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Quality Control and Preventive Maintenance Site Management of Oil Drilling Machinery Equipment Based on Intelligent Monitoring

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Abstract: *In the oil drilling project, especially based on the "daily fee" contract model, the quality management of machinery and equipment and site monitoring are the key factors for the success of the project. Drilling operations are affected by a variety of variables, such as geological environment, operating parameters, owner requirements and equipment performance, which often lead to the accumulation of quality hazards and safety risks. The operation status of equipment not only directly affects the efficiency and safety of drilling operations, but also determines the market competitiveness and brand image of enterprises in the long run. How to realize real-time monitoring and dynamic management of equipment quality through intelligent monitoring technology has become the core challenge to improve project execution effect and guarantee project quality. The intelligent monitoring system provides accurate equipment operation data and timely detection of potential problems through data-driven analysis, enabling preventive maintenance and optimized management decisions, minimizing risk and wastage, and providing continuous quality assurance and efficient management support for projects. The application of this method not only improves the science and accuracy of site management, but also provides a practical reference for the intelligent transformation of the oil drilling industry.*

Keywords: *Mechanical equipment; Quality control; Site management; Intelligent monitoring; Preventive maintenance; Data-driven; Risk early warning; Drilling operation*

1. Introduction

Oil drilling operation is the core link of oil and gas exploitation, the quality control of machinery and equipment and site management play a vital role in ensuring the smooth operation. There are many kinds of equipment involved in drilling operation, including drilling rig, derrick, drill bit, drilling fluid circulation system, etc. The performance and stability of each equipment are directly related to the quality and safety of the operation. In the high-intensity, complex drilling environment, any minor equipment failure can set off a chain reaction that can lead to delays, safety incidents, and even the economics of oil and gas production. Comprehensive quality management of machinery and equipment to ensure that it always maintains the best working condition is the basis for ensuring the smooth progress of drilling operations.

The core task of oil drilling site management is to coordinate the relationship between people, equipment and processes to achieve efficient, safe and accurate operations. Managers not only need to closely monitor the operating status and fault warning of equipment, but also must deal with various emergencies and technical adjustments on site. This requires the site management system to have a high degree of responsiveness and coordination, can quickly deploy resources, optimize the work process. The application of intelligent monitoring technology is particularly important. Through intelligent sensors and data acquisition systems, every working parameter of the equipment can be monitored in real time, and any deviation can be detected and warned in time. These real-time data can not only provide accurate decision-making basis for field managers, but also help to predict faults, identify potential failure points in advance, implement preventive maintenance, and avoid the impact of sudden equipment failures on the work schedule.

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2. Related research

F Liu, Y Li designed an intelligent storage tank level monitoring system based on infrared thermal imaging. The hardware part of the liquid level measurement system is mainly composed of the host, microcontroller, magnetic head and infrared thermal imager [1]. Real-time monitoring and control in the breakthrough phase is a key issue in ultrafast laser drilling (ULD). T Sun proposed a new intelligent method to solve the problem of decision bias in breakthrough stage monitoring [2]. Q Wan, L Chen, M Zhu proposed an integrated model of the three concepts of manufacturing a continuous flow process, which is very different from the parts process because there is no explicit production unit [3]. W Jin adopts advanced sensor technology, including water quality sensor, water level sensor, weather sensor, etc., to monitor water quality indicators in real time [4].

3. Factors affecting quality control and site management of oil drilling equipment

3.1 Analysis of the problem of inadequate on-site management of equipment

The state and performance of machinery and equipment directly determine the operational efficiency and safety of an enterprise. Many enterprises focus too much attention on short-term cost benefits in actual operation, ignoring the long-term value of equipment management and on-site monitoring, resulting in imperfect equipment maintenance system, on-site management lack of systematization and foresight. This management deviation makes the equipment prone to failure during long-term, high-intensity operation, which leads to production interruption and safety accidents, and brings non-negligible risks to enterprises.

Oil drilling machinery and equipment in the harsh working environment, often face high load, high strength operation, equipment itself wear and aging is inevitable. Under the traditional management model, many enterprises rely on regular inspections and emergency maintenance after equipment failure, and this reactive management style often fails to identify potential problems with equipment in a timely manner. When the equipment fails during operation, it will not only directly affect the construction progress, but also cause serious safety risks, and even cause larger accidents such as equipment damage and environmental pollution. This passive approach makes it difficult for enterprises to achieve the optimal state of equipment performance, increasing management costs and security risks.

The introduction of intelligent monitoring technology provides a new solution for equipment management. Through the installation of real-time monitoring system, enterprises can continuously monitor the operating status of drilling machinery and equipment, real-time acquisition of equipment temperature, pressure, vibration and other key parameters, and through the data analysis system to detect abnormal fluctuations, predict the possibility of equipment failure in advance. This data-driven management model can not only improve the transparency of equipment status, but also provide accurate decision support for field management to ensure that equipment is operating in an optimal state.

Combined with big data and machine learning algorithms, intelligent monitoring technology enables predictive maintenance of equipment. This maintenance mode can not only take timely intervention measures before the equipment fails, but also identify the potential risk points of the equipment based on historical data analysis, and develop a more scientific maintenance plan. This active maintenance method greatly reduces production stagnation and safety accidents caused by equipment failure, and reduces unnecessary maintenance costs and waste of resources.

3.2 Hysteresis analysis of equipment field management means

There are many kinds of mechanical equipment and different applications, which brings great complexity to the on-site management of equipment. Different types of equipment not only have different performance requirements, but also different working environments and maintenance needs, and how to efficiently and accurately manage equipment has become a major challenge for oil drilling companies. The on-site management of many enterprises still relies on traditional manual methods, and lacks systematic information and intelligent support. This management mode, which relies on manual inspection and experience judgment, has obvious problems of low efficiency and information lag, especially in the high load and complex environment, the potential failure of equipment is often not timely warning and processing.

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Due to the variety of devices and the complexity of the operating environment, it is difficult for traditional management methods to effectively monitor the health status of devices. Equipment failures are often detected after the symptoms become apparent, and this reactive management approach leads to significant downtime and maintenance costs, inevitably affecting operational schedules and safety. Taking oil drilling operations as an example, once the equipment is faulty, it may lead to the interruption of underground operations, which will lead to a series of chain reactions, and even lead to safety accidents or environmental pollution in serious cases.

Field managers face a large number of equipment and complex data, lack of efficient information integration and analysis tools, which makes it difficult to achieve precision and dynamic work. Especially in technical management, excessive reliance on experience often leads to one-sidedness of decision-making and arbitrary operation, and can not timely adapt to the changes in equipment needs and the adjustment of field operating conditions. This limitation not only reduces work efficiency, but also makes it difficult to improve the level of on-site safety management.

In order to solve this problem, the application of intelligent monitoring and information management technology is essential. By deploying smart sensors and real-time monitoring systems, enterprises can track the operating status of equipment in real time, capturing key performance data of equipment, temperature, pressure, vibration and other parameters. Through data analysis, the system can assess the health of equipment in real time, predict potential failures, and issue alerts before problems occur. Unlike traditional passive maintenance, intelligent monitoring technology can provide predictive maintenance based on data, reduce downtime caused by equipment failure, and improve the efficiency of equipment operation.

Intelligent management tools can also help field managers to achieve centralized data management and real-time sharing, avoid information lag or fault, and ensure the timeliness and accuracy of decision-making basis. Through the integration and analysis of data, managers can fully understand the status of field equipment, optimize resource allocation and scheduling decisions, and improve the safety and efficiency of field operations.

3.3 Analysis of the lack of management coordination and the improvement path of personnel management level

The equipment management of oil drilling operation is not limited to the operation of a single mechanical equipment, but a multi-equipment working together and interdependent system. The coordination and cooperation between the equipment directly affect the smooth progress of the operation. Managers not only need to have a deep understanding of the operating principles of each device, but also need to be proficient in the relationships and interactions between them in order to ensure the efficiency and reliability of equipment operation. Especially in the case of equipment failure, only with comprehensive technical knowledge and management capabilities can we quickly take appropriate emergency measures to minimize the impact of the fault on the work schedule and safety.

The traditional management mode often relies on experience and simple periodic inspection, and lacks dynamic monitoring and in-depth analysis of equipment status. Such a management approach is inadequate in the face of increasingly complex and demanding drilling operations. Managers often only realize the seriousness of the problem after the equipment fails, resulting in a delayed maintenance response and a failure to address potential safety hazards and equipment damage risks in a timely manner. In the case of equipment running at high load for a long time, the lack of efficient fault diagnosis and preventive maintenance means often leads to the timely recovery of the system. It increases the probability of failure, affects the safety of operation and the service life of equipment.

The lag of equipment management is not only a problem of insufficient quality and experience of operators, but also a reflection of the insufficient application of information and intelligent technology. Traditional management models do not provide a comprehensive understanding of the real-time condition of the device, and management decisions are often based on limited information or outdated data that cannot accurately reflect the true health of the device. It is particularly important to improve the technical ability of managers and introduce advanced monitoring technology.

The application of intelligent monitoring technology provides an innovative way to solve this problem. By collecting and analyzing equipment operation data in real time, the intelligent monitoring system can accurately identify abnormal fluctuations in equipment operation, predict potential faults and risk points, and provide timely warning information. With this technology, managers can detect problems earlier and take appropriate preventive measures to avoid production interruptions and safety

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accidents caused by equipment failures in the traditional management model. Intelligent monitoring can also optimize maintenance plans through data analysis, enabling managers to develop more accurate maintenance strategies based on the actual use of equipment and historical fault data, further extending the service life of equipment and improving the safety of operations.

4. Quality control and intelligent monitoring strategy of oil drilling equipment

4.1 Improve the importance of drilling equipment management and intelligent monitoring applications

The efficient operation of machinery and equipment is the key to ensure the safety and efficiency of work. In order to achieve this goal, the production units in the oil field must pay more attention to the management of drilling equipment, and formulate feasible management strategies and implementation plans according to the actual operating environment and technical requirements. These strategies should include the optimization of equipment management system, scientific management in the construction process and the application of information management, in order to systematically improve the level of equipment management.

The site management system of equipment should keep pace with The Times and adapt to the needs of modern oil drilling operations. The traditional management mode often ignores the real-time status and dynamic changes of the equipment, resulting in the failure early warning and response is not timely. It is necessary to supplement and improve the equipment management system on the existing basis. The key lies in in-depth analysis of equipment operating characteristics, combined with industry standards and enterprise needs, and continuous optimization of management processes. Especially in high-intensity, high-load drilling environments, managers need to be flexible in their strategies to ensure equipment is always operating optimally and minimize the risk of failure.

The construction management of drilling equipment is not only dependent on the following technical specifications and operating procedures, but also on the scientific decision-making based on the field situation. Managers need to fully consider the balance between the carrying capacity and operation intensity of the equipment to avoid premature aging or failure of the equipment due to excessive load or unreasonable arrangement. The management ability and technical level of personnel play a crucial role in the field management. Excellent managers not only have a solid technical background, but also have the ability to solve unexpected problems, which will directly affect the operation safety and production efficiency of the equipment. In the selection of managers, we should not only rely on technical ability, but also consider their practical management experience and contingency ability.

The introduction of information management means has brought revolutionary changes to equipment management. Through the establishment of information management system, it can collect and analyze the operating data of the equipment in real time, and accurately grasp the health status of the equipment. The intelligent monitoring system can automatically monitor the key parameters of the equipment, and in the event of abnormal fluctuations, the system can quickly send an early warning signal to prompt managers to check and repair. This technology can not only effectively reduce the error of manual inspection, but also provide real-time and accurate data support to help managers make scientific decisions. Combined with big data analysis, the system is able to predict equipment failures, plan preventive maintenance in advance, and avoid production stagnation or safety incidents caused by failures.

4.2 Improve the construction of oil drilling equipment management system and intelligent monitoring system

The normal operation of mechanical equipment is the basis to ensure the smooth operation, and the quality control and site management of equipment directly determine the efficiency and safety of the operation. It is essential to establish a systematic and scientific management system. This not only needs to pay attention to the technical requirements of the equipment itself, but also should develop comprehensive management norms in terms of safety, maintenance, operation, etc., to ensure the collaborative operation and efficient execution of each link.

The formulation of the management system should be based on the actual production environment and operation requirements, combined with advanced management concepts and technical means for

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accurate planning. Oil drilling has high risk, high intensity and complexity. It involves many kinds of equipment and many operation links. The management system should not only cover equipment management and operation specifications, but also match with specific operation scenarios. For equipment with high load and long-term operation, special emphasis should be placed on the status monitoring of equipment, the recording and analysis of operating parameters, so as to detect potential problems in time and carry out preventive maintenance. This requires a management system that is not only operational, but also flexible and can be dynamically adjusted according to equipment usage and field needs.

Safety production management system is an indispensable part of oil drilling operation. Because drilling operations often involve complex machinery and equipment and dangerous operating environments, such as downhole pressure, high temperature, highly corrosive environment, once the failure or operation error, may lead to serious accidents. Safety production system should be based on prevention, covering equipment operation safety, personnel safety, operation process monitoring and other aspects. In addition to the strict implementation of operating procedures, the work safety system should incorporate modern technology to build real-time monitoring and fault warning mechanisms, especially during the operation and maintenance of drilling equipment. Through the introduction of intelligent monitoring technology, the real-time status of the equipment can be accurately tracked, and in the event of abnormal fluctuations or potential failures, the system can automatically issue alarms to help field managers respond in time to reduce the risk of accidents.

The improvement of equipment repair and maintenance system is also the key to improve the operation efficiency of mechanical equipment and extend the service life of equipment. The operating environment of oil drilling equipment is harsh, and it is easy to aggravate the wear and failure of equipment under high strength, high load and harsh environment. Regular repair and maintenance is particularly important. When developing the equipment maintenance system, the maintenance cycle and maintenance content should be determined according to the technical characteristics, workload and actual use of the equipment. In this process, the intelligent monitoring system can provide real-time data support to help identify the health status of the equipment, predict the occurrence of failures, and adjust the maintenance plan according to the actual data. This data-driven preventive maintenance can not only significantly improve maintenance efficiency, but also reduce the occurrence of sudden failures, thus ensuring the long-term stable operation of equipment.

5. Conclusion

The success of oil drilling operations is closely related to the quality control of machinery and equipment and site management. The importance of mechanical equipment in drilling operation is self-evident, and how to ensure its efficient and stable operation has become the key to affect operation efficiency and safety. A series of comprehensive measures must be taken to ensure the orderly conduct of equipment management and field operations. The introduction of intelligent monitoring system can provide real-time data support for device management, real-time monitoring of device operating status and key parameters, and timely warning of potential fault risks. This data-driven management model not only greatly improves the accuracy of equipment fault detection, but also enables rapid response when problems occur, reducing downtime and extending the service life of equipment.

Equipment quality management not only depends on advanced monitoring technology, but also needs a sound on-site management mechanism to support. The oil drilling environment is complex and challenging, and the operation site involves multiple links and positions, which requires cooperation from all parties. Optimization of site management requires clear responsibilities of various departments and the establishment of efficient coordination mechanisms to ensure the rapid and accurate flow of information and decision transmission. Intelligent technology can greatly improve management efficiency, reduce human error through automated scheduling and real-time feedback, and achieve optimal control of field operations.

With the technical complexity of drilling operations and the continuous expansion of equipment scale, the traditional manual management model has been unable to meet the needs of efficient and accurate. In order to achieve long-term stable production, it is necessary to strengthen the technical training of operators and improve the management ability. The high-quality operation team can not only better understand the operating principle of the equipment and the emergency treatment process, but also effectively use information tools to conduct independent monitoring and data analysis, and promote the improvement of operational efficiency. In the development of management plans, we

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should not only consider the technical and operational processes of equipment, but also strengthen the technical reserves and emergency response capabilities of personnel.

The improvement of oil drilling operation management system needs continuous optimization in many aspects. This includes not only the preventive maintenance of equipment, the application of intelligent monitoring, the standardization of field management, but also the management of the life cycle of equipment. Through the introduction of the whole life cycle management concept, combined with big data analysis and artificial intelligence technology, the service life of the equipment can be more accurately predicted, a more reasonable maintenance plan can be made, and scientific decisions can be made when the equipment is aging or updated to ensure the efficiency and safety of the operation.

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