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Cement Mill Feeder Control System

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Abstract - Mainly there are three ingredients used in cement grinding. They are Gypsum, Clinker& slag. They are stored in respective hoppers. The materials from three hoppers are fed to respective weigh feeders. These weigh and feed according to the set ratio and quantity. Then the material is grinded inside the cement mill using grinding media balls. This grinded powder is fed to the separator through air slide and bucket elevator. From the separator fine powder is moved to the silos for storing and coarse powder is sucked by recirculation fan and is moved to the mill for further grinding. These entire processes are to be converted into PLC program and the automation of the cement plant has done. It also includes the automation of the weigh feeder section and the water sprayer section.

***Keywords* - Tachogenerator , Load cell, RTD.**

1. Introduction

The Indian Cement Industry is the second largest producer of cement in the world just behind China. Cement is an essential component of infrastructure development. Cement is the most important input of construction industry such as Government's infrastructure and housing programs which are necessary for the country's socio-economic growth and development. Due to increasing population various constructional activities are increasing day by day. Hence it is important for major industries to update their equipment according to the new standard for increase their production. Here our project deals with a PLC controlled clinker cooling and conveyor system with a SCADA interface.

This section is responsible for the reduction of the temperature of hot clinker by cooling. The cooling process is by blower fans and water spray mechanism. All these processes are controlled by PLC and viewed in SCADA from the control room. The overall operation is timing control. The devices are turned on and turned off sequentially one after another by on delay timer and off delay timer respectively. There are various types of sensors and level detectors usedin each and every critical point to control the entire operation and to reduce unwanted running of machineries. The entire operation is done part by part. Before the introduction of PLC, the system was a hardwired logic.ie, by the relay mechanism. Compared to PLC these were complex due to the wiring and connections.

2. Block Diagram

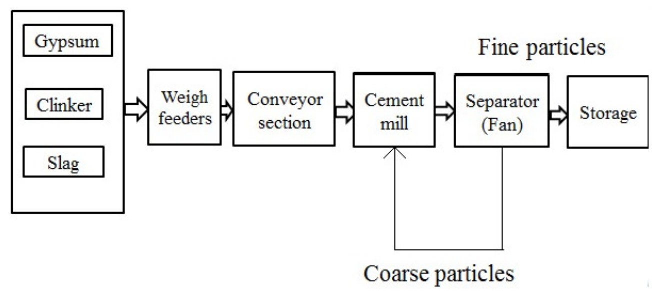


Fig 1. Block Diagram

3. Block Diagram Explanation

3.1 Elements

Mainly there are three ingredients used in cement grinding. They are Gypsum, Clinker, and slag. They are stored in respective hoppers. The materials from three hoppers are fed to respective weigh feeders.

3.2 Weigh feeders

They weigh and feed according to the set ratio and quantity. In order to achieve the desired setting qualities in the finished product, a quantity (2-8%, but typically 5%) of calcium sulfate (usually gypsum or anhydrite) is added to the clinker and the mixture is finely ground to form the finished cement powder. This is achieved in a cement mill. Their accurate proportion cannot be determined as it mainly depends on the requirement and the quality of the three basic materials. The weight of each material is determined by using a load cell. The heart of any weighing system is the load cell. Whilst they are not exciting to watch, load cells are highly accurate transducers which provide the user with information not generally obtainable by other technology due to commercial factors. Load cells are designed to sense force or weight under a wide range of adverse conditions; they are not only the most essential part of an electronic weighing system, but also the most vulnerable. In order to get the most benefit from the load cell, the user must have a thorough understanding of the technology, construction and operation of this unique device.

3.3 Conveyor Section

It consists of a single conveyor belt through which three elements are fed to the cement mill. The belt conveyor is an endless belt moving over two end pulleys at fixed positions and used for transporting material horizontally or at an incline up or down. The main components of a belt conveyor are the belt that forms the moving and supporting surface on which the conveyed material rides. It is the tractive element. The belt should be selected considering the material to be transported. The idlers, which form the supports for the carrying and return stands of the belt. The pulleys that support and move the belt and controls its tension. The drive that imparts power to one or more pulleys to move the belt and its loads. The structure that supports and maintains the alignments of the idlers and pulleys and support the driving machinery.

3.4 Cement Mill

The material is grinded inside the cement mill using grinding media balls. It consists of three grinding balls of different weights. When the balls are positioned at 90 degree, it comes down and grinds the materials. When the balls are positioned at 90 degree, it comes down and grinds the materials. A cement mill is the equipment used to grind the hard, nodular clinker from the cement kiln into the fine grey powder that is cement. Most cement is currently ground in ball mills and also vertical roller mills which are more effective than ball mills. A ball mill is a horizontal cylinder partly filled with steel balls (or occasionally other shapes) that rotates on its axis, imparting a tumbling and cascading action to the balls. Material fed through the mill is crushed by impact and ground by attrition between the balls. The cement mill composed of two chambers. One chamber consists of large ball of size 70-80 mm and the other having 15-30mm diameter. The mill will be running continuously so that the grinding is done inside the chamber. The balls rotate and fall on reaching at right angles inside the chamber and the grinding is done.

3.5 Separator

Then the cement is moved to the 'separator' through air slide and bucket elevator. From the separator fine powder is moved to the silos for storing and coarse powder is sucked by recirculation fan and is moved to the mill for further grinding. In the case of the cement plant, the separator separates fine particles from coarse particles. The fine particles are collected as product while the coarse particles are sent back for further grinding. The trick is to make sure that the stream of coarse particles doesn't contain any fine particles and, likewise, to make sure that the stream of fine particles doesn't contain any coarse particles. An efficient separator prevents over-grinding and the waste of energy that accompanies it. It also keeps product within specifications by making sure that the correct particle size is achieved. All separators use the same basic principles of physics that you probably studied in high school. The first principle is that the faster you spin something around in a circle, the more centrifugal force it has. Think back to your days at the playground. If you sat on the outside of the merry-go-round, the faster that someone spun the merry-go-round, the more force that pushed you to the outside. Separators use the same principle to force particles to the outside of the device. The greater the centrifugal force the more particles that are forced to the outside. On conventional separators adjustments that impact either the centrifugal force or the drag force (which is acting in opposition to the centrifugal force) ultimately determine how coarse or how fine the separated material should be. The terms separators and classifiers are used interchangeably because they perform identical functions. The term classifier though typically refers to the later generation "high efficiency" separators. High efficiency classifiers use the same physical principles as the conventional separators although their internal configuration is quite a bit different.

4. Methodology

The entire process in the cement mill section is studied and it is converted to its corresponding ladder diagram and is implemented in PLC. In Manual Control the operator take all the action related to process control. In such type of control there is a chance of human error and it effect on quality of the final product. In Pneumatic

Control, actions were controlled by a simple manipulation of pneumatic valves, which in turn were controlled by relays and switches. In Manual Control the operator take all the action related to process control. In such type of control there is a chance of human error and it effect on quality of the final product. In Pneumatic Control, actions were controlled by a simple manipulation of pneumatic valves, which in turn were controlled by relays and switches. In Hardwired Logic Control contractors and Relays together with hardware timers and counters were used in achieving the desired level of automation. In Electronic Control using Logic Gates hardware timers and counters were replaced by electronic timers. This reduces size of the control system. The PLC mainly consists of a CPU, memory areas, and appropriate circuits to receive input/output data. We can actually consider the PLC to be a box full of hundreds or thousands of separate relays, counters, timers and data storage locations. The timers, counters etc. do not exist physically but rather they are simulated and can be considered software counters, timers, etc. These internal relays are simulated through bit locations in registers. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result. A PLC (Programmable Logic Controllers) is an industrial computer used to monitor inputs, and depending upon their state make decisions based on its program or logic, to control (turn on/off) its outputs to automate a machine or a process. A PLC is defined as a digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions by implementing specific functions such as logic sequencing, timing, counting, and arithmetic to control, through digital or analog input/output modules, various types of machines or processes. The programming device is used to enter the required program into the memory of the processor.

4.1 Disadvantages of Relay Control

- Too much work required in connecting wires.
- Difficulty with changes or replacements.
- Difficulty in finding errors skillful work force.
- When a problem occurs, hold-up time is indefinite, usually long.

4.2 Advantages of PLC Control

- Rugged and designed to withstand vibrations, temperature, humidity, and noise.
- Have interfacing for inputs and outputs already inside the controller.
- Easily programmed and have an easily understood programming language.
- A Programmable Logic Control program can be tested and evaluated in a lab.
- The program can be tested, validated and corrected saving very valuable time.
- One single Programmable Logic Controller can easily run many machines.

5. Implementation

5.1 FLOW CHART

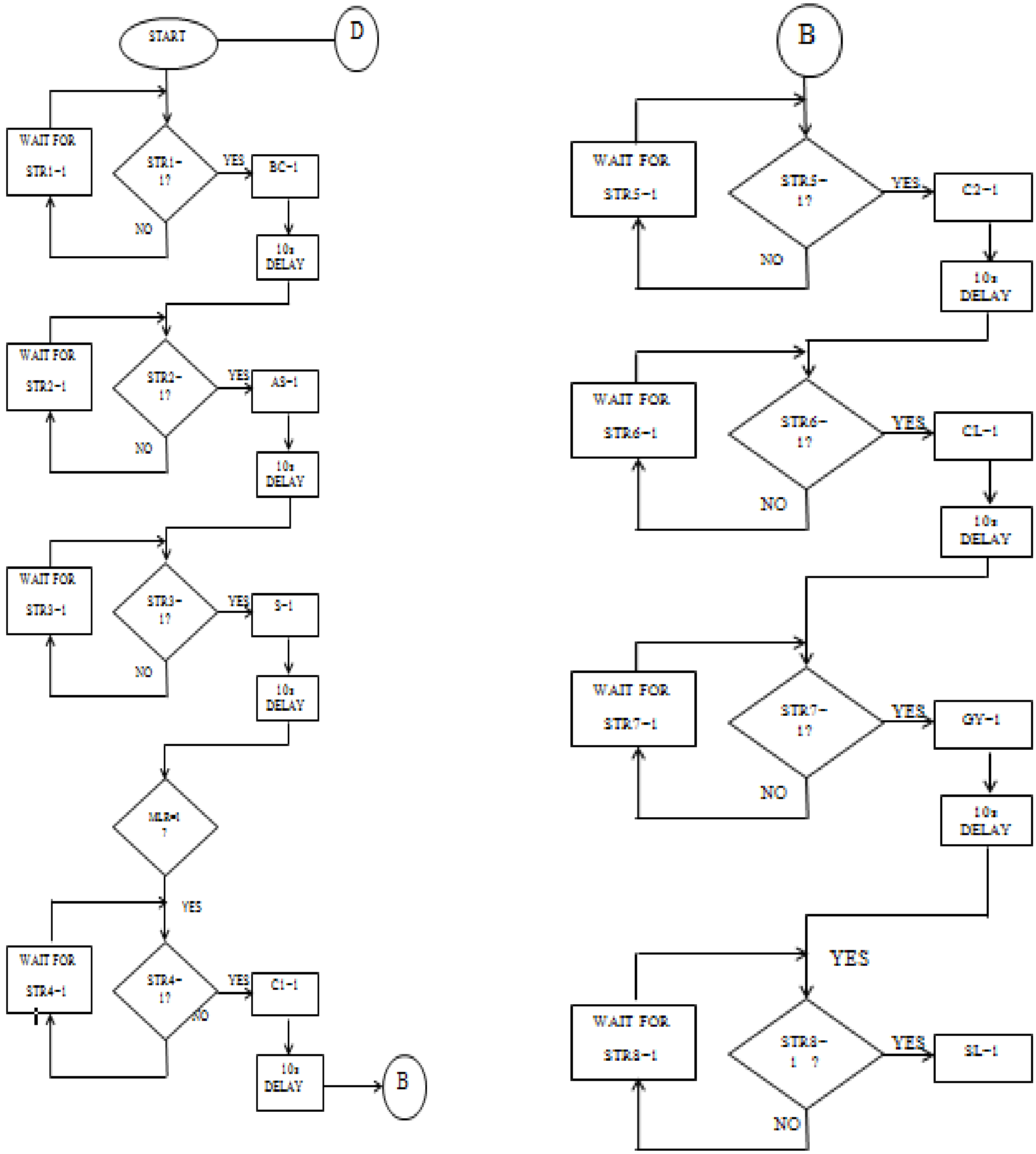
The flow chart of the entire process is given below as section wise. It includes the start & stop section, weigh feeder control section and also the sprayer section.

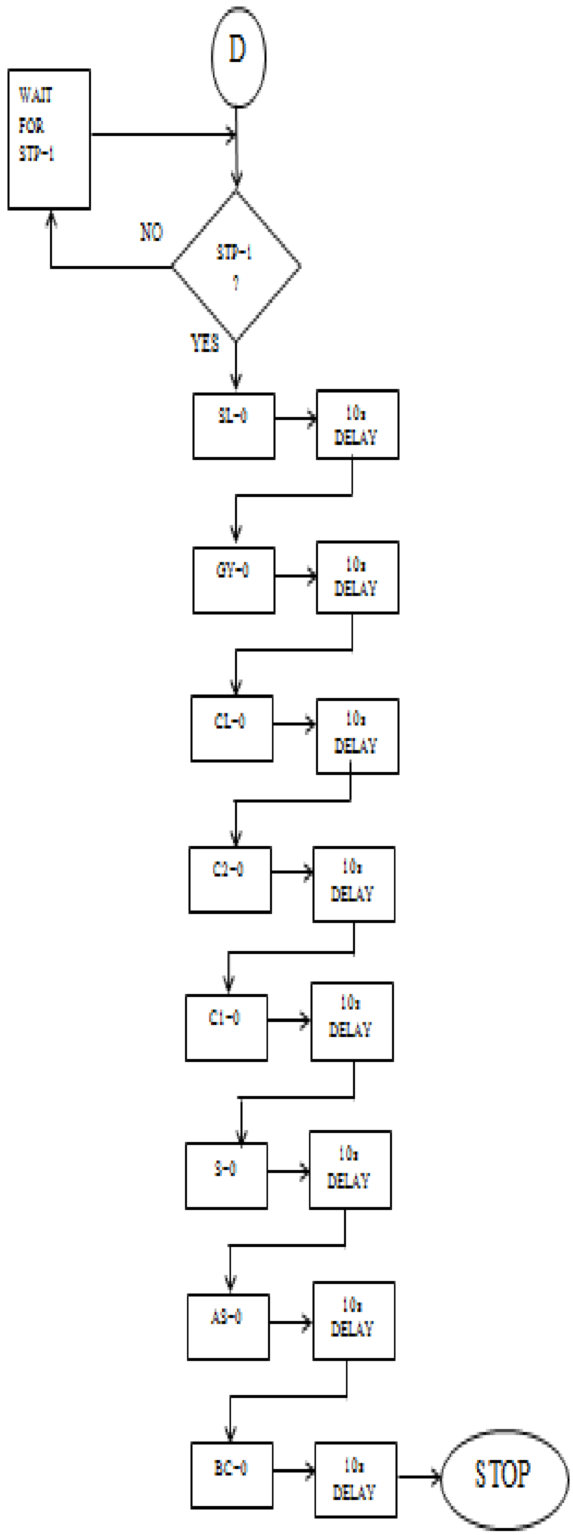
5.2 Turning On

The turning on process includes the starting of the different section in the process. The starting is done in the reverse order of the arrangement of the process. The starting can be done either by remote or local. Remote starting means starting from the control room and local starting means starting locally by the operator in the field itself. Here when the start button is pressed each section is turned on with a 10 seconds delay. At first when the start button is on the belt conveyor is turned on and after a 10 seconds delay the next section that is the air slider is on. In the similar way all other sections are turned on.

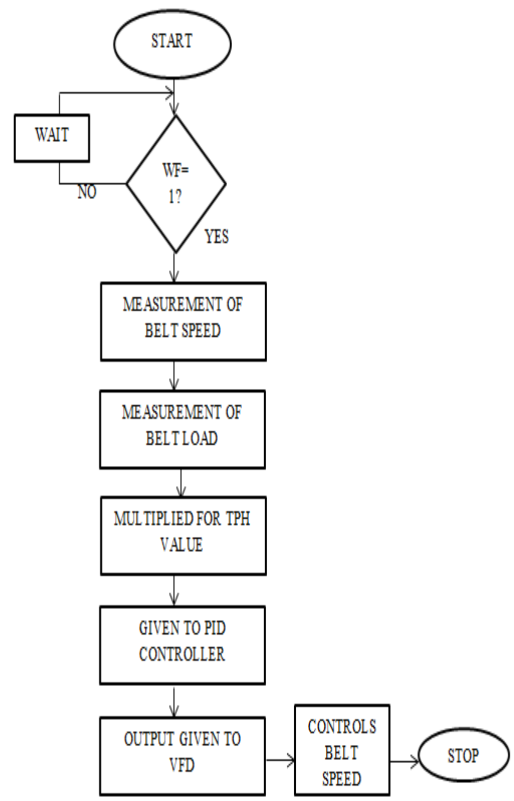
5.3 Turning Off

The turning off process also can be done by remote and local. It is done in the reverse order of starting that is the section which is started first is turned off last. Here when the stop button is pressed the slag weigh feeder is turned off at first and after a 10 seconds delay the next weigh feeder is stopped. The last section to be turned off is the belt conveyor which is the section that is turned on first.


START
D
WAIT FOR STR1-1
STR1-1?
YES
NO
BC-1
10s DELAY
WAIT FOR STR2-1
STR2-1?
YES
NO
AS-1
10s DELAY
WAIT FOR STR3-1
STR3-1?
YES
NO
S-1
10s DELAY
YES
WAIT FOR STR4-1
STR4-1?
YES
NO
C1-1
10s DELAY
B
B
WAIT FOR STR5-1
STR5-1?
YES
NO
C2-1
10s DELAY
WAIT FOR STR6-1
STR6-1?
YES
NO
CL-1
10s DELAY
WAIT FOR STR7-1
STR7-1?
YES
NO
GY-1
10s DELAY
YES
WAIT FOR STR8-1
STR8-1 ?
YES
NO
SL-1

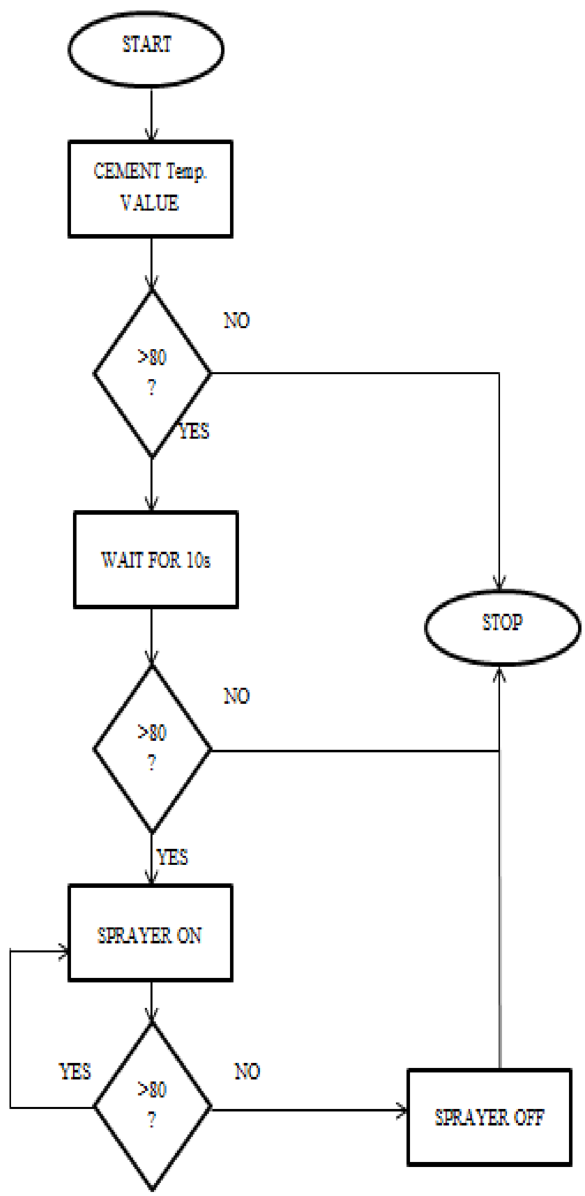


5.4 Weigh Feeder Control



The automatic control of the weigh feeder is done by using a PID controller. Each weigh feeder has a definite set point of materials to be processed. It is expressed in tonnes per hour (tph).So to calculate the tph the load and speed has to be multiplied. The load is measured by using a load cell and the speed by using a tachogenerator. It is then given to a PID controller and then to the VFD so as to control the belt speed. A variable-frequency drive (VFD) (also termed adjustable-frequency drive, variable-speed drive, AC drive, micro drive or inverter drive) is a type of adjustable-speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage. VFDs are used in applications ranging from small appliances to the largest of mine mill drives and compressors. However, about a third of the world's electrical energy is consumed by electric motors in fixed-speed centrifugal pump, fan and compressor applications and VFDs' global market penetration for all applications is still relatively small. This highlights especially significant energy efficiency improvement opportunities for retrofitted and new VFD installations. A proportional-integral-derivative controller (PID controller) is a generic control loop feedback mechanism (controller) widely used in industrial control systems. A PID controller calculates an "error" value as the difference between a measured process variable and a desired set point. The controller attempts to minimize the error by adjusting the process control outputs. The PID controller algorithm involves three separate constant parameters, and is accordingly sometimes called three-term control: the proportional, the integral and derivative values, denoted P, I, and D.

5.5 Water Sprayer



This section is developed to control the temperature of cement after the separator section. If the temperature is greater than 80 degree celcius, a water sprayer has to be turned on till the temperature is controlled. The cement temperature is compared using a comparator and a wait timer is activated, it is done so that the temperature may reduce in that time and if it is still greater than the set point the water sprayer has to be turned on till the temperature is controlled. The increasing temperature can vary the properties of cement.

6. Conclusion

This paper involves the automation of cement mill feeder. Each section of the cement mill is controlled by a PLC program and all sections are connected together. This paper improves the efficiency of the plant production and quality of the product by controlling the ratio of the additives using PLC. The automation technologies are used for the high efficiency working of the plant and also for increasing the production.

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