UDC 666. 94-52

INSTRUMENTATION OF CEMENT PLANT FOR NIHON CEMENT CO., LTD.

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I. INTRODUCTION

The giant kiln is typical of all cement plants and these kilns have been renovated in various ways over the years. Starting with the shaft type kiln, there have been the dry kiln with a waste heat boiler, the wet type long kiln, the Lepol kiln and finally the present kiln with suspension preheater. In addition plants have become larger and changes have been considerable, The main reasons behind these changes have apparently been attempts to make operation easier and also produce products more cheaply. In regard to both these points, the newest dry type kiln with suspension preheater (hereafter referred to as the SP kiln) is the most advanced,

Almost 100% of the newly constructed cement plants employ this SP kiln. Last spring, the Nihon Cement Co., Ltd. completed the No. 7 kiln, an SP kiln, at its Kamiiso Plant. This new kiln can truly be called a mammoth kiln.

As plants attain mammoth size, safe and stable operation become key points not only in cement plants. These points have been emphasized in this recently completed No. 7 kiln at the Kamiiso Plant of the Nihon Cement Co., Ltd. Automation has also been widely introduced to make this a very up-to-date plant. Fuji Electric supplied a centralized control system as the main facet of automation in this plant. The planning and features of this system will be introduced here.

II. PLANT OUTLINE

1. Features of SP Kiln

The main feature of the SP kiln is that the thermal efficiency is very high. In fact, it is the highest of all types of kiln now in use. This is because kiln exhaust gas preheating can be performed satisfactorily by drying and preheating the raw material.

In the wet-type long kiln, the raw material entering the kiln is dried and preheated in the end of the kiln. In the SP kiln, the raw material is dried in the raw material grinding section and is introduced from the top of the suspension preheater which is arranged vertically in the shape of a tower. The exhaust gas which is blown upwords by a fan is preheated by heat exchange. When the exhaust gas enters the preheater, which is at about 1,000°C and when it leaves the upper part, it is at about 350°C. This difference is exchanged with the raw material. The exhaust gas which leaves the suspension preheater is used for drying when the raw material is ground and the exhaust gas is finally decreased to about 100°C These steps are shown in the process flow sheet in *Fig. 2*.

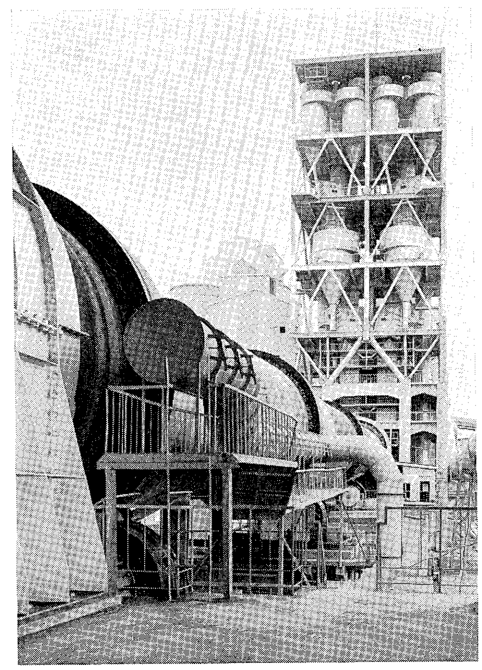

Fig. 1 Humboldt type kiln

The effective use of the sensible heat of the exhaust gas is the reason why the thermal efficiency of the SP kiln is so high. When the raw material is introduced from the preheater into the kiln, the raw material has already been heated to 800°C and is in a state of temporary combusion. Therefore, the burden on the kiln is minimized and the kiln length can be reduced. This also means that operation becomes easier.

2. Main Plant Specifications

The No. 7 kiln of the Kamiiso Plant of the Nihon

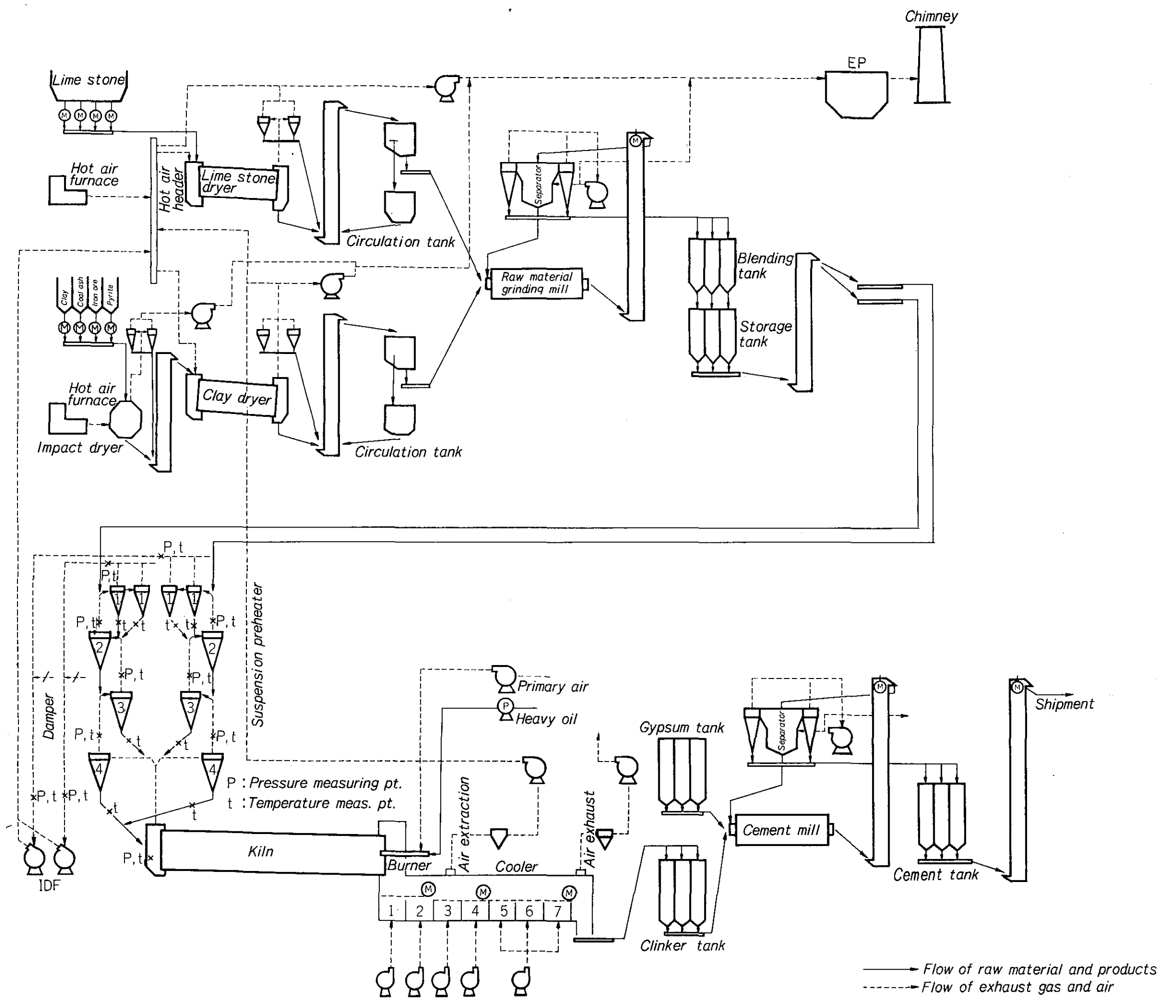

Fig. 2 Process flow sheet of cement plant

Cement Co., Ltd. is an IHI-Humboldt type SP kiln manufactured by Ishikawajima Harima Heavy Industries Ltd. The height of the suspension preheater is 63.5 m and it consists of two networks, No. 1 and No. 2. The length of the kiln body is 95 m and the internal diameter is 5.4 m. The hourly production capacity is about 123.5 t and monthly capacity about 90,000 t maximum. Fuel consumption is approximately 780,000 kcal per ton.

III. INSTRUMENTATION

1. Outline

Previous cement plant instrumentation was generally arranged in an operation panel, the so-called kiln front panel, arranged around the kiln including the air quenching cooler. Recently, however, there has been a trend to use instruments as much as possible from extraction of the raw materials to shipment of the product. The reason for this is to reduce manpower and make operation as stable as possible.

This consept has played a large part in the planning of the No. 7 kiln of the Kamiiso Plant of the Nihon Cement Co. Ltd. The monitoring control equipment from extraction of the raw materials to product delivery has been brought together in the centralized control panel and centralized control of the entire process is possible. The instrumentation used in cement plants can be considered as the most advanced type. The specifications of the instruments are as follows:

1) Instrument panel

Total length: 11 m, centralized point graphic system (*Fig. 3*)

2) Instruments

All electronic TELEPERM system, standard signal DC 10～50 mA

Panel instruments of all vertical type, direct coupling to computer possible.

3) Operating terminal

Electro-hydraulic type

4) Alarm circuit

Contactless type (Fuji F-MATIC N type)

2. Explanation of Instruments for Each Network

This explanation will give features for instruments based on the process flow sheet in *Fig. 2*. This

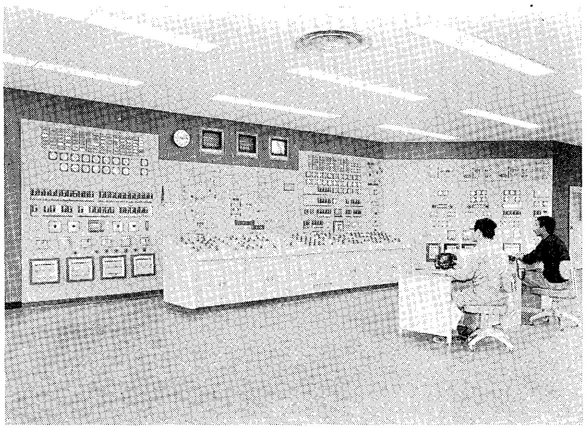

Fig. 3 Centralized control panel

process flow sheet has naturally been simplified.

1) Raw material extraction, drying, grinding and blending section

Here, the processes from extraction of raw materials from the hopper to the storage tank will be described.

(1) Control related to raw material transport

This control system is intented mainly to ensure that the raw material grinding mill operates efficiently. Therefore, it controls the amount of raw materials supplied to the mill so that the load power of the drive motor for the bucket elevator at the mill outlet is a specified value.

The raw materials are extracted from the hopper and until they enter the mill there is a combination of processes with a large time delay such as a belt conveyer, drier, bucket elevator, etc. as shown in *Fig. 2*. Therefore, they are combined to form a single loop with PID control which should be stable. This is a composite loop as follows.

The output of the load power control meter of the bucket elevator drive motor at the mill outlet is cascaded in the raw material supply control system via a ratio setter. As mentioned above, this system has a large time lag and there are also several indefinite elements due to external disturbances. Therefore, the circulation tank level etc. are corrected.

(2) Control of pressure in hot air header of drier

The pressure inside hot air header of the drier is altered by external disturbances of the kiln exhaust gas, cooler steam extraction, and the amount of hot air in the hot air furnace. In order to keep these changes due to external disturbances to a minimum, appropriate operation of a damper in front of the exhuast fan is sufficient but when the external disturbances are great, the amount of damper operation increases considerably, pressure loss rises and the control capacity deteriorates. In such cases, therefore, the damper is operated in a suitable small range so that it does not move so much and the fan speed is changed when required. For these reasons, a control system is used which regulates the degree of opening of the damper and the fan.

(3) Monitoring raw material grinding mill noise level

The amount (level) of material ground in the ball mill can be estimated by the level of sound intensity outside the mill. This sound level plays a considerable role in the efficient operation of the mill. The level is picked up by a microphone on the outside wall and an electric signal corresponding to the concentrated noise is recorded after amplification and filtering and an alarm is given. *Fig. 4* shows the microphone for the raw material grinding mill.

(4) Others

Other control equipment not explained here is for hot air furnace temperature control, drier output exhaust gas temperature control, dust measure flow speed control and various types of monitoring devices.

2) Raw material suppling, preheating, burning and cooling section

In this section, the raw materials are preheated and burnt after insertion into the suspension preheater and then cooled by the clinker.

(1) Raw material supply control

As was mentioned previously, there are two networks in the suspension preheater and therefore the raw material supply control system is independent for each network. The feeder is of the load cell type measure flow system. The amount supplied is measured in the load cell and the measure flow speed is regulated.

(2) Measurement of pressure and temperature around the suspension preheater

As has been stated previously, the suspension preheater preheats the raw materials before they

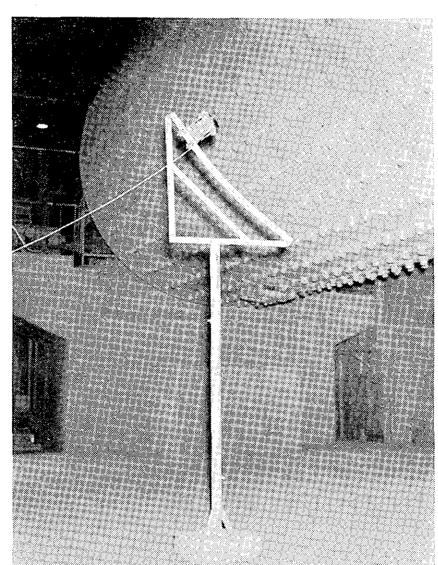

Fig. 4 Microphone for raw material grinding mill

enter the kiln. Methods must be used so that this preheater operates smoothly with good thermal efficiency. In this system, the temperature and pressure at required points on the preheater are measured and monitored.

(a) Temperature monitoring

The temperature of the raw material in each cyclone shoot of the preheater and the temprature of the exhaust gas at each cyclone outlet are measured and the internal heat exchange conditions can be understood by watching the slope of the directions of raw material and gas flow. In other words, the raw material temperature becomes about 800°C when the raw materials are inserted at the top of the preheater, preheated at an appropriate temperature gradient and enter the kiln. On the other hand, the gas temperature is 1,000°C at the bottom and becomes 350°C at the top. Thermocouples are inserted in each part and monitored in the central control panel with indicators or recorders. Alarms are also arranged at main points.

(b) Pressure monitoring

Raw material clogging and stoppages are clearly indicated by pressure changes at the cyclone outlets and inlets. In other words, when the pressure is reduced at an appropriate gradient in the direction of the gas flow, the raw materials flow smoothly but when this is not the case, the above-mentioned phenomena are present at some points. This is also monitored by the same indicators and recorders for temperature.

(3) Exhaust gas analysis

The exhaust gas from the back of the kiln is analyzed for combustion control and O_2 and CO are monitored. A magnetic type is used for O_2 and an infra red type for CO.

(4) Kiln shell temperature monitoring

Measurement of the kiln shell temperature is often used to estimate the inner temperature and detect any fallen bricks in the burning zone. As can be seen in *Fig. 5*, radiation pyrometers are located at several points along the length of the burning zone. The measuring points of these pyrometers are changed once everytime the kiln rotates and the temperatures at these points are recorded. The tempreture are recorded by the same recorders so that the temperature measuring point location can be determined.

(5) Kiln hood draft control

The hood draft is measured by a low pressure transmitter and the cooler exhaust gas damper is operated so that this pressure is kept constant.

(6) Pressure control of cooler chamber No. 1

The pressure of cooler chamber No. 1 is measured and the cooler grate speed is altered so that this pressure becomes a standard value. Since there are three cooler grates, ratio control in which the grate speed of the chamber No. 1 is followed is performed.

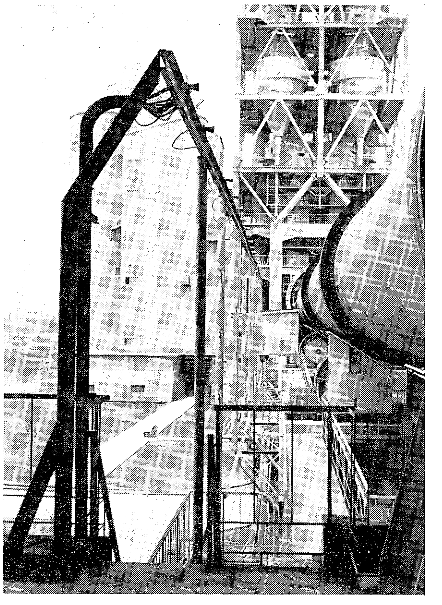

Fig. 5 Radiation pyrometer for kiln shell temperature measuring

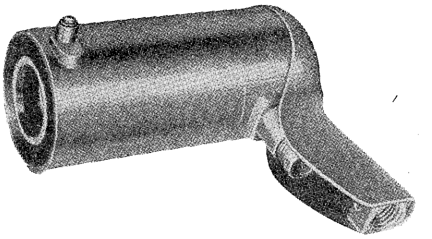

Fig. 6 Two-color radiation pyrometer

(7) Burning zone temperature measurement

In recent cement plants, two color radiation pyrometers are often used. This is because, in principle, these pyrometers are not influenced by radiation of the material being measured and dust also has little influence. However, there are several difficulties in using the so-called two color radiation pyrometer. The Fuji two-color radiation pyrometers (brand name : ARDOCOL) are the same as the former radiation system and the external appearance is almost the same as can be seen from *Fig. 6*. It is therefore simple to handle.

(8) Control of clinker cooling air flow rate

The air flow rate of the Nos. 1, 2 and 3 cooler chambers is controlled for good cooling of the clinker and stable secondary air. However, in general cases, the diameter of the intake duct is 1–2 m and structurally, straight parts, i.e. straight tube lengths are not used. Therefore, there are cases where flow measurement is difficult. In such cases, a perforated pitot tube known as a roll-tube pitot tube is used and good results are obtained. As can been seen in *Fig. 7*, static and dynamic pressure holes are arranged at several points in the roll-type pipe and each pressure is obtained without any disturbance to the flow rate

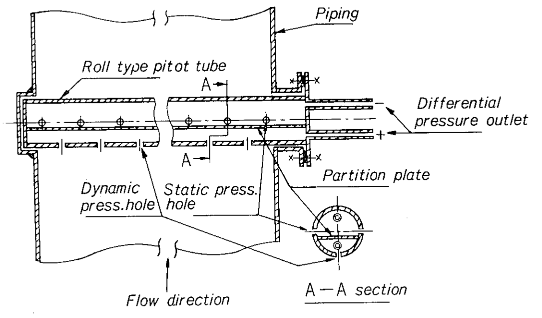

Fig. 7 Roll type Pitot tube

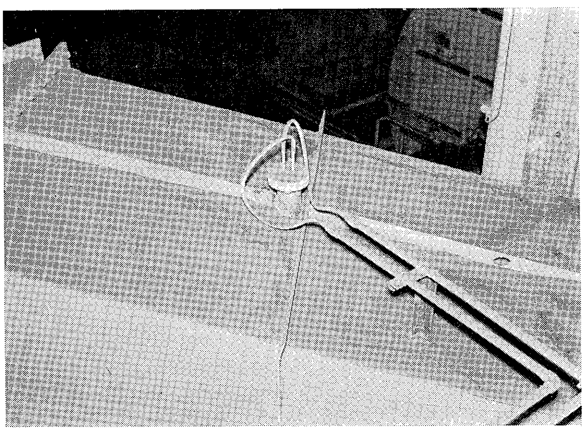

Fig. 8 Roll type Pitot tube at duct

inside the duct. Installation is also simple. An example is shown in *Fig. 8.*

3) Clinker and gypsum grinding section

The control system is the same as that for raw material supply to the grinding mill. The amonnts extracted from the clinker silo and the gypsum silo are regulated so that the load power of the bucket elevator drive motor at the cement mill outlet is a specified value. It is possible to control the ratio of the amount of clinker and the amount of gypsum at a suitable value.

4) Shipping section

Since the Kamiiso Plant is not far from the sea coast, a 1.6 km shipping bridge was constructed as shown in *Fig.* 9. From this bridge, the cement is loaded on ships. The cement extracted from the cement silo is carried by a belt conveyer, but the

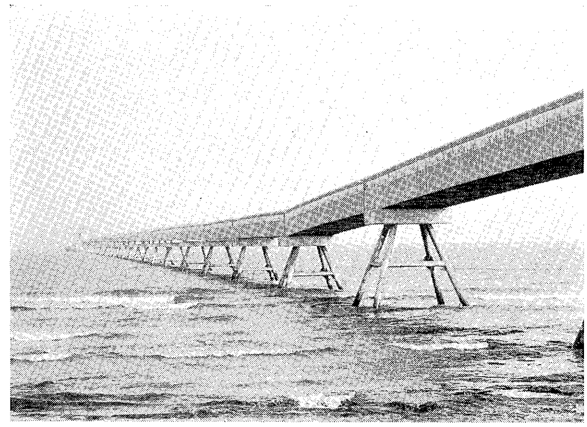

Fig. 9 Shipping bridge

amount transported is regulated by controlling the load power of the drive motor of the bucket elevator at the cement silo outlet.

5) Sequence circuit

Since there is a lot of a dust in a cement plant, there is a trend to change the sequence circuit from the former contact types to contactless types from viewpoint of maintenance. In the Kamiiso Plant, all instruments for control (mainly alarms) are of the contactless type. They are constructed of Fuji Electric F-MATIC N printed board type logic elements. Since there are many processing points, the fact that these elements can be assembled on pointed boards is an important feature for plant arrangement.

IV. CONCLUSION

There are more and more opportunities of using computers for processes in cement plants, and in newly designed kilns, cement makers everywhere are making use of computers.

As the plants increase in size, stable operation not relying on human " thinking " and the reduction of process down time have considerable influence on lowering production costs. Therefore, a time is probably near when computers will be considered essential for process drive.

With this in mind, the No. 7 kiln of the Kamiiso Plant of the Nihon Cement Co., Ltd. was planned for complete computer control. All the instrumentation delivered can be operated by computer input.