Application of ControlLogix in Remote Monitoring System of ESP-FF Hybrid Precipitator

GE Yifei, YU Tiesong, ZHAO Lei
(Zhejiang Feida Environmental Science & Technology Co. LTD. Wangyun Road 88, Zhuji City, 311800)

Abstract: Remote monitoring system in JHARSUGUDA 6×600 MW independent power station in India includes three parts, which are program controls of high voltage ESP, low voltage ESP and fabric filter. The technology applied in this system has reached international advanced levels. RSView monitoring software from Rockwell Automation Power Systems Ltd. and programmable logic controller of ControlLogix series are selected in this system Remote monitoring system provides perfect communication mode and network, and use redundant configuration of double- machine and double-net to ensure the system reliable. This paper introduces the system in detail.

Keywords: New ESP-FF hybrid precipitator, ControlLogix, EtherNet/IP, OPC alias topic, RSView SE

1 INTRODUCTION

Precipitator integrates the low JHARSUGUDA 6×600 MW independent power station is located in Orissa state in India. In the first phase, 4×600MW coal-fired condensing steam unit was installed. In the second phase, 2×600 MW coal-fired condensing steam unit was installed Dust removal system of this program was designed to using ESP-FF hybrid precipitator with double electric field ESP as preliminary dust collector. This program is the largest coal-fired power station program using ESP-FF hybrid precipitator in Asia.

ESP-FF hybrid precipitator was developed and applied in industry by an American company. ESP-FF hybrid resistance advantage of ESP and high efficiency advantage of fabric filter. It has been applied in the dust treatment of large and medium-sized coal-fired power stations, and these ESP-FF hybrid precipitators are all in good working condition. Remote monitoring system of ESP-FF hybrid precipitator uses field bus technology to achieve serial multi-node digital communication among micro-computerized measurement equipments. It is an open and digital bottom control network of multi-node communication, and breaks the limitation of DCS closed system. It makes integrative complete distributed control system of network come true. In the same time, it solves the problem of field bus using different communication protocols in bottom control network and widens the space of bottom control network.

ControlLogix serial controller of American A-B company has been widely applied in all kinds of production process because of its high reliability, high adaptability of field and strong network function. It can realize sequence control, loop regulation, data acquisition, decentralized control and centralized management. It is an important mean to realize electromechanical integration. The network architecture of NetLinx is open, and the technology, which can help to seamlessly integrate from workshop to top, is from Rockwell Automation Power Systems Ltd. Three layers of network that are DeviceNet, ControlNet and EtherNet/IP, using the same protocol and providing the same communication function, make up the architecture of NetLinx. The protocol is common industrial protocol (CIP), which can help the uses to real-time control and collect date in any NetLinx network conveniently.

2 CONTROL SYSTEM STRUCTURE AND HARDWARE ORGANIZATION

Date collection, date processing, control operation and control output are finished by field control units of ESP-FF hybrid precipitator control system. The control system communicates with upper monitoring computer by mean of EtherNet/IP network. Character, list, curve, graphic and animation in the upper monitoring computer can reflect the condition of field and provide reliable and accurate real-time information to the operators. In the same time, the field control units receive the orders of upper administrative ethemet to realize the remote monitoring of ESP-FF hybrid precipitator.

High voltage ESP, low voltage ESP and fabric filter program control make up the field control unit of whole control system. High voltage rectifier control equipment forms the measurement and control unit of high voltage ESP. Control function, address, current limit and parameters are set by I/O expansion interface. The communication protocol is ModBus standard protocol, and every high voltage control unit links to the ModBus as a node. Query, parameter setting and start-stop of high voltage board are finished by the execute program of PLC main station. The PLC directly controls the low voltage part of ESP and fabric filter.

PLC receives input of switch state and temperature of electric heater, and output the signal of switch state to control the rapping motor and start or stop the electric heater. It can time the electric heater, rapping equipment and unloading equipment, and can monitor various operation feedback signals to dynamic display the operation condition and fault alarm, in the same time, by monitor operation pressure difference of fabric filter, control the rapping of fabric filter. Remote monitoring system of ESP-FF hybrid precipitator absorbs distributed measurement and control method of fabric filter, and integrates the characteristics of ESP and fabric filter

monitoring system to instead the traditional processing measurement and control system of ESP which mainly measures the analog signal of voltage and current to realize the communication among equipments and communication between the system and the external.

There are three working modes in the system, which are manually operation, half manually operation and total automatic operation. The high voltage board can apply to many kinds of working conditions, keep moderated spark rate and monitor operational state of ESP automatically to find any fault of ESP in time. IT has many kinds of control functions, such as spark tracking, intermittent power supply and truncation recovery. Main hardwares of remote monitoring system of ESP-FF hybrid precipitator are upper ethernet, network bridge equipment, high-voltage part and low-voltage part. Fig. 1 shows detail structure of the control system.

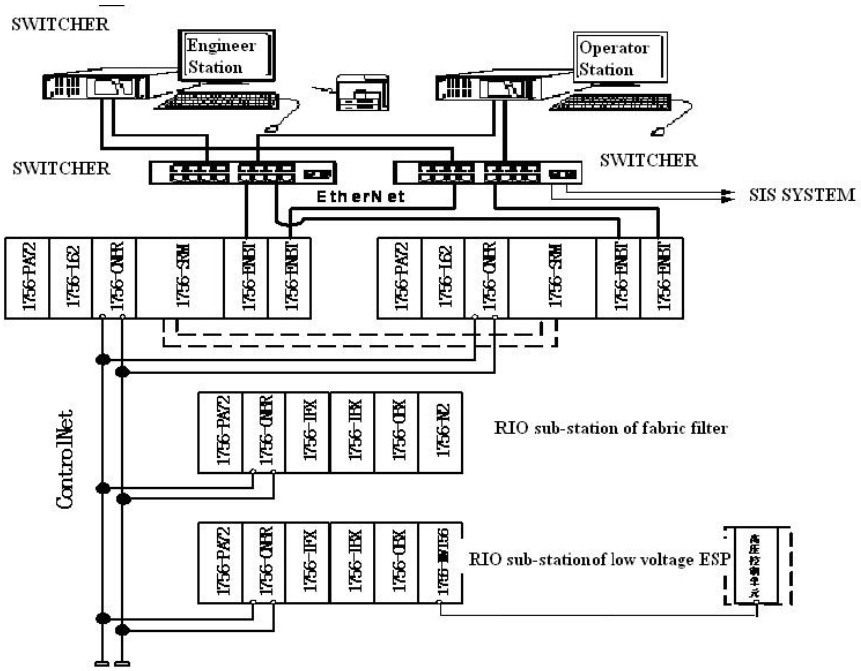

Fig. 1 Structure of the control system

3 HOT STANDBY REDUNDANT CONFIGURATION OF THE CONTROL SYSTEM

CPU hot standby and network redundant configuration is used widely both in China and other countries as an efficient instrument to improve reliability of the system. So this program uses ControlLogix serial programmable logic controller (PLC) from Rockwell Automation Power Systems Ltd to form double CPU redundant hot standby system. In communication system, double-card and double-network are used, that means plugging two Ethernet cards in upper machine and setting two ENBT communication modules for each framework which is as a hot standby to each other. There are four communication channels, each of which can be hot standby of others, to make the whole system reliable.

3.1 Double-CPU, Double-power Supply and Double-framework

ControlLogix is suitable to the redundant configuration of double-CPU without programming to switch to the redundant configuration.

We can see from Fig. 2, two CPUs are put in framework A and framework B respectively, hanging on the ControlNet in the same time, and the two modules connect with each other by cable. The main CPU and sub-CPU are synchronous in date and program. When the main CPU has problems, the sub-CPU is to be operated, which changes into main CPU in the same time. The CPU in fault can be stopped to be examined and repaired without influence on controlling the equipments. When the repair is finished, the CPU in fault can be used as sub-CPU and operated with main CPU in the same time. So we can draw the conclusion that redundant configuration of double-CPU can improve the reliability of the system dramatically.

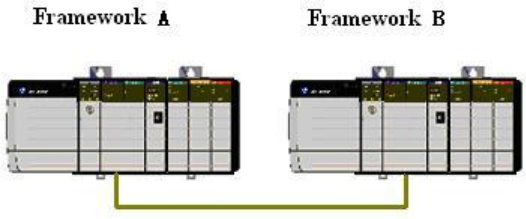

Fig. 2 redundant configuration of double-CPU and double-power supply

3.2 Redundant EtherNet/IP Network Communication

The upper machine communicates with the main controller through EtherNet/IP protocol. To make the communication stable and reliable, a couple of ENBT module is added in every redundant framework. Two Ethernet cards in upper

machine are set in two different network segments. Alias topic switch software of ControlLogix redundant system can keep the communication between user's HMI and the main controller. RSLinx gives an alias topic to each ENBT module alias topic stands for communication route connecting the collector.

In the redundant system of ControlLogix, alias topic points to the main controller, and after switch, alias topic will point to the new main controller (see Fig. 3).

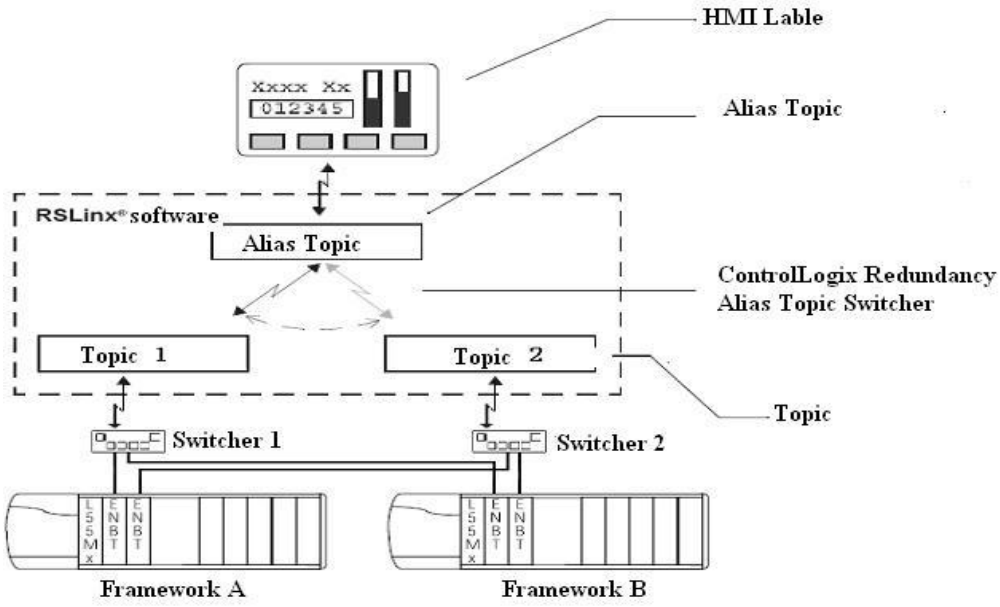

Fig. 3 Switch picture of alias topic

4 SOFTWARE CONSTITUTE OF THE SYSTEM

RSView SE is used as upper machine monitoring software and RSLinx, which can provide all the communication service for the connection between field equipments and man-machine interface systems, is used as the communication software in this remote monitoring system. Through user's graphic interfaces of RSLinx, communication between any two equipments from different networks can be finished conveniently. RSView SE and RSLinx are both from Rockwell Automation Power Systems Ltd. CPU hot standby and network redundant configuration is used widely both in China and other countries as an efficient instrument to improve reliability of the system. So this program uses ControlLogix serial programmable logic controller (PLC) from Rockwell Automation Power Systems Ltd to form double CPU redundant hot standby system. In communication system, double-card and double-network are used, that means pluging two Ethernet cards in upper machine and setting two ENBT communication modules for each framework which is as a hot standby to each other. There are four communication channels, each of which can be hot standby of others, to make the whole system reliable.

4.1 Upper Machine Monitoring Software of the System

Graphic display picture are created and edited by object-oriented graph and animation. Monitoring and control picture of ESP-FF hybrid precipitator programmed by RsView SE include ESP part and fabric, filter part. Display and adjustment pictures of voltage, current, thyristor operating angle, spark rate, raping and material level are included in the ESP part. Display and adjustment pictures of gas temperature of inlet and outlet, pressure difference of the fabric filter and action addiction of rapping are included in the fabric filter part.

Keeping the temperature of fabric filter inlet in certain range is the key point to make the fabric filter operating stability. Boundary of inlet temperature, temperatures when side air door is opening and closing and temperature when machine is stopped in a urgent are all can be set through the monitoring and control picture. And also, the pressure difference and the highest pressure difference of the fabric filter can be set to keep the system in the best operation condition. By switching freely among different monitoring and control pictures, the operators can know the operation condition of the equipments completely and make correct judgment and operation in time.

4.2 Communication Software—RsLinx

RsLinx can provide all the communication drivers needed by the network. It can support the traditional Allen-Bradley network and also can support the hardware products, such as PCMCIA card, serial port and network adapter based on the computer, which are supported by the newest and powerful ControlLogix Gateway. In the same time, RSLinx can be an OPC sever, provide necessary ports to the clients. The client can access the RSLinx gateway through TCP/IP network. Date communication can be realized by DDE/OPC.

4.3 Alias Topic Switcher Software

ControlLogix Redundancy Alias Topic Switcher software can keep the communication between user's HMI and main controller after switching.

Alias Topic Switcher is operated As a sever of the system. It will start automatically and display on the toolbar of desktop after the user's computer is turned on.

4.4 Field Control Sofeware

RSLogix serial program software is operated on Windows operating system. It has reliable communication function, powerful programming ability and eminent diagnosis ability. RSLogix 5 can support PLC-5 serial programmable processors; RSLogix500 can support SLC500 and MicroLogix serial programmable logic controller; RSLogix 5000 can support Logix 5000 serial programmable logic controllers.

Serial software of RSLogix5000 enterprise edition is a software package which can meet IEC 61131-3standrad. It can provide logical ladder diagram, structured text, function chart and editor of sequential function chart to the client. RSLogix5000 enterprise edition also has programming function of axis configuration and motion control.

5 CONCLUSIONS

Remote monitoring system of ESP-FF hybrid precipitator absorbs distributed measurement and control method of fabric filter, and integrates the characteristics of ESP and fabric filter monitoring system to instead the traditional processing measurement and control system of ESP which mainly measures the analog signal of voltage and current.

Protocols of field bus can converse and connect with each other through 1756-CNBR network module and MV156-MCM protocol conversion module. Upper management equipment uses the most advanced Ethernet technology to connect the main communication port-PLC main station to the switch through Ethernet bridge module. High date rate, low time delay and little bit error rate of the Ethernet keep whole communication performance of the system stable. Information between equipment and equipment and between system and the external can change in time. In the same time the using of the redundant communication way can keep the communication of whole system reliable. This method has reference function to similar automation system and Ethernet redundant system.

REFERENCES

1. Oglesby, S. Jr, Nichols, G. B, Electrostatic presipitator, China WaterPower Press, 1983.
2. Li Feng, Modification and design of ESP control system in Wuhan steel plant, Engineering design and construction, 2002, 01.
3. Zhang Huajun, Control system of fabric filter, Tech information development and economy, 2006, 03.
4. RockWell_Automation, RSView SE white paper.
5. RockWell_Automation, ControlLogix Redundancy System User Guide.