

# INSTRUMENTATION SYSTEMS IN CEMENT AND GLASS FACTORIES

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## 1. FOREWORD

Not only the kiln industry, but also steel, chemical, and other production plants, instrumentation systems are shifting to distributed control systems and their operation method is shifting to the use of CRT operation. Moreover the EIC unified system, which unifies electric (E), instrumentation (I), and computer (C), is the mainstream of the approach to the overall system.

The basic concept of the instrumentation system used at the cement factory and the glass factory in the kiln industry is introduced.

## 2. PLANT SCALE AND INSTRUMENTATION SYSTEM

The main tool of the Fuji Electric instrumentation system is the distributed control system MICREX. When viewed by plant scale, the cement factory and glass factory are large scale plants reaching several hundred to several thousand analog and digital points. Therefore, unification of the instrumentation system of the entire plant is not performed for instrumentation systems which can handle up to several thousand points. MICREX handles up to 17280 loops and 30720 points so that the entire plant is managed, and is large enough for a large scale plant, such as a cement factory or glass factory. Moreover, because MICREX is an EIC unified system, connection to a computer (COMPACT-A, etc.) and programmable controller (MICREX-F) for performing advanced control (fuzzy control, etc.) and production control is easy, and excellent system expandability is featured.

## 3. INSTRUMENTATION SYSTEM CONFIGURATION AND FUNCTIONS

The newest system can be configured at the cement factory and glass factory by applying the MICREX to the basic system configuration of the instrumentation system.

### 3.1 Operator station (OCS-1500)

The operator station is the man-machine interface for

supervision and control of the plant by the operator. The plant is controlled by CRT and keyboard. The plant control screens are displayed on the CRT. The screens are grouped into two types. One of these is the standard screen and the other is the plant screen. As its name implies, the display format of the standard screen is standard. If the user defines the plant unit Tag No. and name, assignment, etc., the screen is displayed and the functions of that screen can be used. The standard screens frequently used at a cement factory and glass factory are:

#### (1) Group screen, loop screen

These screens display the loop data in the form of an instrumentation diagram on a CRT. Set value, manipulated variable, or control mode switching is also performed at this screen. An instrument diagram is provided for the specification function, adjustment function, integrating function, etc.

#### (2) Trend screen

This screen displays the recording function chart on the CRT. The charts for up to eight points can be displayed on one screen.

#### (3) Annunciator screen

This screen displays the annunciator conventionally installed on the instrumentation panel on the CRT.

#### (4) Multi point screen

This screen displays the controller, described later, internal operation constants and timer value and set or contact signals, etc. It is used more as a controller and plant screen data interface intermediate screen than independently.

#### (5) Process alarm screen

This screen displays loop upper and lower limit alarms and contact alarms by time series. When alarms were defined at the loop screen and multi point screen, they can be displayed on the process alarm screen.

The plant flowchart is drawn on the plant screen and the process variables (temperature, pressure, flow, etc.) and the data of the devices (motors, valves, etc.) in the chart are displayed by numerics, bar graph, color switching, etc. If necessary, the process variables adjustment function can be set and operated and the devices can be operated. This setting and operation can be realized by touch screen, a special feature of the OCS. Operator sight and judgment and opera-

tion are connected so that smooth operation is possible.

### 3.2 Process station (PCS-500)

This controller is used mainly for implementing the instrumentation signal input/output processing and control function. It handles the electrical signals within the limits, as required. In the case of the cement factory, the electrical signal input/output processing and control function (batch control) function frequently uses the programmable controller to be described later. However, when a sequence function incorporating instrumentation such as automatic plant starting and stopping is performed, the process station (PCS-500) time chart is used. For the glass factory, there is a burner switching sequence around the melter and the input/output processing and control function can be amply implemented by process station (PCS-500) time chart. For both the cement and the glass factory, instrumentation processing is performed by loop design function.

### 3.3 Programmable controller (HDC-500 and MICREX-F)

This is mainly a controller for implementing the electrical signal input/output processing and control function. It can handle some instrumentation signals. Whether the HDC-500 or the MICREX-F is used depends on the system scale, processing speed, budget, etc. However, the HDC-500 is for high-speed use and the MICREX-F is for general use. The HDC-500 can connect directly to a data-way (DPCS-F) that performs operator station (OCS-1500) and process station (PCS-500) data transmission. However, the MICREX-F connects to a dataway (DPCS-F) via the process station (PCS-500). This connection uses a P link (5MB/S), and data transmission much faster than when an RS-232C (19200B/S) general purpose interface is possible.

### 3.4 Data base station (DBS-1500)

The data base station (DBS-1500) is the central device that becomes the unified data base in the MICREX system. It is indispensable at the system, but is used almost unconsciously from the standpoint of operation.

### 3.5 Computer (COMPACT-A)

The introduction of a computer into the control system is indispensable for upgrading control, stable plant operation, or production control. For a cement factory, raw material mixing control, kiln control, and production control data collection are performed by computer. Regarding kiln control, in particular, we have an expert system (AI) represented by fuzzy control and self regression model, gain schedule, and other advanced control standard software packages. Control is implemented by using these packages. For a glass factory, fuzzy control can be used to stabilize the melting furnace combustion.

### 3.6 Process LAN

MICREX uses the process LAN by application. Optical fiber cable can be used, as required.

#### (1) Dataway (DPCS-F)

The dataway transmits data between the MICREX OCS, DBS, PCS, HDC, and COMPACT-A. It has a fast transmission speed of 10MB/S.

#### (2) P link

The P link transmits data between PC and HDC and the MICREX-F processor. It has a transmission speed of 5MB/S.

#### (3) T link

The T link transmits data between MICREX-F I/O capsule and processor. Its transmission speed is 500B/S.

## 4. INSTRUMENTATION SYSTEM AT CEMENT FACTORY

### 4.1 Basic approach to system configuration

At a cement factory, the man-machine interface part of the instrumentation system is installed in the central control room and the controller part is installed at the site electric room.

### 4.2 Man-machine interface

The main tool of the man-machine interface is the MICREX operator station (OCS-500). Usually, two to three CRTs are used per kiln. Multiple OCS controller are also available, and there are many cases when redundancy is achieved by CRT switching. The instrumentation data is displayed numerically and operation is instrument diagram interrupt. Electrical data display is device symbol and line color switching display. Operation is key area switch operation and touch operation. There are many cases where the data base station (DBS-1500) has a duplex configuration. This is done to improve reliability.

### 4.3 Controller

The MICREX process station (PCS-500) is used as the instrumentation controller and the MICREX programmable controller (HDC-500 or MICREX-F) is used as the electrical controller. The controller is divided into stations for each process, and is installed in each electric room. There are no tentative rules for using the HDC-500 and MICREX-F. However, there were many cases in the past when the MICREX was used alone by each user. Taking familiarity and expansion to CRT operation into account, the point is its easy fusion with the MICREX fusion.

### 4.4 Other devices

Most cement factories now use a computer, and raw material mixing control is minimal. However, currently, the result of introduction of the computer at raw material mixing control only is small and kiln control is also becoming common.

Therefore, if the control system and computer of the entire factory cannot be closely coupled organically, its value is small. However, close coupling known as "dataway direct coupling" is realized with the MICREX and COMPACT-A, and a system that can be used easily by the user can be build.

Fig. 1 System configuration diagram (cement factory 1)

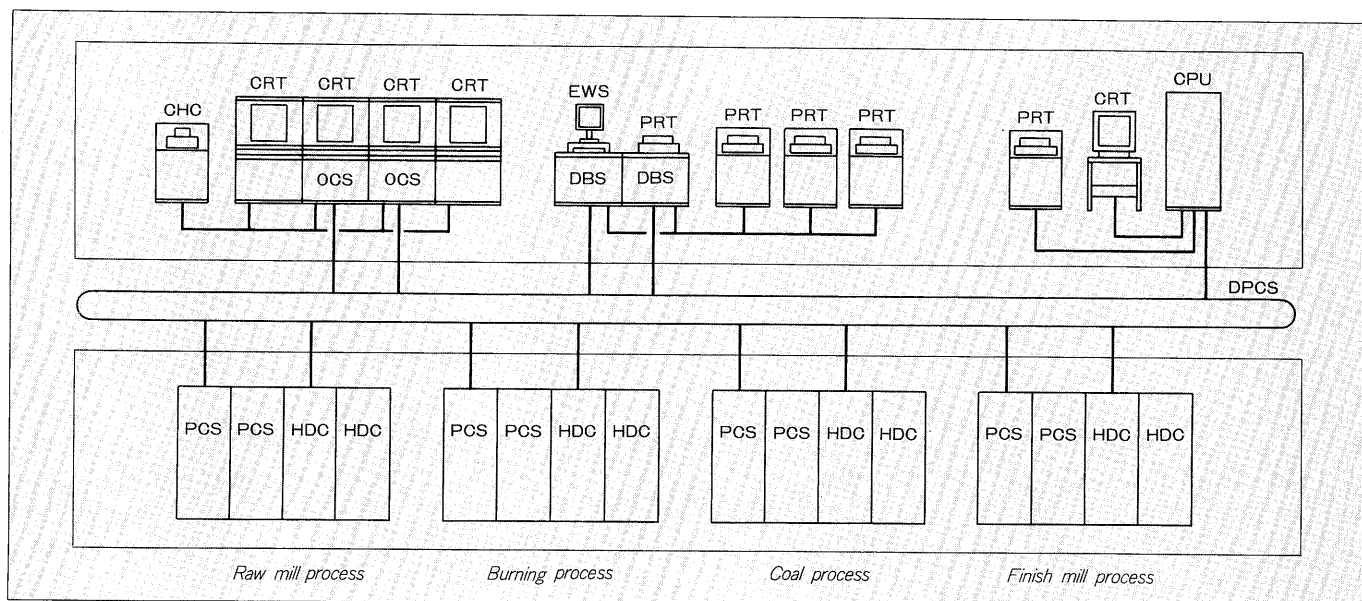
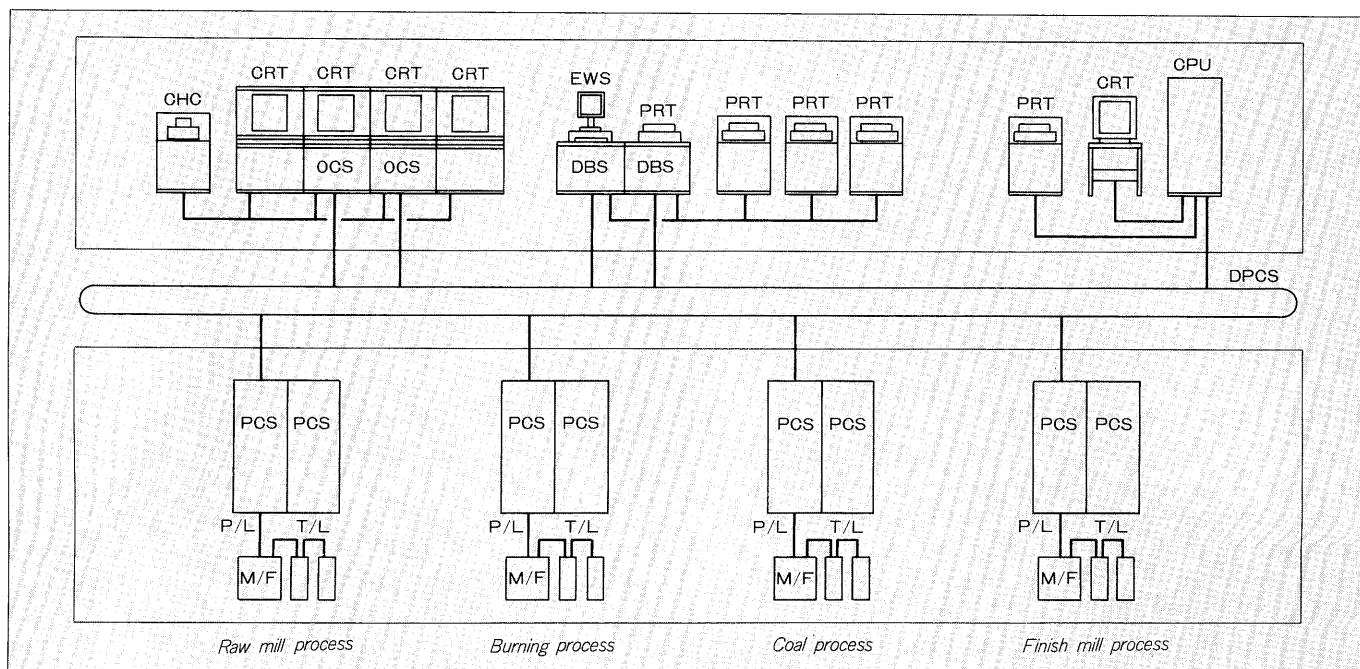


Fig. 2 System configuration diagram (cement factory 2)



## 5. INSTRUMENTATION SYSTEM AT GLASS FACTORY

### 5.1 Basic approach to system configuration

At a glass factory, the man-machine part is installed in the central control room and the controller part is installed in the site electric room to centralize plant operation and distribute control, the same as the cement factory.

### 5.2 Man-machine interface

The MICREX operator station (OCS-1500) is the man-machine interface at a glass factory. Usually, since one CRT

per melter is used and there are multiple furnaces in the factory, multiple CRTs are installed and the OCS controller is also made redundant. The important management items in a glass factory are combustion control and temperature management. The data for displaying and controlling these is displayed on the CRT plant screen. To switch the burners for the melter, in particular, a special plant screen is created so that the controller sequence status display and setting are performed and operation is easy. Moreover, the data base station (DBS-1500) has a duplex configuration and can cope with continuous operation of multiple furnaces for a long time.

Fig. 3 System configuration diagram (glass factory)

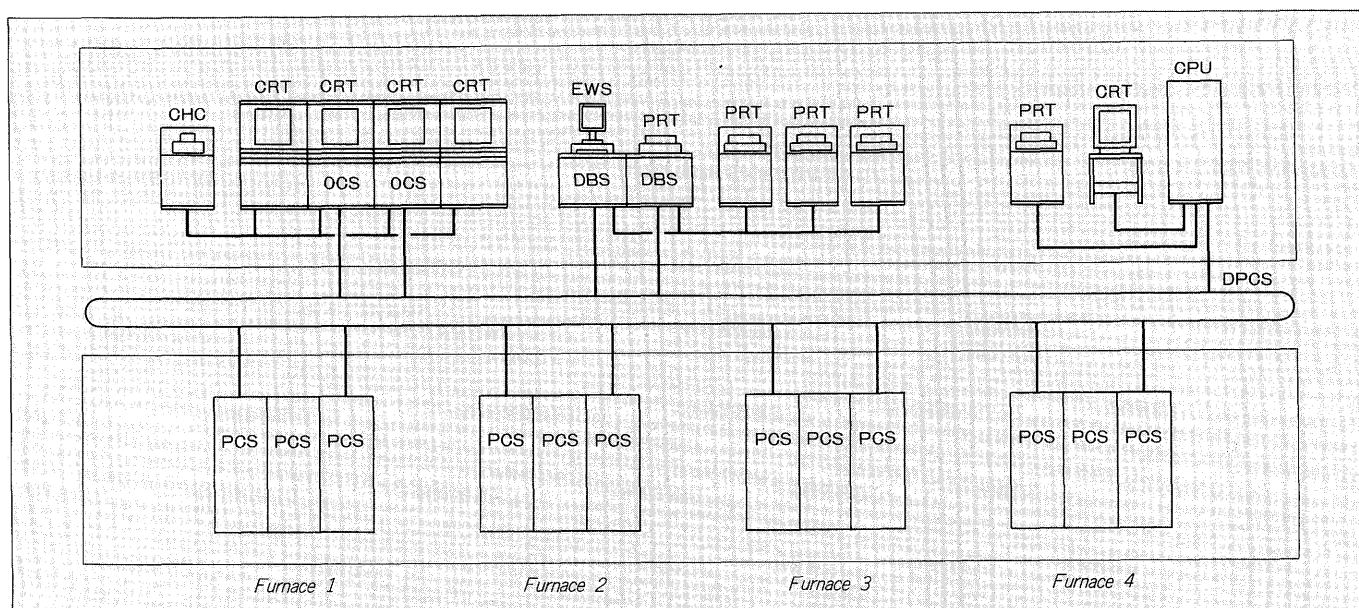


Table 1 Definition of block diagram symbols

Symbol	Device name
OCS	Operator station (OCS-1500)
CRT	
CHC	Color hard copy
DBS	Data base station (DBS-1500)
EWS	Engineering work station (EWS-500)
PRT	Printer
PCS	Process station (PCS-500)
HDC	Programmable controller (HDC-500)
DPCS	Dataway (DPCS-F)
M/F	Programmable controller (Micrex-F)
P/L	P link
T/L	T link
CPU	Process computer (COMPACT-A)
CRT	CRT display
PRT	Printer

### 5.3 Controller

The I/O processing and functions for combustion control and burner switching sequence, including the temperature data of several hundred points at the melter is implemented by means of one or two process stations (PCS-500) per furnace. The switching sequence function is implemented by time chart. The time chart is the best method for this purpose. Fusion with combustion system loop control is also easy.

### 5.4 Other devices

Once a melter is started it is operated continuously for almost 10 years. Therefore, minimum system back up must be considered. A control desk with recorder back

up controller, and switching sequence operation switches and indicator lamps is available.

## 6. INSTRUMENTATION SYSTEM IN CIM CONCEPT

For both a cement factory and glass factory, the instrumentation system described above is positioned at the process management and control level in the CIM concept of the overall factory. It is the time at which the system has become a total system construction which takes into account not only automation at the factory level, but also production control at the entire company level. When such a large concept is realized gradually, a control system that includes our MICREX and a computer is developed on a design concept for this purpose, and can certainly be said to be a system suitable for the age leading cement factory and glass factory.

## 7. CONCLUSION

The ultimate purpose of introducing an instrumentation system at a cement factory or glass factory is the manufacture high quality products at minimum cost by the systematic succession of know-how and continuous improvement and development. Both factories have a combustion system process which produces products from stone. The effect increases as control is incorporated in cost unit improvement and various control is performed to improve product quality. In the near future, cost unit improvement, product quality improvement, and nighttime unmanned operation, etc. will be realized. At that time, our MICREX is expected to be seen in the cement factories and glass factories of each area.