The Application of PLC Control System in Oil and Gas Pipeline Transportation

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Abstract. In the field of oil and gas pipeline transportation, it becomes more and more important to use the automation system to realize the process parameters monitoring in the operation of the whole line. It is directly related to the safety and stability of pipeline transmission. In the paper, researching on the PLC control system in oil and gas pipelines, with the single station control system as the research object, describe the system architecture and software design.

Introduction

With the advantages of economy and reliability, pipeline transportation has become the most important mode of oil and gas transportation in our country, which plays an important role in the development of national economy. However, the length (thousands of kilometers, hundreds of valve chamber), the transmission intensity, the complex terrain, and easily affected by climate change, which is a great challenge for oil and gas pipeline process operation, management and monitoring.

The PLC control system in oil and gas pipeline is to monitor the parameters of oil and gas pipeline transportation by means of all kinds of automatic monitoring instruments and control equipment, to manage and to adjust field equipment. The purpose is to deliver the oil and gas products to the user in the most economical way and the fastest way under the safe condition. In addition, the automation system can also reduce the degree of labor, save costs and improve the level of the environment.

Analysis and Design of the PLC Control System

Function Analysis of the PLC Control System

(1) Control and monitor all electric valve switches in the station. Display the switch state of the electric valve and control the corresponding electric valve when needed.

(2) Regulate the flow of the pipeline. Adjust the flow rate and pressure of the pipeline through the regulating valve and frequency converter.

(3) Monitoring of temperature, pressure and flow of the internal pipeline of the station.

(4) Alarm function. When the parameters of the oil pipeline exceed the threshold set by the system, the system automatically generates audible and visual alarm.

(5) Data transfer function. Transmit the analog, digital and video signals to the dispatching center to realize the remote monitoring of the field data.
**Overall Structure design**

The system uses a hierarchical control structure, including the station floor equipment layer, PLC field control layer, PC monitoring layer, is shown in Fig.1:

1. **The station floor equipment layer**: includes pressure sensor, temperature sensor, flow sensor, electric valve, pump, valve, inverter and other field instrumentation equipment. It is mainly to complete the monitoring of the oil pipeline transportation process parameters, the regulation of the oil and gas pipeline valve switch, pipeline flow and pressure.

2. **PLC field control layer**: It is mainly composed of PLC controller. It mainly completes the real-time data collection and uploads to the host computer monitoring system. According to the requirements of the monitoring system, PLC adjusts the electric gate valve, regulating valve, pump, inverter switch and pump and other field equipment. PLC can be connected to ordinary IO devices, and it can also be connected to the fieldbus device. PLC can be extended through the expansion module. Multiple PLCs should communicate with each other. A number of PLCs and workstations, as well as related field equipment constitute a control network. PLC and the host system should support redundancy communication.

![Overall structure of PLC control system.](image-url)
(3) PC monitoring layer: It is composed of workstations and related software. Workstation can be a general industrial control computer, and it can also be an ordinary computer. It is mainly to complete the function of oil station dynamic parameter display, alarm, data query etc.

Software Design of Monitoring System

System Software Module Function

The system software function module is mainly composed of six parts, including: system monitoring center, system data report, system database, system data curve, system alarm, system user management. These six modules constitute the core of the whole monitoring system. Software structure diagram is shown in Fig.2:

1. The monitoring center module, using the combination of static graphics and dynamic images, display the structure and running state of the system visually. Refresh the oil and gas temperature, pressure and other analog in real time.

2. The data curve module, the trend curve describes the change of the data with time directly, including the real-time curve and the historical trend curve. The real time curve is the graphical representation of the field data, and the historical trend curve records the past data of the system, which is convenient for the system administrator to analyze the historical data and events.

3. The data report module, it can not only reflect the real-time production of the system, but also can carry on the statistics and analysis to the long-term production process, so that the managers can grasp and analyze the production situation in real time.

4. Database management module, it is connected to the upper and lower computer. Provide real-time data storage, data query, data output and other functions.

5. Alarm management module, when the actual value of the parameter beyond its set alarm range, alarm immediately, to remind the manager.

6. The user management module, in order to ensure the normal monitoring, to prevent disoperation caused a major accident, clear operating duty, at the same time, to take into account the security of the software itself, to prevent non operator disoperation.
System Software Workflow

In the PLC control system in oil and gas pipeline, because of the bad environment, the station is often unmanned working state, which requires monitoring software to work around the clock. The polling way is used automatic field data collection, field control, and remote data communication. When an alarm event occurs, the PLC system prompts managers to take manual intervention or emergency treatment by PLC according to the alarm level. PLC control system monitoring software in oil and gas pipeline workflow is shown in Fig.3.

![PLC system software flow chart](image)

Figure 3 PLC system software flow chart.

Conclusions

The application of PLC system in oil and gas pipeline, not only can improve the work efficiency and management level, reduce the operation cost of the pipeline, but also can reduce the loss caused by the adverse effects, and reduce the labor intensity, to ensure safe and reliable production line.
Reference


