# The Distributed Control System for Cement Plants

Kazuo Umemoto

## 1. Introduction

With the recent burst in the bubble economy, Japan's cement industry undergoing difficult times. This is due to sluggish private demands, including a sharp decline in building construction in big city areas, and due to inexpensive imports from abroad because of the strong yen. As a result, business is deteriorating for cement manufacturing companies.

Under these circumstances, cement companies are taking great strides toward radically reforming themselves through mergers and restructuring. In cement production facilities and control systems, advanced equipment is required to achieve a reduction in source material per basic unit output, stable production and an improvement in product quality, and automatic operation. This paper introduces an example of a "distributed control system" that have been implemented cement plants.

## 2. Outline of the Cement Plant

The production of cement can be roughly divided into the four processes described below.

### 2.1 Raw materials processing

This process blends, dries and crushes the raw materials, which may include limestone, clay, silica, and pyrite cinder. The composition of the raw materials is analyzed with a fluorescent X-ray spectroscope in order to ensure a quality product.

### 2.2 Burning

This process burns the blended materials at the high temperature of about 1,450℃ in a kiln, producing the half-finished product known as clinker.

### 2.3 Coal processing

This process dries and pulverizes coal into a powder, which is used as fuel in the kiln and calciner.

### 2.4 Finish grinding

This process gives a finish grinding to the clinker. A small amount of gypsum is then added to produce the final product, cement.

In addition to the above, the cement making process may also include raw material receiving which makes use of receiving facilities and product shipping which makes use of the shipping facilities.

## 3. Configuration of the Distributed Control System

Figure 1 shows the system configuration of the distributed control system. Figure 2 shows the various functions of the distributed control system.

### 3.1 Human communication interface (HCI)

An essential component, the HCI is directly related to plant operation and consists primarily of the Operator Station IOS-2500. The IOS-2500 requires a system proficient in monitoring and facilitating operation in order to reduce the operator's tasks, to operate the plant efficiently, and to assure reliable cement quality. To meet these requirements, the CRT on the IOS-2500 is normally equipped with a touch screen and an alarm, making user friendly operation possible.

At cement plant, three or four CRTs per kiln are normally used during operation. With the IOS-2500, monitoring and operation of both instrumentation and motor controls on one CRT are possible. Consequently, unification or separation of both the instrumentation and motor controls can be fully realized, even through there are several hundred motors in one plant.

In addition to a network of computers, data display and data setting pertaining to control of the raw materials or the kiln can be performed on the IOS-2500.

With regard to the CRT, a one- or two-stage stacking console is available and can be selected in accordance with the system. The latter makes effective use of control room space as well as reduces the number of operators needed for monitoring and operation. A color hard copy machine is connected to each CRT to record operating conditions.

### 3.2 Database station

The database station IDS-2500 provides the database for centralized data management in the MICREX-

Fig. 1 System configuration of the distributed control system

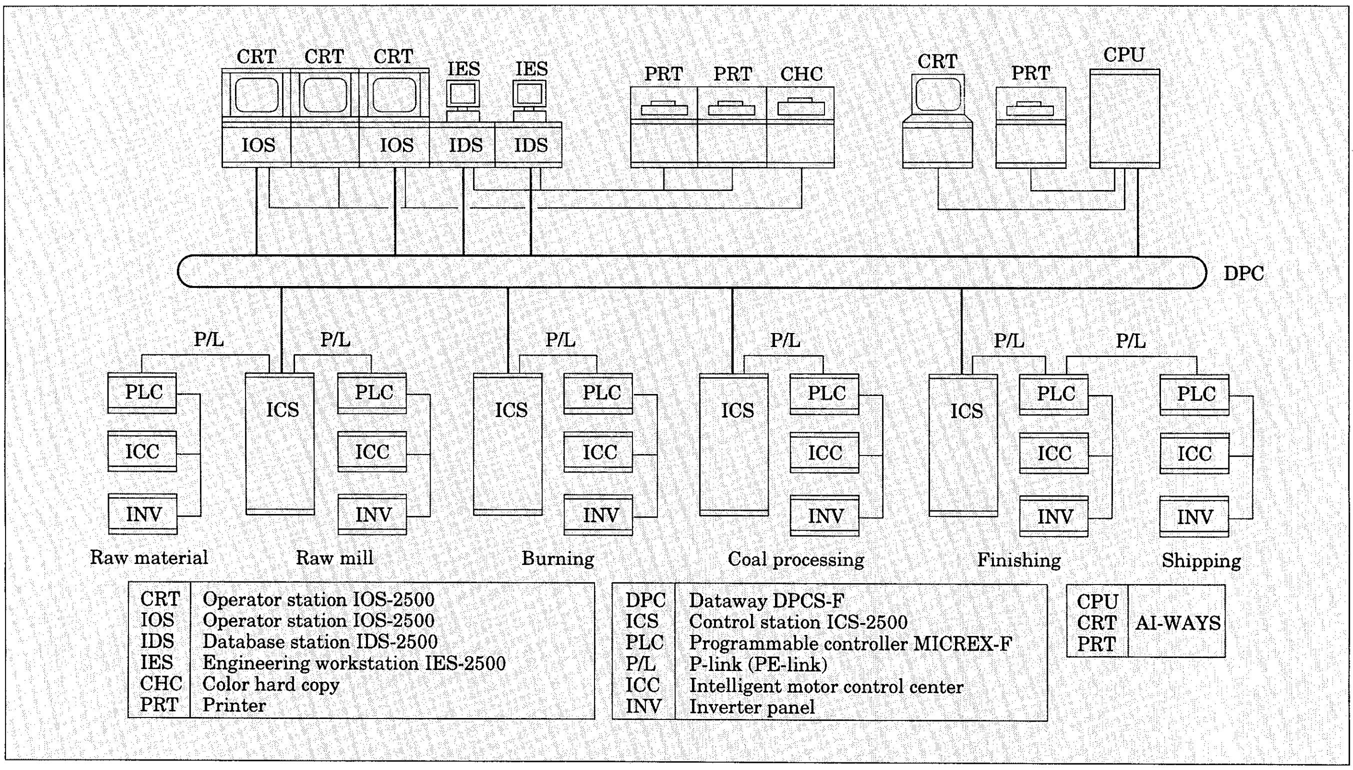
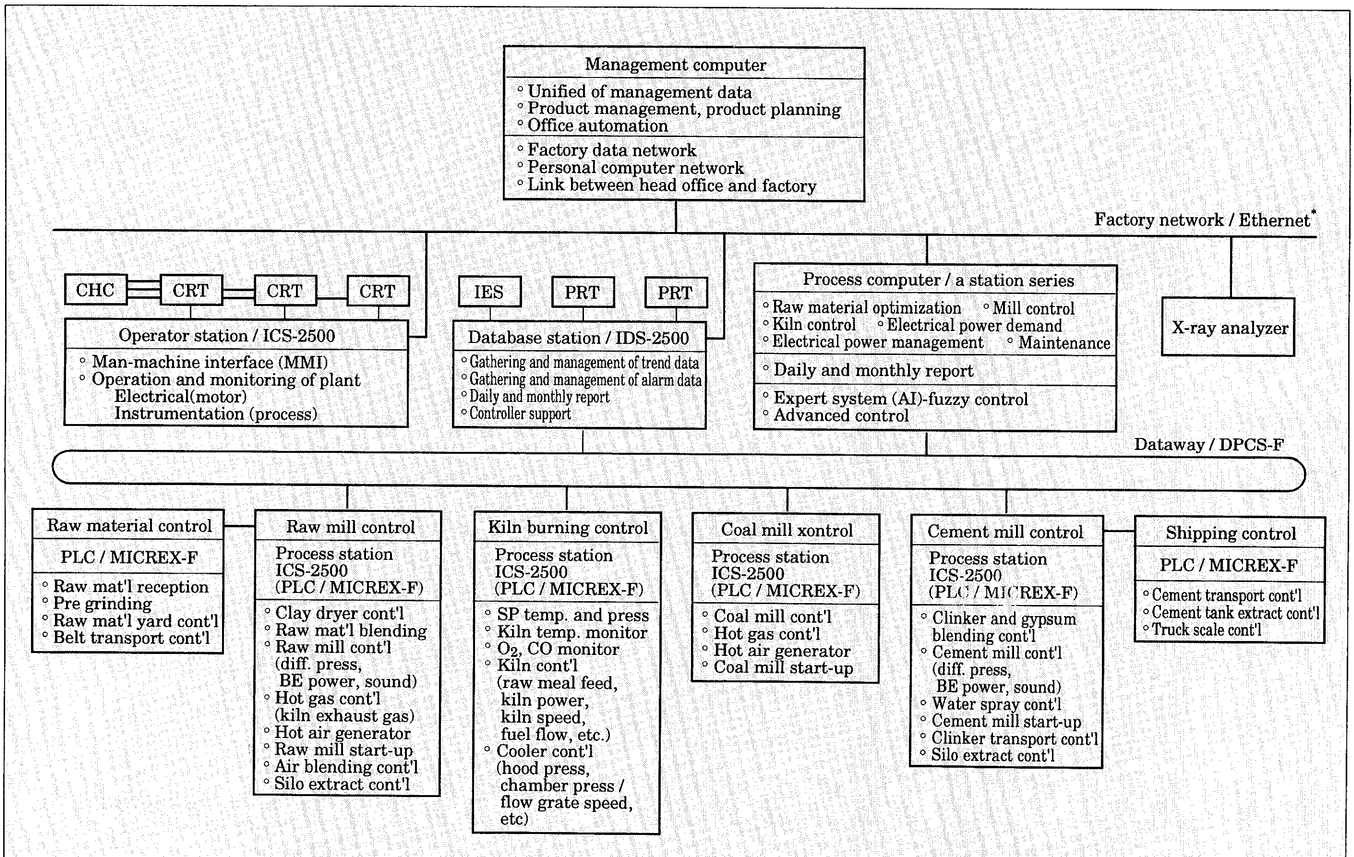



Fig. 2 Functions of the distributed control system




* : Ethernet is a registered trademark of XEROX, USA.

IX.

The IDS-2500 collects all plant data and stores necessary data.

Since the distributed control system may often be delivered over several construction periods, and since a changeover after each period is necessary, the IDS-2500 has been arranged in a duplex, configuration to improve reliability and to reduce the shutout time caused by software upgrade.

### 3.3 Process controller

The MICREX series controller ICS-2500 is used as a process controller, the heart of instrumentation control. In many cases, the functions of these controllers are divided according to each process, and the controllers are installed in the electrical room corresponding to each process.

Major components, such as the processor units, power supply units, and internal buses can be arranged in a duplex configuration to achieve stable operation.

The process controllers enable the preparation of every machine's sequential and automatic start and stop or the interlocking between machines, making use of various functions. These functions include not only loop control or instrumentation control, but also a time chart, a ladder sequence, a sequential function chart (SFC), and a function block diagram (FBD). A start signal output from a controller is transferred, via a P/E-link to a programmable controller, which will be described in the next section. From there, a start or stop signal is transmitted to a machine.

Operation and fault signals fed from programmable controllers through P/E-links are displayed on the HCI via process controllers.

### 3.4 Programmable controller

The MICREX-F series controllers are adopted as programmable controllers, which are central to motor control. They can also be distributed and installed by connecting their processor and IO units through local networks called P/E- and T-links, respectively. This results in a reduction in wiring . Furthermore, optical fiber cables can be adopted in P/P- and T-links to achieve highly reliable communication without being affected by external noise in the transmission lines.

### 3.5 Motor control center

The motor control center is the actual part that turns the motors on and off.

In the past, the programmable controllers were connected to the motor control center using a PIO (parallel I/O) connection. However, the creation of an intelligent-type motor control center has made it possible to connect the programmable controllers to the motor control center through local area networks called P/E-link and T-links. This has resulted in efficient and simple

Table 1 Fuji Electrics application technology for cement plant

| Item | Function | Content | Application technology | Remarks |
|---|---|---|---|---|
| Steady state operation | Raw material blending control | ◦ Labor reduction<br>◦ Stabilization (raw material composition, amount of supply) | ◦ Rate control<br>◦ PID control | Fluorescent X-ray analyzer |
| | Burning control<br>Calciner<br>Kiln<br>Cooler | ◦ Labor reduction (automatic operation)<br>◦ Stabilized operation (kiln power, burning zone temperature, clinker temperature)<br>◦ Stabilized quality (free lime)<br>◦ Energy saving (reduction of fuel basic unit) | ◦ Fuzzy control IAR model<br>◦ AIMAX C (control system AI)<br>◦ PID control<br>◦ Noninterference control<br>◦ Bandwidth control | Stabilization control (optimum control)+trouble shooting control (fuzzy control)<br>(coating breakaway, standard value change, cleaning) |
| Non-steady state operation | Start-up control | ◦ Quick, stable start-up of a plant<br>◦ Labor reduction | ◦ AIMAX C (control system AI) | |
| | Stop control | | ◦ AIMAX C (control system AI) | |
| Integration | Integration with production planning | ◦ Preparation of various types<br>◦ Improvement in production efficiency | ◦ Optimum scheduling<br>◦ Transfer of high quality information at appropriate time | |
| | Utility management (in-house power plant, etc.) | ◦ Reduction of basic unit | ◦ Estimate of supply and demand+optimization | A great store of experiences in utility control center of a steel production plant |
| Operation support | Diagnosis/maintenance | ◦ Reduction of plant shutdown period<br>◦ Reduction of maintenance personnel | ◦ AIMAX D (diagnostic system AI)<br>◦ Relational database | Past fault history+prediction based on the model |
| | Engineering | ◦ Grasp of plant properties<br>◦ Design of advanced control system | ◦ SAPL | Simple, multiple analyses of a large number of actual values |
| | On-line manual | ◦ Automatic guidance in nonsteady state<br>◦ Documentless | ◦ Automatic guidance in nonsteady state<br>◦ Relational DB<br>◦ Word processor | Immediate display of related manuals and document information at the occurrence of abnormalities (bit-mapped display) |

wiring as well as a closer connection of the instrumentation and motor controls.

### 3.6 AI advanced work station

A computer system is an essential part of the entire control system so that advanced control, stable operation, and production management of a plant can be achieved.

Fuji Electric has prepared a variety of packaged software classified by functions, making effective use of artificial intelligence (AI) and advanced control technology. In addition, Fuji Electric provides the AI advanced work station AI-AWS, which has an on-line function directly connected with the data highway of the distributed control system.

Table 1 shows Fuji Electric's application technologies for the cement plant.

The application of these technologies enables a reduction in the amount of operation as well as a steady supply of products. In the non-steady state appropriate operation according to plant conditions with AI control is also possible. Furthermore, with the application of an operation support system, even those users who have only limited software knowledge can analyze past operation records. In addition, based on past operator experience, transfer to the AI-AWS can be easily accomplished.

## 4. Introduction of the Distributed Control System

Major problems in introducing a new control system include securing the construction period necessary for the changeover from the old system to the new one and accommodating the shutdown period based on the operation schedule. For these reasons, it is important to carry out the changeover in the shortest time period possible.

Because a long shutdown period is required to overhaul the whole control system, it is common to install the controllers after every process. In this case, however, construction will take longer to complete the changeover of the whole system, but the changeover for every process can be quickly yet dependably performed.

It is also possible to install the programmable controllers first, before any other control system, and then introduce the distributed control system for CRT operation.

## 5. Conclusion

An example of a "distributed control system" as applied to a cement plant is presented in this paper.

Fuji Electric is determined to develop and provide enhanced-function and high-quality products to specifically meet a variety of user needs in the future.