown that underestimation of injection wells' effect while decline curve analysis results in considerable errors in calculation of incremental oil production.

For a prompt assessment of separation of treatments' effects, the authors suggest using capacitance-resistance models (CRM), which are analytical solutions of the material balance equations. It has been shown that CRM models can significantly improve the accuracy of assessment of treatment efficiency. Furthermore, the offered approach makes it possible to estimate efficiency of the conformance control operations taking into consideration the actual well interference coefficients.

Key words: *assessment of treatment efficiency, separation of effects, CRM, well interference, effect from formation pressure maintenance, decline curves, reservoir simulation*

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Application of optimization algorithms in the formation of a long-term program of production enchancement operation under conditions of constraints

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Abstract. Hydrocarbons demand and oil prices decreasing, restrictions on oil production, share of depleted reserves and water cut increasing - all these factors face oil companies with the task of adjusting their own asset management strategies.

The article considers an approach of improving the quality of management decisions in oil fields development based on long-term multi-period planning of production enhancement operations. The article describes methodology of applying optimization models to long-term development plan for all oil facilities of the company, considering the restrictions on capital investments or oil production for a specific period. The objective functions used in the optimization models are presented. The effectiveness of neural network algorithms and high-performance computing in solving large-scale problems is shown.

Key words: *production enhancement operations, planning, investment portfolio, optimization models, neural networks, high performance computing*

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Technology digital control of the gas field for example on planning of technological mode

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Abstract. This article discusses the most promising method of managing gas production based on the use of deterministic physical and mathematical models. The concept of operational production management is presented. Examples of application of the PC-Hydrasym and GasNet-VBA v1.0 software for gas field management and results of comparison with the PipeSim software package are given.

***Keywords**: digital twin, deterministic mathematical model, self-adaptation*

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Investigating the feasibility of real-time pressure management in multilayered oil reservoirs based on maintaining the stability of producing gas-oil ratio of each production zone

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Abstract. The paper discusses the challenges associated with the operation of complex and expensive telemetry equipment intended to control and manage production from a multi-layered field using dual completion technology. Wireless and wired telemetry systems are disadvantageous in that the former fail to provide remote control at long distances and the latter lack the required reliability. Thus, the authors come up with a new method for real-time monitoring and management of reservoir pressure based on measurements of current gas-oil ratio of the wellstream produced from each production zone using dual completion system for production and maintenance of relative stability of gas-oil ratios through real-time pressure management using dual completion system for injection. It is proposed that commercially available AGZU-OZNA measuring units equipped with appropriate sensors be used for measurements.

Field trials of the proposed reservoir pressure management method in two-layer reservoir of the Tedynskoye field operated by OOO Lukoil-Severneftegaz and in a multi-layered field of OOO Sheshmaoil proved its efficiency and became a rationale for development of the corresponding procedural guidelines and for patent application.

Key words: *dual completion system for production, dual completion system for injection, reservoir pressure, saturation pressure, current gas-oil ratio, relative pressure differential*

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On the possibility of a pump-ejector system implementation for swag with using nitrogen

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Abstract. This article is devoted to the development and calculation of a pump-ejector system for the implementation of SWAG on the reservoir in the conditions of the N. field.

The practical significance of water-gas stimulation by injecting into the formation a fine-dispersed water-gas mixture consisting of water, nitrogen and a foaming surfactant is considered.

For the N field, a diagram of a pump-ejector system was developed and its parameters were calculated, at which it is possible to implement water-gas treatment with high efficiency. The given schematic diagram of the pump-ejector system takes into account the need for injection of nitrogen and surfactants. The pressure and energy characteristics of the ejector are calculated, the calculation methods are indicated. The choice of the booster pump is substantiated.

Key words: *pump-ejector system; water-gas mixture; associated petroleum gas; injection of a water-gas mixture using nitrogen*

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Casing exit operations using whipstocks with Different configurations of deflection surface

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Abstract. In view of ever-increasing activities associated with lateral-hole and horizontal sidetrack drilling from existing wells, success rate of such operations was analyzed. This analysis enabled to reveal the cases when drilling assembly failed to pass through a window cut in the casing wall. In order to determine the main factors affecting the passability of drilling assemblies and liners through casing windows a number of casing exit technologies and tools available from foreign and Russian companies were reviewed. Graphic analytic method allowed to analyze configurations of casing windows cut using various wedge-shaped whipstocks. Wear limit of whipstock body during casing exit operations was determined. Recommendations for improvement of casing exit tools and technologies are provided to increase the success rate of sidetracking operations.

Keywords: *casing window, sidetrack, deflection surface, groove, whipstock, milling cutter, drilling tool, liner (casing string)*

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State regulation in the sphere of subsurface use and problems of regulatory support

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Abstract. The issues of state regulation in the sphere of subsurface use are considered. In accordance with the main directions of state regulation of subsurface use relations, the problems of legal support are outlined. Separate proposals for improving the current legislation are formulated.

Key words: subsurface use; geological study of subsurface resources; state regulation; management in the field of subsurface use