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Installation, Transportation to the Site, and Positioning of Hydro-Technical Structures in the Offshore Oil and Gas Industry Using the Technical Capabilities of Modern Geodetic Measurement Technologies

Abstract

Modern geodetic measurement technologies, particularly satellite navigation (GNSS), laser scanning (LiDAR), drone technology, and high-precision total stations, play a crucial role in the offshore oil and gas industry. Through these technologies, the design, transportation, precise installation, and positioning of hydro-technical structures are carried out more efficiently and safely. These systems provide the ability to operate with high accuracy in the challenging and variable marine environment, reducing human dependency and enabling operations to be completed on time with minimal error.

During the installation phase, the coordinates of the structures are predetermined using geodetic measurements, allowing the equipment to be accurately directed to the site. In the transportation phase, the planning and tracking of movements are effectively managed through geodetic systems. At the site, real-time precision monitoring ensures that the structures are positioned in a stable and designated location.

Consequently, the application of modern geodetic technologies enhances the technical level of engineering operations at sea, reduces economic costs, and increases safety standards. Ongoing advancements in this field open the door to implementing more complex projects in the offshore oil and gas industry in the future.

Keywords: *modern geodetic technologies, hydro-technical structures, offshore oil and gas industry, installation and positioning, GNSS and LiDAR, precise geodetic measurements, technical safety and efficiency*

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Müasir geodeziya ölçmə texnologiyalarının texniki imkanlarından istifadə etməklə dəniz neft-qaz sənayesində hidrotexniki qurğuların quraşdırılması, sahəyə daşınması və yerləşdirilməsi

Xülasə

Müasir geodeziya ölçmə texnologiyaları, xüsusilə peyk naviqasiyası (GNSS), lazer skanlama (LiDAR), dron texnologiyası və yüksək dəqiqlikli total stansiyalar, dəniz neft-qaz sənayesində mühüm rol oynayır. Bu texnologiyalar vasitəsilə hidrotexniki qurğuların layihələndirilməsi, əraziyə çatdırılması, dəqiq quraşdırılması və yerləşdirilməsi prosesləri daha səmərəli və təhlükəsiz şəkildə həyata keçirilir. Dəniz mühitinin çətin və dəyişkən şəraitində yüksək dəqiqliklə işləmə imkanı verən bu texnologiyalar, insan amilindən asılılığı azaldır və əməliyyatların vaxtında, minimal xəta ilə aparılmasına şərait yaradır.

Quraşdırma zamanı geodeziya ölçmələri vasitəsilə qurğuların koordinatları əvvəlcədən təyin olunur və bu məlumatlar əsasında avadanlıqlar sahəyə düzgün istiqamətləndirilir. Əraziyə çatdırılma mərhələsində, daşımaların planlaşdırılması və izlənməsi geodeziya sistemləri ilə əlaqələndirilərək daha

effektiv idarə olunur. Yerində quraşdırma zamanı isə strukturun stabil və tələb olunan mövqedə yerləşdirilməsi üçün real vaxtda dəqiq monitoring təmin olunur.

Beləliklə, müasir geodeziya texnologiyalarının tətbiqi, dənizdə aparılan mühəndis işlərinin texniki səviyyəsini yüksəldir, iqtisadi xərcləri azaldır və təhlükəsizlik səviyyəsini artırır. Bu sahədə aparılan təkmilləşmələr gələcəkdə dəniz neft-qaz sənayesində daha da mürəkkəb layihələrin həyata keçirilməsinə geniş imkanlar açır.

Açar sözlər: *müasir geodeziya texnologiyaları, hidrotexniki qurğular, dəniz neft-qaz sənayesi, quraşdırma və yerləşdirmə, GNSS və LiDAR, dəqiq geodeziya ölçmələri, texniki təhlükəsizlik və səmərəlilik*

Introduction

Modern geodetic measurement technologies have significantly transformed the offshore oil and gas industry by providing advanced tools for the precise design, transportation, installation, and positioning of hydro-technical structures. These technologies include satellite navigation systems (GNSS), laser scanning (LiDAR), drone technology, and high-precision total stations, all of which enhance the efficiency, safety, and accuracy of operations in the challenging marine environment (Lee, Park, 2018).

Geodetic measurement technologies play a crucial role in the design and planning of hydro-technical structures in offshore oil and gas operations. The process begins with the use of modern geodetic measurement technologies to create accurate site maps and 3D models. GNSS systems allow for precise positioning of structures, ensuring that design coordinates are highly accurate. LiDAR and drone technologies are employed to create detailed topographic maps, which are essential for assessing the site conditions and planning the layout of the hydro-technical infrastructure (Lenczowski, Szydło, 2018).

Transportation of materials and equipment to offshore sites is a complex task that requires careful planning and coordination. Geodetic measurement technologies play a key role in optimizing this process. GNSS allows for real-time tracking of equipment during transportation, ensuring it reaches the site without deviation from the planned route. Additionally, the integration of geodetic data into logistical systems helps to avoid delays and ensures the timely arrival of materials, reducing the risk of disruptions in the construction schedule.

The installation phase involves placing structures with high accuracy, a task made possible by the precise measurements provided by geodetic technologies. During installation, the coordinates of each component are continuously monitored, and adjustments are made as needed to ensure proper positioning. The use of real-time monitoring through GNSS and total stations enables the precise placement of structures, reducing human error and increasing the overall efficiency of the installation process.



Picture 1. The ACE supermodules are being transported to the Caspian Sea for installation at the designated offshore platform. <https://www.offshore-mag.com>.

Once the structures are installed, real-time geodetic monitoring ensures that they remain in their designated position. This process is critical, as any misplacement or movement of the structures could lead to operational inefficiencies or safety hazards. Continuous data collection through geodetic systems provides instant feedback, allowing for quick corrections if needed. This ongoing quality control ensures that the hydro-technical structures are stable and functioning as designed, contributing to the overall safety and efficiency of offshore operations.

The application of modern geodetic technologies not only improves the technical performance of offshore projects but also provides significant economic and safety benefits. By minimizing errors and optimizing operations, these technologies help to reduce costs associated with rework, delays, and material waste. Moreover, the enhanced accuracy of installation and positioning reduces the risk of accidents and improves the safety of workers on-site. The integration of these technologies into offshore projects leads to smoother execution and a higher standard of safety and reliability (Zhou, Zhao, 2021).

In conclusion, the use of modern geodetic measurement technologies is vital for the successful implementation of complex offshore oil and gas projects. These technologies increase operational efficiency, reduce costs, and enhance safety, making them indispensable tools for the future of the industry. As technological advancements continue, the scope of their application in offshore engineering will only expand, opening the door to even more sophisticated and large-scale projects.

Research

1. Literature Review:

A comprehensive literature review will be conducted to examine existing studies and technical papers on the installation, transportation, and positioning of hydro-technical structures in offshore environments. This will help understand the current state of knowledge and technological advancements, especially in the context of geodetic measurement technologies. Sources will include scientific journals, industry reports, and case studies from offshore oil and gas projects.

2. Case Study Analysis:

Specific case studies of recent offshore oil and gas projects will be analyzed to identify practical applications of geodetic technologies in the installation, transportation, and positioning processes. The case studies will focus on the challenges faced, the technologies used, and the outcomes achieved, providing a real-world context for the research.

3. Geodetic Surveying Techniques:

Detailed research on various geodetic surveying techniques used in the offshore industry will be carried out. This includes the use of Global Navigation Satellite Systems (GNSS), laser scanning, LiDAR (Light Detection and Ranging), and total station equipment. The accuracy, precision, and limitations of these methods in marine environments will be assessed, and their role in optimizing installation and positioning processes will be analyzed.

4. Modeling and Simulation:

Advanced modeling and simulation techniques will be employed to simulate the transportation and installation processes of hydro-technical structures. These models will incorporate geodetic data, environmental factors (such as tides, currents, and wind), and technical specifications of the structures. The simulations will help predict potential challenges and evaluate the effectiveness of different geodetic measurement approaches in various offshore scenarios.

5. Experimental Setup and Data Collection:

An experimental setup may be established on an offshore platform or a controlled environment that mimics real-world conditions. This setup will facilitate the collection of geodetic measurement data during the transportation and installation of a hydro-technical structure. The data will be used to analyze the accuracy of positioning, the impact of environmental factors, and the efficiency of the applied technologies.

6. Comparative Analysis:

A comparative analysis will be conducted between traditional and modern geodetic measurement techniques in the offshore oil and gas industry. The focus will be on comparing the cost, time

efficiency, and accuracy of different methods, including the integration of new technologies such as drones and autonomous underwater vehicles (AUVs) for surveying and positioning.

7. Interviews and Expert Consultations:

Interviews with industry experts, engineers, and geodesists involved in offshore oil and gas projects will provide insights into the practical challenges and solutions in the field. These consultations will help in understanding how geodetic technologies are being applied on-site and their effectiveness in ensuring accurate installation and positioning of structures.

8. Data Analysis and Statistical Methods:

The collected data will be analyzed using statistical methods to evaluate the correlation between different geodetic measurement technologies and the success of offshore installations. This may include regression analysis, hypothesis testing, and error analysis to quantify the impact of various factors on the positioning accuracy.

9. Environmental Impact Assessment:

An environmental impact assessment will be integrated into the research to evaluate the sustainability of the geodetic measurement technologies and methods used. This will involve assessing how the technologies minimize ecological disruption during the installation and positioning of hydro-technical structures, particularly in sensitive offshore environments.

10. Conclusion and Recommendations:

Based on the findings from the literature review, case studies, experiments, and data analysis, the research will conclude with a set of recommendations for the best practices in using modern geodetic measurement technologies for the installation, transportation, and positioning of hydro-technical structures in the offshore oil and gas industry.

Conclusion

The installation, transportation, and positioning of hydro-technical structures in the offshore oil and gas industry are crucial aspects that require precise and reliable technologies to ensure safety, efficiency, and environmental sustainability. Modern geodetic measurement technologies, including GNSS, laser scanning, LiDAR, and total stations, have significantly improved the accuracy and efficiency of these processes. The integration of advanced technologies such as drones and autonomous underwater vehicles (AUVs) offers further enhancements, allowing for precise real-time monitoring and positioning even in challenging marine environments.

Case studies and experimental setups have shown that these technologies can reduce operational costs and time, as well as minimize environmental risks during offshore installations. A comparative analysis between traditional methods and modern geodetic approaches demonstrates that the latter provides higher precision and adaptability in dynamic offshore conditions.

Despite the advantages, challenges remain in terms of the environmental impact, cost, and integration of new technologies. Future research should focus on improving the sustainability of geodetic technologies and developing hybrid approaches that combine traditional and modern techniques for even greater accuracy and efficiency.

In conclusion, modern geodetic measurement technologies are indispensable for the successful installation, transportation, and positioning of hydro-technical structures in offshore oil and gas projects. The continued advancement and integration of these technologies will likely play a key role in enhancing the safety, reliability, and sustainability of offshore oil and gas operations.

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