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Issue Article

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LABORATORY AND CALCULATION METHODS DETERMINATION OF PROPERTIES AND COMPOSITION OF OIL, GAS AND CONDENSATE FOR FIELD DEVELOPMENT BY DUAL COMPLETION OPERATION

Abstract*: the article is devoted to the complete study of the physical properties of oil and gas for the development of the Altyguyi field by dual completion (DC). This study is given for the DC of oil and gas with two elevators in one well.*

The article describes in detail the analyses carried out from the selected oil and gas samples to determine the temperature, gas factor, buffer pressure, water content, flow rate of productive formations with the creation of a recombined sample and field measurements.

The article also reflects the determination of the properties of reservoir fluids and gases, provides calculations for determining the dependence of the volume of dissolved gas in oil, the volume coefficient of dynamic viscosity and density to the saturation pressure, determining the compressibility coefficient and other necessary indicators for the development of the multi-layer Altyguyi deposit by DC operation.

Such work can be useful in the development of multi-layer deposits by the DC method, in order to determine the heterogeneity of oil and gas productive horizons.

Key words*: temperature, volume coefficient, gas factor, wellhead, gas-saturated oil, dynamic viscosity, reservoir oil.*

Language*: English*

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Introduction

To date, the properties of the reservoir oil of the NK_q horizon at the Altyguyi oil and gas field have been studied for six exploration wells (№№ 1, 2, 3, 4, 7 and 10).

Due to the absence of a deep sampler at 4 wells (№№. 2, 3, 4 and 7), studies were carried out with the creation of a recombined sample at the AK IPN-1 installation from the obtained oil and gas samples at the wellhead [1].

The perforated depth of the wells is in the intervals of 3608-3750 meters. Hydrodynamic studies were mainly carried out on 3.4 and 5 mm fittings. The reservoir temperature of the deposit in the range of 90 – 100 °C averages 93.3°C.

During the study of the 4th and 10th wells, the oil flow rate per day was 259,1 m^3/day and 166,6 m3/day at wells 1, 2, 3 and 7 was in the range of 33,1-66,7 m^3/day.

The field gas factor according to the measurements carried out is different, in the range of

92.0-275.6 m^3/m^3, on average equal to 163 m^3/m^3. The water content of productivity of 7-10 wells is 3-7.2%.

Tables 1 and 2 show the results of studies on wells of recombined oil samples from wells 1-10, the values of the main indicators of reservoir oil are determined by calculation.

Table 1. The results of the analysis of oil and gas samples obtained from the wellhead

Well number (object)	Perforation interval (m)	Fitting diameter (m)	Pressure kgf/cm^2			
			P_{buf}	P_{annul}	$P_{downh.}$	P_{res}
2(I)	3608-3618	4	139	180	395	652
3(I)	3732-3738	4	102	187	355	550
4(I)	3728-3740	5	218	281	482	710
7(II)	3746-3750	3	183	225	560	643
10(I)	3653-3662	8	100	129	305	662
1(I)	3670-3680	5	50	148	263	587

Table 2. The results of analysis of oil and gas samples obtained at the wellhead

Well number (object)	Perforation interval (m)	Fitting diameter (m)	Reservoir temperature °C	Flow rate m^3/day		% of water	Gas factor m^3/m^3
				Q_k	Q_w		
2(I)	3608-3618	4	89	45,8	-	170,3	-
3(I)	3732-3738	4	100	33,1	-	178,6	-
4(I)	3728-3740	5	98	259	-	275,6	-
7(II)	3746-3750	3	88	67,7	4,2	92,0	2,9
10(I)	3653-3662	8	95	166	4,1	129,8	7,2
1(I)	3670-3680	5	90	53,4	-	135,0	-

The study of the physical properties of recombined samples was carried out on standard and differential types of degassing.

The main thermodynamic parameters for each well are determined by a decrease in the pressure of 5-6 feet, therefore, more reliable information is obtained with the differential method [2, 3].

In order to substantiate the physical properties of reservoir oil, based on the results of processing the information obtained from the experiments, graphs of the dependence of the volumes of dissolved gas in oil, volume coefficient, dynamic viscosity and density on the saturation pressure are constructed. (Figure 1-4)

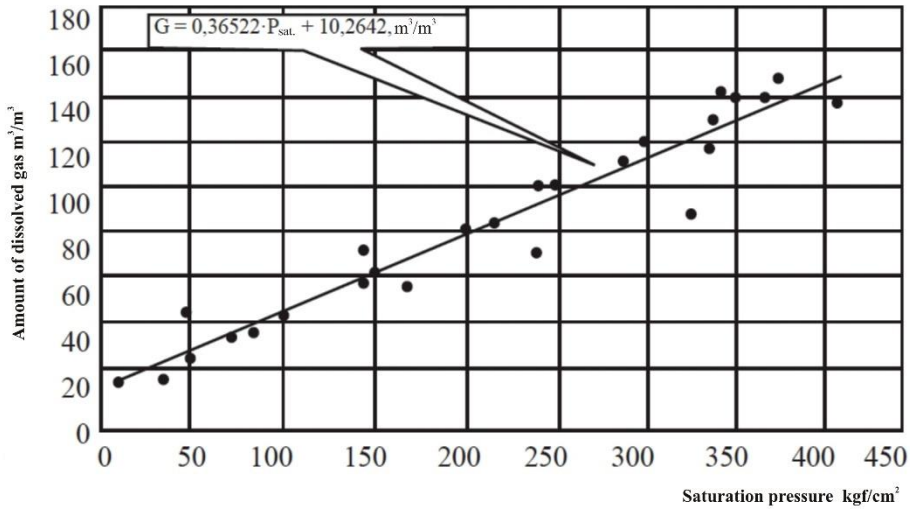

Figure 1 - Dependence of the amount of dissolved gas in reservoir oil on saturation pressures.

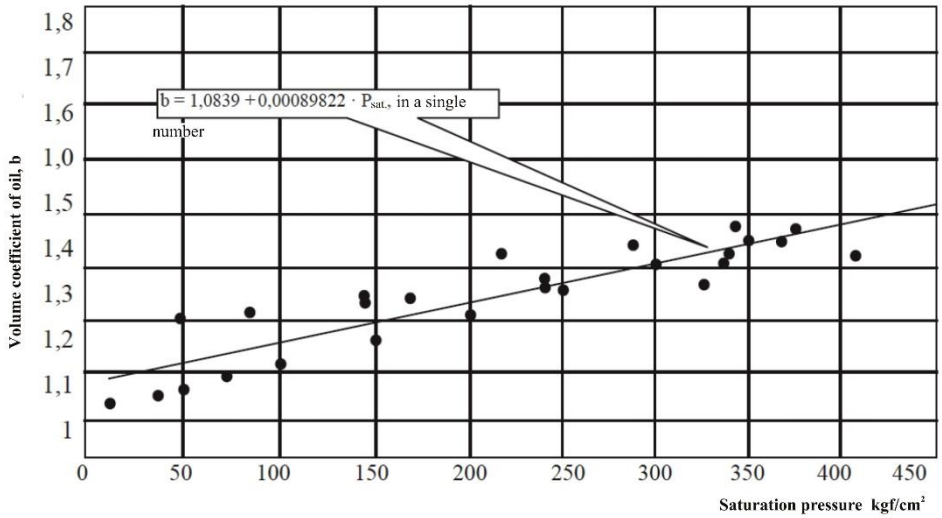

Figure 2 - The dependence of the volume coefficient of oil on the saturation pressure.

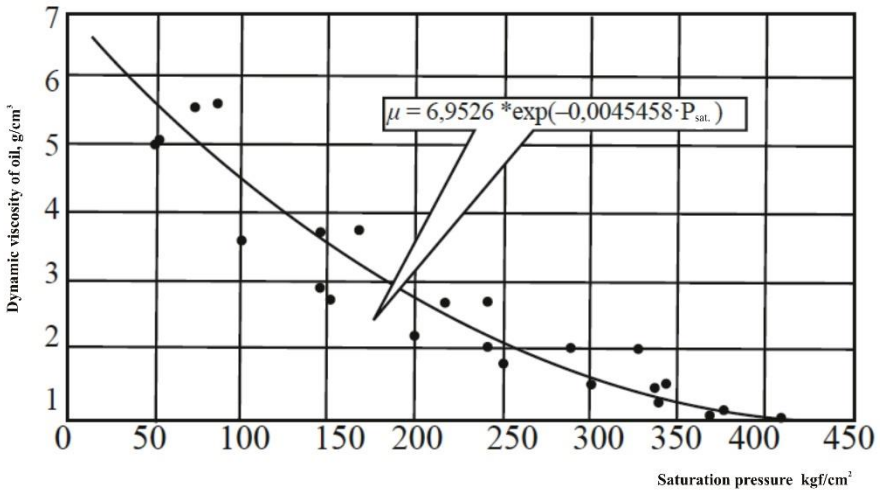

Figure 3 - Dependence of the dynamic viscosity of oil on reservoir pressure.

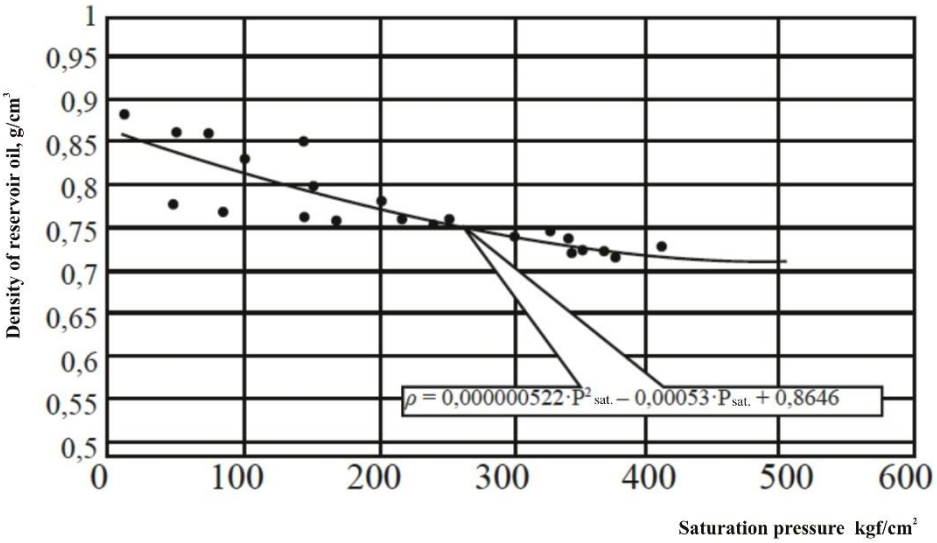

Figure 4 - Dependence of oil density on saturation pressure in reservoir conditions.

The analytical dependence of the volume of dissolved gas in oil, the volume coefficient of dynamic viscosity and density on the saturation pressure is given in the following form [4, 5]:

$$G = 0{,}3652 \times P_{sat.} + 10{,}265$$

$$b = 1{,}0839 + 0{,}0008982 \cdot P_{sat.};$$

$$\mu = 6{,}92526 \cdot \exp^{-0{,}0045489 \cdot P_{sat}};$$

$$\rho = 0{,}00000052 \cdot P_{sat}^2 - 0{,}00053 \cdot P_{sat} + 0{,}8645;$$

here :

$P_{sat.}$ -saturation pressure, kgf/cm^2;

G is the volume of dissolved gas m^3/m^3;

b is the volume coefficient of oil;

μ is the dynamic viscosity, sp;

ρ is the density of reservoir oil, g/cm^2.

To determine the value of the initial volume coefficient at the initial reservoir pressure, the following dependence is used [6]:

$$b_{init.} = b \cdot \left[1 - \beta \cdot \left(P_{res.pres.} - P_{sat}\right)\right];$$

here:

b- at saturation pressure;

$P_{sat.}$ - volume coefficient of gas-saturated oil;

β is the compressibility coefficient of reservoir oil.

To determine the compressibility coefficient given in this work using a graph of the relationship between saturation pressure and the density of reservoir oil, polynomial interpolations are constructed [7, 8].

$$\beta = \left(8{,}16562 \cdot \rho^2 - 20{,}35479 \cdot \rho + 12{,}12085\right) \cdot 10^{-4};$$

here:

ρ-density of reservoir oil, g/cm^2

The dynamic viscosity at reservoir pressure of carbonated oil is determined by the formula obtained from the dependence of the Bill graph [9]:

$$\mu_{res} = \mu_{res.sat.} + \sigma \cdot \left(P_{res} - P_{sat}\right);$$

here:

μ_{res} - viscosity of oil with dissolved gas at reservoir pressure and reservoir temperature, sP;

$\mu_{res.sat}$– viscosity of gas-saturated oil at reservoir pressure and reservoir temperature, sP;

P_{res}–P_{sat} – reservoir pressure and saturation pressure, kg/cm^2

σ– the coefficient of approximation of the dependence of the equation of the Beale graph.

The initial values of the reservoir oil of the wells of the NK_9 horizon of the Altyguyi field are given in Tables 3 and 4.

Table 3. The result of the analysis of recombined (artificial) oil samples

Well number	Degree of degassing	Saturation pressure (kgf/cm^2)	Volume of dissolved gas in reservoir oil (m^3/m^3)	Volume coefficient of oil (b)
2	P_{res}	480	-	-
	P_{sat}	374,5	157,8	1,433

	I	350	148	1,406
	II	300	127,4	1,351
	III	250	107	1,296
	IV	200	86,5	1,241
	V	150	66,1	1,186
	VI	100	45,6	1,130
		50	25,2	1,075
3	P_{res}	408	-	1,418
	P_{sat}	342	150,7	1,435
	I	288	118,8	1,387
	II	216	89,4	1,360
	III	144	60,8	1,256
	IV	72	35	1,100
		360	15,5	1,060
4	P_{res}	504	-	1,367
	P_{sat}	408	148,0	1,384
	I	336	125,5	1,360
	II	240	107,0	1,312
	III	144	75,3	1,269
	IV	48	45,3	1,210
		12,0	13,9	1,040
7	P_{res}	408	-	1,260
	P_{sat}	326,4	96,5	1,320
	I	240,0	77,3	1,300
	II	168,0	60,0	1,270
	III	84,0	37,1	1,230
10	P_{res}	338,4	137,7	1,380
1	P_{sat}	367,0	149,0	1,406

Table 4. The result of the analysis of recombined (artificial) oil samples

Well number	Dynamic viscosity of oil, sP	Oil density g/cm^3		Gas density g/l
		in formation conditions	in atmospheric conditions	
2	-	-	-	-
	1,261	0,729	0,9024	0,730
	1,357	0,737		
	1,600	0,753		
	1,879	0,771		
	2,245	0,790		
	2,773	0,811		
	3,622	0,835		
	5,028	0,861		
3	1,745	-	-	-
	1,623	0,734	0,9100	0,565
	2,107	-	-	-
	2,737	0,768	-	-
	3,760	0,856		
	5,550	0,862		
	8,200	-		
4	1,290	-	-	-
	1,163	0,745	0,9035	0,569
	1,590	0,746		
	2,096	0,762		

	2,975	0,767		
	4,999	0,780		
	6,900	0,881		
7	2,240	-	-	-
	2,126	0,760	0,916	-
	2,763	-		
	3,798	0,764		
	5,612	0,772		
10	1,356	0,749	0,8982	-
1	1,176	0,737	0,9121	-

The initial value of the main physical indicators of the oil horizon NK_9 Altyguyi field [10]:

- Initial volume of dissolved gas in reservoir oil -148.6 m^3/m^3;
- The initial volume coefficient of gas-saturated oil is 1.408;
- The initial coefficient of dynamic viscosity of gas-saturated oil is 1.316 sp.

The composition and properties of hydrocarbon fluids are given in Tables 5, 6 and 7.

Table 5. Initial values of reservoir oil indicators of the NK_9 horizon

Well number	Initial saturation pressures kg/cm^2	Initial volume of dissolved gas in reservoir oil m^3/m^3	Initial volume coefficient of gas-saturated oil	Initial coefficient of dynamic viscosity of gas-saturated oil, sP
1	367	149	1,406	1,176
2	374,5	157,8	1,433	1,261
3	342	150,7	1,435	1,623
4	408	148	1,384	1,163
7	326,4	96,5	1,320	2,126
10	338,4	137,7	1,380	1,356

Table 6. Properties and composition of oil and condensate (horizontal average)

Horizon	Perforation interval (m)	D^{20}_4	T_{sol} C^0	Viscosity, sPz	
				20 C^0	50 C^0
oil					
NK-9	3670-3680	0,9103	+36	non - fluid	63,8
condensate					
NK -7d	3512-3624	0,7943	-3	1,9	-
NK -8	3616-3625	0,7903	+3	1,8	-

Table 7. Properties and composition of oil and condensate (horizontal average)

Horizon	Perforation interval (m)	End of boiling %, up to temperature C^0					
		100	150	200	250	300	exit
oil							
NK -9	3670-3680	-	4	7	10	16	-
condensate							
NK -7d	3512-3624	12	29	42	56	74	90
NK -8	3616-3625	9	27	42	57	76	93

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