

# Application of PLC technology in fire-fighting control system of oil field united station

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**Abstract.** In recent years, many hidden dangers have appeared in the process of using energy, especially the fire safety in the joint station of oil field. Fire control used to be controlled by hand, and should be updated. In this paper, PLC technology was introduced into the fire protection system of the oil field joint station, and a fire control model was established and applied to the oil field united station. The model results show that PLC technology can help the whole oilfield joint station achieve integrated fire control, simplify operation flow, reduce operation difficulty and improve its reliability and stability. Therefore, PLC technology can effectively improve the automation technology of oilfield joint station, and ensure its operation more security.

**Key words.** Oil field united station, fire-fighting control system, PLC technology.

## 1. Introduction

Oil is a very important source of energy, which occupies a very important position in human daily life and production, and can effectively promote the development of social economy [1]. Therefore, the dependence of mankind on oil is getting higher and higher, the efficiency of oil use is also increasing, and the oil field united stations are built up, which also occupy a very important position in the oil and gas gathering and transportation system [2]. In this context, the safety of the oil field united station has received increasing attention [3]. With the continuous development of information technology, all walks of life are beginning to introduce information technology into the industry to apply [4]. Then, the oilfield oil and gas gathering and transportation system also introduces the PLC technology, and it is widely applied to all aspects of the oil field united station [5]. At present, the fire control safety of many oil field united stations is still the manual operation, and this backward control method is often prone to errors, so there is an urgent need to improve the management level [6].

When there is a fire in the oil field united station, people need to promptly detect

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and analyze the fire situation and make a rapid response to the sudden situation, while it is more prone to security risks through the antiquated manual operation [7]. Therefore, it is necessary to build a series of advanced, scientific fire-fighting control safety system, so as to ensure the safety of the oil field united station. Therefore, the PLC technology was introduced into the fire-fighting control system of the oil field united station in this paper, thus improving the control level of its fire-fighting safety [8].

## 2. State of the art

Because the oil field united station has a pivotal position in the whole system, it is necessary to take strict control on its safety control, so as to guard against the safety accident [9]. Since the fire safety part is the focus of the safety control system, it is necessary to strictly control its control mode [10]. As the past oil field fire-fighting control system is controlled by manual operation, so its control mode must be reformed. Therefore, this paper applies the PLC technology to the oil field united station fire-fighting control system and makes an in-depth discussion on its application effect [11].

PLC technology has more prominent advantages, for example: the faster transmission speed of this technology, the stable and high transmission quality, which is very important for the application of the oil [12]. Till now, the production control and safety control of many oil field united stations have been done manually, which have required a larger area for the oil field united station [13]. Thus, it is currently imminent to improve the information level of the operation mode of oil field united station [14]. Therefore, in recent years, our country has also begun to update the fire safety control operation of the oil field united station through PLC technology [15].

## 3. Methodology

### *3.1. Overview of fire-fighting control in oil field united station*

In the design process of the fire-fighting control system of the oil field united station, the PLC technology is adopted as the core technology of its control system, furthermore, an engineering station is set up in the control office of the fire safety system, so that the engineers can control the fire safety of the oil field united station. In addition, two operator stations are also set up to enable staff to effectively control the safe operation of the oil field united station at all times.

PLC technology can quickly transfer fiber to the system and retain the Ethernet interface, so that the higher management personnel of the control center can more easily check and monitor the production process of all aspects of the oil field united station, and the data and information in the system can be transmitted to the superior management office, in addition, the orders issued by superior can also be

received, so as to make a quick response. Through the above-mentioned work links, the degree of automation of management and control work of various aspects of oil field united station is rapidly improved. Figure 1 shows the oil field operations site, and the oil field safety must be fully protected.



Fig. 1. Oil field operation field

When the sudden fire of the oil field united station happens, the fire safety control center will find the fire location in a fastest speed and issue an alarm. When staffs of the oil field united station hear the alarm, they can respond timely and go to the fire control center to control the electric valve and fire pump, and the fire situation. Furthermore, the cupping foam mixture is opened through the remote control system, so that the fire can be quickly controlled. In addition, the fire-fighting control center can also view the main line of fire water in real time, and timely warning. When the pressure in the fire-fighting system is less than 1 MPa, the control center will automatically open the circulating pump, and when the pressure in the fire-fighting system is greater than 1 MPa, the control center will delay for ten seconds and suspend the circulating pump. Subsequently, according to the water level in the fire pool, the control center will control it, and take a high level alarm mechanism, so that staff can find the security risks existing in the oil field united station, quickly remove these risks, so as to ensure the safe operation of the oil field united station.

### ***3.2. Description of fire-fighting interlocking in oil field united station***

The initiation of oil field united station is usually equipped with detectors and fire dike, which can detect the temperature of this region. When the temperature exceeds a certain extent, the fire alarm button can be opened. When the area bursts fire, a warning can be sent at a very fast speed through the PLC technology, then, the fire situation can be confirmed quickly and the staff can be informed. After the staff confirming the fire, the fire electric valve and water valve, as well as the pump can be quickly opened through the remote control system, so as to control the fire. After the above links, the staff can also close the electric valve in this area, thereby guarding against the fire risks caused by power leakage.

When there is an oil field united station fire in the reality, a fire signal will be quickly issued. And when the staff in the control center quickly finds the fire, the first step is to immediately confirm it and quickly open the foam tube and fire water pipes. The second step is to open the first set of fire pumps and foam pumps after 15 seconds, and open second fire pumps and foam pumps after another 10 seconds. The third step is to send the control status to PLC in time when the fire water pumps and foam pumps of the above two groups are opened for 15 seconds, and to analyze the feedback information in depth through PLC technology, so as to make accurate judgments about the process and causes of the fire. If the fire water pumps and foam pumps of the above two groups are already open, then, there is no need to open the fire pumps and foam pumps in the third group.

Then, the control center is also capable of conducting the real-time detection on the fire-fighting water main line pressure. When the detected pressure is less than 1 MPa, the first group of fire pumps and foam pump will automatically open, and its operation situation is detected, then, the detected information is sent to the PLC center. After 10 seconds, if the operation is relatively smooth, there is no need to open the second fire pump and foam pump. However, when the first group of fire pump and foam pump suspends its operation, the second group of fire pump and foam pump must be opened. When the detected pressure is greater than 1 MPa, the first and second groups of fire pumps and foam pumps will be suspended after 10 seconds.

### ***3.3. Hardware configuration of fire-fighting control system in oil field united station***

PLC technology is introduced into the fire-fighting system of the oil field united station, and then, a fire control model is established. According to the prescribed process, the series S7-300C PLC technology is selected and the fire-fighting duty office is set up in the control center. In addition, the engineer and operation rooms are also set up in the control center, so as to facilitate the operation of staff. Among various equipment of the oil field united station, the transmission and exchange of information can be carried out through the switch. Moreover, the fire-fighting system capacity adjustment is conducted through these control equipment. Figure 2 shows the hardware configuration of the fire-fighting control system of the oil field

united station.

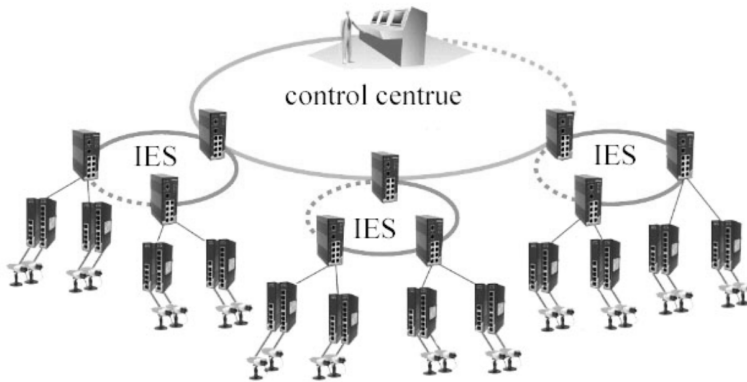


Fig. 2. Hardware configuration of fire-fighting control system in oil field united station

At the same time, a power supply is installed and three digital input and output modules are configured. In addition, in the fire-fighting control center, the industrial-grade switches are also purchased for information exchange. In order to allow the system's information exchange to maintain long-term stability of the state, three microcomputers are also configured to help the data transmission work, so as to make the whole system can run perfectly and smoothly.

### ***3.4. Software design of fire-fighting control system in oil field united station***

After the above design, the software design of the fire control system of the whole oil field joint station was also carried out in this paper, so that the system can have perfect performance and practicality. Firstly, the PLC technology was selected as the basis of the system, and STEP7 was regarded as the system's development environment. In the design of the system software, the programming was achieved in accordance with the ladder language, which can fully ensure that the system can be more efficient and smooth in the use process, so that users can more easily grasp the use methods. At the time of using PLC technology to conduct programming, the fire-fighting safety control process of the oil field united station should be comprehensively designed.

At the aspects of the design of man-machine interface and the choice of hardware, based on facilitating users' application, the engineer station and operator station set by the control center were also constructed through high performance computers. In the software selection, the SIMATIC WinCC V6.0 algorithm was selected, and furthermore, the system interface was devised more concise and the entire system parameters were designed more reasonably. Figure 3 showed the basic structure of the fire-fighting control system of the oil field united station.

The basic architecture in Fig. 3, is divided into three layers. These three layers

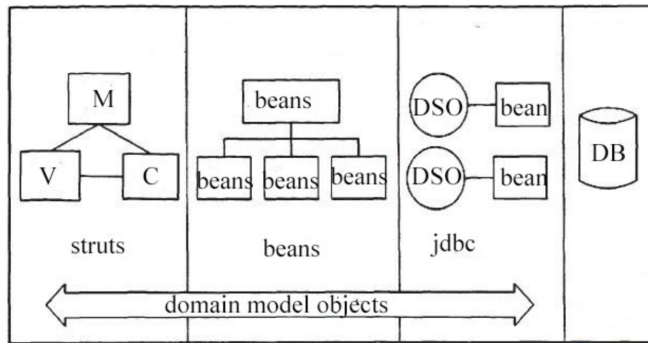


Fig. 3. Basic structure of fire-fighting control system in oil field united station

are data layer, liaison layer and transport layer. The first layer is responsible for collection, analysis and data storage. The second is responsible for the various functional modules communicating with each other, and the third layer is responsible for all kinds of information sharing and transmission functions.

In terms of function settings, the system was enabled to perfectly support the fire-fighting control, report production and printing, network information release and other functions. In the functions that the system can implement specifically, all operations of the oil field united station were explained through the main screen, and the comprehensive control was also carried out. Furthermore, all parameters, such as pressure, temperature and other data, were set in advance. While at the interface of the control center, an emergency device was displayed. When an emergency occurs, the staff can react quickly. In addition, a report production and display interface were also set up to clearly show the data and information on the report to staffs. At the same time, the information management of the file can be also achieved. The most important thing was that the alarm interface can display alert messages, so that the staff can respond quickly after receiving an alarm.

#### 4. Result analysis and discussion

In this paper, PLC technology was introduced into the oil field united station, and through these technologies, the fire safety aspects of the oil field united station were strictly controlled, thus establishing the fire-fighting control system of the oil field united station. After the establishment of the fire-fighting control system of oil field united station, it was necessary to apply the system to the oil field united station, so as to verify the safety control ability of system in the operation process of the oil field united station. After the above research, the fire-fighting control system of the oil field united station was applied into the oil field operations, and a complete collection for the resulting data was carried out. Moreover, functions and effects of the system on the fire safety control of the oil field united station were determined through these data. The following Table 1 the data obtained by applying the oil field united station fire-fighting control system to the oil field united station.

Table 1. Experimental data collection of fire-fighting control system in oil field united station

| Project      | Oil field a | Oil field b | Oil field c | Oil field d |
|--------------|-------------|-------------|-------------|-------------|
| Experiment 1 | 8.11        | 3.67        | 6.65        | 6.95        |
| Experiment 2 | 5.30        | 0.63        | 3.84        | 4.15        |
| Experiment 3 | 4.58        | 4.91        | 4.88        | 3.05        |
| Experiment 4 | 1.27        | 5.66        | 3.46        | 6.10        |

The data collected above was the level of fire safety in four stages of the experiment of the oil field united station fire-fighting control system applied by the oil field united station, so the data would be analyzed deeply after collecting data. Then, the above data were input to the system and calculated, and after getting the results, the data were analyzed, so that the fire-fighting safety role of the oil field united station fire-fighting control system on the oil field united station was obtained. The following Table 2 shows the results calculated by the oil field united station fire-fighting control system.

Table 2. Calculation results of fire-fighting control system in oil field united station

| Project      | Oil field a | Oil field b | Oil field c | Oil field d |
|--------------|-------------|-------------|-------------|-------------|
| Experiment 1 | 8.31        | 7.63        | 6.48        | 5.88        |
| Experiment 2 | 2.09        | 8.64        | 5.98        | 1.87        |
| Experiment 3 | 5.49        | 2.95        | 7.13        | 1.13        |
| Experiment 4 | 2.19        | 1.22        | 6.77        | 9.96        |

Then, the above data was analyzed, and the impact to the fire safety control level after applying the oil field united station fire-fighting control system to the oil field operation was summarized. Figure 4 shows the role and effect of the fire-fighting control system of the oil field united station.

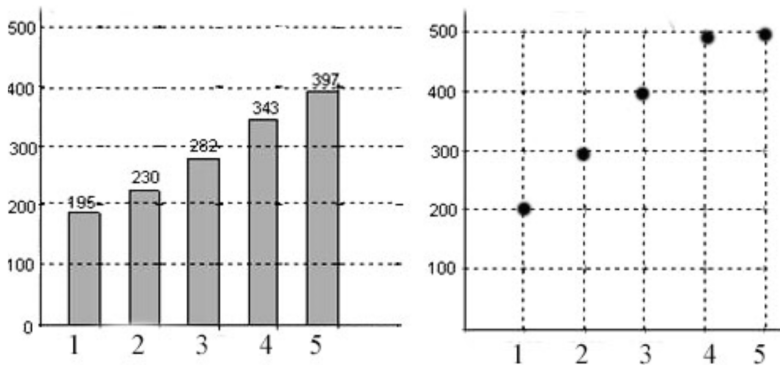


Fig. 4. Application effect of fire-fighting control system in oil field united station

From Fig. 4, it could be clearly seen that according to selection of PLC technology to complete the entire oil field united station fire-fighting control, the entire fire-fighting system could make the operation easier and the maintenance could be more convenient. At the same time, the system had higher reliability and security, which greatly improved the level of automatic production of the oil field united station, ensured the safe, efficient and stable operation of the oil field united station. And then, after the system was put into operation, the good results were achieved.

The fixed temperature fire detector and manual fire alarm button are set up at the top of the tank. When the fire occurs in the tank field, the system can quickly sends the warning to the oil field united station fire-fighting control system in the control room and the fire duty room, meanwhile, the start button of the fire confirmation is set up in the control room and the fire duty room, after the operator on duty determines the fire, the fire confirmation button is started. In addition, oil field united station fire-fighting control system can also bring good economic benefits to the oil field united station. At the same time, the system takes the Ethernet as its communication way, making the whole system very rhetoric, which can upgrade the system all the time in accordance with the actual size of the united station, support remote download and program modification, so as to make the whole system easier to maintain.

## 5. Conclusion

As the human's development degree on the oil is getting higher and higher, the control on the production and security is the focus of the entire united station in the whole production operation of the oil field united station. In this paper, PLC technology was used to control the fire safety in the oil field united station, so as to expect to make fire-fighting control operation more convenient. Therefore, based on the PLC technology, in this paper, the fire-fighting control system of the oil field united station was established, and the system to the actual operation of the oil field united station was applied, so that the fire safety control level of the oil field united station was effectively improved. This not only greatly improved the safety of the oil field united station, but also fully improved its level of information. Furthermore, its production level was also effectively improved, which brought great economic benefits. Therefore, the application of PLC technology in the oil field united station fire-fighting control work can effectively improve its fire safety control level.

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