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INSTRUMENTATION OF HUMBOLDT TYPE KILN FOR MYOJO CEMENT CO., LTD.

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I. INTRODUCTION

Humboldt or Dopol type kilns with suspension preheaters have been more frequently constructed in recent years. Most of these plants are suspension types, as this type provides higher heat efficiency than wet/dry types.

This method has become feasible due to developments in material air-blending techniques, and corresponding material uniformity obtained in the wet method has been attained.

Myojo Cement Company constructed a Humboldt type kiln with a production capacity of 1800 tons per day at its Itoigawa Factory last year. This kiln is operating very satisfactorily.

The main equipment of this plant was manufactured and delivered by Ishikawajima-Harima Heavy Industries. Electric motors, overall control systems, and plant instrumentation were manufactured and delivered by Fuji Electric. In the paragraphs to follow, the instrumentation system will be introduced and outlined.

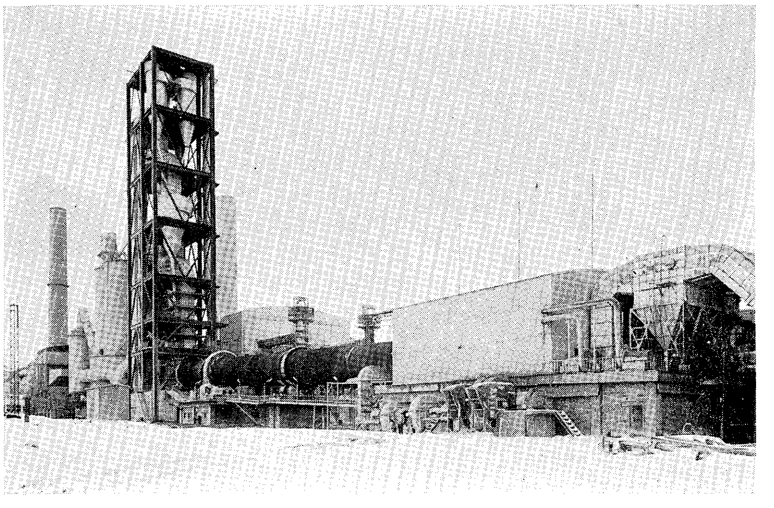

Fig. 1 Humboldt type kiln

Table 1 **Specifications of the Plant**

Type	Humboldt type
Capacity	1800 tons per day
Dimensions of kiln	4.6 m$\phi\times$74 mL
Preheater	66.25 mH
Cooler	Type ♯1460 (Fuller)

II. OUTLINE OF PLANT

The most conspicuous feature of this plant is its suspension preheater, 66 meters high. It consists of five cyclones connected in four-stage series, as shown in *Fig. 2* (the two uppermost units are in parallel).

Material is fed through a hot-air duct to the top cyclone, where it is floated in hot air. Separated from gas, material is fed through a chute to the hot air duct leading to the second cyclone. As it is fed to the bottom-stage cyclone, material is sufficiently preheated through heat-exchange action in the opposite direction by kiln exhaust gas, and is then fed to the kiln. Kiln exhaust-gas temperature is lowered to approximately 350°C upon leaving the preheater, while temperature of exhaust gas upon leaving the kiln is approximately 1000°C.

III. EXPLANATION OF INSTRUMENTATION SYSTEM

1. General

Basic instrumentation of the cement kiln with suspension preheater is identical to that of dry/wet or Lepol type kilns. The only difference is that of instrument conditions: ambient temperature is rather high and the surrounding atmosphere dust laden. Full attention has been paid to these factors in design of the instrumentation system, based on experience and kiln case histories.

The instrumentation system consists mainly of TELEPERM S-series, which has been widely used in allied fields and has proven performance and reliability. Moving-coil-type units are used as indicators and self-balancing-type units as recorders. Control

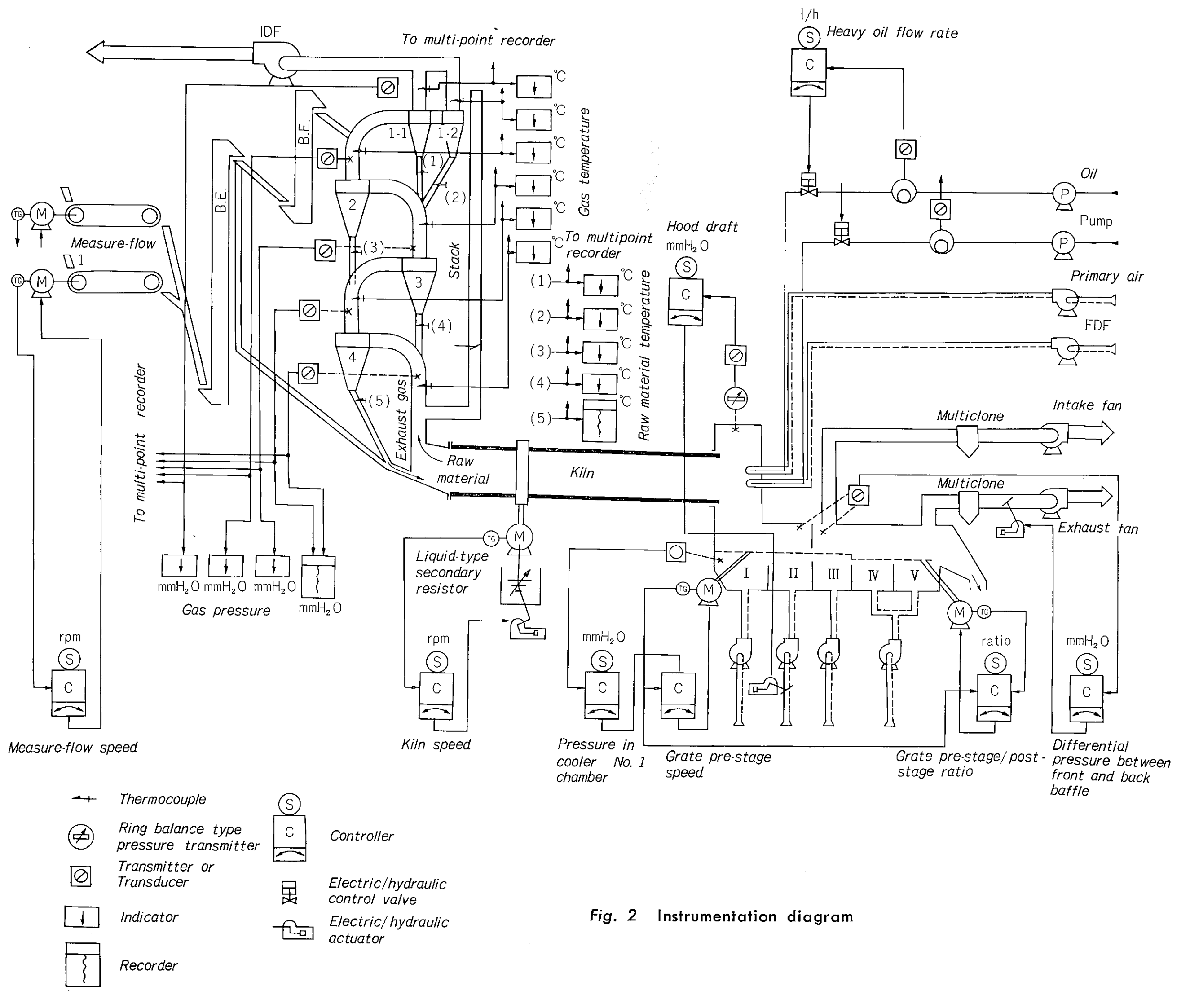

Fig. 2 Instrumentation diagram

is unified with electric/hydraulic systems.

The cement production process is a typical-flow process. If failure occurs at one point of the process, it effects the overall process and forces shut-down of the entire system. A graphic control-panel system is employed to detect failure as quickly as possible and take positive remedial action.

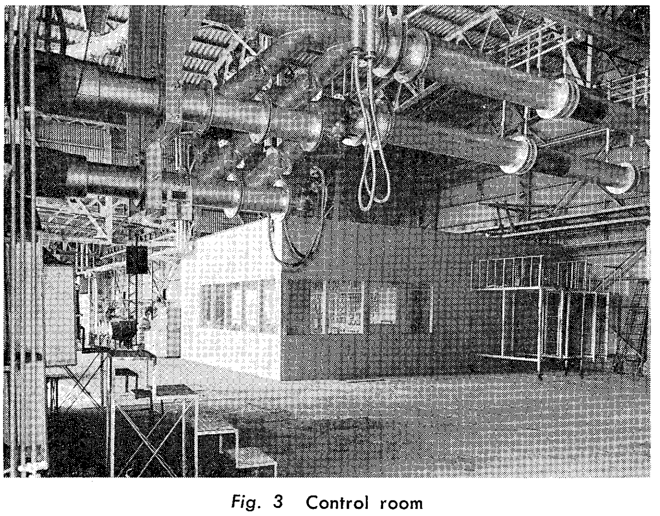

Fig. 3 Control room

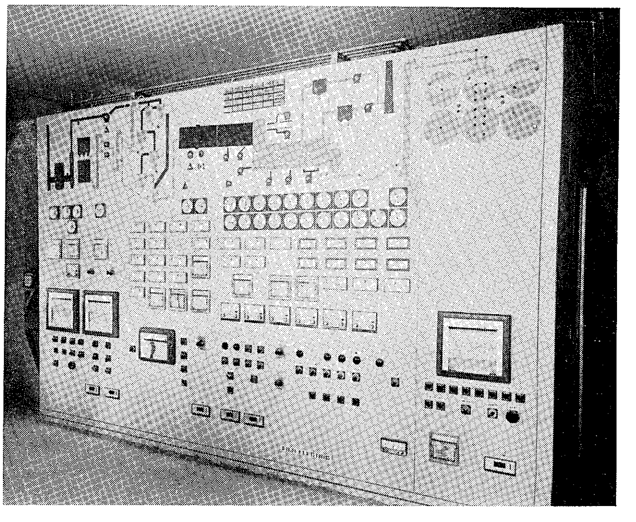

Fig. 4 Control panel

2. Explanation of Measuring and Control Loops

The scope of this instrumentation system takes in control of the burning process, from the point of feeding raw material to the preheater to cooling the clinker. In the order of actual process, individual measuring and control loops are described in the paragraphs to follow.

1) Raw material feed control (measure-flow speed control)

Feeding of raw material is controlled by measure-flow and the flow rate through flow-speed control.

Dc motor act as actuators for control-end devices.

The controller is a magnetic amplifier type. Output of the controller is amplified, and the amplified output is fed to the field coil of the dc motor.

The revolution speed of each measure-flow detector is recorded by a two-pen, self-balancing electronic recorder, and the revolution speed signal is fed to an electromagnetic counter for signal integration to indicate total feed quantity of the raw material

2) Temperature measurement of preheater stages raw material and gas

Preheater stage raw material and gas temperature are monitored to insure that proper heat exchange between the raw material and gas is made. Temperature is detected by a CA thermocouple and is indicated by a moving-coil indicator. All temperatures are recorded by a multi point strip-chart recorder, so that overall temperature trends can be monitored and temperature distribution readily known.

3) Measurement of preheater internal-gas pressure

Preheater internal-gas-pressure monitoring is as important as temperature monitoring. Preheater inlet and outlet exhaust gas pressure in the final stage is recorded by a two-pen recorder, which has an alarm. The nine pressures remaining are indicated by corresponding indicators, and are recorded in parallel by a multi point strip-chart recorder, so that all cyclone-stage pressure trends can be constantly monitored. Transmitters are TELEPERM system types, indicators are moving-coil types, and the recorder is a self-balancing type.

4) Control of kiln-revolution speed

For stable operation of the kiln, it is essential that revolution speed be constantly maintained at the desired level.

The kiln is driven by a wound-rotor induction motor. Hydraulic secondary resistance of the motor, which has an electric/hydraulic control device, controls revolution speed. A magnetic amplifier acts as the controller. The speed-control panel and liquid second resistor are shown in *Fig. 7*.

Fig. 5 Detecting element for temperature of raw material in preheater

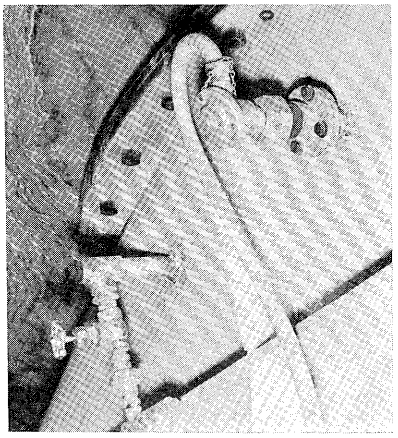

Fig. 6 Detecting element for temperature and pressure of gas in preheater

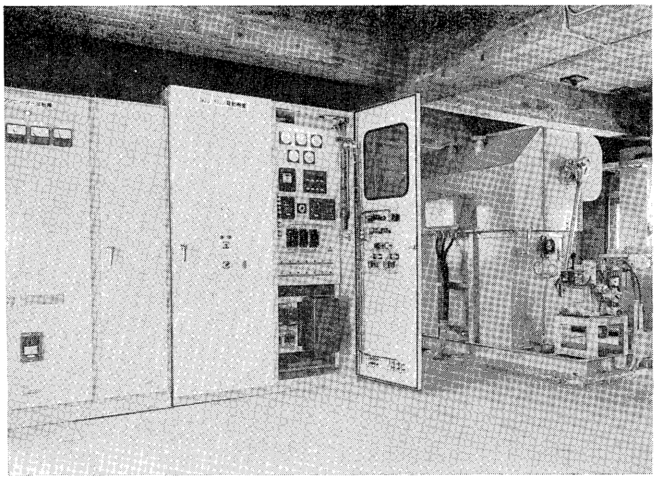

Fig. 7 Speed control panel and liquid second resistor for kiln

5) Control of kiln-hood draft

Kiln-hood draft must be controlled at a certain level so that secondary air flows uniformly into the kiln. This is accomplished by control of the flow rate of cooling air fed to cooler chamber II through control of the opening on the fan inlet damper.

Hood draft is detected by a ring-balance-type pressure transmitter. Variation in resistance of the transmitter is converted into signal form by a TELEPERM converter and fed to the controller.

The output signal of the controller is converted to hydraulic power by the electric/hydraulic converter, and actuates the damper, preventing full closure of the damper. An output lower-limiter is incorporated in the output circuit of the controller.

6) Control of pressure difference between front and back cooler baffle plate

Clinkers falling into the cooler are cooled by air blown from beneath the grate. A part of the heated air is fed into the kiln as air for combustion, the remaining being exhausted into the atmosphere. The baffle separates the air into two parts. The opening of the exhaust-gas damper must be controlled in accordance with the required air-flow rate of the kiln.

Differences in pressure between front and back baffle are detected by a ring-balance transmitter, and the exhaust flow-rate control damper is adjusted so that pressure becomes constant.

7) Control of cooler chamber I pressure

The degree of air penetration in the clinker layer (on the cooler grate) depends on clinker size and thickness of the layer. Air penetration affects feeding of secondary air to the kiln and the extent of clinker cooling. To maintain air penetration at a constant level, control of the pressure in chamber I of the cooler is made by varying the speed of the cooler grate, establishing a constant value.

A dc motor drives the cooler grate. The control system functions in such a manner that the speed-control system of the preceding cooler stage is coupled in a cascade mode to the pressure-control loop. Further, ratio control is made by allowing grate speed of the latter stage to follow that of the preceding stage. The ratio is adjusted in accordance with operating conditions.

8) Analysis of exhaust gas

Measuring O_2 and CO content in exhaust gas is essential in monitoring combustion states of the kiln.

The O_2 analyzer is a magnetic type and the CO analyzer an infra-red ray type. The gas-sampling device is used in common for both analyzers, and the two signals are recorded by a two-pen recorder.

9) Measurement of burning zone temperature

The burning temperature is the most important factor relative to clinker burning. Burning temperature is measured with a radiation pyrometer.

10) Fuel-flow control system

Heavy oil is used as fuel. Two burners are employed. The flow rate of heavy oil within these burners can be independently controlled.

Flow rate is detected by a volumetric flowmeter and the output voltage (millivolt signal) of the flowmeter is converted into signal form by a TELEPERM transducer and is fed to the controller. Controller

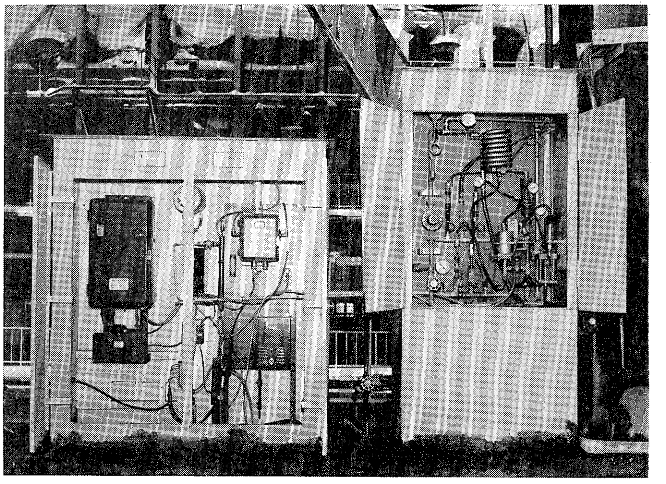

Fig. 8 O_2 and CO analyzer and gas sampling set

output is fed to an electric/hydraulic actuator, where it actuates the control valve. Signals from both burners can be indicated and recorded independently.

11) Others

The preceding paragraphs have outlined control loops and major monitoring instruments. In addition to these, the following have been delivered as auxiliary equipment.

(1) Control inlet exhaust gas temperature recorder
(2) Primary air flow indicator and manual controller
(3) Secondary air temperature recorder
(4) Individual cooler chamber pressure indicators
(5) Cooler hot air multiclone inlet/outlet static pressur indicators
(6) Cooler hot air multiclone inlet temperature indicator
(7) Cooler exhaust gas multiclone inlet/outlet static pressure indicators
(8) Cooler exhaust gas multiclone inlet temperature indicator
(9) Clinker temperature indicator

IV. NOTES

Designing a control system for a cement plant is closely related to sequence control of electric motors. With instrumentation and electric divisions, Fuji Electric was able to design an efficient control system.

At a later date, a raw material mill and associated equipment were installed. Fuji also manufactured and delivered the greatest portion of electrical equipment for this additional installation.