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ESTIMATION OF RESERVES AND RESOURCES USING MONTE-CARLO METHOD IN UNCERTAINTY MODULE OF ROXAR RMS SOFTWARE

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Abstract. Today, a large variety of petroleum reserves and resources classifications exist in the oil and gas industry, and each of them has its benefits and drawbacks. This paper presents analysis, comparison, and correlation of the results obtained from otherwise different methods of hydrocarbon reserves and resources estimation.

The objective of this paper is to discuss details of reserves estimation by different methods and examine the possibility and practicability of application of probabilistic approach to reserves estimate. Oil reserves have been estimated by volumetric method based on the geological model generated by IRAP RMS software. Variation of volumetric parameters was assigned in Uncertainty module, which makes it possible to build a geologic model with equally probable implementations with limited data on key reservoir characteristics.

In estimating the uncertainty, variations were assigned for the following parameters: oil-water level, correction factor, porosity and water saturation. After calculations and search of possible implementations, the software generated the result in three parameters: P10 (possible), P50 (probable), and P90 (proved). To compare the results of reserves estimation, generated net pay maps were used that allow analyzing distribution of in-situ reserves.

The research suggests that input variables and different methods of 3D geological modelling affect the results in distribution of reservoir properties and key parameters for volumetric estimation of reserves. Multi-variant distribution of volumetric parameters in the geological environment provides consistent estimates of reserves (resources).

Key words*: risk, probabilistic-statistical estimate, Monte Carlo method, Classification System for Oil and Combustible Gas Reserves and Resources (2013), Petroleum Resources Management System (SPE-PRMS), comparison of Russian and international reserves estimation methods*

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IMPROVED APPLICATION OF FLOW UNIT METHOD TO PREDICT RESERVOIR PROPERTIES IN UNCORED WELLS

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Abstract. This paper reviews improved procedure of flow unit method application offering higher accuracy of predictions compared to conventional approach. The paper explains why conventional application of flow unit method can give erroneous results. It has been proved that virtually any subset of porosities and permeabilities measured from cores for an individual field is non-representative. On the other hand, application of global degrees of quality minimizes error level in reservoir quality evaluation. The paper presents successful application of improved procedure in one of the West Siberian fields.

Key words: *HFU, FZI, reservoir quality, flow units*

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ESTIMATING GEOMECHANICAL PROPERTIES OF BAZHENOVSKIAN-ABALAKSKIAN ROCKS FOR PREDICTING FRACTURED ZONES

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Abstract. Special logging and laboratory-based core analysis data for the wells of Em-Egovskoye field were used to create a geomechanical model for the Bazhenovskian-Abalakskian productive play, to estimate the state of stress in the rocks mass, and determine rock brittleness index. A pseudo-3D model of brittleness index distribution within the Bazhenovskian-Abalakskian rocks of Em-Egovskoye field was constructed.

Key words: *geomechanical rock properties, brittleness index, fractured zones*

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CONSIDERING THE EFFECTS OF GEOLOGICAL FACTORS ON HYDRAULIC FRACTURING PERFORMANCE: A CASE STUDY OF NOVO-POKURSKOYE FIELD

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Abstract. The paper addresses improvements in the efficiency of hydraulic fracturing operations in Novo-Pokurskoye field. Geological factors that have substantial impact on the performance of hydraulic fracturing are discussed.

Key words: *hydraulic fracturing, incremental oil production, local structure, vertical heterogeneity*

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EVALUATION OF SAFE DRAWDOWN PRESSURE FOR PREVENTING SAND PRODUCTION FROM GAS-SATURATED CENOMANIAN STRATA

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Abstract. The paper present an approach to quantitative assessment of safe differential pressure drawdown to minimize adverse effects of sand production through the example of Cenomanian gas deposits.

Combined efforts of structural divisions of Tyumen Petroleum Research Center resulted in the development of testing procedure with thick-wall cylinders, interpretation and incorporation of laboratory test results into the process of geomechanical modeling.

Sensitivity of safe drawdown pressure to input parameters; particularly, sandstone grain size, rock strength and stresses, wellbore geometry and horizontal well sand screen mesh size, was analyzed.

Recommendations for optimal horizontal lengths, liner parameters, and downhole pressures are proposed to minimize the risks of complete wellbore collapse and production of solids.

Key words: *development of gas fields, geomechanical modelling, sand production, thick-wall cylinder, safe drawdown pressure.*

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ANALYSIS OF CRITERIA FOR ASSESSMENT OF PERFORMANCE OF FORMATION PRESSURE MAINTENANCE SYSTEM IN FIVE DEVELOPMENT BLOCKS OF LATE-STAGE ROMASHKINSKOYE FIELD EAST-LENINOGORSKAYA AREA

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Abstract. The paper presents a novel method to assess the performance of formation pressure maintenance system in five waterflooded blocks of East-Leninogorskaya area of the mature Romashkinskoye oil field operated by NGDU AZNAKAEVSKNEFT. To this end, the authors offer to apply the value of divergence between the project and the current recovery factors (RF) for each block for a certain production period as a criterion of effectiveness of the formation pressure maintenance system. They also introduce three more coefficients as key indicators of formation pressure maintenance system performance. These are: the injected water-produced oil ratio, the produced water-injected water ratio, and the injected water-ROIP reserves ratio. The maximum divergence between the RF values was noted in Blocks Nos. 3 and 5. The authors attempt to explain the observed phenomenon by peculiar behavior of correlation-statistical relationships between the injected water-produced oil ratio, the produced water-injected water ratio, and the reservoir properties of the development targets, on the one hand, and the voidage replacement ratio for all five blocks, on the other hand. The analysis of the above relationships showed that they can be used as diagnostic criteria of effectiveness of formation pressure maintenance system in each of the five blocks under consideration.

Key words: *formation pressure maintenance system, injection, oil recovery factor, the injected water-produced oil ratio, the produced water-injected water ratio, and the injected water-ROIP reserves ratio, voidage replacement ratio, induced hydrofrac.*

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METHOD OF INTENSIFYING PRODUCTION OF EXTRA-VISCOUS OIL. CYCLIC INJECTION OF COMPOSITION SOLVENTS FOR THE DEVELOPMENT OF THIN PRODUCTIVE DEPOSITS

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Abstract. In this paper, a physical simulation of the displacement of extra-viscous oil from a porous medium was carried out. The variant of cyclic injection of composite solvent was investigated. As a base solvent, a byproduct of a catalytic reforming process was used, the composition of which is represented mainly by light saturated hydrocarbons. An inhibitor of asphaltene precipitation and a minimum fraction in the composition of the displacing solvent was selected. The effect of oil saturation, water saturation, and solvent holding time in the reservoir model on the oil displacement rate and the final oil recovery value is estimated.

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

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IMPROVED QUALITY OF CEMENTING JOBS THROUGH REDUCED CONTRACTION OF CEMENT

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Abstract. High quality of cementing jobs is a challenging issue today. One of the reasons for poor cementing quality is cement contraction resulting in a number of adverse effects. These include influx of reservoir fluids from the surrounding rock due to de-aeration of pore system in set cement; dehydration of clay mud residues on impermeable rock and casing walls; setting of cement in tubing-casing annulus or against an impermeable rock can result in cement shrinkage, which in turn entails channeling across the set cement, and so on. Contraction is decrease of bulk volume of material in chemical or physical processes.

This paper analyses contraction and its types, studies contraction behavior, degree of contraction over time, discusses current contraction control methods and a new efficient method to eliminate or minimize contraction. The paper analyzes two types of contraction, molecular and physical. The proposed new method is based on volume filling with gas liberated during cement setting. A number of additives have been selected to control cement contraction, and the primary agent is a gas-yielding aluminum powder. Aluminum powder can uniformly propagate over the total volume and release oxygen in alkaline environment. Rate of oxygen release is much higher than rate of contraction. Moreover, oxygen evolution starts immediately, yet oxygen is required some time later to control contraction, when the process of cement slurry thickening starts in the annulus. Hence, some additives have been selected in theoretical and practical terms to retard oxygen release and to provide the required incubation interval for the aluminum powder. Synergetic effect obtained during additives selection and research tests delivered the desired results.

Key words: *contraction, negative contraction, adsorption, gas-yielding additive, cement slurry, hydration, cement*

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EXPANDABLE PROFILED CASING STRINGS CONTROL DRILLING AND PRODUCTION TROUBLES IN OIL AND GAS WELLS

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Abstract. The paper presents various expandable profiled casing strings applications to control drilling and production troubles. A number of assemblies of the expandable equipment for well casing in the process of drilling have been improved, which made it possible to save time. A new world record has been set – an expandable profile liner with a length of 70.6 m was set for 22 hours without the wellbore diameter loss and without cementing.

Key words: *expandable profile liner, mandrels, setting head, results of rig testing, threaded connections of expandable profiled pipes, threads and setting head expansion pressure.*

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ANALYTICAL STUDIES OF BHA ELEMENT OPERATION

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Abstract. Numerous research works and drilling experience reveal that drilling performance can be significantly improved by applying dynamic loads to a rock-cutting tool while maintaining its constant contact with the borehole bottom.

The authors have developed a dynamic bottom-hole assembly (BHA) configuration combining static bit load and dynamic impulse. An above-bit oscillator-turbulator is used as a dynamically active element of the BHA designed by Almetyevsk State Petroleum Institute.

This paper discusses the results of theoretical studies of the oscillator-turbulator using Mathcad software. Dynamic equation of an oscillator-turbulator valve has been obtained to evaluate the effect of density, viscosity, circulation rate, and valve inertial characteristics on vibration amplitude and frequency.

Key words: *dynamic BHA, oscillator-turbulator, theoretical studies, circulation rate, density, viscosity, frequency, amplitude*

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FIBER-REINFORCED LIGHTWEIGHT CEMENT

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Abstract. Despite the wide application in the well construction, lightweight materials cannot provide the required quality of the well cementing. It happens due to the fact that the most common method of obtaining lightweight cement is to increase the initial water content of solutions (water-cement ratio – W/C), leading to deterioration of the basic properties of the cement slurry and the resulting cement stone. The use of expanding cements containing additives, which are increased in volume when interacting with water, increases the adhesion of the cement stone to the confining surfaces, but in lightweight cement the efficiency of the expanding additive is significantly reduced. The addition of the reinforcing additives into a lightweight cement increases the effectiveness of expanding additives, improves the impact resistance of the resulting stone and improves the sealing of the annular space.

The research was carried out on modern instruments, according to the API standards (American Petroleum Institute), ISO 10426 and GOST 1581-96.

As lightweight additives were applied: glass microspheres - 30 μm in diameter, alumina-silicate hollow microspheres with a diameter of 50-300 μm, foam glass with a particle size of 200-500 μm. As an expanding additive - DR-50, based on oxide expansion.

Increasing the W/C always lowers the coefficient of linear expansion (LEC).

Fiber of any type has a reinforcing effect on the expansion of the cement stone, the best results were obtained with the addition of polypropylene fiber.

The use of foam glass showed the best values of LEC compared to other lightweight additives.

The best results in assessing impact resistance were obtained with the addition of basalt fiber.

The use of various reinforcing additives to a cement has an impact on the stability of the cement stone to dynamic loads. Moreover, the addition of any type of fiber in an amount of up to 0.5% does not adversely affect the mobility of cement slurries.

Key words: *cement slurry, fiber, basalt fiber, microsphere, expansion, linear expansion coefficient, well construction.*