Low Cost DCS Application for Cement Plant Process Automation

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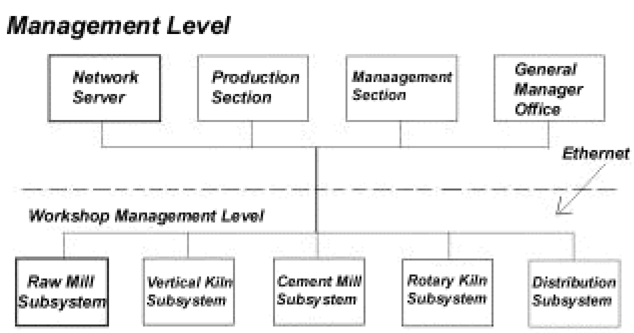
Recent developments within the cement industry have seen widespread implementation of computational technologies into the automation of production processes. Many recently built or renovated medium and large-scale cement product lines have adopted Distributed Control Systems (DCS). Unfortunately, many of the smaller plants aren't up to speed technologically, rather depending heavily on traditional instrumentation. Some such plants monitor and control the process manually. The inauspicious setup at these sites hinders product quality and quantity; it also keeps plants from saving energy, reducing consumption and being competitive. The cost of large-scale DCS systems is so high that these firms can't afford it. In order to solve these problems we have developed a new DCS system that is lower in cost and have implemented it in our plant.

The field environment in our plant is high in temperature, with extensive dust and serious electromagnetic interference (EMI) produced by many transducers, and the technical measurement points are very spread out, which increases wiring costs and workload. After investigating and selecting products from different manufactures with the best price/performance ratios, we chose the I-7000 series remote data acquisition 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.



- 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

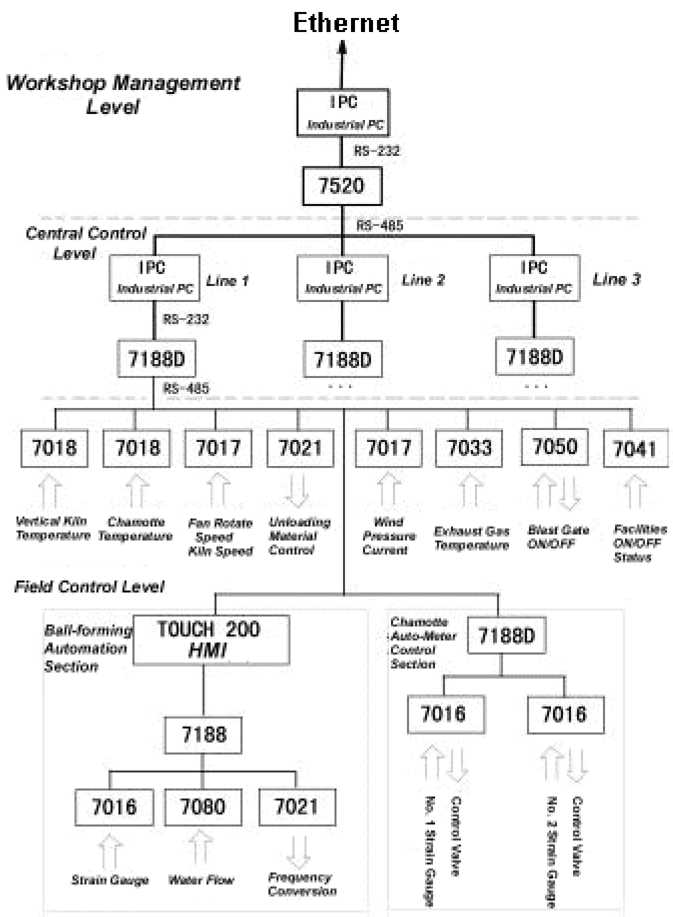
The raw mill subsystem and cement mill subsystem can be automatically turned on and off. The temperature and current of the supply oil system of the mill and main equipment are monitored and controlled and can be optimized and adjusted by manipulating the parameters.

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

Integrated control of the wet mill and the coal mill has been realized in the rotary kiln subsystem. Simultaneous monitoring and control of the equipment, production and energy consumption of the rotary kiln product line can be partially automated.

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

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



2. Subsystem Architecture

We can take the vertical kiln system as an example:

1) The principle of vertical kiln

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

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

To keep the ball at stable water content levels chamotte employs the I-7188, I-7016, strain gauge and SRR to auto-measure and control relevant levels. It can coordinate the output of the kiln to sync with the fluctuating value of kiln-outgoing chamotte.

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

The IPC in the 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 their information and send them to down-outputting modules through IPC. Then the module will drive the performance mechanism.

The IPC at the workshop management level performs computing, displaying, analyzing and storing of data and works out the control standards for each technical argument based on the evaluation requirement which, in turn, is regarded as the main criteria.

3) System Software

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

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

4) Operation Results and Experience

At the beginning of 1998, the system was installed in the first product line, and after improving its performance it has been used in five product lines in 1999. This system can guaranty the stabilization of heat for the vertical kiln and improve output and quality of the chamotte by improving qualified product ratio of ball-forming and maintaining the balance of incoming and outgoing material.

Almost no failures occurred during the operating of the system. Moreover we have replaced the old hard-disk with ICP's IDE FLASH disk which resolves the problem of the hard-disk's frequent inability to read and write in harsh environments.

5) Conclusion

Since I-7000 series modules can communicate using the RS-485 (that is they can communicate at a long distance) all of the modules in the system can be connected via twisted-pair wires. The system has many advantages such as faster communication speed, high sampling resolution, intelligent operation, photoelectric isolation, strong protection against interference and dual watchdog timers. All of these characteristics make it possible to enhance the system's reliability and high speed data I/O and make it easier to develop the software. And because the host is connected to the network with the RS-232 communication port nearly any computer with a RS-232 port can connect to this network, which improves the interoperation of facilities and reduces the difficulties of maintenance and workload. Furthermore, with the self-adapting feature of the I-7000 communication modules and multiple serial port design of the I-7188 the old facilities with communication features (such as transducers and smart instruments) can connect to the network so as to save the investment.

In conclusion, since accomplishing the application to the vertical system we continue to use I-7000 modules to implement the network in other subsystems because this kind of system can meet the product requirements and obtain the best price/performance ratio. On the whole the implementation of the system marks a great achievement in the automation and management in our company.