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The Construction Progress and Technology Application of Intelligent Oilfield Production in the Eastern South China Sea

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Abstract

With the continuous development of industrial technology in recent years, such as remote monitoring, image recognition, infrared detection and other technologies have made great progress, but offshore oilfield production monitoring is still in conventional applications, and there are some cutting-edge explorations in the field of oil reservoirs and drilling. For oilfield production and operation, there is a lack of grounded intelligent technology applications. The South China Sea Eastern Oilfield has combined various units to conduct practical exploration and application of intelligent production based on existing technical strength and on-site needs, and has achieved the expected results. This will help to enhance and promote the intelligence level of China's offshore oil and gas.

Keywords

Oil Field; Intelligent Production; Infrared Monitoring; Robot Inspection.

1. Introduction

The current environment of the oil industry is changing, Oil prices continue to be sluggish, exploration and development costs are rising. The implementation of the new safety and environmental protection law, and the country’s attention to clean and alternative energy sources pose greater challenges to the production and operation of oil and gas enterprises. The petroleum industry has begun to transform into an era of "technology is king". With the in-depth development of "Made in China 2025" in the energy field, intelligence has become an inevitable trend in the development of traditional domestic oil and gas development technologies, and technological innovation has also become the main driving force leading the development of the domestic energy industry.

Offshore oilfields are a major force in petroleum exploration and development, The characteristics of enterprise production determine the complexity of both production scale and management mode. Under the traditional management model, oilfield production efficiency has not been effectively improved for a long time. The manual method of inspection will also be due to differences in personnel's professional ability and sense of responsibility. There may be hidden and undiscovered problems on site. It means that the investigation and resolution cannot be carried out in the first time, which may lead to the occurrence of hidden dangers, which will be detrimental to the normal development and management of production.

Therefore, it is urgent to realize the construction of intelligent oilfields by applying advanced scientific and technological means to establish a digital and information-based oilfield management and production system, effectively replacing traditional manual operations, and effective for some areas beyond the reach of manpower. Monitoring and management, improve the management quality of oilfield production and operation, improve production efficiency, ensure the intrinsic safety of the production process, provide accurate information for safe production and management decisions, and help decision-makers make correct decisions. The development of oilfield intelligence should be

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carried out according to the needs of the oilfield itself, starting from actual landing applications and solving practical problems.

2. The Progress of Intelligent Construction

In simple terms, the intelligent construction of oilfields is to realize the effective combination of oilfield production and intelligent technology by means of Internet technology and information technology, and change the original production and maintenance mode, which is also an important direction for the sustainable development of offshore oilfields.

2.1 Progress in Intelligent Construction of Foreign Oilfields

In the 21st century, large foreign oil companies have successively carried out technical research and construction of intelligent oilfields, and BP and Shell have become pioneers in the construction.

BP's construction plan is called the "future oil field" and is divided into three stages: 2000-2005, through a large number of open and integrated tools to verify the validity of the digital oil field concept; 2005-2011, focus on optimizing real-time remote monitoring, Oil well monitoring, equipment reliability fields, etc. after 2011, scale integration and implementation of solutions in various fields to obtain higher intelligence capabilities and insights.

Shell Oil's construction plan is called "smart oil field" and was implemented around 2000. Through standardized technical components and infrastructure architecture, strengthen internal cooperation to deliver synergistic value, and greatly improve oil wells, reservoirs, facility management and production operations s efficiency.

Since 2014, due to the fluctuation of international crude oil prices and the maturity of the application of emerging technologies such as the Internet of Things, big data, and image recognition, cross-border cooperation has become the focus of the transformation and efficiency of foreign oil companies. In 2017, Halliburton and Microsoft reached a strategic alliance to promote the transformation of the oil and gas industry. In 2018, Total and Google Cloud reached an agreement to provide new solutions for exploration and development. In 2019, Chevron cooperated with Schlumberger and Microsoft to accelerate the development of innovative petroleum technologies.

2.2 Progress of Intelligent Construction of Domestic Offshore Oilfields

The construction of China intelligent oilfields started relatively late. CNPC Xinjiang Oilfield Company began to construct comprehensive intelligent oilfields in 2011, covering all aspects of oil and gas production; Sinopec's intelligent oilfield projects promote the development of application systems from the traditional "shaft mode" The shift to the construction model of "platform + data + application" has improved the construction quality and application efficiency.

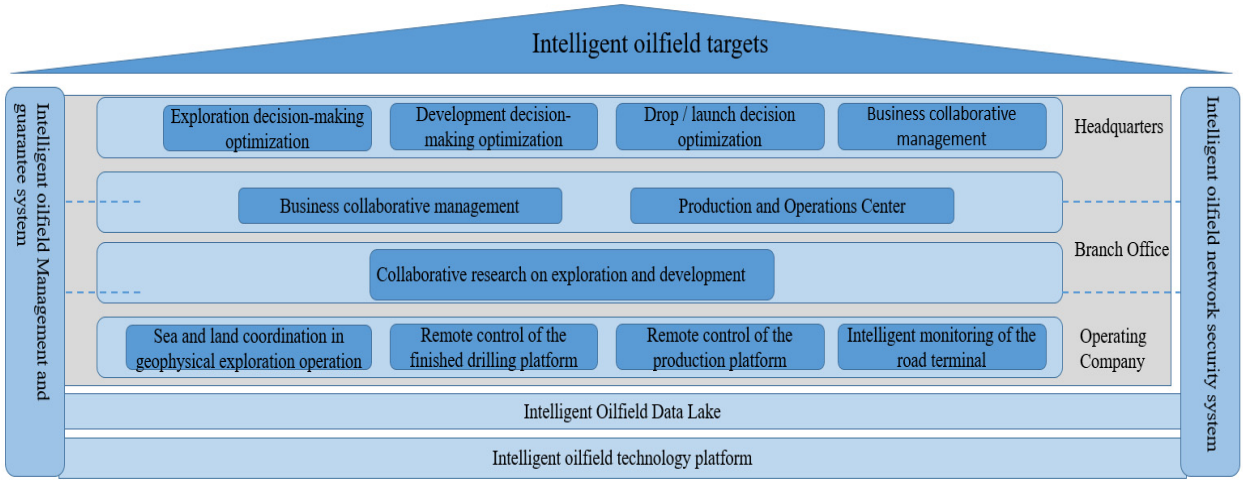

Figure 1. CNOOC's smart oilfield construction ideas

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CNOOC launched the intelligent construction of oil fields in 2014, closely integrating exploration, development and production and other businesses with emerging digital technologies. Since 2018, CNOOC has begun to promote the construction of unmanned and intelligent production of offshore oilfields. In 2019, CNOOC launched a rolling plan for smart oilfields based on the previous construction practices, and through the analysis and summary of the best practices of intelligent oilfields at home and abroad, put forward the general idea of the next step of the construction of CNOOC intelligent oilfield: building a platform, forming a lake of data, formulating two sets of systems, serving three-level organization, and building four types of applications.

✧Network basic aspects

CNOOC has been continuously optimizing the network environment of offshore oilfields for a long time, establishing a basic network with offshore platform business bearer network and emergency communication network as the core. In the East China Sea and the South China Sea, the first commercial application of Ka high-throughput satellite is realized, providing stable network support for the intelligent construction of offshore oilfields.

✧ Data foundation

CNOOC has established a unified standard, unified storage, unified interface, and unified release system for real-time data of various offshore facilities, and transmits on-site production data, equipment data, and energy consumption data to the data center in real time to support CNOOC's internal Research and application development of various specialties.

The South China Sea Eastern Oilfield has established a basic framework for remote data transmission and storage through the construction of a remote monitoring support center. The data and screens that could only be displayed by offshore facilities are connected to the remote support center, and the existing monitoring data is gradually solved through facility transformation. Insufficient completeness and insufficient effectiveness. For example, the MES system reads various data of offshore oil wells through industrial protocols such as OPC, so that reservoir personnel can understand the changes of oil wells in time, analyze, judge and process in advance, and realize coordinated operation.

Unmanned and continuous production during typhoons (Eastern South China Sea Oilfield)

For the eastern South China Sea oil field, which is often disturbed by typhoons, how to increase the production time rate and how to reduce the operating cost of small platforms is an important part of intelligent construction. For example, offshore unmanned platforms are an important part of offshore oil production and operation. Compared with traditional manned platforms, the new model can provide cost-effective and productive solutions for offshore oil resource development. Regardless of whether it is unmanned or continued production during a typhoon, it is mainly considered from the two dimensions of perception and safe production:

Comprehensive perception and remote monitoring:

a) Through the addition of servers, combined with virtualization and other technologies, centralized management of the sub-control systems of the various professional decentralized management on site

b) The equipment or data that cannot be remotely monitored at present needs to be remotely transmitted to the central control system or electrical control system through modification

c) Improve the data transmitted from the skid equipment to the central control system, and conduct a comprehensive monitoring of each skid

d) Using technology such as process flow modeling to replace the on-site instruction table for remote reference analysis of process personnel

e) The areas that cannot be monitored are improved by adding cameras or inspection robots, etc.

f) Emergency response in case of communication loss to ensure safety

g) The data link should be stable and low latency.

Safety Production

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a) Deluge valve, FM200, foam and other fire-fighting systems need to realize the function of soft start on the screen of SCADA. In an emergency situation where the hard button fails, personnel can release the operation remotely through the screen to protect the safety of the equipment

b) Monitor the oil pollution on the sea surface by adding cameras on the legs of the piles

c) Improve the monitoring of gas leakage and fire through technologies such as spectroscopy, ultrasound or thermal imaging

d) Realize the function of intelligent inspection through intelligent reports and data analysis

e) Through intelligent analysis of equipment mechanical status, instrumentation, electrical and other data, to judge the actual operating status of the equipment

f) When an abnormal situation occurs, the production can be shut down in time and the process can be replaced.

Through the coordination of various resources and the innovative application of technology, the unmanned operation of the 102 platform in Panyu Oilfield and the function of continuing production during the typhoon in Enping Oilfield have been basically realized. Among them, the unmanned intelligent construction of the platform has realized the functions of remote monitoring, remote production, HART instrument remote management, and intelligent reporting of the wellhead platform from the central platform. The intelligent construction of Enping Oilfield has realized the continuous production of the oilfield during the typhoon, as well as emergency shutdown and replacement functions in emergency situations, these are important progress in intelligent construction.

3. Typical Technology Applications

The rise and application of emerging technologies have accelerated the process of modernization of production. From the current development status of the existing industrial technology, combined with the actual conditions of offshore oilfields, the selection of technologies with practical value for integration and the creation of intelligent oilfields are sustainable for oil and gas companies. The only way to develop. At present, the popularized and practical application of technology in the oil fields in the eastern South China Sea has produced practical value and is of reference significance:

3.1 Video Linkage

The traditional method of video system of the oil field is only used as a function to visually check the situation on the spot, and it is independent of the central control FGS system. When there is a fire, the personnel manually operate to view the corresponding video screen, which cannot be linked in a timely and effective manner, which is not conducive to emergency. Therefore, it is necessary to break the barriers between systems and realize the sharing and linkage of data signals.

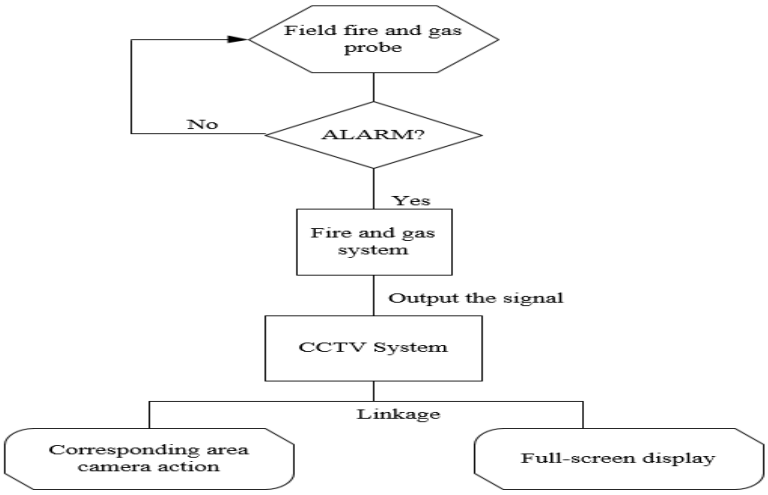

Figure 2. Technical path and example of video linkage

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Since the video surveillance system usually has its own communication interface, through the intermediate signal module, the output signal of the FGS system is parsed into the data signal recognized by the video system. The FGS system transmits the probe alarm signal to the linkage control module to mobilize the video surveillance system The camera images of the corresponding area are directly displayed on the large screen, and the on-site personnel can monitor the status of the alarm location in the first time through the large screen.

3.2 Infrared Monitoring

Infrared thermal imaging is to use an infrared detector and an optical imaging objective lens to receive the infrared radiation signal of the measured object, scan the infrared thermal image of the measured object through the photosensitive source electronic scanning circuit, convert it into an electrical signal and an infrared optical system for amplification. At the same time, it is converted into a standard video signal. Due to the high temperature of the extracted crude oil, if there is a leakage, the temperature will be abnormal and the surrounding area. The infrared thermal image of the area is displayed through infrared monitoring. If an infrared high temperature occurs, an alarm will be issued in time.

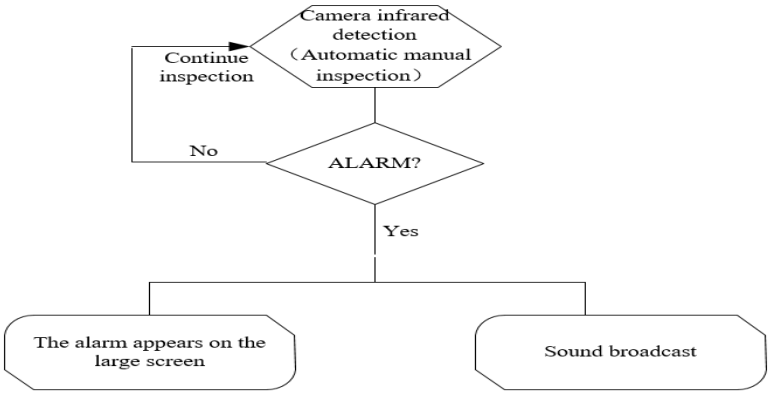

Figure 3. Technical path and example of infrared monitoring

3.3 Robot Inspection

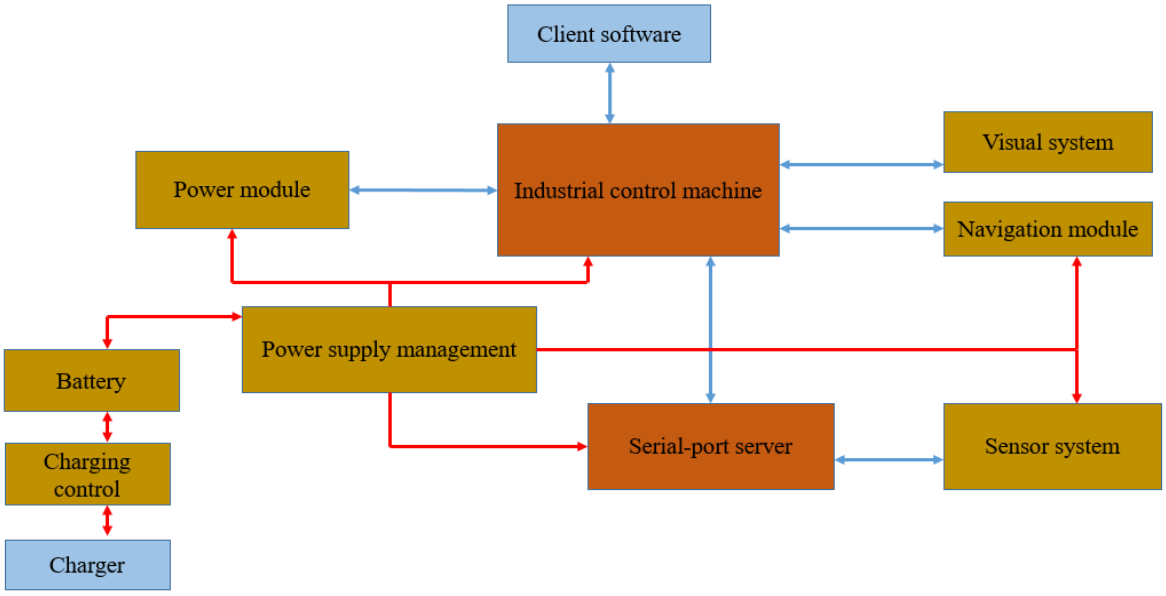

Figure 4. The structure of the robot inspection

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Due to the traditional on-site inspection by personnel, it takes a long time and the paper records are easy to lose. Especially during unmanned or typhoon production, it is impossible to know the data of the on-site instrumentation, which is not conducive to the reliability of the production process data. Therefore, through the robot inspection system, using its own positioning technology and image recognition technology, automatic or manual inspections are realized, which greatly improves the effectiveness and purpose of inspections.

The inspection robot is equipped with precision and high-efficiency sensors such as lidar, so that the inspection execution device can autonomously locate, and through the deeply optimized obstacle avoidance algorithm, it can bypass the obstacles in the planned path and choose the optimal route to move forward. Through model training and edge detection algorithms, it can automatically identify and record various instruments and status indicators on the machinery and equipment at the specified location, and automatically judge the operation of the current equipment by identifying the instrument readings and the color status of various status indicators. And according to the alarm conditions set by the user in advance, when an abnormal reading or an abnormal color of the indicator light is found, real-time messages and on-site images and videos can be sent to the intelligent inspection operation system.

4. Recommendations for Intelligent Oilfield Construction

a) Plan to build a standardized system

In order to promote the long-term consideration of intelligent construction, it is necessary to build a standardization system. The establishment of standards can ensure that there are rules to follow in the construction process, achieve standards, uniformity, norms, and safety, which can shorten the construction period, reduce construction costs, and improve the quality of construction so as to achieve the purpose of sharing and collaboration.

b) Planning of construction cost

Each oil field should formulate a matching development strategy according to its own situation and intelligent construction plan, do a good job in the evaluation of economic benefits after the intelligent transformation of different facilities, Complete the construction of intelligent oil fields in stages, in batches and in a planned way. Oilfield construction, in order to reduce the pressure of sharp increase in cost brought about by the process of intelligent oilfield construction.

c) Strengthen cooperation with high-tech companies

Oilfield companies are good at petroleum exploration and production, while high-tech companies have new technologies and new technologies. Therefore, in the construction of intelligent oilfields, technical exchanges and application innovations with high-tech companies should be strengthened to continue to increase the intelligent level of oilfields.

d) Consolidate the talent pool

As a traditional energy facility, offshore oilfields lack a reserve of new technical talents. Therefore, in the critical period of subsequent upgrading and transformation, the construction of a talent team is very urgent, and multiple measures should be taken to train or introduce new technical talents.

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