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Issue Article

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OPERATION OF WELLS BY FOUNTAIN, GAS LIFT METHODS AND TECHNICAL AND TECHNOLOGICAL MEASURES TO INCREASE PRODUCTION

***Abstract**: It is recommended to call one or several productive formations or a part of a layered productive section developed by a single grid of production and injection wells using an independent technology as an operational object.*

Possible changes in the operating modes of energy resources as a result of exposure to them. At the same time, the possibility of joint rather long-term operation of reservoirs in depletion mode or pressure mode is evaluated.

Since most of the discovered fields contain several productive layers or horizons, the number of grids of production and injection wells, as well as flow rates, permissible depressions, the cost of producing tons of oil and other indicators depend on the correct allocation of objects, first of all, the number of grids of production and injection wells, as well as flow rates, permissible depressions, the cost of producing tons of oil and other indicators; consequently, the amount of material costs for drilling and operation of the field.

***Key words**: fountain, buffer pressure, depth of occurrence, trunk curvature, gas factor, sand plug, elevator, lifting pipes, initial pressure.*

***Language**: English*

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Introduction

A number of geological and commercial, climatic and technological factors are manifested at the gas condensate field, which characterize the operation of wells as operation in complicated conditions.

A number of geological and commercial, climatic and technological factors are manifested at the gas condensate field, which characterize the operation of wells as operation in complicated conditions.

The main features complicating the operation of oil wells of this field are:

- large depths of productive formations;
- high initial pressures drop sharply, respectively, the liquid level in the wells decreases;
- operation of wells at pressures below saturation pressure;
- high values of the gas factor;
- curvature and curvature of well pillars;
- oil formations have a sharp degree of cementation from dense sandstones and siltstones to loose sands and siltstones, which leads to sand formation;
- the extracted oil is highly paraffinic;
- productivity coefficients vary widely;

increase in the estimated depth of gas input into the lift of gas lift wells from the mouth.

The choice of mechanized methods of oil production at the Altyguyi field is carried out taking into account the above factors. In addition to them, relief climatic conditions, inter-repair periods, the presence of paraffin and mechanical impurities in the extracted liquid, the reliability of equipment, the need for maintenance personnel and repair equipment, ease of maintenance in the process of mechanized oil production, production capabilities, the need for energy resources are also taken into account [1].

Multi-layer gas condensate fields of Turkmenistan by the nature of saturation are marked by the presence of pure oil deposits, pure gas deposits and gas deposits with oil fringes. For most deposits, the mixed regime is characterized by the predominance of the energy of gas released from oil and the manifestation of the activity of contour waters at a later stage of development.

The development project does not provide for the maintenance of reservoir pressure, and therefore the exploitation of deposits will be carried out with a continuous drop in reservoir pressure, a decrease in static fluid levels in wells and an increase in the height of its rise.

In the fields of Turkmenistan, the gas lift method of oil production has been widely used.

The extraction capabilities, as well as the reliability of the use of gas lift operation, have shown that it is more efficient than other methods of mechanized extraction.

The conditions for lifting the liquid in a gas lift well mainly depend on the parameters of the lift itself, the pressure of the working agent and the parameters of the reservoir. At the field in the Western part of Turkmenistan, specific factors are: a high lifting height, low flow rates, an increase in the water content of products over time, the availability of working agent (gas) resources. The practice of gas lift operation at this field proves the expediency of its use both in continuous and periodic lifting of liquid. For the purpose of the most efficient operation, wells with debits above 30 t/day are recommended to be operated with a continuous gas lift. Wells operating with debits below 30t/day should be operated with a periodic gas lift. In the conditions of this field, a periodic gas lift is the most realistic, ensuring the design production volumes until the end of the field development [2].

When studying the geological and operational characteristics of the field, it was revealed that oil and gas layers alternating in productive horizons are isolated from each other by impermeable layers having relatively large thicknesses. To a large extent, gas formations overlap oil formations by area, which creates favorable conditions for the implementation of methods dual completion (DC) of oil and gas facilities by one well. At the same time, it is also advisable to partially use the technology of the downhole gas lift, the most efficient method of operation that does not require additional capital investments.

When choosing the gushing mode (the diameter of the fitting), it is necessary that the well has an optimal flow rate with a small gas factor, gives less water and sand, gushes calmly, without large pulsations, Only, when these conditions are met, it is possible to ensure the most rational consumption of reservoir energy and long-term, uninterrupted gushing of the well. [14].

When choosing the mode of operation of a fountain well, reservoir conditions are also taken into account - the proximity of contour water, the possibility of a plug in the well, the mode of the field itself, etc. [14].

The main reasons for the disruption of the normal operation of fountain wells are the waxing of fountain pipes, the formation of a sand plug, corroding of the fitting, clogging of the fitting or ejection of paraffin complications, etc. [4, 14].

Measures to restore the operation mode of wells are carried out depending on the reason that caused its violation. [14].

When a sand plug is formed in the fountain pipes, which caused the buffer pressure to drop to zero and the supply is stopped, a liquid (oil) pump is flushed into the annular space to restore circulation and eliminate the plug. [14].

A significant decrease in pressure in the annular space indicates the formation of a plug at the bottom and the appearance of water, the latter is detected by taking a sample from the jet. When water appears, it is necessary to increase the pressure on the face by reducing the diameter of the fitting. To eliminate the downhole plug, the well is allowed to work without a fitting or oil is pumped into the annular space. [14].

The pressure drop on the buffer while increasing the flow rate of the well indicates that the nozzle is corroded by sand, in this case it is necessary to transfer the fountain jet to another outlet and immediately change the nozzle. [14].

If the specified method fails to eliminate sand jams in the lifting pipes or at the bottom, then the well is stopped for repair work, after which it is put into normal operation.

Dewaxing of the elevator is the main way to ensure the normal operation of fountain wells. The largest amount of paraffin is deposited in the upper part of the lifting pipes, at a length of 400 - 1000 m from the wellhead and in the field oil collection system, in which paraffin deposition increases during the cold season. Several methods are used against waxing of lifting pipes. First of all, these are regime measures: reduction of pulsation and frequency of gushing, regulation of the gas factor in order to reduce it as much as possible. [14].

If these measures do not give results, it is necessary to clean the lifting pipes from paraffin.

There are 3 types of cleaning from paraffin: mechanical, thermal, chemical [5].

Mechanical cleaning of pipes from paraffin is carried out during the operation of wells without stopping them with scrapers of various designs.

When exposed to heat, the lifting pipes are heated with steam, hot oil pumped into the annulus of the well without stopping it. The melted paraffin is carried out by a jet of oil to the surface, while the paraffin melts in the switch line. The thermal method does not prevent the deposition of paraffin in pipes, it is used sporadically, under favorable conditions and when for some reason it is not possible to use other more effective methods. [14].

As a solvent of paraffin, it is envisaged to use condensate (gasoline), which can be extracted at the field in sufficient quantities.

The most characteristic complications in gas lift mining are the appearance of sand and cork formation, the deposition of paraffin in lifting pipes and discharge lines. [14].

Measures against sand entering the well are of a regime nature and are reduced to limiting depression, i.e. limiting fluid intake. The amount of liquid extraction from gas lift wells is regulated by changing the amount of injected working agent, the depth of immersion of lifting pipes or their diameter. To prevent the settling of sand during the periods of its greatest inflow from the reservoir, without interrupting operation, oil is pumped into the annulus in small portions by a mobile pump. [14].

Sometimes the pressure of the gas injected into the well increases sharply when the liquid supply is stopped at the same time. This may occur due to the formation of a so-called cartridge sand plug in the lifting pipes, which blocks the section of the lifting pipes, preventing the mixture of oil and injected gas from reaching the surface. To destroy such a plug, gas is pumped not into the annular space, but into lifting pipes. If in this way it is not possible to push the plug from the pipes to the bottom of the well, then it is necessary to remove the pipes [6, 7].

When wells are equipped with a single-row lift, it is finished with a shank of a smaller diameter than the main tubing string. The descent of the lifting pipes with a shank to the filter facilitates the conditions for the removal of sand by the liquid to the surface and prevents the formation of sand jams. [14].

Measures to prevent paraffin deposits in lifting pipes during gas lift operation of wells, and methods for cleaning pipes from paraffin are similar to those used in fountain operation. [14].

With the drop in reservoir pressures and the flooding of reservoirs at some stages of development in the gas condensate fields of the western part of Turkmenistan, it is planned to improve the gas lift. It is proposed to install a column of lifting pipes equipped with borehole chambers with gas lift valves (starting and working) located in them in the production column on the packer. This eliminates the influence of the injected gas on the flow of liquid into the well. It is planned to conduct research on optimizing the operating modes of gas lift wells according to known methods to determine the optimal flow rate. [14].

It is also necessary to equip the gas lift gas distribution system with regulating and measuring equipment.

All the measures mentioned above are aimed at increasing and stabilizing gas lift production and reducing the volume of injected gas. [14].

At the gas condensate fields under development, with the expiration of the operating time, the number of gas lift wells will grow, because with the cessation of well gushing, it becomes impossible to transfer them to a mechanized method [8, 9].

Under the existing modes of gas lift lifts, the depth of the input of the working agent (gas) is in the range of 1400 - 3000 m, the gas input into the lift is carried out through holes (punchers) temporarily replacing the working valves. [14].

The determination of well operation parameters and the forecast of development indicators was carried out on the basis of reserves of gas condensate horizons and areas for which the presence of oil rims was not detected.

It should be noted that there are a number of uncertainties in the estimation of individual parameters for the field that can affect the accuracy of the final calculation results. The main ones are:

- the degree of activity of the legal area of deposits and the prediction of its impact on the dynamics of drainage regimes in the future;
- insufficient number of measurements of reservoir pressure, the impossibility of establishing a pattern of its change over time for most horizons;
- insufficient number of definitions of filtration parameters "A" and "B" to average them across individual development objects;
- a small number of experimental determinations of the condensate recovery coefficient.

To maximize the use of available data on reservoir pressure measurements and to approximate the results of the forecast of reservoir pressure dynamics to real conditions, the following methodological technique was used.

$$\overline{P}_{res.} = f(\overline{Q}_{g.}) \quad (1)$$

$\overline{P}_{res.}$ - the ratio of the current value of reservoir pressure to its initial value;

$(\overline{Q}_{g.})$ - the ratio of accumulated gas extraction to its initial recoverable reserves.

Based on the analysis of field data using available practical data on reservoir pressure measurements for horizons, graphs of changes in reservoir pressure from accumulated gas extraction are constructed in dimensionless form.

When determining the initial recoverable gas reserves, the expected final gas recovery coefficient equal to 0.85 was adopted.

According to the experience of developing gas condensate deposits in Western Turkmenistan, it is known that during their operation, along with the gas regime, the pressure of marginal and plantar waters appears, and its share increases over time [10].

In the calculations, the isotherms of differential condensate in reservoir conditions given in [2, 11] were used. These data are preprocessed with polynomials for the convenience of performing calculations on a computer.

The calculation sequence is as follows.

1. For the lower reservoir, the annual and accumulated gas production, as well as the average flow rate of gas wells (q_1) for the future for the option of developing it by an independent grid of wells, are preliminarily calculated.

With known accumulated selections (Q_1), the dynamics of reservoir pressure along the lower formation is determined by the formula:

$$P_{res.init.1} = P_{res.init.}\, f(\overline{Q}_{g.1}) \qquad (2)$$

2. Using the filtration coefficients "A_1" and "B_1", with a known gas flow rate q_1 and the value of reservoir pressure P_1, the bottom-hole pressure P_{b1} is determined.

$$P_{b1} = \sqrt{P_1^2 P - (A_1 q_1 + B_1 q_1^2)} \qquad (3)$$

3. To lift the liquid to the surface, the wellhead pressure is determined by the following formula:

$$P_2 = e^{-S_{on}} \sqrt{P_1^2 - 1.377\lambda_l \frac{Z^2{}_{av.l} T^2{}_{av.l}}{\rho_l d^5{}_{int.l}} Q^2 mix._1 (e^{2S_{on}} - 1)} \qquad (4)$$

$$S_0 = 0.03415 \frac{\overline{\rho}\rho L}{Z_{av} T_{av}} : \rho = \varphi + (1-\varphi) \frac{\rho_{liq.}}{\rho_{g.op.}};$$

$$\rho_{g.op.} = \frac{\rho_g P_{av.} T_{st.}}{P_{at} T_{av.}} : \varphi \le \beta = \frac{Q_{liq.}}{(Q_{g.op.} Q_{liq.})};$$

$$Q_{g.op.} = \frac{Q_{g.} P_{at.} T_{av.}}{P_{av.} T_{st.}} : Q_{mix.} = \frac{G_g + G_{liq}}{(\rho_{g.})}; \qquad (5)$$

$$G_g = Q_g \rho_g ; \overline{\rho} = \frac{\rho_g}{\rho_{air}} ; T_{st} = 293^0 K$$

$$\theta = 1{,}377\lambda \frac{(Z^2{}_{av.} T^2{}_{av.}}{d^5} (e^{2S} - 1)$$

ρ_g. ρ_{air} ρ_{liq} - density of gas, air and liquid, kg/m^3;
$\rho_{g \cdot op}$., $Q_{g \cdot op}$ - respectively, the density and flow rate of gas in the wellbore under operating conditions, kg/ m^3 and thousand m^3 day;
G_{liq}, G_g, - mass flow of liquid and gas, t/day;
Q_{mix},Q_{liq},Q_g - volume flow of the gas-liquid mixture, liquid and gas, respectively, at P_{at} and T_{st}, thousand m^3/day.

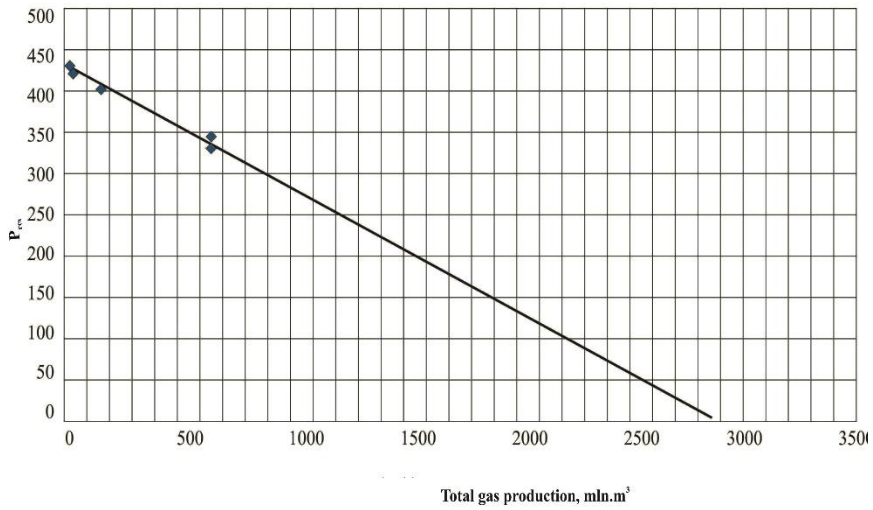

Figure 1. Graph of changes in reservoir pressure from accumulated gas extraction in the NK$_8$ horizon

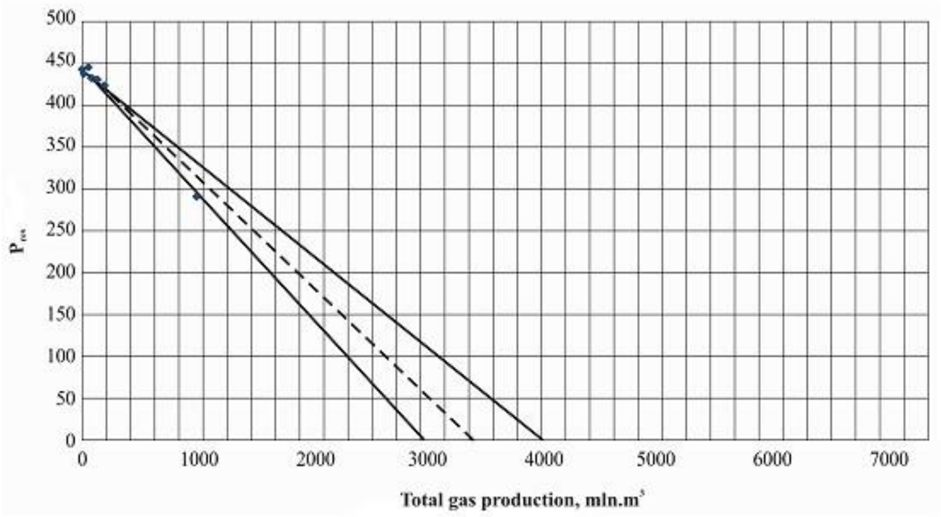

Figure 2. Graph of changes in reservoir pressure from accumulated gas extraction in the horizon of NK_{7d}.

The true volumetric gas content should be determined experimentally as the ratio of the true volume of gas V_t in the well to the volume of the hole $\varphi = \frac{4Vg}{\pi D^2 L}$, However, due to the great difficulties of such measurements, it can be estimated by the consumable gas content β according to the above formula (5).

Since it is always φ <β, using β instead of φ leads to an underestimation of the downhole pressure as much as the difference between the amount of liquid in the well and the outflow of gas is greater. The coefficient of hydraulic resistance λ must be determined based on the results of well studies in various modes. Due to the absence of such studies, its value is assumed according to [12, 13], for the pipe λt = 0.025 and for the packer λp = 0.0815.

All values (Z_{av}, $\rho_{g.op}$, $Q_{g.op}$, β, etc.) depending on the P_{av} are calculated by the method of successive approximations.

When predicting the gas factor, oil and gas resources of the productive deposits of the field, characterized by very complex drainage regimes, serious problems are created. In addition, during the development of the field, there is a continuous change in specific types of energy that displace oil from the bottom of producing wells, which significantly affects the dynamics of the gas factor. At the same time, the dynamics of the gas factor was determined taking into account the experience of the development of the NK (lower red color) horizons of other fields.

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