Low Cost DCS Applied in the Process Automation of Cement Plant

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Computer technology has been widely used in the production process automation of cement industry since its development in recent years. Many new-built or reconstructed large or medium cement product lines have adopted Distributed Control Systems (DCS). However many small plants are still in the low level of technology. They depend heavily on the traditional instruments. Some of them monitor and control the process manually. All of these disadvantageous factors hinder them from improving product quality and quantity, saving energy and reducing consumption and being competitive. The cost of large-scale DCS system is so high that these firms can't afford it. In order to solve these problems we have developed a new DCS system with lower cost, which has been implemented it in our plant.

The field environment in our plant is under a high temperature, with extensive dust and serious electromagnetic interference (EMI) produced by many transducers, and the technical measurement points are very scattered, which increases the wiring cost and workload. After investigating and selecting the products from different manufactures with the best price/performance ratio, we chose the I-7000 series remote data modules, industrial computer and related I/O devices provided by ICP Shenzhen.

1 System Architecture

As shown in figure 1, the system is divided into five function subsystems according to the production of cement.

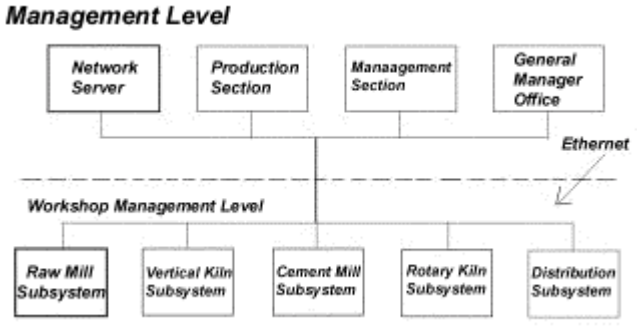

Figure1 System architecture of automation product process in a cement

- Raw mill supervisor system
- Vertical mill calcining process supervisor system
- Cement mill supervisor system
- Rotary kiln supervisor system
- The operating of distribution equipment and consumption Supervisor system

The raw mill subsystem and cement mill subsystem can be automatically turned on and turned off. The temperature and current of bearing supply oil system of the mill and main equipment are under monitor and control and can be optimized and adjusted depending on the change of arguments.

The vertical kiln subsystem comprises the equipment on and off monitor of vertical kiln product line, automatically watering in raw mill to form ball, fire-offset automatically correction and vertical kiln calcining process smart control, etc.

Interlock control of wet mill and coal mill has been realized in rotary kiln subsystem. At the same time the equipment, production and energy consumption of rotary kiln product line are under monitor and control and can be automatically controlled partly.

The distribution subsystem mainly inspects the operating of the transformers and large-scale hosts in all distribution rooms and makes a record.

Each subsystem connects to the company's existing management network via Ethernet and uploads the organized data on the network for calling by management department.

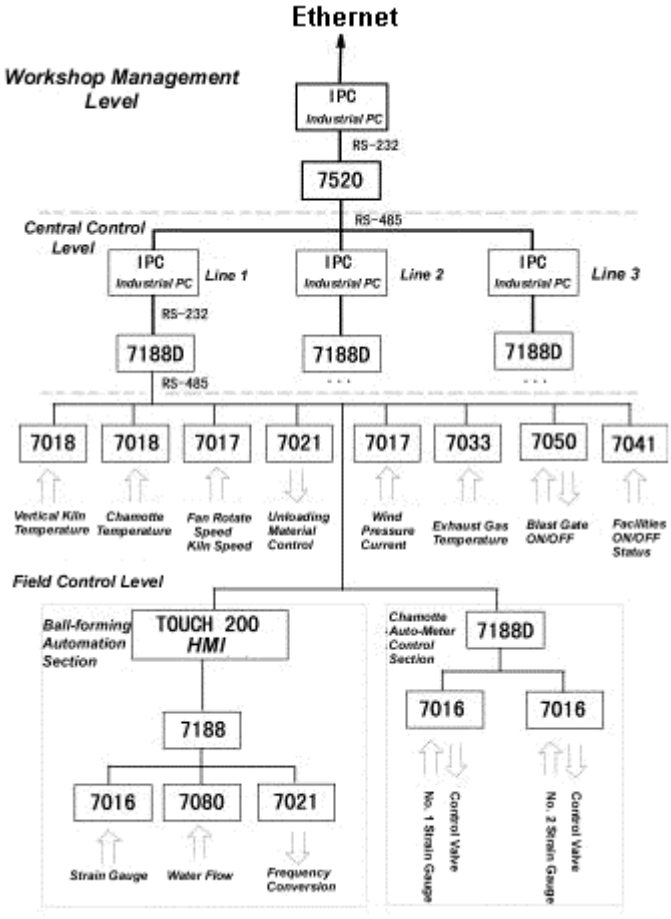

Figure 2 Vertical Subsystem Diagram

2 Subsystem Architecture

We just take vertical kiln system as an example.

1) The principle of vertical kiln
As shown in figure2, vertical kiln subsystem has three levels, which is workshop management level, workshop control room and workshop field level. The connection among the three levels was through RS-485 and technical arguments in vertical kiln is acquired by modules including I-7018, I-7018, I-7033, I-7050, I-7021, I-7041 etc.

Automation controller used in the formation of ball of raw cement comprises embedded control module I-7188, TOUCH 200 human machine interface (HMI), Data I/O modules (such as I-7016, I-7080, I-7021), strain gauge, flux sensor and transducer.

To keep the ball in a stable range by tracking and adjusting water in cement.
Auto-measure controller of chamotte consists of I-7188, I-7016, strain gauge and SRR. It can compute the output at the time of kiln outgoing with the flux value of kiln-outgoing chamotte.

In the central control room we take I-7188 with multiple serial ports as data buffer between IPC and field level. In this way 2-3 IPC can work at the same time and all of them can control or adjust the arguments in the system.

The IPC in workshop control room is mainly used for computing, displaying, auto analyzing, storing and controlling the data in the system. The operators in the central control room can give adjustment instructions with the information and send them to down-outputting module through IPC. Then the module will drive the performance mechanism.

The IPC in workshop management level implements computing, displaying, analyzing and storing of data and works out the control standard of each technical arguments based on the evaluation requirement which will be regarded as the premium criteria.

2) System Software

Because of the complexity of the system requirements, which include friendly HMI and real-time monitor and control, we develop the control software for IPC in Visual Basic 5.0 for Windows. The software is composed of system management module, simulation display module of process flow diagram, simulation display module of instrument screen, database management module, data communication module, control algorithm module，etc. The use of many ActiveX controls in the software greatly reduces the time of development.

We use the library files provided by ICPDAS for I-7188 in QuickBasic during the development of the software. About 200KB memory is enough for performing control function. And the software is composed of data processing and data communication modules. The system of the formation of ball of raw material includes function module, which can implement the conversation between human and machine.

3) Operating Result and Experience

At the beginning of 1998 the system was installed in the first product line, and after improving it’s performance it has been used in five product lines in 1999. This system can guaranty the stabilization of heat of the vertical kiln and improve output and quality of chamotte by improving qualified product ratio of ball-forming and keeping the balance of incoming and outgoing material.
Almost no failure occurs during the operating of the system. Moreover we have replace the harddisk with ICP’s IDE FLASH disk which resole the problem that common harddisk can’t frequently read and write in harsh environment.

3 Conclusion

Since I-7000 series modules can communicate by RS-485 (that is they can communicate in a long distance). All of the modules in the system can be connected via twisted-pair wire. The system has many advantages such as faster communication speed, high sampling resolution, intelligent operation, photoelectricity isolation, and strong ability against interference and dual watchdog. All these characters make it possible to enhance the system reliability and high speed data I/O and make it more easy to develop the software. And because the host is connected to the network with RS-232 communication port nearly any computer with RS-232 port can connect to this network, which improves the interchange of facilities and reduces the difficulties of maintenance and workload. Furthermore, with the self-adapting feature of I-7000 communication modules and multiple serial port design of I-7188 the old facilities with communication feature (such as transducer and smart instrument) can connect to the network so as to save the investment.

Therefore, after accomplishing the application in the vertical system we continue to use I-7000 modules to establish the network in other subsystems because this kind of system can meet the product requirements and obtain the best of price/performance ratio. On the whole the application of the system make great achievement in automation and management in our company.