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Issue Article

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

TECHNOLOGICAL MODE OF OPERATION OF WELLS AND FEATURES OF IMPROVING THE SYSTEM OF COLLECTION, PREPARATION AND TRANSPORT OF NATURAL AND ASSOCIATED GAS AT GAS CONDENSATE FIELDS

Abstract*: Mandatory research and measurement complexes for monitoring development should cover evenly the entire area of the development object, the entire fund of observation wells. They should contain measurements of reservoir pressure for control and piezometric wells, measurements of reservoir and bottom-hole pressures, well flow rates for liquid, gas factors and water content of products for producing wells, measurements of wellhead injection pressures and injection volumes for injection wells, hydrodynamic studies of producing and injection wells in stationary and non-stationary modes, studies on the control of the oil and water contact, gas and oil contact, oil and gas saturation, technical condition of the wellbore by field-geophysical methods, selection and research of deep oil samples, surface rock products of wells (oil, gas, water).*

The article is devoted to a detailed consideration of proposals to improve the system of collection, preparation and transport of natural, associated gas and condensate on the example of the Altyguyi gas condensate field. The topic of operation of gas wells, the state and proposals for improving the system of collecting and preparing gas and condensate are touched upon. The resources of high-pressure gas that ensures its preparation to the required conditions at the integrated gas treatment plant, corresponding to the calculated values of the inlet pressure.

Key words*: condensate degassing, aggregate, group measuring unit, separation, measuring gauge, booster pumping unit, associated gas, bottom hole, gas factor, perforation interval, gas lift, gas separation.*

Language*: English*

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Introduction

The operational and technical characteristics of productive oil wells of the Altyguyi field are given in Tables 1 and 2.

The flow rate of 24 fountain wells is 82-6 t/day, the water content is 1-30%, only the water content of 3 wells (№ 7, 16, 18) is 73; 71; 77%. The gas factor is 205-1129 m^3/t and the oil solidification temperature is 36-37 ºC.

In 2011, 2 wells (№. 3 and 51) were transferred to gas lift operation. In 2014, due to the transition of these two wells to a semi-spontaneous mode of operation, the supply of a working agent was stopped [1]. And now these wells are working in a fountain way. During the operation of wells by the gas lift method, over time, there was a decrease in annular pressure, oil degassing and an increase in dissolved gas in the composition of the extracted products. As a result, this condition led to the transition of wells from the gas lift to the fountain method of operation.

Subsequently, with the time of reduction of reservoir pressure on productive formations, it will be necessary to restore the gas supply and switch to the gas lift method of operation.

Table 1. Operational and technical characteristics of productive oil wells of the Altyguyi field

№ wells	Method of operation	Horizon	Down-hole (m)	Interval Perforations (m)	Output (t/day)		Water cut, %	Gas factor m^3/t
					Q_{fluid}	Q_{oil}		
1	2	3	4	5	6	7	8	9
21	fountain	NK-8	4007	4001-4004 3993-3998 3994-4000	17	16	6	401
3	fountain/ gas lift	NK -9	3757	3732-3778	19	17	13	309
4	fountain	NK -9	3770	3728-3740	40	39	3	289
7	fountain	NK -9	3758	3746-3750	26	7	73	461
10	fountain	NK -9	3674	3653-3662	24	22	8	513
11	fountain	NK -9	3868	3833-3839	53	37	30	349
12	fountain	NK -9	3740	3720-3726	60	58	3	501
16	fountain/ gas lift	NK -9	3875	3850-3857 3800-3806 3769-3775	7	2	71	1129
1	2	3	4	5	6	7	8	9
17	fountain	NK -9	3860	3842-3848	79	78	1	331
18	fountain	NK -9	3905	3890-3896	35	8	77	403
19	fountain	NK -9	3910	3891-3897	84	82	2	401
24	fountain	NK -9	3751	3691-2302	56	52	7	205
51	fountain/ gas lift	NK -9	3685	3652-3662	13	12	8	403
52	gas lift	NK -9	3685	3672-3679	16	15	6	290
102	fountain	NK -9	3727	3695-3704	37	36	3	332
104	fountain	NK -9	3760	3714-3723	17	16	4	612
105	fountain	NK -9	3860	3838-3844	56	55	2	250
106	fountain	NK -9	3810	3783-3792	43	33	23	283
107	fountain	NK -9	3885	3864-3869	40	39	3	318
108	fountain	NK -9	3829	3790-3796	35	33	6	303
110	fountain	NK -9	3820	3789-3791	12	11	8	513
111	fountain	NK -9	3880	3834-3842	71	70	1	283
112	fountain	NK -9	3771	3763-3769	55	53	4	374
113	fountain	NK -9	3705	3686-3695	7	6	8	726
114	fountain	NK -9	3700	3682-3691	44	36	18	403

Table 2. Operational and technical characteristics of productive oil wells of the Altyguyi field

№ wells	Method of operation	Horizon	Downhole (m)	Interval Perforations (m)	$P_b/P_{ann.}$	Fitting diameter (mm)	Gas inlet depth (m)	Note
21	fountain	NK -8	4007	4001-4004 3993-3998 3994-4000	34/118	5	2200	
3	fountain/ gas lift	NK -9	3757	3732-3778	60/105	4		
4	fountain	NK -9	3770	3728-3740	44/106	8		
7	fountain	NK -9	3758	3746-3750	24/153	5		
10	fountain	NK -9	3674	3653-3662	76/154	6		
11	fountain	NK -9	3868	3833-3839	27/136	6		
12	fountain	NK -9	3740	3720-3726	153/248	8		

16	fountain/ gas lift	NK -9	3875	3850-3857 3800-3806 3769-3775	152/155	5		Puncher 2000 m
17	fountain	NK -9	3860	3842-3848	57/143	8		
18	fountain	NK -9	3905	3890-3896	15/116	4		
19	fountain	NK -9	3910	3891-3897	114/122	8		
24	fountain	NK -9	3751	3691-2302	118/144	8		
51	fountain/ gas lift	NK -9	3685	3652-3662	31/94	5		Puncher 2000 m
52	gas lift	NK -9	3685	3672-3679	46/76	6	2200	Puncher 2000 m
102	fountain	NK -9	3727	3695-3704	100/114	6		
104	fountain	NK -9	3760	3714-3723	63/154	4		
105	fountain	NK -9	3860	3838-3844	81/152	8		
106	fountain	NK -9	3810	3783-3792	122/136	5		
107	fountain	NK -9	3885	3864-3869	78/110	5		
108	fountain	NK -9	3829	3790-3796	63/115	6		
110	fountain	NK -9	3820	3789-3791	52/137	4		
111	fountain	NK -9	3880	3834-3842	57/148	8		
112	fountain	NK -9	3771	3763-3769	13/167	4		
113	fountain	NK -9	3705	3686-3695	70/112	8		
114	fountain	NK -9	3700	3682-3691	102/136	6		

Currently, 52 wells are being operated at the field. According to the calculations of the field development, the transition of all fountain wells to operation by the gas lift method is being considered.

Table 3 shows the proposed options for the development of the transition of fountain wells to the gas lift method of operation.

Table 3. The proposed variant of the development of the transition of fountain wells to the gas lift method of operation for the Altyguyi field

(basic option I)

Indicators	Unit of measurement	2022	2023	2024	2025	2026	2027
Oil production	thousand tons						
Liquid extraction	thousand tons						
Associated gas resources	miln m^3						
Transfer of wells to the gas lift method	well		5	6	7		
Fund of gas lift wells operating until the end of the year	well	1	6	12	19	19	19
Average oil flow rate of operating wells	t/day						
by liquid	t/day						
Water cut	%						
Required gas resource for gas lift	miln m^3	1,9	5,9	30,2	32,3	43,1	41,7
(Option II)							
Oil production	thousand tons						
Liquid extraction	thousand tons						
Associated gas resources	miln m^3						
Transfer of wells to the gas lift method	well		7	12	12	12	12
Fund of gas lift wells operating until the end of the year	well	1	8	20	32	44	56
Average oil flow rate of operating wells	t/day						
by liquid	t/day						
Water cut	%						
Required gas resource for gas lift	miln m^3	1,9	19,7	68,8	141	188	209
(Option III)							
Oil production	thousand tons						

Liquid extraction	thousand tons						
Associated gas resources	miln m^3						
Transfer of wells to the gas lift method	well		11	24	13	7	6
Fund of gas lift wells operating until the end of the year	well	1	12	36	49	56	62
Average oil flow rate of operating wells	t/day						
by liquid	t/day						
Water cut	%						
Required gas resource for gas lift	miln m^3	1,9	11,0	45,4	88,7	120	120

In the gas lift mode, the supply of the working agent in the range of 2000-2200 meters lifts are carried out at 38 ^{0}C with heated gas through the holes of the gas lift valves temporarily installed in place [2, 3].

At the field, gas is supplied to gas lift wells with operating pressures of 70-85 kgf/cm2 by special gas compression lines. The gas consumption for each well currently averages 15 thousand m^3/day.

To operate the lift with the greatest efficiency, i.e. with the minimum specific consumption, it is necessary that the lift operates at the optimal flow rate, which requires the greatest immersion under the dynamic level, i.e. the length of the lift must be equal to the depth of the well. The minimum specific flow rate in the maximum feed mode is provided if the relative immersion is $\xi = 0.5$, and for the optimal mode the relative maximum flow rate is $\xi = 0.6$ [4].

Operated gas lift wells need to be optimized according to existing methods. According to calculations, in gas lift wells with a gas inlet point of 2300 - 2500, we accept a working pressure of P_{work} = 6.4; 7.4; 8.4 MPa, and in wells with a gas inlet depth of 3000 - 3500 m - 10-12 MPa. At gas condensate fields, it is necessary to implement a closed-cycle compressor gas lift with high-quality gas preparation for the needs of the gas lift and with further gas supply to the export gas pipeline.

The system of collection and preparation of products at the wells of the Altyguyi field is compatible with the collection and preparation of products at the wells of the Korpedje field.

The system of collecting and preparing gas condensate wells of the Altyguyi field is shown in the figure 1.

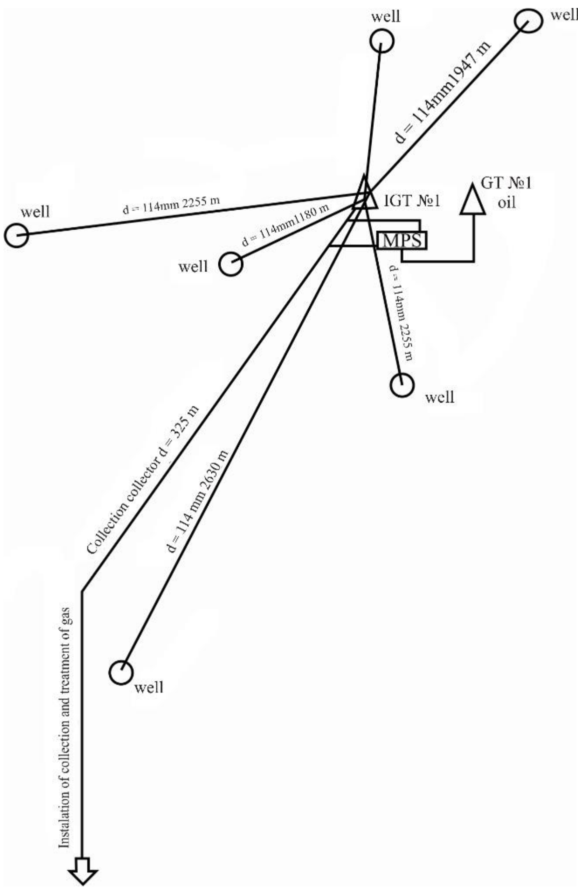

Figure 1. The system of collecting and preparing gas condensate wells of the Altyguyi field

The products of gas condensate wells with gas pipelines are sent to a complex metering unit and from there they are sent through collectors to the first stage of the Korpedje complex gas treatment plant.

Let's consider the features of the energy technology complex of a gas condensate field on the example of the Western part of Turkmenistan, including producing wells, a collection system, a preparation system and compression of the extracted gas in the aspect of expediency (necessity) of modification (reconstruction) for the future covered by the field development project [5].

The compressor station (CS) provides:

1. compression of associated gas coming to the CS reception through the gas pipeline in three compression stages: from 0.3 MPa to 7.5 MPa;

2. compression of associated gas coming to the CS reception via combined gas pipelines from oil and gas collection points (DNC-1 and DNC-2) by fields;

3. compression of the natural gas of the gas condensate field itself, which is received by the CS through an incoming combined gas pipeline connected to the corresponding group measuring units (GMU).

The technical and technological features of the CS are also:

- the presence at the compressor station of two units (with cooling systems) of the first and second stages of compression of associated gas from an inlet pressure of 0.3 MPa to a pressure of 2.8 MPa, which is the inlet pressure to the terminal (third) compression stage;

- the presence at the compressor station of three units at the third compression stage, one of which is designed to compress associated gas, and the other two to compress natural gas coming directly to the final compression stage from the natural gas supply pipeline;

- the presence of a gas cooling system by low-temperature mechanical refrigeration, i.e. by low-temperature condensation, which is provided by generating cold on steam compression machines using a refrigerant - freon.

The gas resources that can be disposed of (sent to the consumer with the required gas quality) through the CS are unambiguously equal to its design productivity per year while maintaining the above pressure at the inlet to the CS through two gas streams [6,7].

A feature of the operation of the gas processing unit (integrated gas treatment unit) at the current stage of field development is the need to maintain a pressure at the inlet to the installation that ensures the required quality of export gas, i.e. obtaining dew points for water and hydrocarbons established by the gas supply contract.

The current analysis of the parameters of the operation of the IGTU reveals a shortage of reservoir energy of the gas pressure entering the IGTU in the modes corresponding to the design performance.

We note that the overall (integral) effect of gas cooling using low-temperature gas separation technology using regenerative heat exchange largely depends on the type of installed heat exchanger, i.e. its design features and the area of the heat exchange surface [8].

The heat exchangers installed on the IGTU provide an almost twofold decrease in the temperature of the gas entering the low-temperature separator in relation to the Joule-Thompson choke effect [9,10].

The formula for determining the required operational value of the gas separation temperature (in a low-temperature separator) is presented as:

$$T_{sep} = T_{ent.} - \Delta T_{thr.} - \Delta T_{TO}$$

$T_{ent.}$ is the temperature of the gas at the entrance to the IGTU;

$\Delta T_{thr.}$- reducing the temperature on the throttle due to the Joule Thompson effect:

$$\Delta T_{thr.} = \frac{\Delta P}{\varepsilon}$$

$\Delta P_{thr.}$ is the pressure drop on the throttle, MPa;

ε is the Joule-Thompson coefficient, determined by the thermodynamic conditions of throttling and assumed to be $\varepsilon = 0.27$ MPa/°C;

ΔT_o is a decrease in the temperature of the gas in the heat exchanger, which, according to operational data, is represented as:

$$\Delta T_{thr.} = 2\Delta T_{thr.}$$

The critical value of the pressure at the inlet to the IGTU, at which the conditions for the preparation of conditioned gas are met, is determined by the ratio:

$$P_{ent.cr.} = P_{req.} + P_{thr.}$$

where $P_{req.}$ is the pressure at the beginning of the gas pipeline (at the outlet of the IGTU), which, in turn, is determined depending on the values of the required pressure at the end of the pipeline and pressure losses in the pipeline;

$$P_{req} = P_{ter.} + \Delta P_{g.p.} \quad ,$$

where: P_{ter} is the terminal pressure accepted under the terms of gas supply equal to 5.6 MPa.

As a result of calculations based on the above ratios, the necessary pressure drop at the IGTU to obtain conditioned gas with a dew point on water $T_{d.w.}$ = 0 °C is in summer ΔP ~ 3.0 MPa and in winter ΔP ~ 1.5 - 2.0, which corresponds to the need to provide at the entrance to the IGTU pressure P_{ent} ~ 9.5 MPa in summer and 8.5 MPa in winter.

The resources of high-pressure gas, which ensures its preparation to the required conditions at the IGTU, corresponding to the above calculated values of the inlet pressure, are determined in this field development project for the future under consideration [11, 12].

Due to the projected reduction in high-pressure gas resources in the future, in order to maintain the operation of the gas compressor station in modes that ensure gas preparation to export condition, an urgent construction of a booster compressor station is required.

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