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Application of PLC Control System and Communication Technology in Chemical Plant Equipment Renovation

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In order to improve the safety and reliability of the entire system of the adhesive plant, the plant's equipment was retrofitted in this design. This design is based on the reactor as the main object of control, the main controller is AB Controllogix type PLC L72. The communication network adopts high speed control Net control network. In the main communication protocol of the system, Ethernet / IP high-speed Ethernet communication is the main way. In addition, Wonderware Intouch is used as the host computer interface software. At the same time, in the RSLINX network configuration, OPC is used as the middle end of the service, thus interacting with the seamless connection of the lower computer data. Finally, EXCEL is used as a server for intermediate exchange of data in order to view historical data. Therefore, this design can not only ensure the safety of the entire production line, but also has the advantages of high reliability, low cost, low power consumption and good man-machine interface.

1. Introduction

In recent years, computer information technology is developing rapidl. On the basis of continuously expanding the function of the products, suppliers continue to reduce the price, so that PLC, communication technology, process motion control software have made great progress (Hendra et al., 2016). In industrial control, the application of PLC is more and more common (Greve, 2016). At the same time, integrated logic control, motion process control, communication data processing PLC products continue to appear, the old logic function of the PLC has been unable to meet the industrial production control requirements (Kerahroudi et al., 2016). Therefore, in the equipment transformation process, the original equipment must be retained, so as to ensure the smooth progress of equipment transformation (Vaquette et al., 2016). In addition, the equipment needs to be purchased in batches, thus avoiding communication problems between the legacy system and the new system (Suzuki, 2016). This shows that the upgrading of equipment not only can reduce costs and improve efficiency, but also can improve the competitiveness of enterprises in the industry (Panchal et al., 2016). In this subject, AB PLC and powerful network communication technology is used, in order to achieve an adhesive factory industrial intelligent transformation (Milik et al., 2016). On the basis of preserving the more advanced equipment, AB L72 controller and network communication protocol are applied to the transformation project, so the reliability of the system is enhanced (Priyanka et al., 2016).

2. PLC control scheme design

2.1 System basic situation

The existing original equipment includes Siemens PLC complete sets of cooling system devices, heat exchange devices, Siemens weighing system devices and Siemens intouch 10-inch 227 touch screen and other equipment (Massa et al., 2016). Adhesive chemical plants have annual production capacity of 10,000 tons of adhesive finished products, but most of the equipment are used manually. These devices are controlled by relays and contactors (Benaissa et al., 2016). The number of electrical control elements is large, and the components are installed in the electrical shop (Chermak et al., 2016). Therefore, the operation of the control system is difficult (Chu, 2016). And the workload, maintenance is very large, thus seriously affecting the plant's normal production. The adhesive centralized control system has become a bottleneck restricting

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the plant's production (Zhang et al., 2014). In order to reduce downtime and improve equipment operating rate and productivity, the plant decided to retain some of the functional equipment, and then transform the entire control system (Kuzmin et al., 2016).The contents of the transformation shown in Figure 1.

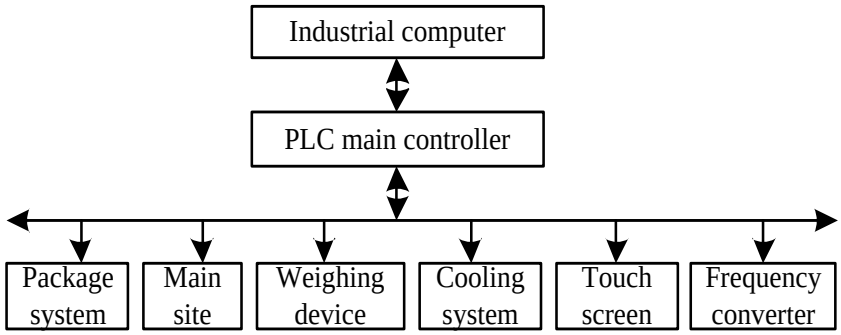

Figure 1: System frame

The specific requirements are as follows:
(1) The main controller PLC not only has a large memory, but also have fast processing speed.
This will not only ensure the system response speed, but also improve system redundancy, so that all the system IO points can be controlled.
(2) As the various manufacturers of the control protocol is not consistent, different manufacturers can not directly communicate between the PLC. This requires the selected host controller must have a variety of factory communication protocol functions. In order to ensure mutual communication, the system should be equipped with the corresponding network interface module.
(3) In the control of the mixer, high-speed Ethernet / IP communication protocol is used. It can not only control the inverter, you can also control the speed, thereby reducing energy consumption.
(4) The technician of the field operation can not only obtain the status of the current device, but also can read the device parameters. So the project added three different production location AB touch screen.

2.2 The choice of communication control network

This design uses Control net control network, it is a high-performance industrial LAN . It is not only a high performance, flexibility, openness, and network configuration and diagnostic capabilities are very powerful. Control Net network structure shown in Figure 6. As can be seen from the framework communication structure contained in Figure 2, the Control net network directly affects the control logic between the entire system control layer and the management layer (Yuan, et al., 2016). Therefore, the choice of control network is also a very important indicator of network planning configuration.

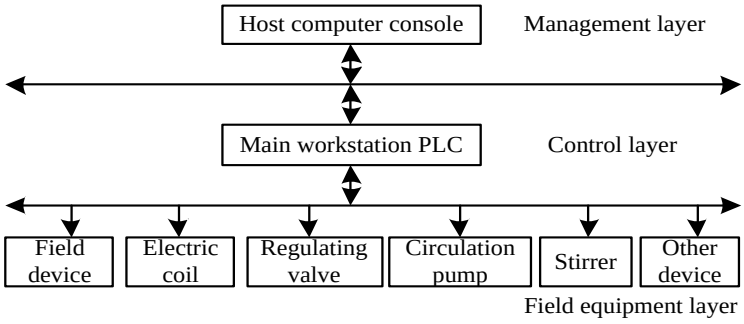

Figure 2: Control Net network diagram

2.3 The selection of network communication protocol

(1) In order to ensure efficient operation of the system network nodes, most of the remote device communication is replaced by Ethernet / IP Ethernet communication. This is not only easy to debug, but also can enhance the overall speed of field equipment control.

(2) For some important but slightly lower control level of the device, MODBUS protocol is used. These devices only have modbus communication capabilities. In order to facilitate monitoring of the status of the device, the third-party protocol module VI94-MCM is used, it can connect MODBUS site data to the main AB controller.

2.4 The selection of Inverter

Adhesive plant mixer motor using low-voltage variable frequency three-phase asynchronous motor, its model is H-compact 1LA8317-2. Its rated speed is 2979rad / min, power factor is 0.91, rated torque of 1010N · M. It is worth mentioning that the old system stirrer can only be controlled by the motor start and stop stirring state. This control strategy can not only lead to an increase in the time of complete melting of crude oil and materials, but also increase energy consumption and speed. As a result, AB's Power Flex 750 Series AC Inverters Power Flex 755 is selected. Its advantages are as follows:
(1) High flexibility:
The drive's performance range is 1350 Hp to 900 kW, integrated with the Logix control platform Power Flex 755, which seamlessly integrated into the Logix environment. It not only simplifies and improves configuration, programming and debugging processes, but also can diagnose and maintain work.
(2) Network configuration ability:
The drive uses a user-defined configuration file or an embedded instruction. This approach not only shortens engineering design time and reduces associated costs, but also improves configuration, control, and data acquisition capabilities.
(3) Standard protection performance:
The Power Flex 755 frequency converter has additional standard protection features, including built-in protection devices.

3. Software design

3.1 System process

The production process of the system consists of three parts, namely, refueling feeding control system, refueling feeding reactor mixing system, cooling and packaging system components. The main control system is shown in Figure 3.
(1) Refueling feeding control system
When the work order needs oil, the oil will be stored in the tank through the pump through the pipeline, and the amount of feeding and the amount of oil will be set to the screen prevail.
(2) Refueling feed reactor Mixing system
Raw materials and hot oil are stirred in this system. The system mainly includes vacuum pump vacuum action and nitrogen, so as to ensure that the mixing process requirements.
(3) Cooling packaging system
When the reaction of the reactor mixture is completed, the mixture will be cooled and dried, and the cooling material is cut and packaged.

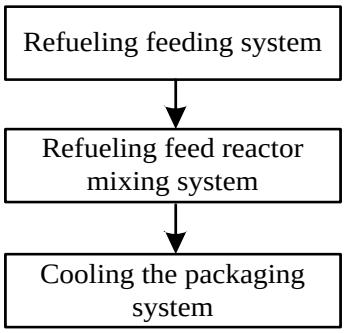

Figure 3: Main control systems

3.2 Feeding and refueling control production system

In the feed refueling control system, the feeding, fueling can reach the preset set value. The oil pump can transfer the oil from the T-100 oil tank to the oil tank of H1, H2 and A1. This control mode can select the minimum pressure-sensitive adhesive reaction tank. When the accumulated value of the flowmeter reaches

the preset amount of fuel, the refueling valve will be closed. When the start button is activated, the system will automatically jump to the fuel pump promoter subroutine and flow meter cumulative subroutine.
The actual fueling process automatically compares the actual value of the oil and the set value. When the actual fuel value and the advance off valve value is less than the fueling set value, the weighing system flag will become 1, thus completing the refueling weighing system refueling work.

3.3 Refueling feed reactor mixing system

The system is the prerequisite of the design system. Rubber materials, hot oil, and resin ingredients can be completely dissolved in the process of meeting the requirements of the process.
Before the system is initialized, the status of the valves on the reactor needs to be checked. When the system requirements are met, the technician can control the jogging and automatic control of the frequency converter.
In addition, the speed of the stirring motor D6212 is controlled. In order to ensure the melt to meet the technical requirements, TIC1201 temperature sensor needs to control the FV1201 valve. In the process of increasing the temperature, FV1201 valve opening degree will gradually decrease with the increase of TIC1201 temperature, so as to ensure the system temperature is constant.

4. System communication integration application

4.1 System main frame design

Figure 4 shows the network topology of the system. On the basis of Control Net, the system uses two kinds of protocol control: The first is the Modbus protocol. It includes the cutter set of equipment, the fan's state temperature, the heater temperature, thus ensuring it is Modbus master-slave control. In addition, in order to facilitate the integration of the system, MVI94 module is used. It can transfer all the information to the L72 AB PLC's memory. At the same time, the touch screen interface and the host computer screen will display real-time data information. The other is Ethernet control. When the system is configured, its IP address will be encoded. In addition, the data is exchanged at high speed. Among them, AB-OMRON PLC communication and Wonderware and PLC's OPC Ethernet communication is the key point of the system.

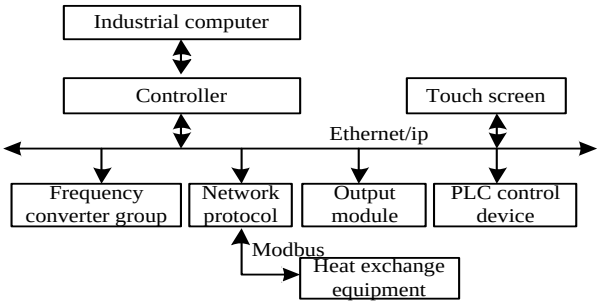

Figure 4: Main frame of the system

4.2 AB_EIP21 configuration

In the RSlogix5000 interface, open the program OMO_EIP2_AB. Communication between different PLCs requires the exchange of data by configuring the MESSAGE structure of the data type, so the system must be set to CIP Generic. Specific procedure is shown in Figure 5. When the program is executed, on the basis of the EIP21 communication module, the MSG instruction reads the data in the OMON and transfers it to the pre-set tag AB [0] -AB [99]. Finally, the touch screen or the host computer will display the read data information.

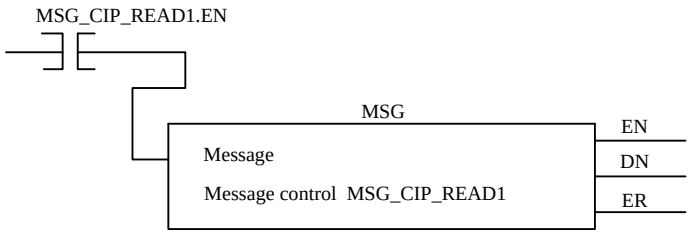

Figure 5: EIP_21 ladder diagram

Based on the project requirements, Intouch10.1 is used as the host computer software.
In order to ensure that the host computer can communicate with the master controller L72, the RSLOGIX5000 needs to use OPC as the service end in the RSLINX network configuration. In addition, EXCEL is used as an intermediate exchange data server to enable technicians to view historical data and monitor changes in field data. At the same time, in the Intouch development interface, the technician can view the status of field devices running in real time. Moreover, Intouch also provides developers with a simple development environment and module function blocks. Electrical engineers can not only establish an automated application interface, but also can deliver data in real time. In this project design, Intouch software and AB PLC cannot communicate directly. Therefore, the OPC third party communication protocol is adopted. The driver can be downloaded free of charge on the wondeware official website. This method has the advantages of quick debugging, low cost and good reliability.

4.3 RSLINX communication configuration

The main equipment of this project is AB related products, such as programming software RSLogix5000, AB host computer software RSView SE, and configuration software RSLINX and other applications. The software forms the control system software shown in Figure 6.
RSLinx's main interface window is RSWho. The system of the control system bus and the instrumentation device on the network can be displayed by RSLINX. It has a variety of functions, including: browsing ladder program, monitor data function, monitor PLC controller memory.
The RSLinx Gateway version is used in this project and has the following features. Firstly, Powerful drive functions. Intouch or WINCC can communicate with RSLinx Gateway using remote OPC software. Second, multiple clients can access data directly from the same RSLinx Gateway via remote OPC. This project mainly uses RSLinx as OPC server. Past dedicated I / O device driver software will be replaced by OPC, and thus to the host computer interface software RSView SE to provide data services.

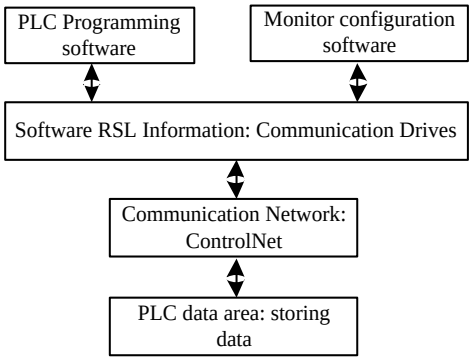

Figure 6: Control system software diagram

This article designed an intelligent selection of a single production process, which can be followed in order from top to bottom. At the same time, when the unit test is completed, the overall test is carried out. It can not only reduce the risk, but also can increase the stability of the control system. After a week of single-step operation and sequential commissioning, the system has been able to fully meet the requirements of the previous project. Through the commissioning and acceptance of the project, the design has all reached the completion and acceptance criteria.

5. Conclusion

The subject of a binder chemical plant in Guangzhou as the background, based on the production process design PLC ladder program, introduced PLC to achieve the process. In addition, flexible technology such as process control and Control Net network communications are used in control system retrofits. On the basis of the network architecture features of the distributed control system, the Ethernet and Modbus network protocols between PLCs are written. At the same time, the integrated application of these two protocols can enhance the communication capability of field devices. Therefore, the system can not only improve the remote control of the central control room technician, but also can optimize the operation parameters of the equipment. This equipment can control the order and quantity of various raw materials into the reactor and control the temperature of the reactor coil. It can also stir the raw materials, so that all kinds of raw materials are fully

reacted. When the reactor raw materials are fully reacted, the raw material is transferred to the middle irrigation. Finally, the feedstock is cooled and cut into products.

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