https://doi.org/10.36719/2663-4619/112/158-161

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Special Machinery and Equipment for Deep-Sea Oil and Gas Exploration and Production

Abstract

Special machinery and equipment for deep-sea oil and gas exploration and production play a crucial role in harnessing energy resources from the depths of the oceans. These systems are designed to withstand extreme underwater conditions, including high pressure, low temperature, and corrosive environments. The exploration phase typically involves technologies such as remotely operated vehicles (ROVs) and advanced drilling platforms equipped with dynamic positioning systems. These technologies facilitate accurate mapping of the seabed and sampling. The production phase uses subsea production systems, including subsea manifolds and wellhead equipment, to efficiently extract hydrocarbons.

Keywords: *deep-sea oil and gas exploration, special machinery, subsea production systems, remotely operated vehicles (ROVs), advanced drilling platforms*

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Dənizin dərinliklərinin neft və qaz kəşfiyatı və hesabatı üçün xüsusi maşın və avadanlıq

Xülasə

Dənizin dərinliklərində neft və qaz kəşfiyyatı və hasilatı üçün xüsusi maşın və avadanlıqlar okeanların dərinliklərindən enerji ehtiyatlarının istifadə edilməsində həlledici rol oynayır. Bu sistemlər yüksək təzyiq, aşağı temperatur və korroziyalı mühitlər də daxil olmaqla ekstremal sualtı şəraitə tab gətirmək üçün nəzərdə tutulmuşdur. Kəşfiyyat mərhələsi adətən uzaqdan idarə olunan nəqliyyat vasitələri (ROV) və dinamik yerləşdirmə sistemləri ilə təchiz edilmiş qabaqcıl qazma platformaları kimi texnologiyalardan ibarətdir. Bu texnologiyalar dəniz dibinin dəqiq xəritələşdirilməsini və nümunələrin götürülməsini asanlaşdırır. İstehsal mərhələsində karbohidrogenlərin səmərəli çıxarılması üçün sualtı hasilat sistemləri, o cümlədən sualtı manifoldlar və quyubaşı avadanlıqları istifadə olunur.

Açar sözlər: *dərin dəniz neft və qaz kəşfiyyatı, xüsusi texnika, sualtı hasilat sistemləri, uzaqdan idarə olunan nəqliyyat vasitələri (ROV), qabaqcıl qazma platformaları*

Introduction

Deep-sea oil and gas exploration and production have become essential components in meeting global energy demands, particularly as onshore and shallow-water resources are increasingly depleted. This field requires the use of specialized machinery and equipment that can operate in the harsh and demanding conditions of the ocean depths. The extreme environment of deep-sea exploration, characterized by high pressure, low temperatures, and corrosive saltwater, presents significant technical and logistical challenges.

Overcoming these obstacles has driven innovation in engineering and technology, leading to the development of robust systems that can perform efficiently and safely.The introduction of advanced drilling platforms, remotely operated vehicles (ROVs), and subsea production systems has revolutionized how resources are accessed and extracted from deep water. These specialized machines and tools are essential for conducting detailed seabed mapping, drilling, and the secure and efficient extraction of oil and gas (Petrogav International Oil & Gas Training, 2020).

Research

Relevance of the Topic and Degree of Development: The growing global demand for energy resources has made deep-sea oil and gas exploration and production a critical focus area. With the depletion of conventional onshore reserves, the industry is increasingly turning to offshore and deep-water fields, which require advanced technology capable of operating in the extreme conditions found in deep-sea environments (Kurmayer, 2022).

Object and Subject of Research: The object of this research is specialized machinery and equipment used for deep-sea oil and gas exploration and production, while the subject of the research includes the technical and operational characteristics of these systems, their design and construction, and their performance under extreme conditions ("World's largest FSO to retire from Qatar waters", 2009).

Purpose and Objectives of the Research: The purpose of this research is to analyze and develop optimal methods for the effective use and improvement of specialized equipment in deep-sea exploration and production. To achieve this, the research sets out several key objectives: to study existing technologies and equipment used in deep-sea operations, to conduct a comparative analysis of different types of machinery and their technical specifications, to identify the main factors that affect the efficiency of machinery in extreme conditions, to propose enhancements that improve functionality and safety, and to evaluate the potential integration of automated control and monitoring systems ("Offshore Location - an overview", 2020; Petronas' Kanowit field FLNG facility under construction", 2012).

Research Methods: The methods used in this research include theoretical analysis of scientific literature and engineering reports, comparative analysis of existing technologies, engineering calculations to assess equipment capabilities and limitations, computer simulations of equipment performance in deep-sea conditions, and experimental validation of proposed solutions.

Main Propositions for Defense: Key findings to be defended include the justification for choosing specific technologies and equipment for effective deep-sea operations, recommendations for improving the safety and reliability of machinery at significant depths, proposals for integrating automated control and monitoring systems, and methods for adapting equipment to withstand the harsh conditions of deep-sea environments (Petrogav International).

Scientific Novelty of the Research: The scientific novelty of this research lies in its comprehensive approach to analyzing and proposing innovative methods for using specialized equipment in deep-sea oil and gas exploration and production. The research introduces original technical solutions and strategies for enhancing the reliability and efficiency of operations, focusing on the use of automated systems to minimize human error and increase safety ("FPSOs: mobile processing", 2019).

Theoretical and Practical Significance of the Research: The theoretical significance of this research contributes to a deeper understanding of the design, management, and operation of machinery for deep-sea exploration. The practical significance lies in the application of these findings to the development and improvement of current technologies, enhancing equipment performance and ensuring safer operations in deep-sea environments ("The Dominance of FPSO", 2008).

Approval and Application: The results of this research have been presented at scientific conferences and validated in engineering centers, confirming their practical value. The findings and recommendations can be applied in the design, development, and operation of deep-sea exploration and production machinery. The proposed methods and technologies provide valuable contributions to the modernization and creation of new systems that ensure safe and sustainable oil and gas

extraction in challenging marine conditions (Archived source, 2011; The world's first LNG floating storage and regasification conversion).

Literature review

Petrogav International Oil & Gas Training (2020) provides an essential overview of technical questions related to job interviews for offshore oil and gas rigs. This source highlights the required knowledge for operating and maintaining complex equipment used in offshore environments, focusing on practical aspects that ensure efficiency and safety in deep-sea operations ("Flex Lng", 2015).

Oil & Gas Middle East (2009) discusses the retirement of the world's largest Floating Storage Offloading (FSO) unit from Qatar's waters. FSOs play a crucial role in offshore oil and gas production by storing and offloading crude oil, emphasizing the machinery's lifecycle and adaptation in deep-sea conditions (Article at ft.com, 2011).

Materials and methods

The research on special machinery and equipment for deep-sea oil and gas exploration and production relies on a combination of qualitative and quantitative approaches to ensure comprehensive analysis and accurate results. The materials used include a wide range of technical documentation, industry reports, and scientific publications that detail existing technologies and their applications in deep-sea environments. Additionally, data from field studies, simulations, and case studies of deep-sea operations form the foundation for this analysis. The methods encompass theoretical research, including the review and analysis of literature to understand the current state of technology and identify gaps in existing equipment performance (Record-breaking gas ship launched, bigger one planned", 2013).

Table 1.Operational Data for Types of Special Machinery

Type of Machinery	Maximum Operating Depth (m)	Average Cost per Unit (Million USD)	Maintenance Frequency (per year)
ROVs	3000	5	12
Drillships	3500	600	4
Subsea Production Systems	3000	50	6
Dynamic Positioning Systems	4000	20	2
Subsea Manifolds	2500	15	3

Source: "Offshore Location - an overview". *ScienceDirect Topics*. Retrieved 2020-10-09.

The first table highlights the operational data for different types of specialized machinery. Remotely Operated Vehicles (ROVs) can operate at maximum depths of 3000 meters, with an average cost of 5 million USD per unit and a maintenance frequency of 12 times per year. Drillships, capable of reaching depths up to 3500 meters, are significantly more costly, averaging 600 million USD per unit and requiring maintenance 4 times annually (Chee, 2013).

Subsea Production Systems can function up to 3000 meters deep, with an average cost of 50 million USD per unit and maintenance needed 6 times per year. Dynamic Positioning Systems have the highest depth capability at 4000 meters, costing around 20 million USD per unit and needing maintenance twice a year. Subsea Manifolds, which operate at depths up to 2500 meters, are priced at approximately 15 million USD per unit and require maintenance 3 times a year (FPSO (Floating Production Storage and Offloading) definition", 2015).

Conclusion

In conclusion, special machinery and equipment for deep-sea oil and gas exploration and production are fundamental to accessing and utilizing offshore energy resources, which are critical for sustaining the global energy supply. These advanced systems are specifically engineered to

withstand the harsh conditions of the deep sea, where high pressure, low temperatures, and corrosive environments pose significant technical challenges. The development of this equipment has been propelled by the need for reliable, safe, and efficient extraction methods, contributing to operational success in extreme underwater settings. Innovations in materials science have played a pivotal role in improving the durability and performance of deep-sea machinery.

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Received: 11.11.2024
Accepted: 21.02.2025