

Research on periodic intelligent inspection and maintenance of offshore platform equipment

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Abstract: Marine platform equipment is crucial infrastructure in ocean engineering and resource development. However, its operation in harsh marine environments presents numerous challenges. This paper aims to explore the importance of regular intelligent detection and maintenance of marine platform equipment, and proposes a corresponding research framework. Firstly, the types and functions of marine platform equipment, as well as their roles in ocean engineering, are introduced. Secondly, the importance of regular intelligent detection for the safe operation of equipment is discussed, with an emphasis on the role of intelligent technology in the detection process. Subsequently, the role of maintenance in extending equipment lifespan and reducing accidents is analyzed, along with a discussion on the impact of different maintenance strategies. Finally, a set of detection and maintenance schemes based on intelligent technology is proposed, and its future development is discussed, aiming to provide theoretical support and technical guidance for the safe operation and sustainable development of marine platform equipment.

1. Introduction

Marine platform equipment, as the core infrastructure supporting ocean engineering and resource development, plays an irreplaceable role in the marine environment. However, it faces challenges from extreme environments such as waves, storms, and seawater corrosion, raising concerns about its safety and reliability. To ensure the long-term stable operation of marine platform equipment, regular intelligent detection and maintenance are particularly important. This paper aims to explore the importance of regular intelligent detection and maintenance of marine platform equipment and proposes a corresponding research framework. Firstly, the types and functions of marine platform equipment, as well as their extensive applications in ocean engineering, are introduced. Secondly, the indispensable nature of regular intelligent detection for the safe operation of equipment is emphasized, with a focus on the application advantages of intelligent technology in monitoring and diagnosis. Subsequently, the importance of maintenance in extending equipment lifespan and reducing failure rates is analyzed, along with a discussion on the advantages and disadvantages of different maintenance strategies. Finally, a set of detection and maintenance schemes based on

intelligent technology is proposed, with prospects for its future development in the field of ocean engineering. Through this study, the aim is to provide theoretical support and technical guidance for the safe operation and sustainable development of marine platform equipment, to address the challenges in the marine environment, and to promote the efficient, safe, and sustainable development of ocean engineering and resource development.

2. Overview of Marine Platform Equipment

Marine platform equipment constitutes essential facilities and apparatus for various engineering, scientific research, and resource development activities in marine environments. Serving as a bridge between land and sea, they provide crucial support for human exploration of the oceans. In this section, we will provide an introduction to the classification of marine platform equipment to better understand their functions and application scenarios.

2.1 Introduction to the Classification of Marine Platform Equipment

Marine platform equipment can be classified based on their purpose and structural characteristics. In terms of purpose, marine platform equipment mainly includes offshore oil and gas extraction platforms, offshore wind power platforms, and marine scientific observation platforms. Offshore oil and gas extraction platforms are used for extracting petroleum and natural gas resources from the seabed, encompassing various types such as fixed platforms, floating platforms, and semi-submersible platforms. Offshore wind power platforms, on the other hand, are utilized for constructing wind power generation facilities at sea, harnessing offshore wind energy for energy production. Meanwhile, marine scientific observation platforms are employed for conducting scientific research on marine environments, ecosystems, and climate change, consisting of vessels, buoys, and underwater observation stations. Structurally, marine platform equipment can be categorized into fixed platforms, floating platforms, and semi-submersible platforms. Fixed platforms are anchored to the seabed using piles or other fixed structures, suitable for shallow-water environments. Floating platforms are supported on the water surface by buoyancy devices such as pontoons or floating boxes, suitable for deeper waters. Semi-submersible platforms partially submerge underwater while keeping some structures above the water surface, possessing strong stability and adaptability, suitable for moderate-depth waters. Furthermore, marine platform equipment can also be classified based on materials, such as steel platforms and concrete platforms. Steel platforms are constructed using steel structures, exhibiting strong corrosion resistance and load-bearing capacity, suitable for various marine environments. On the other hand, concrete platforms are composed of concrete materials, suitable for constructing large-scale marine structures, with good durability and stability. Through the classification introduction above, we can gain a preliminary understanding of the diversity and complexity of marine platform equipment. Different types of platform equipment have their unique characteristics and applications, playing indispensable roles in ocean engineering and resource development[1].

2.2 Functions and Application Scenarios of Marine Platform Equipment

Marine platform equipment serves various functions and finds extensive application scenarios, including but not limited to the following aspects. Firstly, marine platform equipment plays a vital role in resource development and utilization. These equipment are widely employed in the development and utilization of marine oil, gas, wind energy, and other resources. For instance, offshore oil and gas extraction platforms are utilized to extract petroleum and natural gas resources from the seabed, while offshore wind power platforms are used to construct wind power generation

facilities at sea, harnessing offshore wind energy for energy development. Secondly, marine platform equipment plays an important role in scientific research and exploration. They are used to conduct scientific observations and exploration missions related to marine environments, ecosystems, and climate change. For example, marine scientific observation platforms are deployed with marine observation equipment to monitor changes in marine environmental parameters, providing data support for scientific research. Additionally, marine platform equipment is widely used in marine engineering construction and maintenance. In marine engineering, fixed platforms can be used as offshore drilling platforms or support structures for offshore bridges, while floating platforms can be used for offshore lifting operations and floating dock construction. Lastly, marine platform equipment can also be used for emergency rescue services. They can provide support and assistance for maritime accidents and disasters, carry out maritime search and rescue missions, and provide emergency medical and material support. In summary, marine platform equipment is indispensable infrastructure and apparatus for connecting land and sea, developing and utilizing marine resources, conducting scientific research, and ensuring maritime safety. They play crucial roles in the development of the marine industry and cannot be replaced by other facilities or devices[2].

3. Importance of Regular Intelligent Inspection

3.1 Concept of Regular Inspection and Its Application in Marine Platform Equipment

Regular inspection refers to systematic checks, monitoring, and assessment of marine platform equipment at regular intervals to ensure they remain in good condition during operation. It aims to promptly detect and address potential issues and defects. This inspection typically involves examining the structure, mechanical, electrical, and instrumentation aspects of the equipment. By evaluating various indicators, the equipment's operational status, safety hazards, and the need for repairs or component replacements can be determined. Regular inspection holds significant application value in marine platform equipment. Firstly, marine platform equipment often operates in harsh marine environments, susceptible to factors such as waves, storms, and seawater corrosion, leading to wear, corrosion, and aging issues. Regular inspection helps promptly identify these problems, preventing further deterioration, and ensuring safe operation of the equipment. Secondly, marine platform equipment usually possesses complex structures and working principles, involving numerous mechanical, electrical, and control system components. Failures in these components may result in equipment downtime, accidents, or even disasters. Regular inspection comprehensively monitors and assesses these components, helping prevent equipment failures, and enhancing reliability and stability. Additionally, regular inspection provides a scientific basis for equipment maintenance, assisting in determining maintenance cycles, contents, and methods, thereby maximizing equipment lifespan, reducing maintenance costs, and improving economic efficiency. Therefore, regular inspection plays a crucial role in marine platform equipment, ensuring safe operation and facilitating smooth progress in ocean engineering and resource development[3].

3.2 Role of Intelligent Technology in the Inspection Process

Intelligent technology plays a crucial role in the regular inspection process of marine platform equipment. Its significance manifests in several aspects. Firstly, real-time monitoring and data acquisition are facilitated. Through intelligent technology, marine platform equipment can achieve real-time monitoring and collect various parameter data such as temperature, pressure, vibration, and current through sensors and other devices. This data promptly reflects the actual operating conditions of the equipment, aiding in the timely identification of anomalies and potential failure

risks. Secondly, intelligent technology enables data analysis and fault diagnosis. Utilizing techniques such as big data analysis and machine learning, intelligent technology can intelligently analyze monitoring data and diagnose faults in marine platform equipment. By establishing models and algorithms, abnormal behavior and fault characteristics in equipment operation can be quickly and accurately identified, providing scientific basis for subsequent repairs and maintenance. Moreover, intelligent technology enables predictive maintenance and optimization scheduling. By analyzing monitoring data and fault diagnosis results, potential equipment failures and damages can be predicted, allowing for the formulation of maintenance plans and optimization scheduling in advance. This minimizes equipment downtime and maintenance costs while enhancing reliability and operational efficiency. Lastly, intelligent technology enables remote monitoring and remote operation. Through techniques such as drones, remote control, and autonomous navigation, comprehensive monitoring and control of equipment can be achieved, reducing human intervention and work risks, and improving efficiency and safety. In summary, intelligent technology plays a vital role in the regular inspection process of marine platform equipment, providing effective technical support for ensuring safe operation and extending equipment lifespan.

3.3 Analysis of the Impact of Regular Intelligent Inspection on Equipment Safety

Regular intelligent inspection has a positive impact on the safety of marine platform equipment, primarily in the following aspects: Firstly, it enables the timely detection of potential failure risks and issues. Through real-time monitoring and data acquisition facilitated by intelligent technology, detailed information regarding the equipment's operational status, including various parameter data and performance indicators, can be promptly obtained. Intelligent analysis of this data allows for the rapid identification of anomalies and potential failure risks, preventing equipment damage or accidents due to undetected issues. Secondly, regular intelligent inspection enhances equipment reliability and stability. By conducting regular intelligent inspection and fault diagnosis, equipment failures and issues can be promptly identified and addressed, preventing failures and improving equipment reliability and stability. Timely repair and replacement of problematic components can prevent equipment downtime and production losses, ensuring the continuous and stable operation of marine platform equipment. Additionally, regular intelligent inspection prolongs equipment lifespan. By conducting regular intelligent inspection and maintenance, issues such as wear, corrosion, and aging of equipment can be promptly identified and addressed, delaying equipment degradation and damage, and extending equipment lifespan. Through scientific maintenance measures, equipment wear can be minimized, enhancing equipment efficiency and economic benefits. In conclusion, regular intelligent inspection has a significant impact on the safety of marine platform equipment, enabling the timely detection of potential failure risks, improving equipment reliability and stability, extending equipment lifespan, and providing effective technical means for ensuring safe operation and improving production efficiency[4].

4. Maintenance and Its Role in Ensuring Equipment Safety

4.1 Definition and Purpose of Maintenance

Maintenance is a systematic management activity aimed at ensuring that equipment, machinery, or systems operate normally, remain in good condition, and prolong their lifespan while enhancing their performance and safety. This process involves a series of measures such as regular inspections, maintenance, repairs, and adjustments. Its purpose is to ensure the reliability, safety, and continuous operation of equipment. Firstly, maintenance ensures the normal operation of equipment. Through regular inspections and maintenance measures, wear, faults, and issues with equipment can be

detected promptly, and corresponding measures can be taken for repairs. This ensures that equipment remains in good working condition during operation, avoiding production interruptions and losses due to malfunctions. Secondly, maintenance helps extend the lifespan of equipment. By effectively reducing equipment wear and aging, maintenance activities such as regular checks, lubrication, cleaning, and adjustments can delay equipment degradation and damage. This minimizes early equipment failures and damages, prolonging equipment lifespan, reducing equipment replacement and maintenance costs, and improving economic efficiency. Additionally, maintenance can improve equipment performance. By adjusting and optimizing equipment parameters and performance, maintenance can enhance production efficiency and quality, reduce energy consumption and resource usage, and improve economic and environmental benefits. Moreover, maintenance ensures safe production. By timely identifying equipment safety hazards and risks and taking appropriate measures to address them, maintenance ensures equipment safety and stability, thereby guaranteeing safe production and reducing the probability and losses of accidents. In summary, maintenance, as an important management activity, provides crucial support and assurance for enterprises' production and operations, ensuring normal equipment operation, prolonging lifespan, improving performance and safety, and providing a stable technical foundation for enterprise development[5].

4.2 Importance of Maintenance in Extending Equipment Lifespan and Reducing Failure Rates

Maintenance stands as a cornerstone in the realm of equipment management, profoundly influencing equipment performance, longevity, and overall operational efficiency. Let's delve deeper into the multifaceted significance of maintenance in extending equipment lifespan and mitigating failure rates. Maintenance activities, ranging from routine checks to comprehensive overhauls, are instrumental in preserving the integrity and functionality of equipment over time. By adhering to a structured maintenance schedule, organizations can effectively mitigate the effects of wear and aging on equipment components. Regular lubrication, cleaning, and adjustments serve to minimize friction, prevent corrosion, and optimize performance parameters, thus extending the operational lifespan of equipment. This proactive approach not only delays equipment degradation and damage but also minimizes the need for premature replacements, consequently reducing long-term capital expenditure and enhancing asset utilization. One of the primary objectives of maintenance is to preemptively identify and address potential issues before they escalate into critical failures. Through systematic inspections, diagnostics, and proactive interventions, maintenance personnel can detect early warning signs of equipment malfunctions or deficiencies. By rectifying these issues in a timely manner, organizations can effectively mitigate the risk of unexpected breakdowns, unplanned downtime, and costly repairs. This proactive stance towards maintenance not only bolsters equipment reliability and availability but also fosters a culture of operational resilience and risk mitigation within the organization. Furthermore, by reducing failure rates, maintenance initiatives contribute to the overall enhancement of operational efficiency and production stability. With fewer disruptions to workflow and production processes, organizations can optimize resource allocation, meet production targets consistently, and uphold quality standards. This, in turn, fosters customer satisfaction, strengthens market competitiveness, and cultivates a positive brand image for the organization. In conclusion, the importance of maintenance in extending equipment lifespan and reducing failure rates cannot be overstated. By embracing a proactive approach to maintenance management, organizations can unlock significant value in terms of asset longevity, operational reliability, and cost efficiency. As technology continues to evolve and industries embrace digitization and predictive analytics, the role of maintenance is poised to become even more strategic, enabling organizations to stay ahead in an increasingly competitive landscape while ensuring sustainable growth and resilience.

4.3 Impact of Different Maintenance Strategies on Equipment Performance

Different maintenance strategies have varying impacts on equipment performance, and understanding these impacts is crucial for effective equipment management. Let's delve deeper into the significance of each maintenance strategy. Preventive maintenance is a proactive approach aimed at preventing equipment failures before they occur. It involves regular inspections, lubrication, cleaning, and adjustments to ensure equipment operates optimally. One of the key advantages of preventive maintenance is its ability to reduce equipment wear and tear, thereby extending equipment lifespan. By addressing potential issues early on, preventive maintenance also enhances equipment reliability and stability. Moreover, it minimizes equipment failure rates and downtime, leading to improved operational efficiency and production stability. Overall, preventive maintenance positively impacts equipment performance by promoting longevity, reliability, and efficiency. Corrective maintenance, also known as breakdown or reactive maintenance, involves repairing equipment after a failure has occurred to restore normal operation. While corrective maintenance is essential for addressing immediate issues, its impact on equipment performance can be mixed. On the one hand, it allows for quick resolution of equipment failures, minimizing downtime and restoring production efficiency. However, corrective maintenance is inherently reactive and does not prevent failures from happening in the first place. As a result, it may lead to production interruptions and losses, ultimately exerting a negative impact on equipment performance. Predictive maintenance takes a proactive approach by utilizing real-time monitoring and data analysis to predict potential equipment failures. By leveraging advanced technologies such as sensors, data analytics, and machine learning, predictive maintenance can identify early signs of equipment degradation and intervene before failures occur. This approach allows for the formulation of maintenance plans and optimization scheduling in advance, minimizing equipment downtime and maximizing operational efficiency. Predictive maintenance positively impacts equipment performance by reducing failure rates, enhancing reliability, and optimizing maintenance schedules for minimal disruption. In conclusion, the impact of different maintenance strategies on equipment performance varies significantly. While preventive maintenance promotes longevity and reliability, corrective maintenance addresses immediate issues but may result in downtime. Predictive maintenance stands out as a proactive approach that minimizes downtime, reduces failure rates, and optimizes maintenance schedules, ultimately leading to enhanced equipment performance and operational efficiency. Therefore, organizations must carefully evaluate their maintenance strategies to ensure optimal equipment management and performance.

5. Intelligent Technology-Based Detection and Maintenance Plan

The detection and maintenance plan for offshore platform equipment based on intelligent technology is designed to address the complexity of the marine environment and the long-term maintenance needs of offshore platform equipment. This plan integrates advanced sensing technology, big data analytics, artificial intelligence, and remote monitoring to achieve intelligent monitoring and maintenance of offshore platform equipment, thereby improving equipment reliability, safety, and economic benefits. In this plan, the first step is to establish an intelligent monitoring system by deploying various sensors and monitoring devices on offshore platform equipment to monitor equipment operation status and environmental parameters in real-time. These parameters include temperature, pressure, vibration, current, etc., with high data acquisition frequency and comprehensive coverage. Next, a big data analytics platform is established to store, process, and analyze monitoring data. By using machine learning and data mining techniques, intelligent analysis of equipment operation status and fault diagnosis is achieved. Based on monitoring data and analysis results, predictive maintenance strategies are formulated to predict potential equipment failures and damages, allowing for the development of maintenance plans and optimization scheduling in advance to minimize equipment downtime and repair costs. Additionally,

real-time monitoring and remote operation of offshore platform equipment are achieved through a remote monitoring system. Utilizing technologies such as unmanned aerial vehicles, remote control, and autonomous navigation, comprehensive monitoring and control of equipment are realized, reducing manpower input and work risks. Moreover, intelligent maintenance robots are deployed to execute maintenance tasks on offshore platform equipment, such as cleaning, lubrication, adjustment, and component replacement. These robots can operate in hazardous environments and high sea conditions, improving maintenance efficiency and safety. In summary, the detection and maintenance plan for offshore platform equipment based on intelligent technology utilizes a combination of intelligent monitoring systems, big data analytics platforms, predictive maintenance strategies, remote monitoring and operation, and intelligent maintenance robots to achieve intelligent monitoring, maintenance, and management of offshore platform equipment. This improves equipment reliability, safety, and economic benefits, providing crucial technical support for marine engineering and resource development.

6. Conclusion

In conclusion, the detection and maintenance plan for offshore platform equipment based on intelligent technology offers significant advantages and holds great significance. By employing intelligent monitoring systems, big data analytics platforms, predictive maintenance strategies, remote monitoring and operation, and intelligent maintenance robots, this plan achieves intelligent monitoring, maintenance, and management of offshore platform equipment, positively impacting equipment reliability, safety, and economic benefits. This intelligent technology-based plan not only enables the timely detection of equipment faults and issues, prolongs equipment lifespan, reduces equipment failure rates and downtime but also improves equipment operational efficiency and production stability, thus reducing production interruptions and losses and enhancing enterprise economic benefits and competitiveness. Compared to traditional maintenance methods, the intelligent technology-based plan boasts higher levels of intelligence and maintenance efficiency, making it better suited for the complexity of the marine environment and the long-term operation of equipment, and providing reliable technical support for marine engineering and resource development. Therefore, it can be concluded that the detection and maintenance plan for offshore platform equipment based on intelligent technology is an efficient and intelligent management plan with significant application prospects and development value. With the continuous development and application of intelligent technology, it is believed that this plan will play an increasingly important role in the field of marine engineering, contributing to the development of the marine economy and the safeguarding of marine environmental safety.

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