INDUSTRIAL DATA PROCESSING APPLICATIONS REPORT

Applications	Data Logging - Cement Plant
Type of Industry	Cement
Name of User	Penn-Dixie Cement Corp. Plant No. 10 Petosky, Mich.

Equipment Used	Foxboro 97400 Industrial Digital System, including: Teletype ASR-33 Unit IBM Electric Typewriters Digital Equipment Corp. PDP-5 Computer

Synopsis

The Penn-Dixie Cement Corp. is using a Foxboro 97400 Industrial Digital System for data logging at its Plant No. 10 in Petosky, Mich.

The data logging system produces three log sheets and an alarm record after process inputs are monitored and calculations and conversions made. Off-normal points are identified as they exceed a preselected limit.

The system is designed to keep up with the process, and alarms are made available before any possibility of damage to the process. In addition, the system performs high-speed calculations.

The modern cement plant is a highly automated complex that uses sensors and instrumentation, controllers, strip chart recorders and other automatic control devices. All this instrumentation has helped cement-making become more of a science than an art and it also has contributed to making a better quality product.

Typically, a cement plant combines limestone and clay at a high temperature to produce a material containing silicates of calcium and several other compounds of aluminum and iron. For cements to have certain chemical and physical properties, these compounds must occur in specified proportions in the final product.

The total cement-making process can be divided into the following functions:

1. Quarrying - excavating rock from the limestone quarry.
2. Primary crushing - breaking the large rocks into a size suitable for controlled feeding.
3. Proportioning - mixing the correct amounts of additives with the limestone.
4. Raw mix grind - grinding the raw mix to small particle size prior to kiln burning.
5. Homogenizing - blending the raw mix to obtain the desired chemical composition.
6. Kiln burning - heating the raw mix to produce the necessary chemical reactions.
7. Finish grinding - grinding cement clinker to the proper fineness of finish cement.
8. Packing and shipping.

The Penn-Dixie Cement Corp. has completed an expansion program at its Plant No. 10 at Petoskey, Mich. This involved adding a new raw mill to this location and connecting this to the existing raw material crushing and storage system, an existing kiln, and the existing finish-grinding department and cement storage silos.

A Foxboro 97400 digital computer is used as the center of an industrial data logging system for this wet-process cement plant. Computer control in a cement plant can perform six different functions depending upon the particular system. These are:

1. Scanning and alarm.
2. Calculating and printing out data for production logs.
3. Calculating production costs and efficiencies.
4. Calculating and setting raw material feeds, wet or dry.
5. Calculating and setting kiln analog controller settings.
6. Direct digital control of the process.

Scanning and logging can relieve the operator of these routine duties so that he can perform more important functions in the manufacture of the product.

All variables, or the more critical ones, can be scanned periodically with the frequency of scanning determined and programed according to the application. The computer will compare the various important measurements with predetermined high and low levels. Any off-limit condition is printed out, showing the identity of the variable, its value, and the time the off-limit occurred. The operator is thereby alerted and can correct or compensate for the condition.

Automatic logging has a similar advantage since manual recording takes up a considerable amount of the operator's time.

The most important logging function involves calculation, particularly if the calculated function could lead to a process upset if it were not detected and corrected early enough. The computer provides such information on a continuing basis.

At Penn-Dixie Cement, once data logging was chosen, several methods of achieving the result were possible. They ranged from fixed program systems to large digital computer process control systems. A system that fell between these two extremes was chosen. It includes a high speed digital computer with random access core memory and supplemental drum storage. The computer can perform all the functions required of a small process control unit. Inputs are scanned at 20 points a second. Log print-outs are independent of the scan cycle, and high speed calculations are possible.

CONTROL ROOM AT PENN-DIXIE CEMENT CORP.'S PLANT NO. 10

THE SYSTEM

The Plant No. 10 data logging system is part of an integrated instrument and control system purchased by Penn-Dixie from the Foxboro Co. It includes a digital computer, input-output equipment and a program.

The computer is a programed data processor offering random access, high speed magnetic core memory in a general purpose digital computer. It was designed for use in computation or as a control or processing element in an on-line data handling process control system.

An automatic send-receive model ASR-33 Teletype unit is standard equipment for this computer. The Teletype is used for communication with the computer and is used to enter time of day upon start-up, to change alarm limits and to enter and receive blending data.

Foxboro manufactures standard input-output modules that link the computer with the process. There are three types of input modules used by Penn-Dixie. These are:

1. The analog module which receives low level direct current signals from process instruments and sensors. Upon command from the computer a specific input is selected, converted to a digital code proportional to its analog value and stored for subsequent transmission to the computer. The module signals the computer when the requested data is ready. Twenty or more analog points can be prepared and transmitted a second.

2. The contact sensing module reads field contacts and stores their status. Upon command from the computer a digital code representing groups of field contacts is prepared for subsequent transfer to the computer.

3. The manual data entry module links the operator's console with the computer. Through this module, operators are able to change the log cycle frequency and select digital display of any point monitored by the system.

There are two types of output modules used. These are:

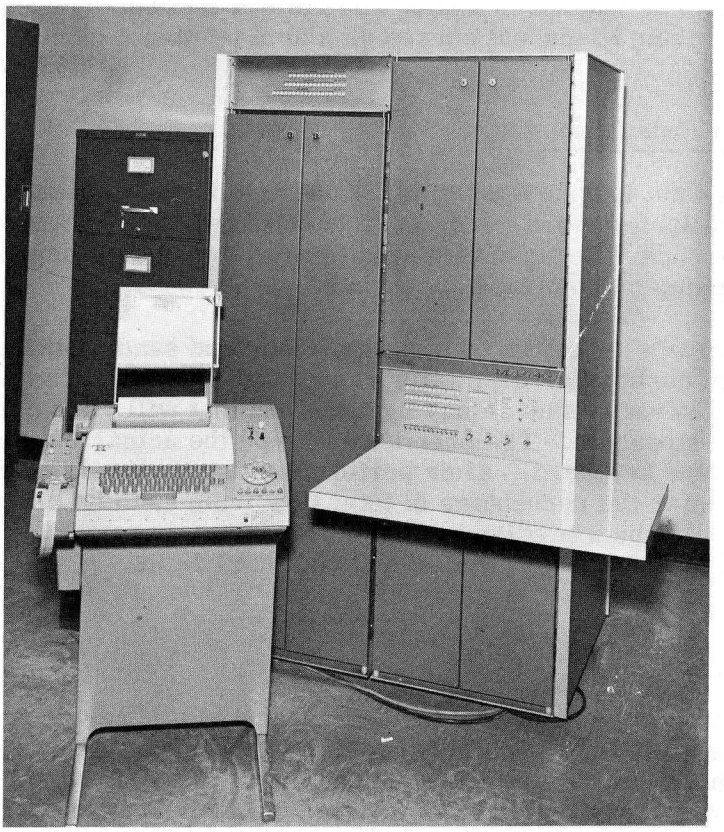
1. The data display module which communicates a digital value for the point selected to the operator's panel.

2. The carriage typewriter module which translates computer signals into signals that operate the logging and alarm typewriters.

System Logs

The result of the data logging system at the Penn-Dixie Cement Corp. is four typewritten pages. Each page is typed on IBM electric typewriters as directed by the computer. The four pages consist of three log sheets and an alarm record. Data is typed out after process inputs are surveyed and necessary calculations and conversions made.

A separate log for each kiln and one for the raw mill-blending complex is produced by the data logging system at Penn-Dixie. They are typed on pre-titled forms. There are three types of log cycles:



FOXBORO

97400

COMPUTER

1. The Current Log Cycle is typed at regular intervals and is adjustable between five and 60 minutes in five-minute increments. Log cycle frequency is easily changed by the control room operator who can initiate a log cycle at any time. Each current log cycle is preceded by the time of day.

2. The Shift Log Cycle is typed every eight hours. All Shift Log Cycles are preceded by an "S" and the time of day; e.g., S1600, S0800.

3. The Daily Log Cycle is typed every 24 hours. All daily log cycles are preceded by a "D" and the time of day; e.g., D0800.

Alarm Record

The alarm record includes a print-out of the time of day with every entry. Any off-normal point is identified as it exceeds a preselected limit. When a point returns to normal, the typewriter records this condition. All alarming points are typed out in red. As they return to normal, type-outs are in black.

In addition to the above, several other plant conditions are monitored. There are high-low alarms to monitor raw material proportions and slurry mix tank proportions.

There are four standard voltages used to check the accuracy of the analog-to-digital converter. An error in any one will cause a high-low alarm print out.

Each kiln has seven analog controllers that can be operated in either automatic or manual mode. Switching to manual causes an alarm print-out identifying the kiln and specific controller.

High Speed Calculations

The data logging system at Penn-Dixie is designed to keep pace with the process. Alarms must be available before the process is damaged, and logs must be typed frequently to pinpoint undesirable trends. Because of its high speed, other uses are made of the computer. For example, a slurry blending calculation is performed.

Slurries, or mixtures of stone, shale and sand (silicon dioxide, aluminum oxide, iron oxide and calcium carbonate) with water are stored in tanks. The plant chemist will analyze the contents of the tanks several times a day by a method that will yield actual ingredient percentages to an accuracy of 0.1 percent. The chemist will type the actual and desired percentages of the ingredients on the teletype keyboard. After performing the required calculations, the computer will type on the teletype printer the percentage of total flow from each tank to make a slurry blend containing the desired ratios of the ingredients. Each percentage is printed out as a three-digit number with the decimal point implied between the second and third digits.

Control Room

The raw grinding, slurry blending and kiln burning are remotely done from a central control room. The layout of the control panels is in the form of an inverted "U" making it easy for a single operator to direct. There is also a digital data display panel, a typewriter for recording off-normal conditions and three typewriters for logging the operating data. The computer system with its teletype and input-output equipment is in an adjoining room.

There are four control panels in use. One for the raw mills, one for kiln feed preparation, one for Kiln No. 1 and one for Kiln No. 2.

RESULTS AND FUTURE PLANS

The digital data logging system was chosen at Penn-Dixie as a start toward more sophisticated systems in the future. The computer has been used for the logging functions as well as for blend calculations.

Already, the system has proved it can increase supervisory capability of the single operator assigned to the control room. Increased productivity and improved quality are the result. A calculation to guide the operator's selection of fuel input for the current raw material feed rate has been added to each log cycle; other similar calculations are planned.

Future plans include greater computer capabilities in the area of mix calculations, quality control and efficiency calculations.

Repetitive calculations done in the laboratory are being reviewed for possible computer solution. These will be limited by available memory space and computer idle time. The trend toward control of the cement manufacturing process with digital computers is being closely watched. It is felt that capability exists to extend present equipment to control functions as it becomes economically justified.