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Technical and Economic Solutions for Oil Production at the Severny Shurtan Field

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Abstract*— the article discusses the main tasks of finding a complex of optimal technical and economic solutions for oil production at the Northern Shurtan field. Also, methods for preventing emerging complications are given, which provides an analysis of the current state of development, the problems he identified, solution methods tested by various design options for further development and a technical and economic analysis of design solutions. Recommendations for increasing the rate of oil production by areal gas injection are given.*

Keywords— severny, shurtan field, technical solutions, economic solutions.

1. INTRODUCTION

At present, when using natural types of energy, oil deposits with "effective" natural regimes are being developed, for which artificial impact is not required, as well as deposits with special geological conditions, in which the methods of impact cannot bring the necessary results or cannot be developed.

Oil reservoirs with effective natural regimes include reservoirs with water-driven and active elastic-water-driven regimes. The latter is called active in the case when its energy resources are sufficient to extract recoverable oil reserves from the bowels at a sufficiently high rate without reducing the reservoir pressure below the bubble point pressure. The most common method of influencing waterflooding does not bring the desired results when the oil viscosity in reservoir conditions is more than 30-40 mPa s, since a stable front of oil displacement by water is not created in the reservoir: the latter quickly moves along the thin most permeable layers of the reservoir, leaving the main volume of the reservoir undeveloped ... Systems and processes for the development of gas and gas condensate deposits have a number of features. Reducing reservoir pressure in the developed gas deposits during their development leads to important consequences. When reservoirs interact with the aquifer, a decrease in reservoir pressure in reservoirs, especially in large ones, affects the state of reservoir pressure in the entire water drive system to which they are confined. [2,3]

The main methods for maintaining reservoir pressure are water or gas injection. Water injection into a productive formation with a thin oil rim entails the threat of rapid flooding of the well and does not solve the problem of oil losses due to its migration into the gas part of the reservoir. Maintaining reservoir pressure by gas injection is often used to prevent oil migration into the gas cap. The increase in the production of liquid hydrocarbons can be due to the displacement of oil by the injected gas, the effect of evaporation, and sometimes the elimination of hydrocarbon losses, which are possible without implementing the process of maintaining reservoir pressure. By injecting gas into productive formations, it is often possible to significantly extend the development period of a reservoir while maintaining the design rate of oil production, which reduces the development time of the reservoir and, accordingly, reduces operating costs.

The Northern Shurtan field has been developed since 2005. Until 2006, the field was developed in a natural mode with advanced development of the oil part of the oil and gas condensate reservoir. In 2006, the "Technological scheme for the development of the Northern Shurtan field" was drawn up, according to the approved version of which the oil and gas condensate reservoir was to be developed at waterless flow rates with controlled free gas withdrawal. But in fact, the development of the field is joint with the advanced development of the gas condensate part. In this connection, there is a sharp decrease in reservoir pressure in the area of operating wells. Further development with the existing system is fraught with an increase in oil losses due to its migration into the gas cap, as well as gas condensate precipitating in the formation. To prevent the complications that arise, this work was carried out, which provides an analysis of the current state of development, the problems he identified, solution methods tested by various calculation options for further development and a technical and economic analysis of design solutions. During the field development design process, four main options were developed.

The most preferred option for further development of the field looks like option II. From the point of view of rational consumption of reservoir energy without maintaining reservoir pressure, this option is closer to the ideal. However, they require a timely transition to the optimal free gas consumption mode, and also involves the installation of multiphase flow meters and the presence of a well-functioning system for monitoring and regulating development. Also, the main measures to eliminate the negative consequences of gas breakthroughs into producing wells are a reasonable choice of the position of the perforation interval and the establishment of the optimal technological mode of well operation. To identify the recommended option, technical and economic analyzes were carried out for further development of the field. For a comparative assessment of field development options, the main indicator of the efficiency of capital investments was used - cash flow. Field development according to the second option will ensure the sale of natural gas in the amount of 408.01 • 106 m3, condensate - 28.78 • 103 tons, oil - 289.73 • 103 tons for the entire settlement period (16 years). The internal rate of return of the project will be the rate of 14.34%. The payback period of the project will be 5 years.

It is recommended to use a reservoir pressure maintenance system by injecting the entire volume of produced gas back into the reservoir or to adhere to the optimal specific gas flow rate for liquid lifting. A negative point in joint development is the complexity of accounting for the produced products, as well as control over the development of reserves at the combined facilities.

To substantiate the final oil recovery factor, oil production volume and GOR in the development of an oil reservoir with a gas cap regime, the calculation of reservoir depletion in a gas cap regime using the finite difference method (Pearson's method), given in [2], was used.

The calculations were carried out for an average well of the Northern Shurtan field using analytical methods of calculation, as well as numerical modeling on mathematical hydrodynamic models. The results obtained are extrapolated to the entire field.

Oil production forecast was calculated using an exponential relationship:

$$q(t) = q_A \cdot e^{-\frac{q_A}{Q_0} \cdot t}$$

where q (t) is the current oil production rate at the time t, t / d; qA - initial (amplitude) oil production rate, t / d; e is the base of the natural logarithm; Q0 - drained oil reserves, t.

From expression (1) it can be seen that the accumulated oil production during the operation of wells for an unlimited time tends to the value of the drained oil reserves. The forecast of free gas production was calculated according to the statistical dependencies of the actual operation of the producing wells of the North Shurtan field using the revealed regularities of the operation of oil and gas producing wells in the South Kemachi field [1,4]. The initial oil production rates of the planned wells were calculated according to the mathematical relationship, taking into account the production rates of adjacent production wells. Depending on the rate of extraction, the dynamics of reservoir pressure in the oil part of the field was determined. The results of analysis and processing of data from hydrodynamic studies of wells operating a thin oil reservoir show that the optimal joint oil and gas production is achieved at a depression of 10 kgf / cm2, while the actual depression in the formation is 20 kgf / cm2.

As stated, for the implementation of the development, the second option was adopted, which provided for the development of the facility in the depletion mode with controlled gas extraction from the gas cap. However, since 2006 the oil and gas sections have been developed jointly, while the gas withdrawal has not been controlled. Such a development system can entail significant losses in the production of recoverable oil reserves, as well as a sharp decrease in the natural energy reserve of the reservoir, which in turn will lead to a decrease in the potential content of gas condensate. To prevent losses and a sharp decrease in reservoir energy, it is necessary to maintain reservoir pressure (RPM) or limit free gas withdrawal to the optimal flow rate for liquid lifting. Currently, at the developed fields of the Republic, the reservoir pressure maintenance process is carried out either by injection of water or gas. Only in a single case were these two processes carried out simultaneously. The program for maintaining reservoir pressure by gas injection is often used precisely to prevent oil migration into the gas cap (the so-called losses due to "shrinkage" of the gas cap) in productive deposits, where there is a movement of natural formation water or water injected into the lower parts of the structure from the surface [2]. The increase in the production of liquid hydrocarbons can be due to the displacement of oil by the injected gas, the effect of evaporation, and sometimes the elimination of losses of hydrocarbons, which are possible without the implementation of the process of maintaining reservoir pressure.

When injecting gas over the entire area of a field, often referred to as areal gas injection, an injection well spacing system is usually used to ensure that the injected gas is evenly distributed throughout the oil portion of the formation. In field practice, the order of placement of injection and production wells varies from conventional correct systems (five-point, seven-point, nine-point, etc.) to random systems with a relatively uneven distribution of wells over the area. It was found that the method of areal gas injection is applicable for deposits with low structural relief and in relatively homogeneous formations with low permeability. Due to the dense placement of injection wells, areal gas injection provides a quick effect in pressure recovery and in stimulation of oil production, as a result of which the development time of the reservoir is reduced.

Since the structural relief of the field is low, and the reservoirs of the productive horizons have low permeability, areal gas injection is most expedient for the Northern Shurtan field. If possible, for injection purposes, it is necessary to use the existing well stock. Gas injection is best done through a small diameter tubing string (60 mm - 89 mm) with a packer near the roof of the production facility. This reduces the likelihood of leaks of the working agent and gives a better preservation of casing, especially in old wells of conservation and abandonment funds.

In conclusion, we note that in order to increase the production of liquid hydrocarbons, it is necessary: optimization of development systems, constant operational control over operation, timely reliable information obtained during operation.

2. References

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