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APPLICATION OF GEOSTATISTICAL METHODS TO STUDY GEOLOGICAL STRUCTURE OF COMPLEX OIL PRODUCTION ZONES

¹R.Kh. Gilmanova, ¹R.G. Sarvaretdinov, ¹A.A. Makhmutov, ²E.V. Korneev,
²A.B. Yankin

¹Neftegaztekhnologiya

²Bayteks

E-mail: Makhmutov_AA@npong.ru

Abstract. This paper presents criteria for evaluation of heterogeneity, particularly, a set of normal distribution features exhibiting steady-state behavior.

Construction and analysis of histogram and variogram as well as calculation of variation coefficient have been shown to enable real-time assessment of the steady state of geological random variables within the region of interest. A decision on application of stochastic approaches during three-dimensional simulations of complex reservoirs is made based on meeting steady state criteria.

Key words: *heterogeneity, random variable, steady state, normal distribution, histogram, variogram, coefficient of variation*

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DRILLING OF WELLS WITH A HIGH HORIZONTAL BORE LENGTH ON VEREY DEPOSITS UNDER THE PROJECT «COMPACTION OF THE DEVELOPMENT GRID»

¹A.S. Pitirimov, ¹V.A. Kurinov, ^{2,4}L.B. Khuzina, ³R.R. Khuzin, ⁴I.F. Khalitov

¹PJSC TATNEFT

²Almetyevsk state oil Institute

³LLC «Carbon-Oil»

⁴Ufa State Petroleum Technical University, Oktyabrsky Branch

E-mail: KurinovVA@tatneft.ru

Abstract. The article is devoted to the implementation at PJSC "Tatneft" project "Seal grid development", in which in early 2019 before the Office for well construction the task was to drill two horizontal wells at Vanaskie deposits with the length of the horizontal wells 650m and 800m. Distinctive feature is: a large offset to an entry point more than 600m, offset by downhole point – more than 1200m; a relatively small depth vertically 830m; a significant number of previously drilled wells with a high risk of crossing ;the presence of an operational column of packers in the equipment for multi-stage fracturing.

Especially given the profile design to minimize the risk of intersection with nearby wells, and examines the process of the descent of the production casing, is complicated not only a large length of the well bore and the horizontal section, and in a snap 9 packers to conduct multi-zone fracturing. To reduce the bending forces on the drill string and the likelihood of a "buckling" effect, it was decided to deviate from traditional design methods, when the initial vertical section is timed to the depth of the conductor's descent. An unconventional solution was used for the descent of the production column – the descent in the "flotation" mode without filling the column with washing liquid and without intermediate flushing during descent, while the low hydrostatic pressure did not exceed the pressure of the casing collapse. This solution made it possible to reduce the pressure on the well walls at the installation site of packers by 3-6 times during the descent of the production column. Thus, in PJSC Tatneft, the well construction Department solved the problem of drilling a horizontal well into the Verey deposits. Thanks to engineering and technological support of construction, calculations in a specialized software package and round-the-clock monitoring without the use of expensive specialized equipment. The effective length of the productive part was 99% of the total length of the horizontal trunk.

Key words: horizontal wells, well profile, the descent of the column, Nadolny module.

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MODELING OF DRILL STRING WORK FOR DRILLING EXTENDED REACH WELLS AT VARADERO FIELD (REPUBLIC OF CUBA)

R.A. Bacallao, R.A. Ismakov

FSBEI HE «Ufa state petroleum technological university»

E-mail: adriancuba8608@gmail.com

Abstract. Currently, there are many articles in the world related to the drilling of long-range wells. This article presents the design of the drill string for the Manto-2 production interval with a diameter of 155.58 mm of the VFN-752 well in the Varadero field.

The use of a combined aluminum drill string and a steel drill pipe is proposed due to the difficulties of this type of well, characterized by high values of torque, drag and equivalent circulation density due to the large horizontal displacement and its depth vertical. A comparison is made of the two proposed drilling string. The first consists only of steel drill pipes, and the second consists of aluminum and steel drill pipes. Using the specialized Landmark (Well Plan) software, the torque, drag and stress values acting on the drill string for various drilling modes and hydraulic calculations were modeled to determine the equivalent circulation density during drilling. The simulation results show that the use of drill strings in combination with aluminum and steel pipes can reduce the torque, drag and stress on the drill string in this type of well, which is an advantage in well drilling with extended reach.

Keywords: *extended reach wells, drill string, torque, drag, aluminum drill pipe, equivalent circulation density*

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**PRACTICAL RECOMMENDATIONS FOR THE PREVENTION AND
ELIMINATION OF GEOLOGICAL AND TECHNOLOGICAL COMPLICATIONS
DURING WELL DRILLING**

V.N. Kuzmin

Udmurt state University", Institute of oil and gas name M.S. Gutserieva

E-mail: nf-kvn@udsu.ru

Abstract. This article presents practical recommendations (measures) for the prevention and elimination of geological and technological complications that often occur when drilling wells for the conductor and production column. The recommendations take into account many years of experience in the construction of wells on fields located in the territory of the Udmurt Republic and neighboring regions and based on the analysis of complications and accidents that occurred during the construction of these wells

Keywords: *Well drilling, prevention and elimination of geological and technological complications.*

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ANALYSIS OF PROCESS FLUIDS AND GAS-LIQUID SYSTEMS APPLICATION RESULTS FOR DRILLING AND WELL REPAIR IN ALRP CIRCUMSTANCES

¹A.A. Singurov, ²S.A. Melnikov, ²E.V. Melnikova, ²V.I. Nifantov, ²V.M. Pischukhin,
³O.V. Makarev

¹Sakhalin Energy Investment Company Ltd.

²LLC «Gazprom VNIIGAZ»

³PJSC «Gazprom»

E-mail: V_Pischukhin@vniigaz.gazprom.ru

Abstract. In conditions of abnormally low reservoir pressures (ALRP), when the bottom-hole pressure of the fluids pumped into the well is significantly higher than the reservoir pressure in the intervals of highly permeable rocks, various complications arise in the technological processes of drilling and well repair. Due to the absorption of washing fluids, violations of the stability of the well bore and other complications, the quality and cost of the work performed is reduced.

At the same time, it is not always possible to reduce the repression on the bottom-hole zone of the reservoir to the required values. In the article, based on the analysis of a large experience of drilling and repair of gas wells in the conditions of anpd, the conditions of the state of the well-formation system at different values of the anomaly coefficient of low reservoir pressure (K_a) are shown. It is established that the value of relative repression on the formation increases by hyperbolic dependence when K_a decreases from 0.85 to 0.061.

Keywords: *process fluids, gas-liquid systems, gas wells, abnormally low reservoir pressures, opening of a productive reservoir, well repair*

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INHIBITION OF DRILLING FLUIDS WITH THE GOAL OF ACCIDENT-FREE DRILLING OF THE INTERVAL OF UNSTABLE CLAY ROCKS

V.N. Kuzmin, T.V. Trefilova

Udmurt state University", Institute of oil and gas name M.S. Gutserieva

E-mail: nf-kvn@udsu.ru

Abstract. The article deals with the issues of reducing the swelling process of unstable clays due to their inhibition, since scree and collapses of unstable clay rocks are still one of the actual problems that arise when drilling wells. Laboratory studies were aimed at preventing swelling of clays due to combined inhibition of them, namely, by introducing an inorganic inhibitor of clays potassium chloride (as a factor of ion exchange) and sulfated asphalt (as a factor of creating a waterproof barrier in the pores and channels of drilled rocks) into the formulation of drilling mud (emulsion drilling mud). Based on the results obtained in the course of laboratory studies for the construction of wells, when passing intervals with clay deposits prone to hydration, it is recommended to use an emulsion drilling mud, the composition of the formulation of which is introduced potassium chloride and sulfated asphalt.

The use of this type of drilling mud, additionally enhanced with clay inhibitors, will prevent hydration and shedding of clays and, thus, reduce the likelihood of technological accidents and incidents.

Keywords: *The drilling of wells; inhibition of clays; inhibitors of clays; drilling fluids*

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DETERMINATION OF THE CEMENT STONE DYNAMIC STRENGTH UNDER CLOSE TO AN ALL-AROUND COMPRESSION CONDITIONS

¹F.A. Agzamov, ²A.O. Belousov, ¹Ya.K. Komlev

¹Ufa State Petroleum Technological University

²KogalymNIPIneft, Branch of LUKOIL-Engineering Company in Tyumen

E-mail: faritag@yandex.ru

Abstract. Currently, the determination of the strength properties of the cement stone is carried out in accordance with the methodology established by GOST 26798.1-96, which provides for testing samples of regular rectangular shape, where normal stresses are the main characteristic that determines the strength of the material. This indicator cannot fully characterize the resistance of the cement stone to be fractured in the downhole conditions. The technique presented in the standard does not take into account the tangential (circumferential, radial) stresses that occur in the annulus during technological operations. These circumstances require the development of the special research methods, as well as auxiliary equipment, which makes it possible to adequately assess the ability of a cement stone to resist emerging stresses under conditions of all-around compression.

Key words: *Strength, cement stone, stresses, all-around compression, deformation.*

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APPLICATION OF CRM MODELS FOR ANALYSIS OF WATERFLOOD PERFORMANCE

T.A. Pospelova, D.V. Zelenin, A.A. Ruchkin, A.D. Bekman

LLC «Tyumen Petroleum Research Center»

E-mail: dvzelenin@rosneft.ru

Abstract. A new CRM-modeling-based approach to identification of performance parameters for reservoir pressure maintenance systems is proposed to meet the challenges associated with the analysis of waterflood patterns for mature field development. This approach relies on approximation of well interference based on field data on production rates, well injectivities and bottomhole pressures. Due to relative simplicity of this approach, history matching is not time consuming and ensures adequate accuracy of the forecasts.

The proposed CRM-modeling-based method for analysis of waterflood performance comprises evaluation of unproductive injection and performance of injection wells, estimation of current injection ratio by grid blocks and individual production wells.

Key words: *waterflood pattern, formation pressure maintenance, CRM, well interference, unproductive injection, injection ratio, daily oil production rate, impermeable barrier*

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RESERVOIR SIMULATION MODELS USED TO STUDY FLUID FILTRATION PROCESSES IN HEAVY AND EXTRA-HEAVY OIL FIELDS DEVELOPED BY AIR INJECTION

¹R.Kh. Nizaev, ¹G.V. Aleksandrov, ²Yu.L. Yegorova

¹TatNIPIneft Institute

²Almetyevsk State Oil Institute

E-mail: nizaev@tatnipi.ru

Abstract. The paper summarizes results of model studies of in-situ processes in heavy and extra-heavy oil reservoirs with differing geological and PVT characteristics developed by air injection. In terms of the mode of oil occurrence, two types of reservoirs with the original oil saturation values 0.4, 0.6, and 0.8 were considered, namely, reservoirs similar to those associated with the Sheshminskian formation dated to the Ufimian age, and reservoirs similar to those confined to the Bashkirian, the Viséan, and the Tournaisian formations. For the former, the original oil viscosities from 1000 to 50,000 mPa·s were used in calculations, while for the latter, the original oil viscosity values ranged from 300 to 900 mPa·s. It was found that for the first type of reservoirs, with the original oil saturation 0.8 and zero free water at initial reservoir conditions, the time period between the start of air injection and the start of the formation temperature intensive growth is defined by the original oil viscosity. Based on the obtained oil recoveries, polynomial and power-law dependencies of oil recovery factor vs. initial reservoir conditions—depth of reservoir, in-situ viscosity, and original oil saturation—were built.

Key words: *heavy oil accumulation, extra-heavy oil accumulation, reservoir flow model, air injection, oil viscosity, average formation temperature, oil recovery factor*

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**STUDY OF THE WAYS TO IMPROVE TECHNICAL AND ECONOMIC
PERFORMANCE OF SIDETRACKING OPERATIONS IN
NGDU AZNAKAEVSKNEFT**

¹Yu.A. Gutorov, ²R.Kh. Nizaev, ³L.G. Rakhmaev

¹RKNTC Neftyanaya Dolina

²TatNIPIneft Institute

³NGDU Aznakaevskneft PJSC TATNEFT

E-mail: azn09sg@tatneft.ru

Abstract. The paper presents the results of analysis of technical efficiency and economic performance of sidetrack drilling deep into the reservoir under conditions of late stages of development of productive areas of the Romashkinskoye field to target terrigenous Pashian and Bobrikovian-Radaevskian reservoirs. The interest to this problem is associated with gradual decrease in technical and economic efficiency of such operations and search for performance improvement opportunities.

Various factors that would affect efficiency of the technologies under consideration were investigated. These included geological and physical as well as geological and field conditions of particular production zones and deposits of the Romashkinskoye field. These studies enabled determination of optimal criteria for drilling target selection based on reservoir properties as well as optimize sidetracking strategies with account of specific geological and physical, and geological and field conditions.

Key words: *well intervention, sidetracking, horizontal lateral, successful, unsuccessful, breakeven point, correlation index, azimuth, deviation.*

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HYDRAULIC FRACTURING APPLICATION

S.A. Dolgih, A.N. Sharofidinov

Kazan (Volga Region) Federal University

E-mail: dolgih_s_a@mail.ru

Abstract. The paper discusses the use of hydraulic c fracturing. Objective: Enhanced oil recovery based on a new method of evaluating the effectiveness of hydraulic fracturing.

Hydraulic fracturing is a downhole well to break a rock and form cracks due to high pressure. Hydraulic fracturing is used to increase the productivity and in jectivity of production and injection wells. The following problems should be solved during hydraulic fracturing:

1. Cracking
2. Keeping the crack open
3. Removal of fracturing fluid
4. Increasing reservoir productivity

To determine the location of the most cracks applied method of radioactive logging. This technology allows you to find out exactly where the gaps.

Keywords: *hydraulic fracturing, cracks, proppant, fluid, efficiency*

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**COMPARISON OF RESERVOIR PROPERTIES BASED ON PRESSURE
DRAWDOWN AND PRESSURE BUILDUP TEST DATA OBTAINED DURING
HYDRAULIC FRACTURING**

E.F. Gilfanov

LUKOIL-Engineering Limited KogalymNIPIneft Branch Office in Tyumen

E-mail: GilfanovEF@tmn.lukoil.com

Abstract. The paper considers combined use of pressure drawdown and pressure buildup test data collected during hydraulic fracturing. A model of permeability distribution along the perforated interval of horizontal well section was obtained. Log-log plots were used to determine fracture propagation into overlying or underlying aquifers.

Key words: *multi-stage fracturing, Nolte function (G-function), pressure buildup curve, pressure drawdown curve, reservoir pressure, permeability index.*

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APPROACH TO THE SELECTION OF TECHNOLOGY FOR OPERATION OF SELF-PRESSING WELLS URENGOY FIELD

T.T. Ragimov

Ufa State Petroleum Technological University

E-mail: ragimovugntu@list.ru

Abstract: At present, the bulk of gas production (more than 90%) of the northern fields of Russia is carried out through the development of purely gas types of deposits. Among the possible complications during the operation of wells, the formation of hydrate plugs, which clog the downhole equipment, as well as flooding of gas wells, and freezing of washing fluid in the well, is noted. The article is devoted to solving the problems of self-jamming in production wells at the final stages of development of the Urengoy field.

The decrease in flow rate and reservoir pressure worsen the conditions for the removal of fluid with mechanical impurities from the bottom of the wells. The process of water accumulation often leads to an increase in filtration resistances, to a further decrease in productivity, and ultimately to a shutdown of wells.

The paper presents operating technology of gas well operation regimes in conditions of water manifestations because of values of maximal possible gas yield supposing non-destruction of bottomhole zones of beds and equipment, and minimal gas yield supposing non-accumulation of liquid. Revealed approaches will afford to reduce number of well air-blowing operations and to rise performance of Urengoy field deposit operation.

Keywords: *self-capping, gas wells, concentric elevator, exploitation, technology.*

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EVALUATION THE EFFECTIVENESS OF ASPHALTIC-RESINOUS PARAFFIN SEDIMENTS CONTROL IN THE EAST-SURGUT DEPOSIT

A.E. Pituganova, I.F. Minkhanov, A.A. Al-Muntaser

Kazan Federal University

E-mail: pituganovaa@gmail.com

Abstract. Undoubtedly, problems of oil production with heavy components arose more than 120 years ago. The formation of asphaltic-resinous paraffin sediments leads to a decrease in oil production, a reduction in the repair period between wells, an increase in labor and material costs, and an increase in the cost of production. Therefore, the process of formation of asphaltic-resinous paraffin sediments and the technology of their controlling is an important practical task in the scientific and technical field. This article analyzes existing methods for the prevention and removal of asphaltic-resinous paraffin sediments, as well as recommendations to increase the inter-treatment period. The geology and analysis of the current state of development the object of the East-Surgut oil field are considered. A comparison of the methods used to combat asphaltic-resinous paraffin sediments that are used in this field is given. The analysis revealed the most effective of the methods used.

Key words: *asphaltic-resinous paraffin sediments, dealing methods with oil sediments, wide fraction of light hydrocarbons, removing with a mobile scraper, stable gasoline*

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APPLICATION OF SOLUTIONS OF SURFACE-ACTIVE SUBSTANCES IN TECHNOLOGICAL PROCESSES OF OPERATION AND REPAIR OF WELLS

D.R. Khayarova, I.I. Mannanov

Almetyevsk State Oil Institute

E-mail: GilDinara14@mail.ru

Abstract. Technological operations using aqueous solutions of surface-active substances are mandatory elements of a significant number of well operation and repair technologies. Currently, the results of studies on the use of aqueous solutions of surface-active substances for regulating phase and energy interactions in the processes of drilling wells, discovering productive formations, increasing oil recovery, treating the bottom-hole formation zone of production and injection wells, oil preparation, and the fight against corrosion of underground equipment are known inhibition of organic deposits.

In modern conditions, increasing the effectiveness of the use of aqueous solutions of surfactants to remove organic deposits formed during the operation of wells is becoming relevant.

The paper presents the results of the analysis of the use of aqueous solutions of surfactants in the field facilities of Tatneft Public Joint Stock Company. The conditions of washing are studied from the point of view of the hydrodynamics of the process, in particular, the pressure values at the beginning of washing and at the end of washing. The main factors determining the effectiveness of well flushing have been identified.

Key words: *flushing liquids, aqueous solution, surfactants, pressure, deep pump equipment, efficiency*

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**DEVELOPMENT OF COMPARATIVE EVALUATION METHODS POLYMERIC
ADDITIVES AT PIPELINE HYDROCARBON TRANSPORT**

G.I. Dusmetova, E.V. Kharitonov, G.O. Burova, L.R. Baybekova, A.V. Sharifullin

Kazan National Research Technological University

E-mail: kharitonov.eve@list.ru

Abstract. A methodology has been developed for a comparative assessment of the effectiveness of anti-turbulent additives. The results of the research from developed NAVA additive and industrially applied additives to increase the throughput capacity of oils and oil emulsions of Oil and Gas production department «Aznakaevneft» with a water content of 10 to 40 % are carried out. Was found that increases in water content, the effectiveness of the Baker Hughes additive decreasing with toward to the additives of the NAVA series. The NAVA additive was prepared by compounding low molecular weight polymers and surfactants with the addition of alumina nanoparticles.

Keywords: *oil emulsion, transport, anti-turbulent additive, laboratory installation, program*

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PROBLEM OF UTILIZATION AND TRANSPORTATION OF ASSOCIATED OIL GAS IN RUSSIA

S.A. Dolgih, O.O. Mirzayev

Kazan Federal University, Institute of Geology and Petroleum Technology

E-mail: dolgih_s_a@mail.ru

Abstract. The paper discusses current problems in the utilization of associated petroleum gas in the Russian Federation. The developed technologies for the chemical processing of gaseous hydrocarbons into valuable liquid products using catalytic systems and barrier electrical discharge are presented. Possible areas of application and prospects for the development of the technology of direct conversion of hydrocarbon gases into liquid, methods of beneficial use of associated gas and reducing pollution of the surrounding atmosphere are shown.

Key words: *Associated Petroleum Gas, refinery, salvaging*

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REALIZATION OF DIGITAL TWINS FOR GAS RESERVOIR MANAGEMENT PROCESS

T.A. Pospelova, A.V. Strekalov, S.M. Knyazev, A.N. Kharitonov

LLC «Tyumen Petroleum Research Center»

E-mail: smknyazev@tnnc.rosneft.ru

Abstract. The paper gives the definition of a digital twin of a gas field in terms of its applicability for the reservoir management process. The problems of realization of a digital twin based on the deterministic physico-mathematical model are considered. Basic system of equations is described, general principles of derivation of basic equations are presented. The authors suggest encapsulating mathematical regulators to limit the rate of flows in the key system elements.

Key words: *digital twin, deterministic mathematical model*

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УДК 628.8

**OPTIMIZATION OF ENVIRONMENT IN LABORATORIES OF CORE ANALYSES
CENTER**

D.V. Tarasov

LLC «Tyumen Petroleum Research Center»

E-mail: dvtarasov@tnnc.rosneft.ru

Abstract. The paper reviews a Supervisory Control and Data Acquisition (SCADA) system that was developed for real-time and efficient control of building services in an effort to optimize environment in the laboratories of Core Analysis Center.

Key words: *environment, air renewal, ventilation, supervisory control, software and hardware suite*