Modeling of geological and technical measures based on drilling a well with modified valve assembly parameters

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Abstract. In the course of the research, an analysis of the development of geological and technical measures at various fields was carried out. The justified application of these measures has been studied, and recommendations have been made to increase the efficiency of oil recovery based on drilling wells with modified valve assembly parameters. The conducted research allows us to obtain optimal performance indicators of pumping equipment associated with such parameters as pressure, flow, taking into account the lowest cost of repair work. For this purpose, modeling of geological and technical measures based on drilling a well with modified parameters of the hydraulic assembly of the drilling pump has been developed. This design solution allows you to obtain optimal performance of the drilling pump, taking into account the lowest costs for current and major repairs. These studies aimed at finding optimal geological and technical measures (GTM) related to increasing the productivity of drilling pumps and oil recovery in general are very promising and relevant.

1 Introduction

The efficiency of oil recovery of reciprocating drilling pumps is determined by limiting mechanical and hydraulic losses. In this article, modeling of geological and technical measures based on drilling a well with improved valve assembly parameters is developed. This design solution allows you to obtain optimal performance indicators for both pumping equipment and the drilling rig as a whole.

By modeling the operation of poppet valves, it has been proved that the shape of the seating surfaces undoubtedly affects the efficiency of the valve assembly. The developed GTM model makes it possible to increase the efficiency of wells by using modified seating surfaces of the disc valve of the drilling pump. For this purpose, the GTM model is proposed using the design solutions of the valve assembly of the drilling pump [1-7].

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2 Methods and Materials

The developed GTM model based on drilling a well with modified valve assembly parameters includes the following tasks:

- Development of methods for effective analysis of the most problematic areas of the drilling rig and field in terms of increasing oil production and oil recovery coefficient.
- Selection of the most effective methods of oil production by increasing the productivity of the drilling piston pump [8-10].
- Development of a model for achieving the most technologically advanced and structurally effective geological and technical measures.

Every year, dozens of activities are carried out at each oil field in order to regulate its development and maintain target oil production levels. This set of works is called geological and technical measures (hereinafter GTM), the implementation of which ensures the fulfillment of design indicators in order to regulate and continuously manage field development and maintain target oil production levels [11-14].

Geological and technical measures differ from other measures at oil wells in that as a result of the implementation of these measures, an increase in oil production is obtained. All work in the well is divided into major and underground (current) repairs:

- Major repairs include work related to changing the object of well operation, fixing collectors, restoring the tightness of the casing, limiting inflows of reservoir, pumped waters and waters from reservoirs, with work from ground equipment [15].
- Underground (ongoing) repairs include work related to the transfer of wells from one mode of operation to another, ensuring a given technological mode of operation of underground operational equipment, changing operating modes and changing this equipment, cleaning the borehole and lifting pipes from sand, paraffin, salts, etc.

Therefore, in most cases, GTMs relate to the overhaul of wells. Certain types of routine repairs can be counted as GTM (for example, changing a downhole pump with a lower capacity to a pump with a higher capacity, changing the hydraulic components of the pump). Geological and technical measures are carried out at all stages of field development, especially in fields with declining production, therefore, the correct setting and implementation of GTM is relevant. The selection of effective GTM methods in an oil field is one of the urgent tasks in oil production. GTM activities are carried out annually at fields of any stage of operation of an oil producing enterprise, and subsequently are periodically clarified and adjusted.

The purpose of the GTM is to analyze the efficiency of oil recovery from producing wells in order to increase the effectiveness of their regulatory impact on oil production. It is especially important to conduct GTM in areas with declining production, therefore, the assessment of the effectiveness of wells depends on the implementation of a set of geological and technical measures to improve the quality of uninterrupted operation of producing and injection wells. In order to identify the importance of methods for increasing oil recovery, it is necessary to consider the advantages and disadvantages of the main modern GTMs used.

Drilling pumps are used to ensure the circulation of drilling fluids during well drilling. Circulation is understood as a combination of the following processes: injection of drilling mud into the well, maintaining the drilled rock in a suspended state, cleaning the shaft and face from sludge, as well as cooling the bit during drilling. According to the research results, the technical life of the drilling pump parts is mainly influenced by the operating conditions in aggressive and abrasive media and the design characteristics of the hydraulic parts. The poppet valves of the drilling piston pump have the lowest operating time for failure, their coefficient of variation is 0.77. The increase in the coefficient is indicated by the sudden and frequent nature of failures of the valve assembly elements, their low service

life does not meet the drilling requirements, which leads to frequent stops of the drilling pump, and in general, the entire complex. Significant material costs are required for repair work in adverse operational and climatic conditions. High discharge pressure, the presence of abrasive particles in the drilling fluid cause intense wear of the valve assembly, which negatively affects the pump performance.

Taking into account the operating conditions, it is impossible to answer many of the questions posed, for example, how the working conditions of the valve assembly become easier or more complicated as drilling deepens, pump supply decreases or increases, and the density, viscosity, and temperature of the drilling fluid increase or decrease [16].

3 Results and Discussion

In the course of the study, an analysis of the geological conditions for the development of various fields in Eastern Siberia, the choice and justification of the use of GTM for a group of fields in the Irkutsk region was carried out, recommendations for increasing their effectiveness were studied. These fields are characterized by a significant decrease in the level of oil production with a sharp increase in the repair work of the drilling rig, and in general the drilling pump. Reducing the rate of decline in oil production and achieving the approved values of the oil recovery coefficient can be achieved by carrying out a set of geological and technical measures proposed in this article.

The valve assembly is one of the main elements of the drilling pump, the durability of the assembly depends on the degree of perfection of the piston pump design. The degree of perfection of the pump is determined by the suction height, the amount of volumetric efficiency, the feed coefficient, and the dynamics of the pumping unit. At the same time, the issue of increasing the efficiency of oil recovery of piston pumps is being solved by reducing mechanical and hydraulic losses. Therefore, further research aimed at finding geological and technical measures related to increasing the productivity of drilling pumps remains very promising and relevant.

According to the results of practical and theoretical research by the author, the effectiveness of the valves is undoubtedly influenced by the shapes of the seating surfaces, the deformed state of the sealing element, the materials of the valve pair, methods of hardening the working surfaces and design features of the valve pair elements. The developed design of the valve pair of the drilling pump makes it possible to reduce the maximum forces resulting in shock loads and wear of the valve pair elements, which ensures an increase in the repair period, while increasing the productivity, reliability of the drilling pump, and in general the drilling rig.

This valve design is presented as follows: when the valve assembly is in operation, the valve seat experiences less wear, therefore the O-ring is mounted on the valve plate, since the seat is subject to the sliding action of a jet of solution, and the plate is additionally impacted. The shape of the seating surfaces of the plate, seat and sealing element has been modified (Figure 1). The seat is in the shape of a cone turning into a cylinder. This design solution ensures the least wear of the saddle and the plate, because the height of the saddle taper is reduced. The container has the shape of a conical disk and rests on a cylindrical surface when landing, which creates a soft landing, i.e. there is no impact. The O-ring is removable of circular cross-section. The bushing has the ability to move axially, relative to the limiter. The limiter is equipped with a thrust nut. Modifications in the design allow for improved sealing due to the sealing ring and due to the pressure action of the clamping sleeve and quick assembly and disassembly. The existing difference of this design is that the presented shape of the sealing element provides an improved fit and double sealing due to the pressure of the clamping sleeve. The implementation of this type of seal allows for interchangeability, saves material consumption and improves the technical and economic

performance of the pump. The valve seat corresponds to the NB125 valve recommended for pumps of the 9T series.

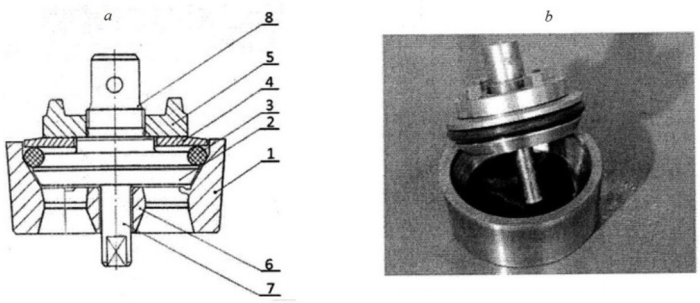

Fig.1. a) the scheme of the poppet valve of the drilling pump: 1 - seat; 2 - poppet; 3 - sealing ring; 4 - clamping sleeve; 5 - thrust nut; 6 - crosspiece; 7 - shank; 8 - lifting limiter; b) disassembled.

The practical significance of this article lies in the fact that the developed design of the drilling pump valve can be used to assess the effectiveness of measures aimed at intensifying oil production and can be used by oil producing enterprises in the development of GTM programs.

The scientific novelty lies in the development of a model of geological and technical measures using a new design of the drilling pump valve in commercial fields.

The GTM program is aimed at solving the following tasks: reducing the inactive well stock; ensuring the daily productivity of wells at the design level; assessment of the technological efficiency of oil production through the use of an improved valve assembly of the drilling pump and an increase in the maintenance period during the oil recovery process; a model has been developed to determine the optimal performance of pumping equipment.

4 Conclusion

This article presents a simulation of a geological and technical event based on drilling a well with modified valve assembly parameters. During the analysis, it was revealed that the use of a new design of the drilling pump valve contributes to an increase in the oil recovery coefficient due to the changed parameters of the valve assembly elements and an increase in the repair period.

The solution of this problem in field development is associated with the development of new GTM methods that affect oil production from producing wells. Based on the GTM with the use of a new valve design, a model has been developed that allows determining the optimal performance of pumping equipment. Based on the results of research that ensures the maximum possible production of wells, taking into account the cost of repair work, the optimal sequence of improvement of each stage of the "chain" is selected due to new technologies and design solutions, i.e. the task of increasing the efficiency of well use through the use of an improved design of the drilling pump valve is solved.

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