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MATHEMATICAL MODEL OF SUBSTANTIATION OF THE GEOLOGICAL AND COMMERCIAL STRUCTURE FOR CONDUCTING TRIAL OPERATION AT THE "ZHANATALAP" PRODUCTION FIELD

Abstract. The relevance of the problem stated in the paper is conditioned by fact that in the last decade, scientific and technological progress in the sphere of petroleum field geology was closely related to the use of advanced science-intensive geoinformational technologies based on modern database management systems. In this regard, the paper considers the general principles of constructing systems for geological and commercial field analysis and oil fields development regulation. The main goal of trial operation is to obtain direct information about the production capabilities of project sites and their geological and geophysical characteristics, sufficient to justify the optimum quantity of recoverable oil reserves and ensure effective reservoir and production engineering, as well as substantiation of the reservoir regime, identification of production facilities and assessment of the prospects for the development of oil production at the field. The leading method of this issue is the substantiation of a geologic model, which allows us to consider this problem as a purposeful and organised modelling method to improve the conduct of trial operation in the Aptian and Middle Jurassic productive horizons. The results of pressure transient analysis were obtained. The terms of trial operation and the volumes of oil production, average daily withdrawals are substantiated, the issues of equipment and technology of oil production, drilling and well development are considered.

Key words: geological processes, complex structure, forecast of dynamics, development process, production wells.

Introduction. The variety of geological objects and methods of their study leads to the fact that the result of geological research is very heterogeneous in nature of information: verbal (descriptive), graphic (cartographic), digital. The inaccessibility of geological objects for direct observation is the reason that geology, as a theoretical discipline, developed in the conditions of an almost complete absence of experimental data and for many years was considered a purely descriptive science. Geological processes and formations have specific features that largely determine the methodology for their study [1-9]: geological processes represent a set of physical, chemical and biological natural phenomena, between which there are complex causal relationships, therefore, the properties of geological formations depend on many factors, are characterised by strong variability, and the objects themselves, as a rule, have a very complex structure; geological processes are long, and geological formations are of considerable size and hidden in the depths, which excludes the possibility of their complete and comprehensive study by direct observation.

The complexity and heterogeneity of the objects under study of the Earth sciences forces us to consider them as natural systems. Geological processes belong to the class of dynamical systems, i.e. systems that change their state in time, and geological formations, due to the slow course of geological processes, in most cases can be considered as static systems, the properties of which are constant in time [10,11]. The elements of dynamic geological systems are either individual factors (parameters) influencing the course of the geological process, or relatively simple natural phenomena (processes), which are considered as components of a more complex process [12-15].

The main goal of trial operation is to obtain direct information regarding the production capabilities of objects and their geological and geophysical characteristics, sufficient to justify the optimum value of recoverable oil reserves and ensure reliable design of field development, as well as justification of the reservoir regime, identification of production facilities and assessment of the prospects for the development of oil production at the field. The task of trial operation is to determine the limiting value of sustainable production rates during operation. First of all, indicator curves and pressure build-up are taken for new wells [16-18].

The optimum regime is considered to be the one that provides the highest cumulative oil production over an equal time interval without a clearly pronounced tendency to decrease in production rate. In general, to perform the tasks of trial operation, namely, for the full implementation of the research program in order to further study the geological and physical characteristics of the productive horizons and the production capabilities of wells (determination of reservoir pressures, recovery time, saturation pressure, optimal reservoir operation and assessment of elastic energy potential of reservoir system), the trial operation period is taken as 2 years [19].

Materials and methods. The significance and purpose of trial operation determines the acquisition of the necessary information about the production capabilities of facilities and their geological and geophysical characteristics, sufficient to justify the optimal value of recoverable oil reserves and ensure reliable design of field development, as well as justification of the reservoir regime, selection of production facilities and evaluation of the prospects for the development of oil production in field. The initial information for drawing up a model of trial operation of the “Zhanatalap” production field was the data of the field exploration obtained as a result of testing, dynamic well testing and well logging in individual wells [3,20,21].

The main task of the trial operation is to determine the limiting value of sustainable production rates during exploitation. First of all, indicator curves and pressure build-up are taken for new wells [4]. The optimal mode is considered to be the one that provides the highest cumulative oil production over an equal time interval without a clearly pronounced tendency to decrease in production rate. In general, to perform the tasks of trial operation, namely, for the full implementation of the research program in order to further study the geological and physical characteristics of the productive horizons and the production capabilities of wells (determination of reservoir pressures, recovery time, saturation pressure, optimal reservoir operation and assessment of elastic energy potential of reservoir system), the trial operation period is taken as 2 years [5].

All studies were carried out in wells with free-flow production method at various modes, with a change in chokes. Measurements of pressure changes were performed with devices PPH-161, PPS-25 and CAMT-02. The data processing of the nozzle studies was carried out using the specialised software product PanSystem. During the exploration period at the “Zhanatalap” field, all wells were tested by swabbing (changing water to oil) and by level tracking. The tests were carried out in 6 wells in 4 horizons, incl. Middle Jurassic horizons J2, J2-I, J2-II were tested in wells S-4PO, R-21PO, R-22PO, R-25PO and S-23PO. The Aptian horizon was tested in the S-4PO well. The opening of the productive horizons was carried out in a sealed well with hollow-carrier perforators – 89 mm. The density of the perforation ranges from 10 to 13 holes per 1 running metre. During testing, measurements of dynamic and static levels, oil and liquid flow rates were obtained.

Results and discussion. Based on the results of graphical-analytical curve-fitting, the following reservoir parameters were determined: flow model, permeability, skin factor, reservoir and bottomhole pressures, piezoconductivity and reservoir conductivity.

On the Aptian horizon (K1a), in the course of testing in well S-4PO, an interval of 550-557 m was investigated. During testing, 63.6 m^3 of pure oil was obtained. Further, hydrodynamic studies were carried out in the well with a method of steady-state filtration mode (IPR and PRC curves) on 23-26.12.2006. For the veracity of results of the work performed, a calculation was carried out using the method of indicator diagram construction. The bottomhole pressure – 4.97 MPa, the drawdown – 1.12 MPa. The interpolated reservoir pressure – 6.08 MPa. According to the research results, the calculated filtration properties of the formation had the following values: permeability k – 1.25 μm^2; piezoconductivity χ – 0.025 m^2/s; reservoir conductivity kh/μ – 0.55 μm^2*m/mPa*s; reservoir temperature T_{re} – 29.6 °C; the skin factor has a value of 10.3, which characterises the contaminated state of the bottomhole zone of the well. It is necessary to carry out geological and technical measures to clean up the bottomhole zone; estimated productivity index K_{pr} – 30.41 t/day*MPa.

The Middle Jurassic horizon (J2) was tested in the S-4PO well in the interval of 593-597 m and in the R-24PO well in the 613-617 m interval. In the S-4PO well, 50.0 m^3 of pure oil was recovered during testing. According to the results of the hydrodynamic studies carried out on November 14-16, 2006 by the method of steady-state filtration (EMI survey and PRC curve), interpolated reservoir pressure – 6.73 MPa, average bottomhole pressure – 6.36 MPa. Pressure measurements were carried out with a PPS-25 device. Reservoir temperature T_{re} – 31.3 °C; The filtration properties of the formation had the following values: permeability k – 2.07 μm^2; piezoconductivity χ – 0.031 m^2/s; reservoir conductivity kh/μ – 0.34 μm^2*m/mPa*s; the skin factor had a value of -2.82, which characterises the good condition of the bottomhole formation zone; estimated productivity index K_{pr} – 63.84 t/day*MPa.

The R-24PO well produced 46.8 m^3 of pure oil during testing. On 06-08.12.2006, hydrodynamic studies were carried out in the well using the method of steady-state filtration. Pressure measurements were carried out with a PPS-25 device. Based on the results of the studies, reservoir bottomhole pressures and filtration properties of the bottomhole formation zone were determined. Reservoir pressure – 7.02 MPa, bottomhole pressure – 6.6 MPa. Accordingly, the drawdown – 0.42 MPa. The filtration properties of the formation had the following values: permeability k – 0.63 μm^2; piezoconductivity χ – 0.021 m^2/s; reservoir conductivity kh/μ – 0.92 μm^2*m/mPa*s; the skin factor had a value of -2.66, which characterises the good condition of the bottomhole formation zone; estimated productivity index K_{pr} – 50.96 t/day*MPa.

I – Middle Jurassic horizon (J2-I) was tested in 4 wells. In the S-4PO well, sampling was carried out in the interval of 613.5-616.5 m using the swabbing method 57.0 m^3 of pure oil was recovered. According to the results of hydrodynamic studies carried out on July 11-14, 2006 by the method of steady-state filtration, the reservoir pressure – 7.03 MPa, bottomhole pressure – 6.32 MPa. Accordingly, the drawdown – 0.7 MPa. Filtration properties of the reservoir were equal to the following values: permeability k – 0.14 μm^2; piezoconductivity χ – 0.029 m^2/s; reservoir conductivity kh/μ – 0.7 μm^2*m/mPa*s; the skin factor had a value of -2.02, which characterises the good condition of the bottomhole formation zone; estimated productivity index K_{pr} – 38.62 t/day*MPa;

As of 01-02.10.2006, well S-4PO was tested in the interval of 606-608 m. 17.0 m^3 of pure oil was recovered. According to the results of testing and pressure build-up, interpolated reservoir pressure – 6.79 MPa, bottomhole pressure – 5.52 MPa. Drawdown – 1.27 MPa. Reservoir temperature T_{re} – 31.7 °C. The filtration properties of the formation had the following values: permeability k – 0.68 μm^2; piezoconductivity χ – 0.018 m^2/s; reservoir conductivity kh/μ – 0.39 μm^2*m/mPa*s; the skin factor had a value of -5.84, which characterises the good condition of the bottomhole formation zone; estimated productivity index K_{pr} – 21.4 t/day*MPa. Studies of I – Middle Jurassic horizon (J2-I) in the well R-21PO were carried out on 02-04.11.2006 in the intervals of 648-652, 655-658 m. During the sampling process, 40.7 m^3 of pure oil was recovered. Hydrodynamic studies were carried out by the method of steady-state filtration modes (EMI survey and PRC curve). According to the research results, the interpolated reservoir pressure – 7.53 MPa, the average bottomhole pressure – 7.09 MPa. Reservoir temperature T_{re} – 33.5 °C. Accordingly, the drawdown – 0.7 MPa. Filtration properties had the following values: permeability k – 0.09 μm^2; piezoconductivity χ – 0.009 m^2/s; reservoir conductivity kh/μ – 0.43 μm^2*m/mPa*s; the skin factor had a value of -3.98, which characterises the good condition of the bottomhole formation zone; estimated productivity index K_{pr} – 23.71 t/day*MPa. In the well R-22PO, testing was carried out on 05-08.11.2006 in the interval of 601-614 m. 78.0 m^3 of pure oil was produced. According to the results of hydrodynamic studies, interpolated reservoir pressure – 6.73 MPa, bottomhole pressure – 6.45 MPa. Drawdown – 0.68 MPa. Reservoir temperature T_{re} – 31.0 °C. Filtration properties had the following values: permeability k – 0.33 μm^2; piezoconductivity χ – 0.008 m^2/s; reservoir conductivity kh/μ – 0.65 μm^2*m/mPa*s; the positive value of the skin factor of 3.89 is due to the strong pollution of the bottomhole formation zone. It is necessary to carry out geological and technical measures to clean up the bottomhole zone; estimated productivity index K_{pr} – 37.56 t/day*MPa.

II – Middle Jurassic horizon (J_2-II) was tested in wells R-25PO and S-23PO. In the well R-25PO, studies were carried out on January 13-15, 2007 in the interval of 667-669 m. 41.7 m^3 of pure oil were recovered. According to the results of hydrodynamic studies, interpolated reservoir pressure – 7.02 MPa, average bottomhole pressure – 7.48 MPa. Correspondingly, the drawdown – 0.28 MPa. Reservoir temperature T_{re} – 33.5 °C. Filtration properties had the following values: permeability k – 0.24 μm^2; piezoconductivity χ – 0.05 m^2/s; reservoir conductivity kh/μ – 1.11 μm^2*m/mPa*s; the value of skin factor was -2.37, which characterises the good condition of the bottomhole formation zone; estimated productivity index K_{pr} – 37.56 t/day*MPa. Similar study was carried out in the S-23PO well. Testing was carried out on 31.01.-02.02.2007 in the interval of 692.5-695.5 m. During testing, 34.8 m^3 of pure oil was produced. According to the results of hydrodynamic studies, interpolated reservoir pressure – 7.02 MPa, average bottomhole pressure – 6.99 MPa. Accordingly, the drawdown – 0.5 MPa. Reservoir temperature T_{re} – 34.8 °C. Filtration properties had the following values: permeability k – 0.21 μm^2; piezoconductivity χ – 0.044 m^2/s; reservoir conductivity kh/μ – 0.96 μm^2*m/mPa*s; estimated productivity index K_{pr} – 52.9 t/day*MPa. At the Aptian horizon (K1a), reservoir pressure at the middle of the perforated interval – 6.08 MPa. Average productivity index – 30.41 t/day*MPa. The average permeability coefficient – 1.25 μm^2, the hydraulic conductivity coefficient – 0.55 μm^2*m/mPa*s, and piezoconductivity coefficient – 0.025 m^2/s.

In the Middle Jurassic horizon (J2), reservoir pressure at the middle of the perforated interval – 6.86 MPa. Productivity index – 58.12 t/day*MPa. The average value of permeability coefficient – 1.43 μm^2, coefficient of hydraulic conductivity – 0.6 μm^2*m/mPa*s, piezoconductivity coefficient – 0.027 m2/s. On the I-Middle Jurassic horizon (J2-I), reservoir pressure at the middle of the perforated interval – 7.1 MPa. Productivity index – 29.95 t/day*MPa. The average value of permeability coefficient – 0.29 μm^2, coefficient of hydraulic conductivity – 0.54 μm^2*m/mPa*s, and piezoconductivity coefficient – 0.017 m2/s. On II – Middle Jurassic horizon (J2-II), reservoir pressure at the middle of the perforation – 7.48 MPa. Productivity coefficient 57.84 t/day*MPa. Average permeability coefficient 0.23 μm^2, hydraulic conductivity coefficient – 1.05 μm^2*m/mPa*s, piezoconductivity coefficient – 0.048 m^2/s. In general, for the I- project site, the average reservoir pressure – 7.29 MPa, productivity index – 43.9 MPa. The filtration properties have the following meaning: the permeability – 0.26 μm^2, the coefficient of hydraulic conductivity is 0.8 μm^2*m/mPa*s, and piezoelectric conductivity coefficient is 0.032 m^2/s. Taking into account the occurrence, the number of deposits and productive strata, the physicochemical properties of oils and reservoir properties in the section of this field, 2 project sites of trial operation are identified: Project site I – Middle Jurassic horizons – J2-I + J2-II; Project site II – Aptian and Middle Jurassic horizons – K1a + J2. The main base is project site I, which contains 76.9% of reserves. The initial geological and physical characteristics of the production facilities are given in the table 1.

Table 1 – Initial geological and physical characteristics of productive objects

Parameters	Project site I	Project site II
Average depth, m	599-628.5	669-695.5
Water-oil contact, m	IX 617 m – X 648 m	IX 641 m – X 714 m
Accumulation type	fault block reservoir	fault block reservoir
Reservoir type	terrigenous	terrigenous
Oil and gas bearing area, ths. m^2	364	707
Mean gross thickness, m	20	36
Average oil-saturated thickness, m	9	20
Porosity, unit fraction	0.28	0.33
Average saturation with oil (gas), unit fraction	0.71	0.76
Permeability, μm^2	0.26	1.34
Net-to-gross ratio, unit fraction	0.35	0.45

Continuation of table 1		
Average number of permeable intervals, unit fraction	2	5
Reservoir temperature, °C	29.6	33.5
Reservoir pressure, MPa	5.95	7.45
Oil viscosity in reservoir conditions, mPa*s	23	16
Oil density in reservoir conditions, g/cm^3	0.857	0.8369
Density of degassed oil, g/cm^3	0.88	0.866
Formation volume factor, unit fraction	1.042	1.056
Content of sulphur, %	0.36-	0.61
Resins and asphaltenes, %	11.4	8.38
Paraffin, %	0.84	2.42
Bubble-point pressure, MPa	4.55	5.0
Gas/oil ratio, m^3/t	23.4	27.7
Water density in reservoir conditions, g/cm^3	1.18	1.12
Average productivity, m^3/(day*MPa)	43.9	44.26
Initial balance oil reserves, ths. tonnes (approved by GKZ RK), C1 + C2 including category C1 including category C2	 895 569 326	 2978 2256 722
Initial recoverable oil reserves, ths. tonnes (approved by GKZ RK), C1 + C2 including category C1 including category C2	 294.9 180 114.9	 1072.5 812.5 260
Oil recovery factor, unit fraction including category C1 and C2	 0.33	 0.36

The oil deposits in the reservoir are consolidated, tectonically-screened and closed on all sides. Taking into account the hydrogeological conditions of the region during the field development, the manifestation of an elastic-water-pressure regime should be expected. At the same time, it is likely that in the initial period of development, the activity of the formation zone will manifest itself after a certain decrease in formation pressure within the reservoir. One of the main tasks in drawing up a project for a trial operation of a field development is to assess the productivity of deposits under elastic-water-pressure conditions over a period necessary for a sufficiently complete study of a productive formation characteristics and assess the feasibility of creating a system for maintaining reservoir pressure. In this study, based on the results of the numerical solution of the differential equation of the elastic regime for a homogeneous reservoir, the dimensionless functions $p(p, \tau)$, $q(p, \tau)$ and $Q(p, \tau)$. The forecast of the dynamics of reservoir pressure on the boundaries of the reservoir is performed at a given constant fluid withdrawal. This basically corresponds to the conditions of mechanised well operation (Eq. 1):

$$P(t) = P_o - \frac{q \cdot \mu}{2\pi kh} \cdot \bar{P}(\tau)\,, \tag{1}$$

where: P_o – pressure on the external boundary (initial reservoir pressure); q – given fluid withdrawal; μ – viscosity of fluid (water) in reservoir conditions; k – reservoir permeability; h – formation thickness; $p(p, \tau)$ – dimensionless function tabulated for different values of p; $p = R_k/R_r$ – the ratio of the radius of the feed loop to the design gallery radius.

In calculations, the boundaries of the deposit are presented as a circular gallery (table 2).

Table 2 – Calculation of changes in the weighted average reservoir pressure in the reservoir during trial operation

Development years	On project site I				On project site II			
	τ	P(τ)	ΔP_{con}, MPa	$P_{re,}$ MPa	τ	P(τ)	ΔP_{con}, MPa	$P_{re,}$ MPa
2008	0.000144	0.000344	0.000159	7.286	0.001250	0.002983	0.000282	5.874
2009	0.000216	0.000516	0.000238	7.281	0.001876	0.004469	0.000238	5.866

However, due to the high viscosity of reservoir oil, with an increase in the stock of producing wells within the boundaries, the reservoir pressure will significantly decrease, which will lead to a decrease in well productivity. In this regard, it becomes necessary to predict changes in reservoir pressure within the deposit boundaries. To assess the decrease in the initial flow rates of wells during the development of deposits in the natural elastic drive, it is necessary to have a dependence of the formation pressure drop not only on the oil-bearing contour, but also in the recovery zone in the central part of the deposits. Reservoir pressure at any given point in the formation during development is determined by (Eq. 2)

$$P_t = P_0 - \sum_{i=1}^{n} P_i \qquad (2)$$

where: P_0 – initial reservoir pressure; P_i – decrease in reservoir pressure from the operation of one of the existing wells or increase in pressure from the operation of injection wells and the impact of the edge water zone (Eq. 3):

$$Pi = \frac{q_i \mu_{н}}{4\pi\kappa h}\left[Ei\left(-\frac{r_i^2}{4\aleph t} \right) \right] \qquad (3)$$

where: $Ei\left(-\frac{r_i^2}{4\aleph t}\right)$ – integral exponential function (tabulated), q_i – flow rate of well i; r_i – distance from the target point to the i well.

The rest of the formula is the same as in the (1). In technological calculations, one option is considered, where the initial flow rates are determined at the bottomhole pressure of 4.55 MPa, which corresponds to the bubble point pressure. Well production rate is calculated by the formula (Eq. 4):

$$Q = K_{pro} * h_t * \Delta P, \qquad (4)$$

where: K_{pro} – productivity per 1 meter of thickness; h_t – oil-saturated thickness; ΔP – drawdown.

For all project wells, design depths of up to 700 m have been established, which ensure the penetration of the J2-II horizon at full capacity with a sufficient drilling sump for equipping the bottom of the production string. Wells No. 101-111 are built in advance. They must perform the task of exploratory wells. Pressure, temperature and gas/oil ratio. First of all, indicator curves and pressure build-up curves are taken for new wells [3,4,8].

Conclusions. The calculation results reveal that with those relatively small fluid withdrawals from the deposits that can be achieved when new wells and previously drilled wells are put into operation, the pressure drop will be insignificant. Within the oil-bearing contours of the deposits, the mutual influence of wells and the change in reservoir pressure can be significant, since the viscosity of the reservoir oil is taken on average equal to 20 mPa*s. In connection with the above, it is necessary: upon completion of the drilling of the first wells, take and examine depth samples of oil in two wells No. 106, No. 105 on the VIII block; perform experimental water injection into one well, which must be selected from the producing during trial operation.

From the above calculation results it follows that the trial operation of the “Zhanatalap” field can be carried out in a natural elastic water drive without maintaining reservoir pressure. According to the objectives of the trial operation, it is necessary to provide for reliable control over the change in the technological parameters of the well operation, filtration and field characteristics of the reservoir system, to monitor the change in bottomhole pressure, formation pressure, temperature and gas factor. First of all, indicator curves and pressure build-up are measured for new wells.

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«ЖАҢА ТАЛАП» КЕН ОРНЫНЫҢ АПТ ЖӘНЕ ОРТА ЮРАЛЫҚ ӨНІМДІ ГОРИЗОНТТАРЫН СЫНАМАЛЫҚ ПАЙДАЛАНУ МАҚСАТЫНДА ГЕОЛОГИЯЛЫҚ-КӘСІПШІЛІК ҚҰРЫЛЫМЫН НЕГІЗДЕУДІҢ МАТЕМАТИКАЛЫҚ МОДЕЛІ

Аннотация. Геологиялық объектілер мен оларды зерттеу әдістерінің сан алуандығы сөздік, графикалық, сандық секілді ақпарат түрлеріне байланысты геологиялық зерттеу нәтижесінің түрлі болуына әкеледі. Тікелей бақылау жүргізуде геологиялық объектілердің жетімсіздігінің себебі – геологияның теориялық пән ретінде тәжірибе жүзінде эксперименттік деректер пайда болмаған уақытта дамуы мен ұзақ жылдар бойы сипаттамалы ғылым ретінде саналып келуі. Мақалада қарастырылатын мәселенің өзектілігі соңғы онжылдықта мұнай кен орны геология саласындағы ғылыми-техникалық прогрестің деректер базасын басқарудың заманауи жүйесіне негізделген алдыңғы қатарлы ғылымды қажетсінетін геоақпараттық технологиялармен тығыз байланысты болуында. Осыған орай, мақалада кен орындарын талдаудың геологиялық-өндірістік жүйе құрылымының жалпы қағидаттары мен мұнай кен орындарын әзірлеуді реттеу қарастырылған. Мәселен, қойнауқаттың есептік моделін негіздеу; мұнай кен орындары геологиясының негіздері; өнімді қойнауқаттардың коллекторлық сипаттамасын зерттеу саласындағы ғылыми-зерттеу мен жобалық жұмыс нәтижелері; геологиялық-техникалық шаралар тиімділігін талдау, көмірсутек қорларын өндіруді талдау; үзіліссіз геологиялық өндірістік процестерді пайдалану мен құру қолданылды.

Тәжірибелік пайдаланудың негізгі мақсаты – өндірілетін мұнай қорының оңтайлы көлемін негіздеу және өндіру, коллекторды тиімді жобалаумен қамтамасыз ету, сонымен қатар коллектор режимін негіздеуге, өндірістік объектілерді анықтау мен кен орнындағы мұнай өндіруді дамытудың болашағын бағалауға жеткілікті жобалық алаңдардың өндірістік мүмкіндіктері мен олардың геологиялық-геофизикалық сипаттамасы жөнінде тікелей деректер алу. Оңтайлы режим болып саналатыны – шығымның төмендеуіне қатысты нақты айқындалған үрдіссіз теңдей уақыт аралығында жиналған ең көп мұнай өндіруді қамтамасыз ететін режим. Жалпы тәжірибелік пайдалану міндеттерін орындау үшін, дәлірек айтатын болсақ, ұңғымалардың өндірістік мүмкіндіктері (қойнауқат қысымын, қалпына келу уақытын, қанығу қысымын, қойнауқатты оңтайлы пайдалануды анықтау мен қойнауқат жүйесінің серпімді энергиясының әлеуетін бағалау) мен өнімді горизонттың геофизикалық сипаттамасын алдағы уақытта зерттеу мақсатында зерттеу бағдарламасын толығымен жүзеге асыру үшін тәжірибелік-өндірістік пайдаланудың мерзімі 2 жыл болып қабылданған.

Берілген мәселені шешудің басты әдісі орта юра дәуірі кезеңінің өнімді горизонттарында тәжірибелік-өндірістік пайдалануды жетілдіру мақсатында аталмыш мәселеге мақсатты бағытталған және ұйымдастырылған модельдеу әдісі ретінде қарауға мүмкіндік беретін геологиялық үлгіні негіздеу болып саналады. Қойнауқат және беткі флюидтердің физико-химиялық қасиеттері мен мұнай қоры талданды. Зерттеулер сүзгілеудің орныққан режимінде жүргізіліп, қойнауқаттың негізгі сүзгілеу сипаттамасын, жүйенің энергетикалық күйі мен оның уақыт аралығындағы өзгерістер сипаттамасын алу мақсатында қысымды қалпына келтірудің қисығы түсірілді. Барлық зерттеулер түрлі режимде еркін ағымда, дроссельдері өзгертіліп тұрған күйінде жұмыс атқарған ұңғымаларда жүргізілді. Бүріккіштерді зерттеу деректерін өңдеу арнайы PanSystem бағдарламалық өнімін қолдану арқылы жүзеге асырылды.

Бейстационар қысымды талдау нәтижелері алынды. Тәжірибелік пайдаланудың мерзімі мен мұнай өндіру көлемі, орташа тәуліктік іріктеу негіздемесі берілді, жабдықтау және өндіру технологиясының, бұрғылау мен ұңғымаларды игеру мәселелері қарастырылды. Кен орнын әзірлеуді, ұңғымалар мен ұңғыма жабдықтарының пайдаланылуы және күйін бақылау бойынша шаралар ұйымдастыру ұсынылып жатыр.

Түйін сөздер: геологиялық процестер, күрделі құрылым, динамика болжамы, әзірлеу үрдісі, өндіруші ұңғымалар.

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МАТЕМАТИЧЕСКАЯ МОДЕЛЬ ОБОСНОВАНИЯ ГЕОЛОГО-ПРОМЫСЛОВОЙ СТРУКТУРЫ ДЛЯ ПРОВЕДЕНИЯ ПРОБНОЙ ЭКСПЛУАТАЦИИ ПО АПТСКОМУ И СРЕДНЕЮРСКИМ ПРОДУКТИВНЫМ ГОРИЗОНТАМ МЕСТОРОЖДЕНИЯ «ЖАНАТАЛАП»

Аннотация. Многообразие геологических объектов и методов их изучения приводит к тому, что результат геологических исследований очень разнороден по характеру информации: словесный, графический, цифровой. Недоступность геологических объектов для непосредственного наблюдения является причиной того, что геология как теоретическая дисциплина развивалась в условиях практически полного отсутствия экспериментальных данных и долгие годы считалась чисто описательной наукой. Актуальность поставленной в статье проблемы обусловлена тем, что в последнее десятилетие научно-технический прогресс в области геологии нефтяных месторождений был тесно связан с использованием передовых наукоемких геоинформационных технологий, основанных на современных системах управления базами данных. В связи с этим в статье рассмотрены общие принципы построения систем геолого-промышленного анализа месторождений и регулирования разработки нефтяных месторождений. В качестве примеров использовались: обоснование расчетных моделей пласта; основы геологии нефтяных месторождений; результаты научно-исследовательских и проектных работ в области изучения коллекторских характеристик продуктивных пластов; анализ эффективности геолого-технических мероприятий, анализ извлечения запасов углеводородов; создание и эксплуатация постоянно действующих геологических производственных процессов.

Основная цель опытной эксплуатации – получение прямой информации о производственных возможностях проектных площадок и их геолого-геофизических характеристик, достаточной для обоснования оптимального количества извлекаемых запасов нефти и обеспечения эффективного проектирования коллектора и добычи, а также обоснование коллектора режим, определение производственных объектов и оценка перспектив развития добычи нефти на месторождении. Оптимальным считается режим, обеспечивающий наибольшую накопленную добычу нефти за равный промежуток времени без четко выраженной тенденции к снижению дебита. В целом для выполнения задач опытной эксплуатации, а именно для полной реализации программы исследований с целью дальнейшего изучения геолого-физических характеристик продуктивных горизонтов и производственных возможностей скважин (определение пластовых давлений, времени восстановления, давление насыщения, оптимальная эксплуатация пласта и оценка потенциала упругой энергии пластовой системы) срок опытно-промышленной эксплуатации принят 2 года.

Ведущим методом решения данной проблемы является обоснование геологической модели, позволяющей рассматривать данную проблему как целенаправленный и организованный метод моделирования для совершенствования проведения опытно-промышленной эксплуатации в продуктивных горизонтах средней юры. Проанализированы физико-химические свойства пластовых и поверхностных флюидов, запасы нефти. Исследования проводились в установившемся режиме фильтрации – снятие кривой восстановления давления для получения основных фильтрационных характеристик пласта, энергетического состояния системы и его изменений во времени. Все исследования проводились в скважинах, работающих таким образом, свободный поток при различных режимах, с изменением дросселей. Обработка данных исследований форсунок проводилась с помощью специализированного программного продукта PanSystem.

Получены результаты анализа нестационарного давления. Обоснованы сроки опытной эксплуатации и объемы добычи нефти, среднесуточных отборов, рассмотрены вопросы оборудования и технологии добычи, бурения и освоения скважин. Рекомендуются мероприятия по мониторингу разработки месторождения, состояния и эксплуатации скважин и скважинного оборудования.

Ключевые слова: геологические процессы, сложное строение, прогноз динамики, процесс разработки, добывающие скважины.

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