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To‘plam elektron ko‘rinishda (pdf formatida) mualliflarga taqdim etiladi. To‘plamga kiritiladigan maqolalarning mazmuni, ulardagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligiga hamda har qanday fikr - mulohazalarga mualliflarning o‘zlari mas’ul hisoblanadilar. Talablarga javob bermaydigan maqolalar to‘plamga kiritilmaydi. Tashkiliy qo‘mita maqola matnini qisqartirish, qisman tuzatish kiritish, seksiyalarga joylashtirish huquqiga ega.

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CONTROL ALGORITHMS FOR OPTIMIZING OIL AND GAS WELL PROCESSES

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Annotatsiya. Ushbu maqolada neft va gaz quduqlarini boshqarish va quduqlarning umumiy tuzilishi ko‘rib chiqiladi. Burg‘ulash tizimlari uchun quduqlarning asosiy parametrlarini boshqarishning samarali boshqaruv algoritmi tahlil qilinadi. Neft va gaz quduqlarini boshqarish jarayonlarida bir vaqtning o‘zida bir nechta parametrlarni yoki bir nechta tizimlarni boshqarish kerak. Quduqlarni boshqarishning bunday murakkab texnologik jarayonlarida optimallashtirish uchun boshqaruv algoritmlarini yaratish kerak. Burg‘ulash jarayonlarining samaradorligini oshirish uchun boshqaruv algoritmi ustida ishlar olib borildi. Burg‘ulash jarayonlariga ta'sir qiluvchi turli parametrik kechikishlar va shovqinlarni aniqlashga qaratilgan boshqaruvda kinematik va statistik yondashuvlarni birlashtirishning ma'lum bir kontseptsiyasi ko‘rib chiqiladi.

Kalit so‘zlar: Burg‘ulash qurilmasi, boshqarish algoritmi, avtomatik boshqaruv, burg‘ulash tezligi, burg‘ulash suyuqligi bosimi, siqilish koeffisienti.

Аннотация. В данной статье рассматривается управление нефтегазовыми скважинами и общая структура скважин. Анализируется эффективный алгоритм управления основными параметрами скважин для буровых систем. В процессах управления нефтегазовыми скважинами необходимо одновременно контролировать несколько параметров или несколько систем. В таких сложных технологических процессах управления скважинами необходимо создавать алгоритмы управления для оптимизации. Проведена работа над алгоритмом управления для повышения эффективности буровых процессов. Рассмотрена определенная концепция сочетания кинематического и статистического подходов в управлении, направленная на выявление различных параметрических задержек и шума, влияющих на буровые процессы.

Ключевые слова: Буровая установка, алгоритм управления, автоматическое управление, скорость бурения, давление бурового раствора, коэффициент сжатия.

Abstract. This article reviews the management of oil and gas wells and the general structure of wells. An effective control algorithm for controlling the main parameters of wells for drilling systems is analyzed. In the processes of managing oil and gas wells, it is necessary to control several parameters or several systems at the same time. In such complex technological processes of well management, it is

necessary to create control algorithms for optimization. Work has been carried out on a control algorithm to increase the efficiency of drilling processes. A certain concept of combining kinematic and statistical approaches in control aimed at identifying various parametric delays and noise affecting drilling processes is considered.

Keywords: Drilling rig, control algorithm, automatic control, drilling speed, drilling fluid pressure, compression coefficient.

INTRODUCTION.

Well drilling is a multifaceted engineering task that involves overcoming a number of technical challenges and designing a system to control drilling rigs. the development of the oil and gas industry has led to the emergence of new drilling technologies and the improvement of existing ones [1].

Automated systems for controlling drilling processes and optimizing technological parameters have been developed for decades. Such systems simplify the work of the driller, reduce the number of emergency situations and rationalize the operation of the drilling tool [5]. Optimization of technological parameters during the construction of wells reduces the cost of electricity consumption, downtime due to accidents and the costs associated with their elimination.

In the field of modern automation, various approaches such as fuzzy logic, neural networks and automatic control are becoming increasingly popular. These approaches are widely used in the automation of processes characterized by a high level of uncertainty and randomness, as well as a significant influence of the human factor [8-12]. Technological processes of well drilling are a vivid example of such a process. The modern drilling industry is experiencing rapid growth, and the main vector of this development is the automation of technological operations, including the introduction of innovative technologies in the field of well drilling through the integration of advanced control solutions [2].

LITERATURE REVIEW.

A lot of scientific research is being conducted worldwide on modeling and optimizing the well drilling process. Technological developments are opening up new opportunities in the oil and gas industry. Innovative methods have been developed and implemented that improve the processes of drilling and servicing wells. Modern intelligent systems increase the efficiency of well drilling processes, ensure safety, and reduce production time. As D. V. Rakhmatullin and A. F. Gaynullin noted, today almost all modern intelligent well drilling systems are produced in the USA and Canada, while Uzbekistan is still developing its experience in this area.

According to V. Alali and N. A. Eremin, about 25% of the time spent on drilling wells is considered ineffective. These losses are increased by equipment

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failure, various delays and losses due to incidents, the need to eliminate their consequences. Losses that significantly contribute to downtime during well drilling include: sticking of the drill string due to rock formations and erosion of rock layers, as well as increased drilling fluid pressure. Such situations lead to a significant increase in the cost of drilling wells. It is much more economical and simpler to prevent losses than to work on their consequences.

RESEARCH METHODOLOGY.

Data collected during the drilling process (including drilling speed, pressure readings, temperature conditions, etc.) are analyzed and the drilling process parameters are adjusted accordingly. Modern drilling technologies are aimed at automating and optimizing this process, which is achieved through real-time data collection and processing, as well as the use of artificial intelligence and machine learning methods.

DISCUSSION AND RESULTS.

The main parameters of the drilling process must be determined. These parameters have a significant impact on the degree of fragmentation of the mineral yield and the efficiency of the entire technological cycle. In a number of sources [1–4], the following parameters affecting the rock cutting process are listed: axial load on the rock cutting tool (F_{OC}); rotational speed of the rock cutting tool (n); coolant consumption (Q); drilling fluid pressure (P); mechanical input speed (υ_{mex}); planned working speed (υ_p).

During the drilling process, it is necessary to constantly monitor the pressure at the bottom of the well and maintain it within a clearly defined range, known as the "pressure window." This range is determined by the geological structure and rock characteristics of the area being drilled [6].

The permissible pressure range is defined as follows:

• Lower limit $\underline{p_b}$: Determined by the pressure of the fluid in the rock (pore pressure). If the pressure at the bottom of the well is lower than the pore pressure, fluid can leak out of the rock, which is considered an unfavorable situation.

• Upper limit $\overline{p_b}$: Determined by the hydraulic fracturing pressure of the rock. If the pressure exceeds this level, cracks will form in the rock, which is also not good, as it can lead to loss of drilling fluid.

That is, the pressure must be higher than the pore pressure, but lower than the hydraulic fracturing pressure.

In practice, the pressure characteristics of the rock during well drilling constantly differ from theoretical predictions. This can complicate drilling operations and cause the pressure to exceed the predicted range [3-5]. Even if the optimal pressure value is determined, unexpected anomalies in the rock during

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drilling can lead to a deterioration in the quality of work. Due to the difficulty of predicting these anomalies in advance, it is necessary to quickly adjust the pressure.

The following equations, based on mass balance, describe the dynamics of pressure in given volumes for the drilling system and annulus:

$$\frac{V_d}{\beta_d} p_p = q_p - q_b, \qquad (1)$$

$$\frac{V_a}{\beta_a} p_c = -V_a + q_b + q_{res} - q_c, \qquad (2)$$

here V_d – drilling rig size, β_d – compress0\\ion ratio in the drill string, p_p – the pressure value generated by the pump, q_p – flow rate transmitted by the drilling pump, q_b – working fluid flow through the drill bit, V_a – annular space volume, β_a – compression coefficient in the annular space, p_c – pressure generated in the valve, q_{res} – rock flow (sludge movement), q_c – the amount of flow passing through the valve.

According to the law of conservation of momentum, the characteristics and dynamics of movement along the channel are determined.

$$(M_a + M_d)q_b = p_p - p_c - F_d q_b^2 - F_a(q_b + q_{res})^2 + (\rho_d - \rho_a)gh_b, \qquad (3)$$

here M_a and M_d - mass coefficients of the annular space and drill string; ρ_a and ρ_d – average density values of the drilling fluid inside the annular space and the column; F_a and F_d - coefficients of friction occurring in the column and annular gap.

The main factor in mechanical rock drilling is the penetration rate, which is determined by the force applied to the drilling tool (axial load) and its rotational speed [7]. Thus, the drilling speed is directly dependent on these two values:

$$\upsilon_{mex} = f(F_{OC}, n, Q) \qquad (4)$$

Another important indicator for assessing the efficiency of the rock removal process is the backcutting or deepening [2, 6]. This parameter represents the thickness of the rock layer cut in one revolution of the rock cutting tool. The processing speed is calculated using the following formula:

$$S_0 = \frac{V_П}{n} \qquad (5)$$

here $V_П$ - the speed of flow of the rock cutting tool to the surface; n - the rotational frequency of the stone cutting tool.

The automated drilling control system must perform the following functions:

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•Maximizing drilling performance: The drilling process requires constant monitoring and accounting for real-time variable factors such as rock hardness and drilling tool wear;

•Maintain a set feedback value: The system must maintain the feedback information received from the drilling process at a predetermined value;

•Adaptability to external influences: It should be possible to automatically change the feedback value as S_0 environmental conditions change;

•Identifying critical tool conditions: It is necessary to identify when a drilling tool is about to fail and take steps to stop and prevent the process.

The proposed algorithm increases efficiency in drilling operations management, in particular by controlling the reverse transmission according to specific conditions, maintaining the overall driving force of mobile drilling rigs, and ensuring control of the rock cutting tool [2].

This algorithm provides a certain drilling performance by coordinating the operation of system drives and has the ability to automatically detect the need to replace tools and adapt to equipment wear. The main goal of the algorithm is to maintain the power of the system drives at an optimal level to ensure maximum drilling performance, taking into account the specified value of the reverse load [4].

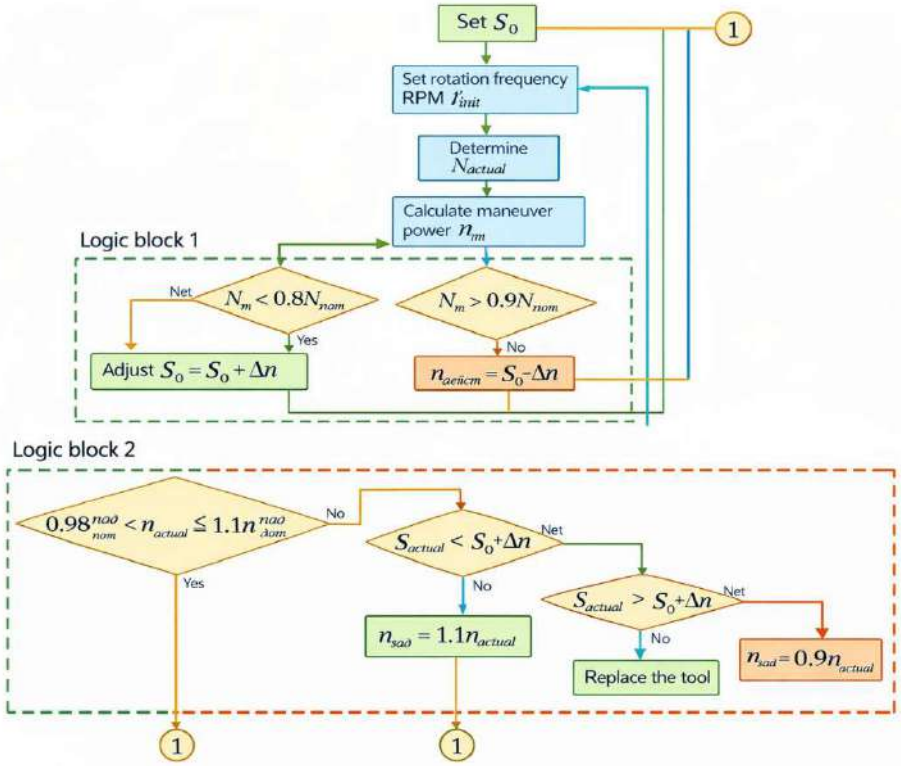


Figure 1. Automated control algorithm that includes the function of automatically determining the degree of wear of equipment used in the well drilling process

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The algorithm for automatic control of the well drilling process can be presented as follows (Figure 1):

1. Setting the counterweight: The value of the counterweight is determined based on the parameters of previously drilled wells.

2. Setting the initial counterweight: The initial counterweight of the rock cutting tool used in the initial stage of drilling is set.

3. Calculation of the current load: The value of the current load is calculated based on the measured rotation frequency of the hydraulic motor of the downhole motor and the set value of the counterweight.

4. The actual power of each drive and the total power of the entire system are calculated by summing the powers consumed by each drive responsible for the working movements.

5. Based on the calculated total power of the drives, the logic block determines the new rotation frequency of the drilling tool. This total power is used to generate a control signal that determines the rotation frequency of the main driven hydraulic motor shaft. The rotation frequency of the drilling rig is directly related to the rotation frequency of the hydraulic motor shaft through the gear ratio of the reducer.

6. If the total power of the drives remains constant, the second logic block adjusts the set value of the feed per revolution. The adjustment is carried out by comparing the set value with the theoretically calculated value.

7. Taking into account the actual value of the feed for each revolution, the rotation speed of the drilling tool is set or, if necessary, the drilling process is stopped and the tool is replaced.

CONCLUSION.

Thus, summarizing the above, we can draw the following conclusion. Automation of the drilling process includes not only rock fragmentation, but also other important stages, such as well cleaning, strengthening, cementing and prevention of emergency situations. Unexpected problems may arise during rock fragmentation and drilling. The specifics of these operations are that they are very difficult to monitor and control in real time. It is important to optimize drilling technology using automation tools and methods, create process control principles and integrate them with hardware and software complexes. The proposed control algorithm adapts to rock erosion and strength while maintaining maximum power using feedback. It also automatically controls the position of the rock cutting tool, ensuring high productivity of the drilling process.

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