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Annaguly Rejepovich Deryaev
Scientific Research Institute of Natural Gas of the State Concern „Turkmengas"
Candidate of Technical Sciences, Senior Researcher,
Ashgabat, Turkmenistan
annagulyderyayew@gmail.com

GEOLOGICAL, INDUSTRY AND TECHNOLOGICAL BASES FOR THE DESIGN OF THE DEVELOPMENT OF MULTI-LAYER FIELDS BY THE METHOD OF DUAL COMPLETION OPERATION OF WELLS

Abstract*: In the article, in order to successfully implement the method of dual completion operation (here in after referred to as DC) of gas reservoirs simultaneously in one and in the other second elevators of oil reservoirs of one well, comparative laboratory analyses and field studies on the properties and composition of oil, gas and condensate, which play an important role in the development of wells DC, were carried out.*

The results of complex field studies of gas wells and reservoirs were carried out in order to establish the gas-dynamic parameters of the reservoir and well and study their gas-condensate characteristics of the Altyguyi deposit. The main attention in the study of the well and the formation was paid to a more accurate determination of the values of the component composition of the formation gas required for the compilation of differential condensation isotherms determined by sampling raw condensate.

Key words*: flow rate, condensate, asphalt, sulfur, paraffin, barometric, pressure gauge, bottomhole zone, molecular weight, isotherms, reservoir gas, filtration mode, hydroconductivity, separator.*

Language*: English*

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Introduction

The determination of the initial indicators of wells and formations at the Altyguyi deposit was achieved using the method of steady-state sampling, which, even under steady-state filtration regimes in the bottom-hole zone of the formation, were carried out in order to establish the gas-dynamic parameters of the formation and wells, to study their gas-condensate characteristics.

The filtration regime was changed by selecting the diameter of the fitting at the wellhead.

The duration of operation in oil and gas wells for at least 24 hours and for gas condensate wells in each mode was from 5 to 24 hours. The measurement on each mode began after the full stabilization of the wellhead pressures of P_{buf} and $P_{annul.}$

The measurement of reservoir and bottom-hole pressures and the recording of the pressure recovery curve were carried out with deep pressure gauges of the MGN2-800kgs/cm^2 type and MSU-1-100-160 and in some places with electronic geophysical devices "Granite" and "Sakmar".

The necessary indicators for calculating the determination of the daily gas flow rate were carried out using a separator of the PBS-350/64 type with a measuring diaphragm with a diameter of 50 mm.

Measurements of the daily gas flow rate were carried out using a complex field installation equipped with a separator of the "Demag" type and flow meters of the DSP-0.063 and DPS-1.6 types.

The parameters for determining the gas flow rate were calculated using 4- or 2-inch diaphragm meters of critical gas flow [13].

Wellhead pressures (P_{buf} and P_{annul}) were recorded with model pressure gauges of the MO type at 250, 400 and 600 kgf/cm^2, accuracy class ± 1, ±

0.6% and ± 0.4%.

Bottom-hole and reservoir temperatures are determined by thermometers with mercury columns of the TP-7 type.

In some facilities, it was not possible to close the well to the reservoir pressure value due to technical reasons. In these circumstances, the reservoir pressure was determined by the experimental method [14].

Application of the method under steady-state filtration conditions of products in the bottom-hole zone of the formation for trial operation (with a change in mode), complex hydrodynamic studies were carried out in 17 objects, 16 wells, in an amount of 22 times. Only on 6 wells (№12, 19, 107, 108, 111 and 112), measurements of the daily flow rate were carried out, and in 4 wells (№№. 7, 21, 105 and 107), a one-time measurement of reservoir and bottom-hole pressure was carried out. At oil well sites № 2 and №. 7, the study was carried out by the method of normalizing the fluid flow – pressure recovery curve (PRC). As a result of processing the obtained materials, the coefficient of hydraulic conductivity and permeability of the formation was calculated by the Horner method. The obtained results of the development, measurements and their definition are given in the table 1. Graphs of the pressure recovery curve are shown in Figures 1 and 2.

Table 1. The results of hydrodynamic studies at the wells of the Altyguyi field

Well num-ber	Horizon	Perforation interval, (m)	Fitting diameter (m)	Coefficient			Note
				Capacity (kg/cm^2)	Hydraulic conductivity (sP)	Permea-bility (mD)	
Research in order							
1(I)	NK_9	3670-3680	5	-	-	-	
			6	-	-	-	
			8	-	-	-	
			-	0,1807	4,4	14,52	
			Repeated research				
			6	-	-	-	
			5	-	-	-	
			4,8	-	-	-	
			5,6	-	-	-	
			6,4	0,264	6,43	21,2	
2(I)	NK_9	3608-3618	4	-	-	-	
			5	-	-	-	
			6	0,9043	10.1 on PRC	34,34 on PRC	
3(I)	NK_9	3732-3738	4				
			5				
			6	0,171	4,2	23,1	
4	NK_9	3728-3740	4,8				
			5,6				
			6,4	1,1107	27,1	74,53	
7(II)	NK_9	3746-3750	4	-	-	-	
			4,8	-	-	-	
			3,1	0,8493	22,03 on PRC	93,4 on PRC	
10(I)	NK_9	3653-3662	6,3	-	-	-	
			8,0	-	-	-	
			4,8	0,4914	12,00	44,0	
106(I)	NK_9	3783-3792	4	-	-	-	
			5	-	-	-	
			6	1,3552	33,0	-	

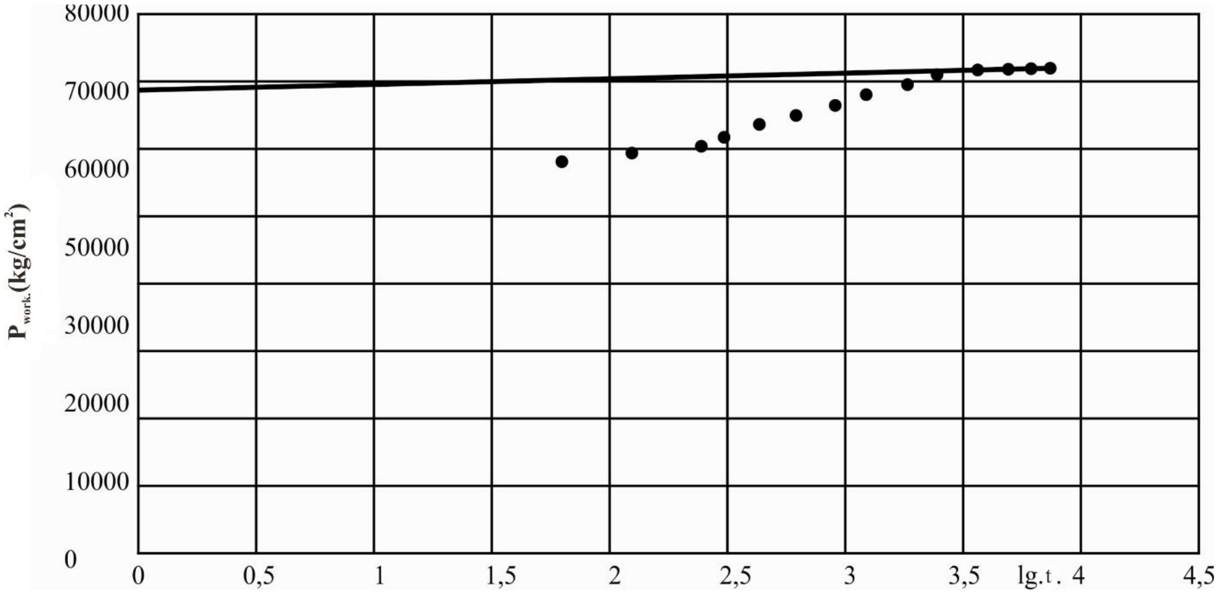

Figure 1. Graph of the curve of recovery of bottom-hole pressure to reservoir pressure, during the study of production well № 2 of the Altyguyi field

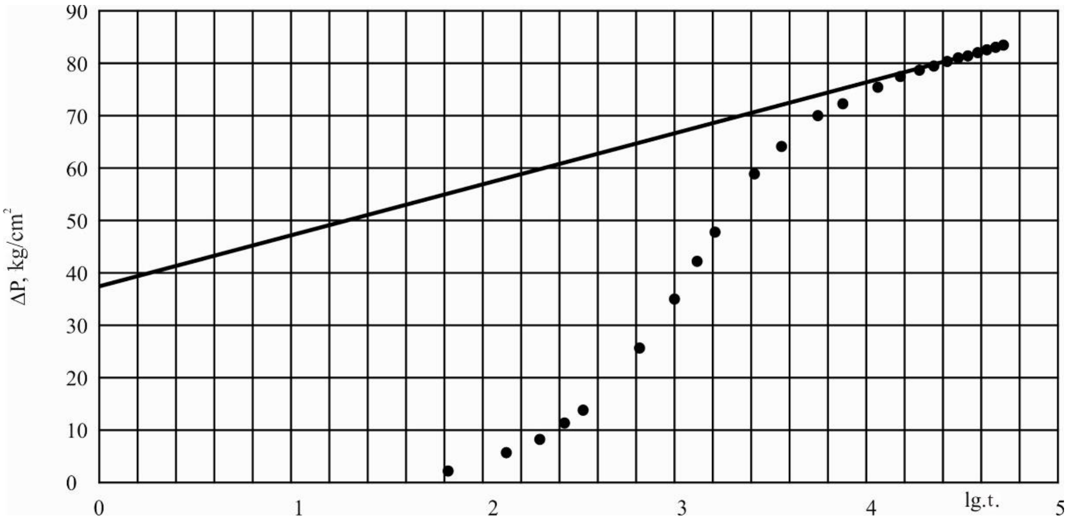

Figure 2. Graph of the curve of recovery of bottom-hole pressure to reservoir pressure, during the study of the II-th object of the exploration well № 7 of the Altyguyi field

The specific gravity of Altyguyi oil in comparison with the oil of other fields in the Southwestern part of Turkmenistan is very heavy (0.910 g/cm^3) and has a lot of paraffin in its composition. In the process of oil extraction, the paraffin contained in the product freezes due to a decrease in temperature at a depth of 800-1000 meters. In this regard, the freezing of paraffin leads to a decrease in the inner diameter of the tubing, an increase in downhole pressure and a decrease in daily oil production [15]. This phenomenon has the opposite effect on determining the productivity coefficient of the well and the exact calculation of some reservoir indicators.

Before conducting hydro and gas dynamic studies, it is recommended to clean the inner walls of the tubing from the layers of paraffin.

Taking into account the above, the proposed values of the initial reservoir pressure and temperature of the NK_9 oil horizon are assumed to be the values of the accurately performed measurements of the II-th object of well № 7 - 643 kgf/cm^3 and 87 ^{0}C.

To study the indicators of a gas condensate field and to determine the amount of condensate released from 1 m^3 of gas, as well as conducting gas-hydrodynamic studies in productive wells and formations, were performed by methods and instruments that were used in gas-hydrodynamic studies in oil horizons.

In some wells, for technical reasons, the reservoir and bottom - hole pressure was determined by the barometric formula on uncovered and not lowered depth gauges:

$$P_{b-h.} = P_{b(annul)} \cdot e^{s},$$

The separation of condensate and water from the products, as well as work on measuring the determination of the amount of separated condensate from 1 m3 of gas, was carried out at a complex field installation equipped with a mobile block separator of the PBS-350/64 type and a separator of the DEMAG type.

In general, during the period of exploratory drilling and testing of the productivity of drilled gas condensate wells, complex studies were carried out in 11 objects of 5 wells in the established modes of liquid or gas filtration (№ 2, 5, 102, 1, 20). In three wells (№1, 2 and 101), 4 comprehensive studies were carried out on unsteady filtration regimes (pressure recovery curve) [16].

The result of working off the PRC for production well № 101 is shown in Fig. 3.

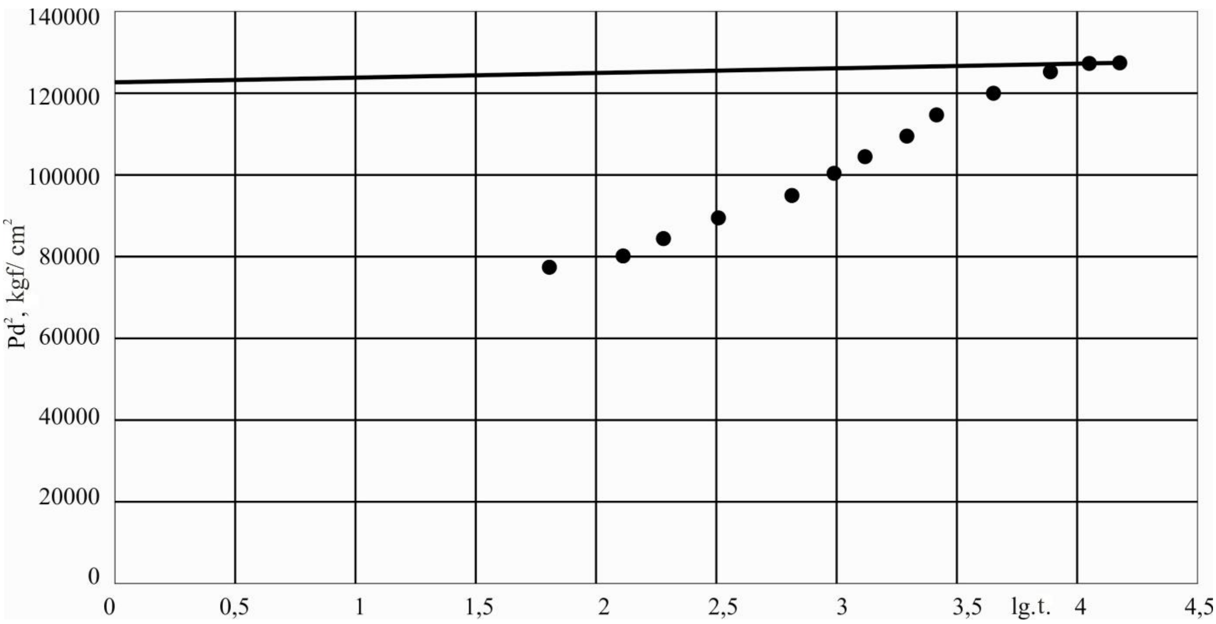

Figure 3. Graph of the curve of recovery of bottom-hole pressure to reservoir pressure for production well № 101 at the Altyguyi field

To determine the initial reservoir pressure and temperature of the NK_{7d} horizon, the average reservoir pressure values of 517 kgf/ cm^2 and 87 ºC are proposed, which were obtained during the study of the NK_{7d} horizon of the II object of well № 2 and the I object of well №.5.

Considering the close location of the NK_{7d} and NK_8 horizons (about 30 m.), the reservoir pressure and temperature were assumed to be P = 517 kgf/cm^2, T = 87 ºC.

Work on the determination of condensate indicators and the study of thermodynamic characteristics of wells and reservoirs for both horizons was carried out jointly.

Gas condensate wells and reservoirs were studied in three stationary filtration regimes [17].

The results of gas dynamic studies and determination of the amount of condensate released from 1 m^3 of reservoir gas (gas condensate factor - GCF) are shown in Table 2.

The results of hydro - gas dynamic studies of wells and formations of gas condensate deposits were processed using a two - term formula:

$$P^2_{res.} = P^2_{b\text{-}h} = aQ_2 + b \cdot Q^2_2,$$

where: $P_{res.}$ and $P_{b\text{-}h}$ - respectively, reservoir and bottom-hole pressure, kgf/cm^2;

Q_g is the flow rate of separation gas, thousand m^3/day;

a and b, respectively, are the coefficients of filtration resistance, depending on the parameters of the bottom-hole zone of the formation and the design of the well bottom.

Table 2. The results of field studies to study the gas condensate properties of wells and formations at the Altyguyi field

№ well	Horizon	Perforation interval, (m)	Fitting diameter (mm)	Operation in the regime (hour)	Condensate output (cm^3/m^3)		Molecular weight of condensate
1(II)	NK_8	3616-3625	12	24	241,9	181,4	-
			10	15	157,4	118,4	-
			-	-	-	-	151,5
			8	8	114,7	88,6	-
			9,5	24	11,7	9,6	-
			8	15	13,9	11,4	-
			6	15	15,5	12,7	-
1(I+II)	$NK_8 + NK_9$	3512-3522 3670-3680	-	-	-	-	150
			10	24	NKH productive		-
			8	18			-
			6	16			-
			-	-			-
			6	24	NKH productive		-
			8	22			-
			10	20			-
2(III)	NK_{7d}	3512-3522	8	24	64,6	56,2	-
			-	-	-	-	-
			12	24	-	60,5	159
			8	22	-	29,6	-
			10	18	-	46,3	-
2(III)	NK_{7d}	3512-3522	6,5	24	107,5	93,4	-
			8	18	97,2	81,6	-
			9	15	99,8	86,2	-
			-	-	-	-	159
			9,5	22	14,3	13,1	-
			8	17	12,9	12,0	-
			6	15	23,4	21,5	-
			-	-	-	-	-
5(I)	NK 7d	3618-3624	10	20	111,8	102,8	-
			8	21	118,6	104,4	-
			6	15	113,1	101,8	-
			-	-	-	-	144,5
			9,5	20	10,6	8,7	-
			8	21	12,8	10,5	-
			6	15	16,2	13,2	-
			-	-	-	-	153,5
			8	24	50,9	43,8	-
			-	-	-	-	149
			12	24	-	51,4	
			8	21	-	46,9	
			10	16	-	46,3	
101	NK 8	3564-3566	12	24	-	-	-
			10	24	-	-	-
			8	16	-	-	-
20 (III)	NK 8	3950-3958	-	-	-	-	-
			9,5	22	-	-	-
			8	17	-	-	-
			6	15	-	-	-
			-	-	-	-	-

The flow rate of the reservoir fluid $Q_{res.fl}$ is calculated using the following formula:

$$Q_{res.fl.} = Q_{s.g.} + \frac{Q_{c.}^{sat} + G_{eqv.}}{10^3},$$

$Q_{res.fl}$ - reservoir fluid, thousand m^3/day;

$Q_{s.g}$ -flow rate of separated gas, thousand m^3/day;

$Q_{c.}^{sat}$ -saturated condensate flow rate, m^3/day;

G_{eqv} is the calculated gas equivalent of the transfer of the liquid phase (condensate) to the gas phase.

The gas equivalent is determined by the formula

$$G_{eqv.} = 23342 \cdot \rho / M,$$

Here ρ and M are, respectively, the density and molecular weight of the C_{5+b} fraction.

The value of the molecular weight (μ) of the C_{5+b} fraction is calculated by the formula

$$M = \frac{44{,}29\left(\rho_{c.}^{st.} + 0{,}004\right)}{\left(1{,}034 - \rho_{c.}^{st.}\right)}.$$

where $Q_{c.}^{st.}$ is the density of stable condensate.

Tables 3, 4 and 5 show the values of reservoir and well parameters determined when processing the results of gas-dynamic studies and the output of stable condensate for the studied objects.

Table 3. The results of calculations of studies to study the gas condensate properties of wells and formations at the Altyguyi field

№ well	Horizon	Perforation interval, (m)	Type of research	Reservoir pressure (kgf/cm^2)	Reservoir temperature (^{0}C)	Stable condensate output (cm^3/m^3)
1(II)	NK_8	3616-3625	initial	496	84	119
			regular	452	89	11,4
1(I+II)	NK_8+NK_9	3512-3522	regular	452	91	-
		3670-3680	regular	308	88	-
2(III)	NK_{7d}	3512-3522	regular	510	81	86,2
			regular	490	87	12
			regular	471	82	56,2
			regular	270	81	60,5
5(I)	NK_{7d}	3618-3624	regular	524	84	103
			regular	487	90	8,7
			regular	426	82	43,8
			regular	274	84	51,4
20	NK_8	3950-3959	regular	400	96	4
			regular	336	87	96,1
101	NK_8	3564-3566	regular	358	78	85,6

Table 4. The results of calculations of studies to study the gas condensate properties of wells and formations at the Altyguyi field

№ well	Horizon	Perforation interval, (m)	Filtration resistance coefficient		Absolutely free gas flow rate (thousand m^3/day)	Coefficient of gas conductivity (m/sP)	Filtration coefficient (mD)
			a	b			
1(II)	NK_8	3616-3625	57,7	0,38	732,3	7,87	26,2
			137,6	0,243	677	3,4	11,2
1(I+II)	NK_8+ NK_9	3512-3522	86,1	0,411	713	5,37	8,1
		3670-3680	11,0	0,423	460,7	41,7	65,9
2(III)	NK_{7d}	3512-3522	92,5	0,1	1205,5	4,73	14,2
			37,9	0,112	1304,3	12,1	36,3
			-	-	-	-	-
			67,8	0,0123	921,2	6,6	20,0

5(I)	NK_{7d}	3618-3624	187,8	0,194	800,4	2,42	12,1
			80,5	0,111	1144,6	5,74	28,7
			-	-	-	-	-
			93,1	0,0144	725,1	4,9	24,4
20	NK_8	3950-3959	-	-	-	-	-
			134,4	0,784	303,2	3,4	12,8
101	NK_8	3564-3566	84,2	0,327	510,4	5,3	79,7

Table 5. The results of the study of the field determination of the properties of stable condensate

№ well	Horizon	Perforation interval, (m)	Fitting diameter (mm)	Condensate output from 1 m^3 of reservoir gas, (cm^3/m^3)		The rate of entry of the fluid into the barrel is tubing (m/sec)
				intense	stable	
1(II)	NK_8	3616-3625	10	157	118	4,95
			9,5	12	10	4,5
			10	A light hydrocarbon is oil. The specific gravity is 0.8455 g/cm^3. Due to the high gas factor, calculations were carried out on gas.		
			6			
2(III)	NK_{7d}	3512-3522	8	97	82	4,1
			8	13	12	4,3
			8	65	56	3,5
			10	-	60,5	4
5(I)	NK_{7d}	3618-3624	8	119	105	4,1
			8	13	11	4
			8	51	44	3,8
			10	-	46	4
20	NK_8	3950-3959	8	-	4	-
			12	-	55	4
101	NK_8	3564-3566	10	-	83	4

The proposed indicators of stable condensate yield are accepted along the horizon of NK_{7g} -95 cm^3/t^3; along the horizon of NK_8-118 cm^3/t^3.

According to the results of measurements, an accelerated drop in reservoir pressure was revealed at the beginning of the operation period [18].

Despite the short period of the start of operation of gas condensate reservoirs, the results of measurements revealed an accelerated drop in reservoir pressure.

For example, well №2 was put into operation in 2009 with an initial reservoir pressure of 510 kgf/cm^2. In 2010, the reservoir pressure was measured at 490 kgf/cm^2, and in 2014 it was 270 kgf/cm^2.

Well № 1 in the gas condensate facility of the NK_8 horizon was put into operation during development with an initial reservoir pressure of 496 kgf/cm^2 in 2009. In 2014, when measured, its readings amounted to a drop to 306 kgf/ cm^2.

We believe that the reason for the low values obtained during the study is not the creation of an appropriate regime for the separation of products.

References:

1. Pirson, S.D. (1961). *Uchenie o neftyanom plaste*. (p.570). Moscow: Gostoptekhizdat.
2. Ostrovskij, Ya.M., & Dzhaparov, A. (1980). *Izuchenie processov obvodneniya neftyanyh zalezhej s pomoshch'yu harakteristik vytesneniya, TurkmenNIINTI*. (p.44). Ashgabat.
3. (1971). *Spravochnoe rukovodstvo po proektirovaniyu razrabotki i ekspluatacii*

neftyanyh mestorozhdenij. pod red. Gimatudinova, (p.342). Moscow: Nedra.

4. (1974). *Spravochnaya kniga po dobyche nefti*/ pod.red. SH.K. Gimatudinova. (p.704). Moscow: Nedra.
5. Deryaev, A.R., & Esedulaev, R. (2017). *Osnovy tekhnologii bureniya pri osvoenii neftegazovyh plastov metodom ORE.* Nauchnaya monografiya. (pp.98-126). Ashgabat: Nauka.
6. Deryaev, A.R. (2014). Osobennosti tekhnologii bureniya dlya odnovremenno-razdel'noj ekspluatacii neskol'kih gorizontov na ispytannyh skvazhinah mestorozhdenij Severnyj Goturdepe. *sbornik statej instituta "Neft' i gaz"* vypusk 8 (2014), pp.238-248.
7. Deryaev, A.R. (2015). Tekhnologicheskie osobennosti vskrytiya mnogoplastovyh produktivnyh gorizontov i osvoenie ih dlya odnovremenno-razdel'noj ekspluatacii. *sbornik statej instituta "Neft' i gaz"* vypusk 11 (2015), pp.183-193, 11.
8. Deryaev, A. (2022). Justification of the potential condensate content in the formation gas, *The scientific heritage journal*, No 99 (99) (2022), Budapest, Hungary, pp.37-41.
9. Deryaev, A. (2022). Determination of the properties and composition of oil, gas and condensate for the development of wells by dual completion, *Znanstvena misel journal* №71 2022, Slovenia, pp.53-56.
10. Lavrushko, P.N., & Murav'ev, V.M. (1971). *Ekspluataciya neftyanyh i gazovyh skvazhin,* Moscow: Nedra.
11. (1990). *Neftepromyslovoe oborudovaniya*. Spravochnik/ pod.red. E.I. Buhalenko. Moscow: Nedra.
12. Ignatenko, Yu.K., & Akopyan, N.R. (1977). *Vremennaya instrukciya po udaleniyu zhidkosti iz gazovyh i gazokondensatnyh skvazhin s pomoshch'yu penoobrazuyushchih veshchestv*. (pp.12-15). Stavropol'.
13. Murav'ev, V.M. (1978). *Ekspluataciya neftyanyh i gazovyh skvazhin*, (p.495). Moscow: Nedra.
14. (1990). *Neftepromyslovoe oborudovanie.* Spravochnik. / pod redakciej E.I.Buhalenko - Moscow: Nedra.
15. Ignatenko, Yu.K., Akopyan, N.R., et al. (1977). *Vremennaya instrukciya po udaleniyu zhidkosti iz gazovyh i gazokondensatnyh skvazhin s pomoshch'yu penoobrazuyushchih veshchestv*. (pp.12-15). Stavropol'.
16. (1994). *Podschet zapasov nefti, gaza i kondensata mestorozhdeniya Korpedzhe po sostoyaniyu na 01.01.94g. Otchet po teme DSP (Institut nefti i gaza, nauchno-issledovatel'skij i proektnyj filial instituta nefti i gaza).* Rukovoditel' Kuz'min A.A., Nebitdag.
17. (1994). *Proekt opytno-promyshlennoj ekspluatacii gazokondensatnyh zalezhej mestorozhdeniya Korpedzhe.* Otchet 93, NIPFING, Nebit-Dag.
18. Zotov, G.A., & Aliev, E.S. (1980). *Instrukciyapo kompleksnomu issledovaniyu gazovyh i gazokondensatnyh plastov i skvazhin*. Moscow: «Nedra».