Analysis on Innovative Application and Advantages and Disadvantages of Blast Furnace Automatic Feeding System Based on PLC Control

Yang Yang

Shengli College, China University of Petroleum, Dongying, 257061, Shandong, China

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Abstract: In recent years, heavy industries such as China's steel and coal mines have ushered in supply-side reforms, and traditional extensive production methods have been unable to meet the demands of modern industrialization. As the core production equipment in these industries, blast furnaces have higher production capacity requirements. However, at this stage, the design of the blast furnace control system is not perfect, and the loading process is not only frequent accidents, but also the full utilization of raw materials cannot be achieved. At the same time, the emergence and continuous improvement of PLC technology has brought new opportunities for the development of industrial equipment automation. In this context, this paper innovatively designed a blast furnace automatic feeding system based on PLC control, and briefly analyzed its advantages and disadvantages.

1. Background of the study

1.1 Literature review

With the continuous improvement of the technology level, the automated electrical control system is gradually updated. The traditional electrical control device using the electrical connection line has great manpower and material consumption, and the daily maintenance work is also very complicated, and the electrical automation control level is generally low. Song Li pointed out that when the distance between the lines is long, the installation and debugging of the automation control system is very complicated. In order to meet the development needs of industrial automation, new electrical automation control systems have been developed on the basis of PLC technology (Song, 2016). Xiong Jiahui took the sand steel 6# blast furnace as the specific research object, and studied the automatic control of the top loading, the control of the cloth chute and the design of the ring fabric, and achieved the goal of improving the control precision and automation. However, due to the severely aged blast furnace equipment, the position feedback accuracy of the distributor is not high, and the fabric form is single, and the raw materials are difficult to fully utilize (Xiong, 2018). Su Haidong focused on the software and hardware characteristics of Siemens S7 series PLC control system, and introduced the main control functions of PLC system (Su, 2013) with the top loading system of Taigang 5#4350m3 blast furnace. Zhang Bo pointed out that there are many complicated physical and chemical reactions in the iron making blast furnace. It is necessary to model according to the actual process to control the blast furnace loading process. On this basis, Zhang Bo used computer modeling to drive the PLC control unit, and used the nonlinear subspace identification method to establish the Hammerstein model, which improved the overall working efficiency of the PLC automatic loading control system (Zhang, 2018). Zhang Peiqi analyzed the development status of blast furnace automation systems at home and abroad, focusing on the automatic feeding process and researching the application of PLC in it (Zhang, 2019). Mao Jiuyong pointed out that in the current era of pursuing high efficiency and convenience, traditional electrical control cannot meet the automation needs. In this context, PLC programmable controllers have a broad application space (Mao, 2013).

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1.2 Purpose of the study

The continuous improvement of the technical level has brought the industrial field automation level to a new stage. Since its inception, PLC programmable controllers have received a focus on the industry. For example, the leader in the domestic automation field, WINCC V6 uses PLC technology to achieve solution development for industrial automation applications. Real-time production information is available and interactively operated at all locations across the enterprise. Steel, coal, etc., as important raw materials for society, are widely used in various fields, and these industries are currently in a critical period of upgrading. Due to national conditions and historical reasons, China's blast furnace automation control technology started late, in which the important part of blast furnace iron making during the feeding process directly affects the output quality. In view of this, based on PLC control technology, designing the blast furnace automatic feeding system, and thus improving the level of feeding, has important practical significance.

2. Theoretical overview

2.1 PLC

PLC is short for Programnl Logic Controller, also known as class program logic controller. Its main functions are logic control, data processing and transmission. Compared with traditional sequential controllers, PLC introduces microelectronics, communication technology, automatic control technology and computer technology (Chen, 2012). To a certain extent, it can replace the relay function to form a flexible remote control system. The advantages of PLC technology are obvious, and it has the functions of strong anti-interference ability, high reliability and simple editing. The internal working production adopts the cyclic scanning mode. Some medium and large PLC devices will set the end-off working mode. After the user debugging program is finished, the editor can be used to record the program into the memory, and the post-work can be automated. The PLC is mainly composed of three parts, namely the power supply component, the microprocessor CPU and the memory, and the input and output components. The microprocessor CPU is the core component, and can be either a standard chip or a programmable controller dedicated chip. The memory is divided into ROM and RAM. The input and output components are the components used when the PLC exchanges data with the production site. Considering the working environment, these components have strong anti-interference.

2.2 Blast furnace automatic feeding process

The so-called blast furnace feeding refers to the whole process of transporting raw materials to the top of the blast furnace and then into the blast furnace from the feeding under the tank (Bi and Xu, 2013). At this stage, there are two main types of blast furnace feeding, namely the inclined bridge and the belt conveyor. Among them, the feeding method of the inclined bridge material truck is the method adopted by most blast furnaces in China, and can be further subdivided into two types of bicycle loading and double-car loading. At present, the single-car loading form that is only suitable for small blast furnaces is gradually being phased out. The technology of the inclined bridge feeding system can be divided into material pit, centralized weighing system, inclined bridge, material truck, winch, and electrical automation control system. Its main features are small investment and simple and reliable process. However, due to the limited distance between the coke ore tank system and the blast furnace, it is not conducive to the layout of the general plan, and also has a certain impact on the pre-furnace slag treatment facilities and environmental protection facilities. Equipment maintenance is also more difficult. The feeding process of the belt conveyor is mainly composed of a belt communication gallery, a main belt, a transmission machine room and an electrical automation control system. Compared with the inclined bridge loading system, the disadvantage is that the investment is large, but the feeding ability is strong, the arrangement is flexible, and the maintenance is convenient.

3. Innovative application of blast furnace automatic feeding system based on plc control

The blast furnace automatic feeding system designed in this paper contains three parts: basic control machine, management control level and communication software.

Among them, the basic control level uses Control Logix control equipment, which is produced by Allen-Bradley Company of the United States. Its biggest feature is that each system is designed as the main network and subnet structure. All systems consist of a redundant Control Net main network and a Control Net subnet. At the same time, there are spare processors and monitoring stations in the system to improve the reliability of the control system.

The basic control level has a total of 6 control subnets. Among them, the subnet No. 1 is mainly responsible for the system batching, transportation mix and materials under the tank and the corresponding monitoring process. Subnet No. 2 is mainly responsible for completing the loading of the top material tank and conducting comprehensive fabric control and monitoring. The No. 3 subnet needs real-time monitoring of the state of the Lushen system instrument control equipment, and according to the specific results, Wanheng mixed air temperature adjustment, liquid level adjustment and other process links. Subnet No. 4 is mainly used to monitor the blast furnace cooling water system data in real time and present trend images. Subnet No. 5 is mainly responsible for controlling the combustion, changing and rest periods of the hot blast stove and monitoring the automatic combustion adjustment process. The last subnet is mainly used to complete the paper cup, transport and blowing process of transporting items.

Each of the six control stations is equipped with a separate Control Logix subnet, enabling efficient communication between the control station and the remote I/O framework. The basic control level system consisting of 6 control stations can complete the equipment control, trend display, data monitoring and timely alarm light function in the blast furnace equipment loading process to ensure the system reliability to the greatest extent.

In terms of management control level, a star topology computer network with good scalability and compatibility is adopted. Network communication is realized through the TCP/IP protocol. The hardware of this system is composed of one data server, three clients and two network promise servers. The system software used by the server is Windows 2000 Server (Chinese) with good stability. The application software used by the client is Delphi, and the system software is Windows 2000 Professional (Chinese version). The database management system uses Oracle, which is more common internationally.

The main task of the management is to collect data in real time and record all relevant data in the production process in time. By establishing

Establish a production database to achieve data sharing in a true sense; at the same time, complete data analysis to guide production management, and provide production reports, ledgers, and basic query functions.

The last part is the choice of communication software. This paper selects VB6.0 software for the development of OPC communication software and Control Logix system communication, in order to complete the data exchange task. Considering the development cost and convenient maintenance, the two-layer communication system is not directly connected, but is isolated from each other and is modularized. Compared with general-purpose software, the communication software used has the advantages of high speed, low cost and high stability.

4. Analysis of advantages and disadvantages

Compared with the traditional blast furnace automatic feeding system, the PLC-based feeding system designed in this paper has the following advantages. First, the monitoring layer adopts a two-layer structure of the main network and the subnet, and can realize communication between the computer, the control station, and the operation station. This network structure ensures system reliability and real-time performance.

Second, the system can effectively implement data management functions. Traditional control

systems cannot process data and analyze it. By establishing a production database, the new system can combine real-time data with data management to achieve integrated processing of production data. At the same time, the new system also provides report analysis and query capabilities to provide data support for operator control.

Again, the new system is highly flexible in the software development of the control system. Through simple programming, the operating steps of the blast furnace automatic control system can be changed, and the symmetrical weighing method, fabric control, feeding speed, etc. can be modified online.

The last point is better visibility. With the monitoring device set up by the management control level, the new loading system can process the monitored data and feed it back to the operator's operation port in the form of reports, ledgers, etc. Simplifies the analysis process for the operator.

Although the designed blast furnace automatic feeding system based on PLC control has many advantages, it should also be noted that the completion of this system requires more capital investment. Moreover, for SMEs, whether or not they have PLC programming capabilities is also a problem.

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