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GENERATING SYNTHETIC DENSITY CURVES FOR CONSTRUCTION OF GEOMECHANICAL MODELS

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Abstract. The paper considers available methods for density measurements of NaCl solutions with different salt concentrations for building geomechanical models. After digitizing specific resistivity vs. salt content cross-plots, analytical formulas have been derived.

Equation correlating the density of NaCl solutions with salt content have been obtained. Then convergence of density values from various formulas has been analyzed. Comparative analysis has also incorporated the equations derived by other authors.

Recommendations on the application of various formulas are presented. It has been shown that these are not applicable in case of abnormally high or low reservoir pressures.

Key words: *rock density, well logging, invaded zone, cross-plots, specific resistivity*

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PHYSICAL SIMULATION OF THE PROCESS OF SUPER-VISCOUS OIL DISPLACEMENT BY A SOLVENT ON THE MODEL OF AN OIL RESERVOIR

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Abstract. Physical simulation of the oil displacement of the super-viscous oil from the Ashalchinskoye field from a porous medium on an oil reservoir model was carried out. The features of asphaltene precipitation upon contact with a condensed alkane in the central and peripheral zones of the model were studied. The possibilities of using composite solvents on the example of n-hexane with the addition of asphaltene precipitation inhibitors for increasing the accumulated oil recovery were estimated.

Keywords: Ultra-viscous oil, hydrocarbon solvents, alkane, simulation, oil displacement.

УДК 665.61

FEATURES OF THE COMPOSITION OF ASPHALTENES AND RESINS OF HIGH-VISCOSITY OIL AND SUPER VISCOUS OIL FROM DEPOSITS OF TATARSTAN

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Annotation. A study was made of asphaltenes and resins of super-viscous oil from Ashalchinskoye field and high-viscosity oil from the Zyuzeevo deposit. Structural and group composition features and molecular characteristics of asphaltenes and resins were detected by using the methods of IR spectroscopy, thermal analysis, EPR and MALDI-TOF mass spectrometry. It has been established that asphaltenes and resins of super-viscous oil have higher values of spectral coefficients characterizing aromaticity and condensation. Asphaltenes of high-viscosity oil are characterized by less thermal stability. High-viscosity oil resins are characterized by higher number average molecular weight than super-viscous oil resins. Asphaltenes of super-viscous oil are characterized by higher content of free radicals and a less content of vanadyl complexes.

Key words: *heavy oil, asphaltenes, resins, vanadyl complexes, free radicals.*

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IMPROVING THE EFFICIENCY OF WATER SHUT-OFF TREATMENTS AT LATE STAGES OF OIL FIELDS DEVELOPMENT

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Abstract. The paper considers various approaches to improving the economics of water shut-off treatments conducted with the aim to combat the problem of channel flows behind the casing (cross-flows) both in production and injection wells. A case study of water shut-off jobs on the Vostochno-Leningradskaya area of the Romashkinskoye oil field helped classify the most common scenarios of annular seal failures and casing leaks. The study has demonstrated poor efficiency (low success rate) of currently available water shut-off technologies, particularly for remedy of behind-the-casing fluid migration problems outside the perforation interval. Selection of treatment targets is proposed based on maximum water use ratio, which does not exceed 0.7 as applied to geological and physical conditions encountered on the Vostochno-Leningradskaya area. This screening criterion is introduced due to its strong correlation with oil recovery factors intended for five blocks on this area.

Key words: *behind-the-casing flows, water shut-off treatment, cement failures, water use ratio, oil recovery.*

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COMPARATIVE ANALYSIS OF METHODS FOR DETERMINATION OF POROSITY AND PERMEABILITY CUT-OFF VALUES FROM CORE STUDIES

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Abstract. One of the issues of concern in reserves estimation is determination of cut-off values for porosity and permeability of rocks capable of trapping and yielding the petroleum. These values divide the rocks into reservoirs and non-reservoirs, and thereby can be used for validation of volumetric parameters by correlating core analysis and well logging.

The paper reviews three most commonly used methods for determination of cut-off values of porosity and permeability (based on laboratory core studies). These are the methods after G.G. Yatsenko and A.V.Ruchkin, V.I. Petersilie and A.V. Chernitsky et al.

Variety of approaches applied by the authors to determination of cut-off values for porosity and permeability and classifying the rocks as reservoirs proves that this issue has been and still is of particular and immediate interest to oil experts and researchers.

These methods have been used to determine cut-off porosity and permeability of the rocks on the Sirenevskoye field in the Republic of Tatarstan.

Key words: reserves estimation, core, cut-off values, confidence range, porosity, permeability, residual water saturation, reservoir.

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A MODERN APPROACH TO RESERVES ESTIMATION USING THREE—DIMENSIONAL GEOLOGICAL MODELS AS APPLIED TO MASSIVE OIL POOL

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Abstract. The paper highlights various approaches to geological modelling of different production zones within one oil field depending on the type of oil accumulation. The authors propose to generate three-dimensional geological models for massive type pools of the Bashkirian and Tournaisian stages while skipping the conventional two-dimensional modelling stage. Efficiency of reserves estimation using three-dimensional models in case of massive oil pools has been substantiated.

Key words: geological modelling, reserves estimation, massive deposits, Bashkirian stage, Tournaisian stage.

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ESTIMATION OF DEVELOPED OIL RESERVES BY MEANS OF PRODUCTION DECLINE ANALYSIS USING STATISTICAL METHODS

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Abstract. In this work, the authors demonstrate how to use a widely known empirical method of oil displacement characteristics for interval and probabilistic estimates of developed recoverable oil reserves. The purpose of the present research was to create a simple, easy-to-understand, reliable and computerizable tool to estimate developed recoverable oil reserves by wells, and to forecast oil production in mid- and long-term.

The authors suggest using a probabilistic method providing for an interval estimate of change of developed oil reserves, and for a statistic estimate of probable developed reserves (P90/P50/P10 estimates).

The authors offer three basic approaches to select probable displaced oil reserves to be used for further forecast of base oil production: to be limited to the most probable (P90), less probable (P50), or the least probable (P10) scenario; to be guided by the largest value of displaced oil reserves distribution density in the interval under consideration, and to combine both approaches.

Key words: *decline curve analysis, developed recoverable reserves, probable developed recoverable reserves, base oil production, forecasting well/reservoir performance.*

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OPTIMIZATION OF FIELD DEVELOPMENT STRATEGY CONSIDERING STRUCTURAL AND MECHANICAL PROPERTIES OF OIL – A CASE STUDY OF TAT-KANDYZSKOYE OIL FIELD

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Abstract: Structural and mechanical properties of oil result in the decrease of oil production rates and, hence, ultimate oil recovery, rapid increase of water cut and higher oil production costs. If structural oil properties are not taken into account, numerical simulation may yield overestimated production forecasts. Forecast production rates from Bobrikovian sediments of the Kandyzskoye oil field with various differential pressures have been estimated for two simulation cases: Newtonian and non-Newtonian flow behavior of oil. These models have also been used to simulate different infill drilling scenarios to investigate the effects of well spacing on production for each residual mobile oil distribution pattern.

Key words: *pressure gradient, structural and mechanical properties, Bobrikovian horizon, oil recovery factor.*

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DEVELOPMENT OF HIERARCHICAL MODELLING SOFTWARE FOR RESERVOIR SIMULATION, FIELD MANAGEMENT AND SELECTION OF APPROPRIATE WELL STIMULATION TECHNOLOGIES

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Abstract. The paper describes KIM EXPERT software package for geological modelling, process simulations and planning of well intervention and production stimulation operations at TATNEFT's production assets.

The work on the development of an integrated hierarchical modeling software package incorporating the best practices of oil field development has begun in TatNIPIneft Institute since the end of 2016.

Currently underway is test operation of the first version of the software, which provides the following capabilities:

an integrated database allowing for data processing and analysis;

hierarchical modelling module (1D, 2D, 3D);

reservoir simulator;

automated planning and optimization of field development strategy, estimation of reserves, selection of well intervention and production stimulation treatments;

cost-benefit and risk analysis;

mapping and well logging suite.

In 2017, KIM-EXPERT software has been extensively used in five projects implemented by TATNEFT. Results are encouraging. To date, the software has been installed in nine oil-and-gas production departments of the Company.

Key words: *oil field, modelling, geological model, reservoir simulation model, simulator, production stimulation*

DEVELOPMENT OF OIL TANK BOTTOMS TREATMENT METHODS

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Abstract. Laboratory experiments have been conducted to work out an optimum workflow for oil tank bottom sludge treatment. The study has been performed with samples of oil tank bottoms collected from various TATNEFT's storage facilities. The research efforts resulted in the development of a two-stage treatment process. The first stage involves thermal-chemical treatment of tank bottoms with solvent to maximize the recovery of hydrocarbon liquids. The second stage consists in thermal destruction of tank bottoms with the recovery of liquid hydrocarbon product and heavy solids. Implementation of this tank bottoms handling technique at TATNET's facilities will facilitate reduction of expenditures on sludge oil treatments performed by external service companies and will enable incremental oil recovery.

Key words: *tank bottoms, solvent, hydrocarbons, thermal cracking, viscosity.*