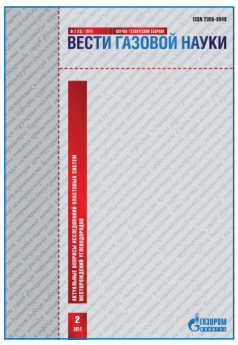

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Actual Problems of Research of Stratal Hydrocarbon Systems

Sklyarova Z.P. Description of the Condensate Resource Base of the Gazprom Group / Z.P. Sklyarova, F.S. Sokolov, V.S. Tkach // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 4–11.

In the nearest decades the deposits containing large amounts of gas condensate – a very valuable resource for the petrochemical industry – will be the main backup for increase of the resource base. Its cost can significantly increase the economic efficiency parameters of development.

Largest dry gas deposits confined to shallow depths and reservoirs with high storage and filtration properties are at the falling production stage, and in the nearest future increase of production will occur mainly by means of putting on production of new deposits containing much gas condensate.

The article gives the description of the structure of condensate reserves in the Gazprom Group on the basis of main geological and physical characteristics: depth, age, lithotype and porosity of hoisting deposits, condensate content, type of fields and deposits, reserves depletion, and design condensate recover factor.

Most of deposits with condensate reserves are associated with clastic reservoirs lying at the depth of more than 2,5–3 km, where hosting formations are characterized by reduced permeability and porosity.

More than a third of explored condensate reserves of the Gazprom Group is in deposits with oil margins.

The design condensate recovery factor for deposits containing about a half of explored reserves of the Gazprom Group is established within the range of 0,6–0,7. The design condensate recovery factor falls for gas-condensate systems with high condensate content and low storage properties.

The parameters of the condensate resource base structure and the dynamics of its change shall be taken into account for planning of resource base development activities within existing and planned gas production clusters.

Keywords: ***gas, condensate, reserve structure, resource base, condensate recovery factor.***

Ryzhov A.E. Impact of the Internal Structure of the Khamakinsky Producing Horizon and Location of its Stratigtaphic Borders in the Southern Part of the Chayandinskoye Field / A.E. Ryzhov, A.I. Krikunov, L.A. Filippova (Ryzhova), N.Yu. Kanunnikova, O.A. Saprina // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 12–18.

The reservoir rocks containing large accumulations of liquid and gaseous hydrocarbons at the Chayandinskoye oil/gas/condensate field located in the Republic of Sakha (Yakutia) are confined mainly to three producing horizons – the Botuobinsky, the Khamakinsky and the Talakhsky ones. The Botuobinsky horizon contains a gas/condensate deposit with oil margin. Wells produce a gas/condensate mixture when the Talakhsky producing horizon is intersected. Until recently it was thought that the Khamakinsky horizon contains pure gas/condensate deposit. However, multiple wells drilled recently contest this conclusion.

The paper describes the internal structure of Lower Devonian clastic formations in some wells drilled in the southern part of the Chayandinskoye field. High tectonic activity within the studied area together with epochs of relatively calm sedimentation processes is justified. Presence of multiple washaway surfaces during the period of formation of main producing horizons is indicated.

Application of the results of study of core material and use of the cycle-stratigraphic analysis allowed to identify in well sections and trace a number of synchronous reference horizons in the area. This approach allowed to clarify the internal structure of the Khamakinsky producing horizon and define the location of its stratigraphic borders in the southern part of the Chayandinskoye oil/gas/condensate field.

Keywords: ***well, field, sedimentation, washaway, horizon, correlation, reference.***

Ryzhov A.E. Specification of the History of Formation of the Southern and the Samanchakitsky Blocks Identified at the Chayandinskoye Field during the Pre-Cambrian Age / A.E. Ryzhov, A.I. Krikunov, L.A. Filippova (Ryzhova), N.Yu. Kanunnikova, O.A. Saprina // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 19–26.

In the tectonic relation the Chayandinskoye oil/gas/condensate field is located in the northeastern part of the Nepsko-Peleduisky arch complicating the Nepsko-Botuobinskaya anticlise.

The Nepsko-Peleduisky arch in its most uplifted part is complicated with graben-shaped downfolds dividing it into four large blocks: Talakansky, Taransky, Alinsky and Chayandinsky.

The paper describes the internal structure of the Khamakinsky producing horizon at the southern periphery of the Chayandinskoye oil/gas/condensate field. Ambiguousness in detection and tracing of faults complicating the major Chayandinsky block in the area by means of seismic exploration is shown. The correlation diagram, geological and paleostructural profiles built in the general direction from west to east and crossing the regional fault which separates the Southern block from the Samanchakitsky block are given. Presence of disjunctive dislocations in the rock complex under study, which remained unnoticed during earlier studies, is proven.

Graphical constructions given in the paper and their analysis give clear idea on extremely complex internal structure and insufficient study of Lower Vendian producing clastic formations at the Chayandinskoye oil/gas/condensate field. The probability that disjunctive dislocations with significant amplitudes of displacement, being intraformational units, can exist here together with identified multiple faults which damage the erosional surface of the Vendian clastic deposits is high. These structural faults can play a significant role in identification of the hydrodynamic relation between separate tectonic blocks and influence the integrity of gaseous and liquid hydrocarbon deposits.

Keywords: ***well, field, seismic exploration, fault, washaway, horizon, correlation, paleostructural profile.***

Parfenova N.M. Gas Condensate of the Astrakhan Gas Condensate Field: Current Condition / N.M. Parfenova, L.S. Kosyakova, I.M. Shafiev, D.R. Krain, E.B. Grigoriev, I.E. Kuznetsov, M.M. Orman, A.A. Tomilenko, L.V. Chashnikova // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 27–35.

The analysis of the current condition of physical and chemical characteristics of condensates collected in 2012–2013 during tests of 20 producing wells of the Astrakhan gas condensate field was executed.

It was found out that the studied condensates of the Astrakhan gas condensate field represent heavy condensates with the density of 797,1–811,1 kg/m^3, paraffinic (the content of solid paraffins – 2,14–3,10 % wt), low-resin (content of silica-gel resins – 0,50–1,01 % wt), high-sulphur (total sulphur content – 1,08–1,23 % wt). In terms of all physical-chemical characteristics the condensates are similar to each other but not identical.

Condensates boil out within a wide temperature range up to 540 °C and contain all marketable fractions: benzene, kerosene and diesel differing with good recoveries. However, since the content of sulphuric compounds in them exceeds the norms for each fuel type, their use as the base for fuel production is possible only after fulfillment of measures for improving their quality, also for increasing the octane and the cetane numbers, and viscosity.

Taking into account the nearness of the current stratal pressure to the pressure of the beginning of stratal system condensation, monitoring of changes in the composition and properties of stratal fluids is recommended.

Keywords: ***gas condensate, fractional composition, component composition, group hydrocarbon composition, benzene, kerosene, diesel fractions, gas-liquid chromatography.***

Kovalev A.L. Filtration-Strength Calculation of the Surroundings of the Vertical Wellbore with the Use of the Drucker–Prager Plasticity Criterion / A.L. Kovalev // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 36–43.

The paper, within the frames of the theory of the elastic-plastic porous medium, suggests numeric computer models for the filtration-strength calculation of the reservoir in the surroundings of an open vertical wellbore. The rock is described by the model of ideal plasticity or model with hardening. The criterion of Drucker–Prager is used. The pressure is defined by the model of stationary filtration depending on the law of the latter and the composition of the moving mixture.

The Runge–Kutt method is used for solution of the problem. It allows to remove limits of the complexity of the filtration law used.

The communication between main stresses in the plastic deformation zone is established in compliance with the associated plastic yield law. The use of the Drucker–Prager criterion allows (as compared to the Coulomb Mohr criterion) to avoid the procedure of selection of the minimum and the maximum of three main stresses. The system of nonlinear equations received at that is solved with the Newton numeric method. The analytical method can be easily adapted also for the case with a non-associated law of plastic yield.

The algorithm of problem solution resolves itself to determination of the boundary between zones of elastic and plastic deformations with set model parameters and boundary conditions. Meanwhile, pairwise equality of main stresses (radial, tangential and axial) and equality to plastic deformation zero shall be followed at the boundary. After the boundary is found in each zone (elastic and plastic), stress, deformation, and movements along the radius are calculated.

Thus, as compared to previous works, the analytical method includes determination of deformations in the plastic zone, which allows to take into account the deformation strength criterion for sand risk evaluation. The description of the proposed methodology is illustrated by a series of calculated examples.

Keywords*: model of stratum material, filtration-strength calculation, stress-deformed condition, stresses, deformations.*

Dakhnov A.V. Increase of Reliability of Open Porosity Ratio Determination with a Gas Volumetric Densimeter «Poromer» / A.V. Dakhnov, I.B. Kryukova // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 44–46.

The gas-volumetric densimeter «Poromer» is designed for express evaluation of the open porosity coefficient, mineralogical and volumetric density of specimens with correct geometric shape. The comparisons of the results of open porosity coefficient determination, defined by means of hydrostatic weighing (Preobrazhensky method) and the gas-volumetric method showed deviations in the results received, the reasons for which are explained by not only increased gas capability to penetrate to the porous space of the research specimen. One of the factors which can cause 'apparent' overestimation of the values of the open porosity coefficient defined with the Preobrazhensky method, as compared to the gas-volumetric method, is the accuracy of determination of the external volume for the specimen under study. In the gas-volumetric method the volume is calculated on the basis of the geometric sizes of the specimen. The calculation accuracy is defined by the degree of deviation of the real specimen shape from the ideal one. In the hydrostatic weighing method the specimen shape does not influence the reliability of determination of the external volume. Comparisons showed the necessity of introduction of an allowance in the results of determination of the open porosity coefficient received using the gas-volumetric densimeter «Poromer».

Keywords: *porosity, porosity coefficient, gas-volumetric method, liquid saturation, hydrostatic weighing, density.*

Gerasimov A.A. Calculation of Phase Equilibriums of Complex Hydrocarbon Mixtures on the Basis of Multiconstant Generalized Status Equations / A.A. Gerasimov, B.A. Grigoriev, I.S. Aleksandrov // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 47–54.

A methodology of forecast calculation of phase equilibriums for complex hydrocarbon mixtures – oil, gas condensates, hydrocarbon fractures and marketable oil products with different production methods was developed on the basis of two earlier generalized fundamental status equations describing the properties of chain and cyclic structure. The methodology of modeling of the complex hydrocarbon mixture composition with pseudocomponents (subfractions) on the basis of the data on the distillation curve and the minimum set of physical and chemical mixture properties – mean boiling temperature, relative density, molar weight – is presented. The complex mixture is modeled with five pseudocomponents – subfractions. Meanwhile, each subfraction is also considered a mixture consisting of paraffinic hydrocarbon and hydrocarbon with cyclic structure with similar boiling temperature and the Pitzer acentricity factor.

The rules of transfer from quazi-single-liquid model of the substance used for calculation of thermodynamic properties to the line model of solution, allowing to calculate phase equilibrium, were developed for the first time. Design ratios were received, and the algorithm and the program of calculation of phase equilibriums for multicomponent hydrocarbon mixtures on the basis of two multiconstant status equations were developed.

The results of calculation of phase equilibriums (boiling and condensation points) of hydrocarbon mixtures on the basis of the proposed methodology and on the basis of cubic status equations are provided. It is demonstrated that the accuracy of forecast calculation of phase equilibriums with multiconstant equations and cubic status equations is approximately similar. However, the accuracy of calculation of thermodynamic properties using multiconstant equations is significantly higher.

Keywords: *thermodynamic properties, phase equilibriums, status equation, volatility, hydrocarbon, oil, gas condensate.*

Bogatyrev A.F. Temperature Dependence of the Coefficients of Hydrocarbon Gas Mutual Diffusion / A.F. Bogatyrev, M.A. Nezovitina // // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 55–58.

Various semi-empiric equations are commonly used for calculation of mutual diffusion coefficients in a wide range of temperatures and pressures. This paper proposes the equation for calculation of the mutual diffusion coefficient value for different pressures and temperatures. The equation was received within the frames of the elementary kinetic theory on the basis of the methodologies for calculation of the mutual gas diffusion coefficients dependence on temperature and pressure, earlier proposed by the authors. The received expression takes into account the dependence of the mutual diffusion coefficient on pressure, temperature and composition of the binary gas mixture.

The paper shows processing of the results of experimental data on pressure build-up for 14 hydrocarbon gas systems in the temperature range of 100–900 K and the pressure interval of 0.1–14 MPa with the least squares method. This allowed to receive the values of the powermode temperature dependence parameter for the studied systems within the specified ranges of thermodynamic parameters. The paper gives detail processing results and the analysis of the results received.

The design values of pressure build-up received as the result of study agree well with the experiment: the mean deviation of the values calculated with the proposed equation from experimental data made 3–5 %. Such results allow to

recommend the proposed equation for calculation of the mutual diffusion coefficients within the specified pressure and temperature range and for prediction of the mutual diffusion coefficient values for calculation of various heat-and-mass transfer processes in existing and developed plants and units in wider ranges of thermodynamic parameters as compared to the study performed.

Keywords: ***mutual diffusion coefficient, temperature dependence, pressure dependence, hydrocarbon gases.***

Kuznetsova M.A. Heating Capacity of Hydrocarbons in Above-Critical Thermobaric Conditions / M.A. Kuznetsov, P.O. Ovsyannikov, E.B. Grigoriev, A.V. Bogdanov // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 59–63.

The paper describes a new approach to the development of hydrocarbon thermodynamic properties calculation methods, consisting in detail numeric description of thermobaric dependence of the property for the substance well-studied experimentally (reference) and to establishment of correlations for a number of thermodynamically similar substances. It was established that in above-critical conditions the thermodynamic properties of hydrocarbons, in addition to their molecular structure, are defined significantly by the nature of the intra-molecular interaction. Therefore, the structural correlating parameter K_1 was suggested, calculated on the basis of the ratio of critical temperatures of the defined and the reference hydrocarbons. The method of interpolation of the heating capacity temperature dependence with the help of the Lagrange polynomial of varying power was used for numeric implementation of the proposed approach. A program was developed for PC.

The values of the heat capacity of hydrocarbons of various homologous series at constant pressure in the above-critical area of maximums calculated on the basis of the program were compared with the available experimental data.

Keywords: ***hydrocarbons, thermodynamic properties, heating capacity, reference substance, Lagrange polynomial of varying power.***

Faizullin M.Z. Reception of Alcane-Series Hydrocarbon Hydrates during Crystallization of Amorphous Ice Saturated with Gas / M.Z. Faizullin, A.V. Vinogradov, V.P. Koverda // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 64–72.

Formation of gas hydrates in gas-saturated low-temperature layers of amorphous ice, received by means of settling of molecular beams of expanded steam and gas on a surface chilled with liquid nitrogen was studied for binary systems «water – methane», «water – ethane» and «water – propane». Vitrification (softening) and further spontaneous crystallization are observed during heating of non-equilibrium condensates. Condensate vitrification and crystallization temperatures at different gas concentration values were defined on the basis of changes in dielectric properties during heating. Measurements were executed in the continuous heating mode with a constant rate of 0,03 K/s in the temperature range of 70–200 K.

Crystallization of amorphous condensates in the conditions of strong metastability leads to formation of crystallohydrates. Avalanche-type occurrence of crystallization centers captures gas molecules, therefore, they are not displaced by the movement of the crystallization front. Increase of the gas content in amorphous ice layers leads to shifting of the crystallization signal towards high temperatures. No significant impact of the gas concentration change on the vitrification temperature was noticed. During layer vitrification a clear peak of gas emission is observed, caused by creeping of the specimen during transfer from solid amorphous condition to liquid viscous yielding condition. A low-temperature peak of gas emission, caused by gas sublimation from the surface and from the porous specimen structure is observed in the vitrification area for amorphous ice condensates saturated with ethane and propane, in addition to gas emission. Preservation of gas hydrates was observed at atmospheric pressure in the liquid pentane medium up to the temperatures close to 273 K. Self-conservation ensured preservation of hydrates in a metastable condition at temperatures significantly higher than their equilibrium dissociation temperatures. The received specimens of gas hydrates contained methane up to 15, ethane – 12 and propane – 13 % wt. The results of studies show the success of use of the molecular beam non-equilibrium condensation method for gas hydrate reception.

Keywords: ***gas hydrates, non-equilibrium condensates, molecular beams, vitrification, crystallization.***

Buleiko V.M. Study of the Impact of Capillary Effects on Phasal Behaviour and Processes of Hydrating of Liquid and Gaseous Propane in Water-Saturated Sand Reservoir / V.M. Buleiko, G.A. Vovchuk, E.B. Grigoriev, A.P. Fedoseev, V.A. Istomin, V.E. Podnek // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 73–82.

In the paper the peculiar features of phasal behaviour of liquid and gaseous propane preconditioned by the effect of propane unwettability of the water film covering the hydrophilous sand reservoir are studied with the methods of precise adiabatic calorimetry. Thermodynamics and kinetics of hydrate formation and decomposition processes are studied. The phasal behaviour of hydrocarbons in the water-saturated reservoir is of specific interest due to the fact that producing stratal systems usually contain water in addition to hydrocarbon components. Therefore, phenomena associated both with capillary water condensation (water wets the hydrophilic surface of the skeleton) and capillary evaporation of hydrocarbons (hydrocarbons do not wet the lyophobic surface of water covering the hydrophilic skeleton) are simultaneously observed. Capillary effects caused by the phenomenon of propane unwettability of the water film exert

significant impact on the evolution of the pre-hydrate metastable condition of the «water – propane» system, leading to the gas hydrate overheating effect.

In addition to the studies of capillary phenomena in the water-saturated sand reservoir, the phenomena of capillary condensation and adsorption of propane in the waterless (dry) sand reservoir are studied for identification of the degree of water impact on the phasal behaviour of hydrocarbons in porous media, expressed in inversion of capillary condensation and capillary evaporation phenomena.

Keywords: ***adiabatic calorimetry, capillary condensation, unwettability, lyophobic behavior, lyophilic behavior, changes of states, hydrates.***

Nefedov P.A. Peculiar Features of Methane Hydrating Kinetics in Water Solutions of Electrolytes / P.A. Nefedov, A.A. Dzhedzherova, V.A. Istomin, S.I. Dolgaev, V.G. Kwon // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 83–89.

The methodology of kinetic experiments on hydrating in water solutions in the reactor with a mixer is described. The study of methane hydrating kinetics in distilled water and in sodium chloride solutions with varying concentrations (up to 150 g/l) was carried out. The hydrating mechanism and the kinetic model of the process were proposed on the basis of kinetic curves received. It is demonstrated that the rate of hydrating slows down in electrolyte solutions significantly at comparable moving force of the process. Calculation modeling of the hydrating dynamics in mineralized stratal waters was carried out (in relation to gas condensate fields of Eastern Siberia). The following conclusion was made: electrolyte solutions are kinematic hydrate inhibitors in addition to the impact on the hydrating thermodynamics.

Keywords:*gas hydrates, hydrate formation, formation kinetic, salt solution.*

Grigoriev B.A. Peculiar Features of the Filtration Flow through Nonstationary Dispersed Media Presented by Salinated Clastic Reservoir Rocks / B.A. Grigoriev, A.E. Ryzhov, D.M. Orlov, N.V. Savchenko, A.P. Fedoseev // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 90–97.

The peculiar features of the filtration flow through nonstationary dispersed media were studied by the example of water filtration through salinated reservoir rocks of clastic type. It was found out that washaway of salts from reservoir rocks by water improves their permeability and porosity. It is also demonstrated that in the process of water filtration, increase of filtration resistance and reduction of the effective permeability in terms of water occur due to colmatage – destruction of the system of main filtering channels by migrating solids formed as the result of salt washaway. It is recommended to take into account the detected effects in calculations of multi-phase filtration during prediction of oil deposit development parameters with the use of waterflood operations.

Keywords:*dispersed media, multi-phase filtration, nonstationarity, salinity.*

Troitskiy V.M. Justification of the Choice of Oil Displacement Agents for Development of Oil/Gas/Condensate Fields in Eastern Siberia on the Basis of Experimental Study Results / V.M. Troitskiy, S.G. Rassokhin, A.F. Sokolov, A.V. Mizin, V.P. Vankov // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 98–105.

Complex experimental studies on physical modeling of processes of oil recovery from oil margins with the use of various innovation technologies and displacement agents are required for efficient development of oil/gas/condensate fields.

This message describes the choice of the most optimal technology of oil recovery during development of the oil margin in the Botuobinsky horizon of the Chayandinskoye oil/gas/condensate field located in Eastern Siberia. A combination of laboratory experiments on oil displacement with various agents serves as the basis of the work. Nitrogen, carbon dioxide, separation gas, water and polyacrylamide solutions in water are proposed for comparison as such agents.

Anomalous thermobaric conditions of hydrocarbon deposits in the Chayandinskoye oil/gas/condensate field (stratal temperature 9–11 °C, stratal pressure – 13,2 MPa) did not allow to complete physical modeling of filtration and displacement processes in stratal conditions until now.

In this work experimental studies of filtration characteristics of reservoir core models were carried out with the use of modern precise equipment (double and three-phase filtration units of Temco and TerraTek production, computer tomograph Tomoscan 60/TX). They allow to propose a methodological approach to selection and sound use of displacement agents for improvement of the oil recovery factor for the Chayandinskoye oil/gas/condensate field.

Keywords: ***oil displacement coefficient, reservoir model, CO_2, nitrogen, water, separation gas, polymer solution.***

Kachalov V.V. Gas Condensate Deposit as an Oscillatory System / V.V. Kachalov, I.L. Maikov, D.A. Molchanov, V.M. Torchinskiy // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 106–112.

The gas-condensate mixture represents a complex mixture of methane and higher derivatives of the methane series with a high methane content. The phase diagram of the hydrocarbon mixture contains the so-called retrograde area, in which formation of a retrograde liquid is possible in the event of pressure reduction up to the maximum condensation pressure, evaporating with further pressure reduction. In addition to the nontypical phase diagram, additional features in the behaviour of effective permeability functions are typical for gas-condensate mixtures. They occur during filtration of the hydrocarbon mixture through the porous medium. Functions of relative effective permeability can have zero values both for the gaseous and the liquid phases.

The paper describes one-dimensional nonstationary filtration of a double-phase double-component hydrocarbon system in porous medium in isothermal conditions in the assumption of pressure equality in phases under the condition of phase equilibrium (typical times of phase transfers are significantly lower than that of hydrodynamic transfers). The mathematic model of the process, the algorithm of implementation of the numeric calculation method and the approximation analysis of the equation system received are given. Possible filtration modes (free discharge, oscillating conditions, damped vibrations) depending on pressure difference (reservoir energy backup), the type of effective permeability coefficients and on the position of initial pressure in the reservoir at the mixture phase diagram are given.

It is shown that oscillations are possible in such a system. A mechanism explaining occurrence of oscillations is proposed. It is proven that the position of the gas-condensate system in the retrograde area on the phase diagram is the required condition for occurrence of oscillations. The properties of the oscillation system are unambiguously defined by boundary conditions for pressure and the mole fraction of light hydrocarbon at the inlet.

Keywords*: mathematic modeling, gas condensate, changes of states, filtration in porous medium.*

Lapshin V.I. On the Problem of Classification of Stratal Fluids in Oil/Gas/Condensate Deposits / V.I. Lapshin, A.N. Volkov, A.N. Kulkov, A.A. Konstantinov // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 113–119.

Oil/gas/condensate deposits discovered recently are in reservoirs in a wide range of pressures and temperatures; they vary in the ratio and the composition of gas and liquid components of reservoir systems.

Phase conditions are an important parameter characterizing the conditions of hydrocarbon accumulations in subsurface. Genetic, migration and geological-tectonic factors are the main interrelated factors preconditioning formation of the phase composition. Native and foreign researchers give quite a wide classification of compositions of stratal gas/liquid systems (SGLS). The most significant factors defining phase conditions of deposits are the ratio of the volumes of gas and liquid components in SGLS, the component composition of gas and liquid phases, physical and chemical properties of phases and thermobaric conditions of fluid deposits.

The completed experimental and analytical studies allowed to propose an improved classification of stratal fluids and required types of studies for reception of gas-condensate and thermodynamic characteristics of stratal fluids.

Keywords: *gas, deposit, condensate, classification, field, stratal fluid.*

Lapshin V.I. Phase Transformations of Hydrocarbonate Oil/Gas/Condensate Systems / V.I. Lapshin, A.N. Volkov, A.A. Konstantinov // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 120–128.

During oil/gas/condensate field development the hydrocarbon oil/gas/condensate system can be in gaseous, liquid and gas-liquid phase conditions. The main studies of phase transformations of liquid hydrocarbon systems were conducted in 1960–1980 at low pressures and temperatures. The occurrence of phase equilibrium plants with wide capacities in terms of pressure and temperature allowed to significantly correct the ideas on phase transformations of hydrocarbon gas-liquid systems.

Experimental and analytical studies of various simulated and real systems and the analysis of types of phase diagrams were performed for identification of the type of ‘real’ phase diagrams with the help of which the description of phase transformations of natural gas/condensate mixtures, gas/condensate, oil/gas/condensate deposits of fields is possible.

It was found out experimentally and analytically for transient systems and light oils that the type of phase diagrams of real oil/gas/condensate mixtures in the real thermobaric range depends on the hydrocarbon C_{5+} content as compared to hypothetic mixtures.

Keywords: *condensation, stagnation point, gas/condensate system, phase diagram, experiment.*

Sklyarova Z.P. Main Tendencies in Subsurface Licensing in Russia for Hydrocarbon Resources in 2005–2013 / Z.P. Sklyarova, V.S. Tkach, F.S. Sokolov, T.T. Shmidt, A.A. Postnikov, S.N. Bedrak // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 129–134.

The paper describes the results of tenders and auctions held at the area of the Russian Federation in 2005–2013 for reception of a right to use sites containing hydrocarbon resources and reserves. The analysis of auction success – the ratio of the number of sites, hydrocarbon reserves and resources put up for auction and sold – was carried out. The dynamics of price increase in the course of auctions was described and changes in the cost of purchase of a title for the ton of reference fuel was analyzed. Cost parameters were brought to a single basis – 2013 prices with the use of the consumer price index as a parameter taking into account the maximum number of indicators, for correct comparison of the data of various years. Increase of the resource base due to purchases for major subsurface users and independent companies was analyzed. Conclusions were made on short-term prospects of the auction business in the Russian Federation.

Monitoring and analysis of tender and auction results assist in selection of the correct strategy by companies during preparation of licensing programs for various planning horizons with account of a competitive medium; they allow to predict the level of cost for purchasing the right to use subsurface in various regions more accurately.

Keywords: ***subsurface use, auctions, tenders, hydrocarbon resources, reserves, resources.***

Voronov V.P. Equilibrium Properties of Carbon Dioxide Hydrate in Porous Media / V.P. Voronov, E.E. Gorodetskiy, A.R. Muratov, V.E. Podnek, B.A. Grigoriev // Vesti gazovoy nauki: Actual Problems of Research of Stratal Hydrocarbon Systems. – Moscow: Gazprom VNIIGAZ, 2014. – № 2 (18). – P. 135–149.

Methods of adiabatic calorimetry were used for study of carbon dioxide hydrate equilibrium properties in the quartz powder with the grain size of 5–8 microns in the temperature range of 260–290 K and the pressure range of up to 5 MPa. Three-phase equilibrium curves «water – hydrate – gas», the hydrate number, the heat capacity of the hydrate and its dissociation heat at the specified line were measured.

Significant difference of the carbon dioxide hydrate from the methane hydrate was detected. The double-phase equilibrium line «methane hydrate – gas (methane)» coincides with high accuracy with a respective methane isochor. Meanwhile, the specified line in the carbon dioxide hydrate differs significantly from the carbon dioxide isochor. This means that with the system temperature change along the double-phase equilibrium line «gas – hydrate» active interphase CO_2 molecule exchange (or significant change of the hydrate number) occurs. In particular, the hydrate number varied from 6,2 to 7,1 in the pressure and temperature ranges studied in the work.

The latent heat of the phase transfer at the line «water – hydrate – gas», with no account of CO_2 solubility in water, turned to be equal to (321 ± 2) J/g. Meanwhile, the heat of dissociation equals to (345 ± 2) J/g, taking into account the solubility effect.

A typical shift of the three-phase equilibrium curve «water – hydrate – gas in porous medium» turned to be equal to 0,72 K. Taking into account the above-specified heat of dissociation of CO_2 hydrate, this means that interphase tension at the «CO_2 hydrate – water» border is approximately 2 times higher than for methane hydrate.

Keywords: ***adiabatic calorimetry, hydrate, carbon dioxide, porous medium.***