RESEARCH ON IMPROVING THE EFFICIENCY OF OIL AND GAS WELL DRILLING PROCESSES

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Abstract: *This article reviews the comprehensive results of the interaction of technical indicators of efficiency based on modern research on improving the efficiency of drilling processes for oil and gas wells. After examining the main technical parameters for assessing the efficiency of drilling for oil and gas wells, modern research is reviewed, based on technological solutions that allow accelerating drilling without increasing risks in drilling processes. Special attention is also paid to the importance of digital control systems for controlling drilling processes, selecting drilling equipment and optimizing operating modes.*

Keywords: *Drilling efficiency, well design, drilling technologies, operation, drilling equipment, drilling monitoring, geological surveys.*

ИССЛЕДОВАНИЯ ПО ПОВЫШЕНИЮ ЭФФЕКТИВНОСТИ ПРОЦЕССОВ БУРЕНИЯ НЕФТЯНЫХ И ГАЗОВЫХ СКВАЖИН

Аннотация: *В данной статье рассматриваются комплексные результаты взаимодействия технических показателей эффективности, основанные на современных исследованиях по повышению эффективности процессов бурения нефтяных и газовых скважин. После рассмотрения основных технических параметров оценки эффективности бурения нефтяных и газовых скважин, рассматривается современный подход к исследованию технологических решений, позволяющих ускорить бурение без увеличения рисков в процессе бурения. Особое внимание уделяется значению цифровых систем управления для управления процессами бурения, выбора бурового оборудования и оптимизации режимов работы.*

Ключевые слова: *Эффективность бурения, конструкция скважин, технологии бурения, эксплуатация, буровое оборудование, мониторинг бурения, геологические исследования.*

Introduction

The efficiency of oil and gas well drilling processes in mining enterprises has become one of the central topics of the modern petrochemical industry, as modern technologies based on technical systems are increasingly used in the industry. Every year, drilling projects move into deeper, more complex formations, where geological uncertainty, high-pressure zones and changing rock properties create additional challenges for engineers. In such conditions, the question is no longer how to drill a well, but how to drill it efficiently: faster, safer and at a predictable cost. This change in priorities has prompted researchers and industry experts to reconsider traditional drilling practices and look for more flexible, technology-based approaches. Many factors affect effective drilling. Some of them - for example, the type of bit, the characteristics of the drilling fluid or the selected well drilling compound - are technical decisions made at the design stage. Others, such as geomechanical surprises, equipment failures or unstable structures, occur directly during operations and require rapid response measures. The interaction of these elements creates a dynamic environment in which successful results depend on how well the drilling team can correctly assess the situation, interpret real-time data and make immediate corrections. In recent years, the integration of digital tools has significantly changed the way drilling performance is managed. Real-time monitoring systems, automated control units and advanced logistics technologies allow engineers to detect anomalies early and reduce downtime. These innovations provide access not only to operational parameters, but also to predictive analytics based on machine learning models and big data sets. As a result, drilling operations are gradually moving from reactive decision-making to proactive planning. However, technology alone does not guarantee efficiency. Organizational discipline, proper planning and skilled personnel are equally important. Most delays are caused not by equipment limitations, but by coordination problems, misinterpretation of well signals or inconsistent communication between the surface team and remote monitoring centers. Therefore, effective drilling should be understood as a balance between the right tools, skilled professionals and a well-structured workflow. The purpose of this study is to examine the key factors that determine drilling efficiency, assess the issues that commonly reduce efficiency, and discuss strategies that can help

achieve consistent, predictable results even in challenging geological conditions. Particular attention is paid to the relationship between operating parameters, dead time, and drilling technology selection. By examining these aspects together, the study aims to demonstrate that drilling efficiency is not a single technical objective, but a multidimensional concept that requires a comprehensive approach. This perspective will allow both engineers and managers to better understand how to optimize operations and reduce costs without compromising safety or well integrity. When it comes to drilling oil and gas wells, efficiency is usually associated with two concepts - speed and cost. However, in practice, everything is much broader. Engineers use a whole set of parameters that allow them to assess how well the process is going and where potential losses are hidden. These indicators serve as a kind of benchmark: they help to compare different wells, monitor the dynamics and identify obstacles that require correction. One of the main parameters is the mechanical drilling rate. It shows how many meters the string can travel per hour or day and is determined not only by the characteristics of the well, but also by the physical properties of the rock, the flushing system and the correctness of the selected loading mode. Increasing ROP is one of the most correct ways to speed up the construction of a well, but it should be remembered that extreme modes can lead to accidents or rapid wear of the drill bit. Therefore, engineers try to find the optimal combination of speed and stability. The coefficient of technical utilization of drilling equipment occupies a special place. It reflects how fully the equipment is used and how stable the operations are. Long downtimes of the equipment, frequent repairs or poor organization of processes usually indicate low efficiency, even if the actual drilling speed looks good. Another criterion is the drilling cost per meter of excavation. This indicator is very dependent on the area, depth and complexity of the geology, but in any case it allows you to objectively assess how justified the costs are. Sometimes the speed can be high, but if very expensive tools are used to achieve this, the overall effect is questionable. Therefore, companies try to find a balance between price and result. These can include indicators such as the number of bit changes, the time spent on lowering and lifting operations, the stability of the parameters of the flushing fluid, the accuracy of telemetry, the percentage of plan execution, and even the level of automation of processes. All of them help to form a holistic picture of how efficiently drilling operations are proceeding. Drilling efficiency is rarely determined by one or two parameters. Usually, it is a set of conditions, decisions, and actions that speed up or slow down the process. In real field conditions, a small detail - the wrong choice of mixture density, excessive tool

reduction, and the wrong choice of drill bit - can change the entire pace of work. Therefore, understanding the factors affecting efficiency is of particular importance for both engineers and project managers. Geology is the basis that determines the nature of the entire process. Strongly abrasive rocks, layer changes, high formation pressure, fractures, or unstable zones can significantly slow down drilling. Sometimes even experienced specialists are forced to reduce the load modes to avoid complications. In soft rocks, on the contrary, with proper adjustment, it is possible to achieve high drilling speeds. The weight of the drill, the revolutions of the rotor or drill motor, the flushing parameters - all this makes up the drilling "mode". The correct balance between load and speed allows you to achieve maximum rock erosion. If the modes are selected incorrectly, there is a risk of clogging of the spiral column, overheating under the influence of heat, or damage to the casing. Today, many parameters are controlled automatically, but the human factor still plays a key role. Drilling fluid is not just a liquid that circulates in the well. It performs several functions at once: it cools the drill, removes cuttings, stabilizes the well walls, and prevents the formation of gas-oil-water formations. Even an experienced team cannot maintain efficiency if the equipment is operating unstable. Problems with pumps, impellers, solution cleaning systems or telemetry lead to downtime, which immediately increases unproductive time. Regular maintenance, preventive inspections and quality training of personnel significantly reduce the likelihood of unplanned downtime. Modern automatic control systems help stabilize regimes and respond to anomalies faster than humans. Vibration analysis programs, failure prediction models, digital twins of wells - all this reduces the likelihood of errors and increases the predictability of work. The more automated the processes, the less random changes and downtime. The development of the oil and gas industry in recent decades has fundamentally changed the approach to drilling. If earlier the main means of accelerating work was the selection of drills and increasing loads, today the main focus is on smart technologies, automation and a clear understanding of geological conditions. Such solutions allow not only to increase drilling speed, but also to make the process more predictable, safe and economical. Today, many companies use software complexes that analyze hundreds of parameters in real time and suggest optimal loading modes, rotations, fluid consumption and drilling pressure. Modern drilling fluids contain additives that regulate their rheology, lubricity, wall stability, prevent clay hydration and reduce abrasive effects. Such solutions increase the stability of the column, reduce circulation losses and improve mud flow. If the solution is chosen correctly, the well is drilled faster and with fewer

complications. Remote control centers allow specialists to monitor well parameters hundreds of kilometers from the drilling site, analyze trends, predict risks and make recommendations in real time. This reduces the burden on the local team and allows for quick decision-making based on large amounts of data. Such integration of knowledge significantly improves the quality of drilling process management.

Conclusion

Today, the efficiency of drilling oil and gas wells is formed by a combination of technology, organization and the ability to adapt to constantly changing geological conditions. Modern efficiency is achieved through the balanced integration of advanced tools, intelligent monitoring systems, well-developed drilling programs and a highly skilled team that can make informed decisions in real time. One of the main conclusions that can be drawn from analyzing the drilling process is that efficiency is not the result of a single action, but a chain of interconnected stages. Improving the performance of the well assembly, reducing ineffective time, optimizing drilling solutions and using numerical analysis - all this leads to a cumulative effect that ultimately determines the cost and duration of well construction.

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