**Internet of Things Remote Intelligent Monitor System of Oil & Gas Field**

Chunming Xiong, Xin Zhang, Ruidong Zhao, Chengyan Sun, Guobin Jiang and Bo Song

**ABSTRACT**

According to the development situation of digital oilfield construction and existing problems in our country, a set of Internet of Things remote intelligent monitoring system with comprehensive functions for oil & gas fields has been successfully developed, which can comprehensively sense production objects, such as oil&water wells and oil & gas station, to realize centralized management and control of production data and equipment state information in the production command center, and use production data in real time for effective analysis. This system breaks the information island and technical barriers, establishes data bridge with CNPC information system, creates conditions and provides guarantee for tens of thousands of field engineers to implement of fine management using solid theoretical foundation and advanced technical tools, thereby saving construction investment and operation cost of oil and gas production.¹

**INTRODUCTION**

As an information sharing system engineering, intelligent oilfield interconnects oil & gas production and is a process which collects field production data through automation instruments and transfers to oilfield operation engineers in real-time to make decision feedback control. In the early 1990s, oil and gas production automation started to be applied in China. The automation technology helps oilfields

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¹Chengyan Sun, Guobin Jiang, Bo Song, Daqing Oilfield, Petrochina, Heilongjiang, China, 163000.
to realize production data monitoring and process control of wellhead and processing stations, but each part runs independently[1]. In the past ten years, oil and gas production has been digitized in different levels in various fields. With the digital construction, field automation instruments and information management system are combined to realize data centralized management of each automatic control system[2]. In recent years, domestic enterprises have developed from imitation of foreign advanced technology to being able to independently research and develop new products and systems, which basically meet the requirements of domestic digital oilfield construction and greatly reduces construction investment. Oil & gas production IoT has the foundation of scale development. Based on the digital technology, interconnected oil & gas production further realizes interconnection of each automatic system and comprehensive analysis of production data[3].

At present the main problems existing in the field of oil & gas production digitalization construction are as follows: (1) Because single well data acquisition equipment don't realize state monitor and standardized management, it causes frequent breakdowns and interruption of production data that seriously influences the accuracy of production analysis and the promotion of digital construction[4]; (2) Data protocol and system interface are not unified resulting in the information island of digital management, and it is impossible to easily conduct correlation analysis of production data generated by each system in real-time. (3) Due to lack of an analysis platform with solid theory and abundant experts experience as support, it is unable to obtain valid information from collected production data; (4) The large amount of data generated in the production process contains rich and effective information. However, traditional analytical methods have difficulty in mining potential value. This paper develops a set of oil & gas field IoT remote intelligent monitoring system with comprehensive functions, which can realize centralized management of various production units and can implement effective analytical decision with oil &gas production data in real time.

MAIN SYSTEM ARCHITECTURE

Main system architecture includes sensing layer, transmission layer and application layer. Through technical combinations of sensing, radiofrequency, communication and advanced computing, oil & water wells, oil & gas stations and other production objects can be fully sensed. By these means, the centralized management and control of production data and equipment state information in production command center and production control center could be realized. A standard and unified data management platform is set up to support oil & gas production process management, provide real-time analysis and optimization of oil & gas production, and further improve the timeliness and accuracy of oil & gas production decision, in order to save construction investment and operation cost of oil & gas production.
SYSTEM FUNCTIONS

The system uses sensing, radio frequency and other technologies to sense oil & gas production information, and establishes an accurate and reliable automatic collection and control system covering the whole process of oil & gas production. Data collection is complete and accurate, process control is precise, and safety management is timely and effective. The system provides on-site acquisition schemes for various production modes such as pumping unit, electric submersible pump, screw pump, gas lift and self-flowing, and the specific parameters are shown in Table 1. Taking rod pumped well as an example, oil pressure, casing pressure, oil temperature, indicator diagram, electric current, voltage, power factor and electric quantity are needed to be collected at the site. Moreover, video monitoring is required for high-risk wells and key wells. The corresponding equipments shall be equipped on site. RTU realizes data integration and control function; DTU implements remote data communication; Power module collects current, power and other electrical parameters; An approach switch or angle displacement module is installed on pumping unit beam to detect pumping units stroke; Pressure transmitter and temperature sensor are installed on wellhead to detect casing pressure, oil pressure and temperature; The integrated wireless load sensor is installed on beam pumping unit to measure indicator diagram which can be used to calculate fluid production. It can also be equipped with flexible control module and solar wind power supply device according to site actual demands. The system conducts integrated monitoring and controlling of automation parameters of single well, station and pipeline to realize fine management. Meanwhile, it integrates harmful gas detection, video, security, fire detection and other security systems to make a prompt and reflect abnormal events such as invasion happening in planning area in a timely and effective manner so as to realize the universal coverage monitoring of production, management and security.

| Unit               | Acquisition parameters                                                                 |
|--------------------|----------------------------------------------------------------------------------------|
| Rod pumped well    | Oil pressure, casing pressure, oil temperature, electricity, indicator diagram          |
| Progressive cavity pump well | Oil pressure, casing pressure, oil temperature, water content, differential pressure flow |
| Electric submersible pump well | Oil pressure, casing pressure, oil temperature, electricity, pump partner parameters, differential pressure flow |
| Gas-lift well      | Oil pressure, casing pressure, oil temperature, water content, liquid level, gas volume, compressor outlet pressure, flowrate, unit electric parameters |
| Flowing well       | Oil pressure, casing pressure, oil temperature, water content, pressure difference, liquid level |
The system adopts wireless heterogeneous network consisted of wireless sensor network, private network and public network wireless technology (wireless transmission technology integration such as WSN, McWill, WiMAX, WiFi, 3G, GPRS, CDMA, and satellite) to transmit data collected from single well and remote station. Production data and video signals from transfer station, united station, gas gathering station, processing station, water injection station and station close to well site are transmitted by wired networks, so as to realize data real-time transmission. Production data transmission mode is described as operation area-oil & gas recovery plant-oil & gas field company-enterprise headquarters. By these means, the WEB management of all sensors, network equipments and subnets can be achieved, and reliable data transmission of oil & gas production IoT can be completed to meet IoT requirements in real-time security and stability.

![Data transmission communication scheme.](image)

The system can make automatic adjustment of times of stroke and intelligent control of intermittent pumping in the field through production data such as indicator diagram and electric parameter. After production data is delivered into server through remote transmission unit, comprehensive analysis module can conduct system efficiency loss analysis, production performance prediction, working condition diagnosis, and then optimized decision module will provide solutions including oil well measures and eccentric wear, implementing remote control of shutdown, frequency conversion, and soft starting on site, to realize wellsite unattended. In addition, field engineers also can manually remotely control shutdown and intermittent pumping through mobile terminals such as smart phones, which facilitates the flexible management of remote wells. By means of production parameter closed-loop control, the overall operation optimization of oil & gas well system is guaranteed.
Equipments have high value accounting for a large proportion in the composition of oil & gas field assets, at the same time there are a large number of equipments with a great variety and long service life. As a result, it is very difficult to track, do statistics and evaluate. Also, they have high maintenance costs. This system makes regular arrangement and update of equipment information database, which reduces the production cost of equipment management. Using RFID technology to number and record equipment information, a lot of functions including equipment warehousing management, equipment using time limit alarm, equipment working environment monitoring, tracking assessment of equipment state, and positioning traces of equipment. Interconnected equipments makes the production planning of oil & gas field more reasonable, saves manpower and material resources, prolongs the life cycle of equipment, and strengthens material safety management.

APPLICATION PROSPECT OF SYSTEM

Through the transformation of production methods, technical tools and management concepts, intelligent oilfield realizes the leapfrog development from traditional automation to emerging digitalized and interconnected oilfields. Remote intelligent monitoring system of oil & gas field IoT has been applied in the whole process of production, fuses the information technology and industrial production, and implements management closely around production operation to improve automation degree of each production unit and ensure continuous, stable and efficient production operation; The system avoids redundant construction and waste of information resources, breaks the information island and technical barriers, promotes data integration and information sharing, and makes full use of CNPC information resources, creating conditions for fine management and providing security for tens of thousands of engineers in optimizing production management process.

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