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Automation of Conveyor Belt in Bricks and Blocks by PLC

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Abstract: The project is to improve the productivity of a small-scale industry named "BOSE BRICKS AND BLOCKS, Chimur Road, Pahami, Maharashtra-441203" which construct bricks using fly-ash. All the materials are mixed in the pan mixer which is driven by a 3-phase motor. Then the slurry made by mixing all these materials is passed to the hopper with the help of conveyor belt. The Pressing Unit forms the brick which is controlled by a commercial programmable logic controller (PLC) while the conveyor belt is still manually operated. The productivity of "BOSE BRICKS AND BLOCKS,PAHAMI " can be improved by-

• Automation of Conveyor belt using PLC. The slurry when moved from pan mixer to the hopper a man is required to operate the switch of the conveyor belt. This manual work requires attention as well as time to fully fill the hopper as well as to empty it. If the conveyor belt is made automatic with the help of PLC it will reduce the man power and increase the efficiency of the plant.

Keywords: Bricks,blocks, PLC,automation

I. INTRODUCTION

The paper "The Design Research on Adaptive Control System of the Ground Belt of Coal Mine" Based on the present situation of running of the belt on coal mine the PLC control according to the size of the load is elaborated in the paper. [1] The information was gathered from the paper "Research and design of monitoring system for belt conveyor" In order to ensure the belt conveyor operation, this paper designs the monitoring system based on PLC technology. [2] The "Programmable Logic Controller" Information and Working of PLC was learnt from this paper by Antonio Sorin Tasu on "Programmable Logic Controller" .[3]. A programmable logic controller (PLC) is an industrial digital computer which has been adapted for the control of manufacturing processes or any activity that requires high reliability control and ease of programming and process fault diagnosis. The small-scale industry "BOSE BRICKS AND BLOCKS,PAHAMI" was visited on. 29th June 2019. We studied the plant working in detail during inspection we got to know that , we need to construct conveyor belt which can run automatically using PLC that helps in reduction of time, labor and eventually increase productivity & profit.

II. WORKING OF THE INDUSTRY

The plant makes bricks with raw material such as fly ash, cement, water etc. It consists of a Pan mixer, Conveyor belt, Pressing Unit, Automation system of PLC. The plant is sanctioned for the electricity of 23 HP while the used electricity is 21 HP. The inputs stone dust, fly ash, cement and water is inserted in the pan mixer by the workers. All the materials are mixed in the pan mixer which is driven by a 3-phase motor. Then the slurry made by mixing all these materials is passed to the hopper with the help of conveyor belt which is manually operated. Hopper is the part of the system where bricks are made of particular size and shape. It is totally controlled by PLC. The pressing unit consists of some various parts like trolley-feed, punch, pallet, ready raw to DIE . Powerpack is a system which provides a hydraulic pressure to whole unit. It consists of 3 phase Induction Motor of 7.50 KW at the speed of 1410 rpm. Motor is coupled with hydraulic pump which creates pressure in BAR. It is also a PLC controlled machine. The pressure in the powerpack is controlled by PLC. The pressure is always maintained. The powerpack uses electrical sensor. And like-wise we get the output in the form of bricks on the pallet.

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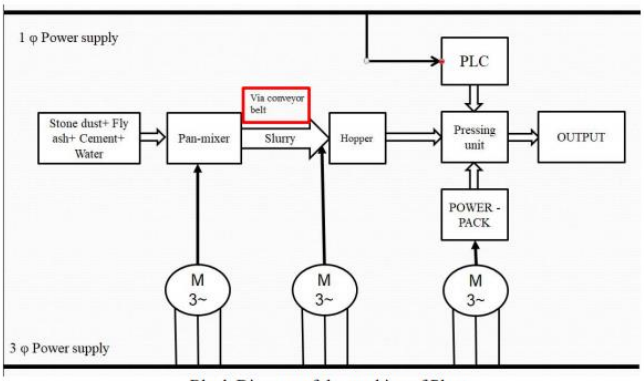

Block Diagram of the working of Plant

This manual operation of the conveyor belt is automated in this project.

III. ABOUT PROGRAMMABLE LOGIC CONTROLLER (PLC)

Programmable logic controllers are the most widely used electronic devices in the control of production and assembly process in most automated factories due to its simplicity and versatility. A programmable logic controller (PLC) is a user-friendly, microprocessor-based, specialized computer carrying out control functions of many types and levels of complexity in industrial applications.

Early PLCs were designed to replace relay logic systems. These PLCs were programmed in "ladder logic", which strongly resembles a schematic diagram of relay logic. This program notation was chosen to reduce training demands for the existing technicians. Programmable Logic Controllers have three components. These three PLC components are: processor, power supply, and an input/output (I/O) section.

- *The Processor*

The processor, or the brain of the PLC system, is a solid-state device designed to perform a wide variety of production, machine tool, and process-control functions. Conventional electromechanical devices, relays and their associated wiring formerly performed these functions. Processors provide these same functions, in a wider scope and variety of control functions, with minimal effort, making the PLC a much more popular choice. The processor operates on DC power (± 5V), that is supplied by the power supply. Internal DC power is also routed through the processor and operates a portion of the I/O and devices connected to the service port of the PLC. Once the ladder-diagram program is entered into the processor, it remains until changed by the user with one of the programming devices. The program is unaltered through power failure or power off conditions.

- *The Power Supply*

The Power supply for a Programmable Logic Controller converts the input source power into voltages required for internal circuitry. In some cases, it also provides an isolated VDC supply to power DC input circuits, switches and other indicators. The Power Supply of the PLC is an essential component to running the PLC.

- *The PLC Input / Output (I/O)*

Electrical noise, such as spikes in the power lines or load kick-back would have serious impact on a PLC's internal circuits since its CPU operates at very low voltages levels. This is where the Input / Output (I/O) portion of a PLC plays a critical role. The I/O, both inputs and outputs, protects the CPU from electrical noise. The I/O section is where status signals are filtered to remove noise, validate voltage levels, and CPU decisions are made and put into operation. The PLC Inputs provide their status to a storage area within the CPU and outputs are driven from similar stored status in the CPU. Real world devices such as pushbuttons, limit switches and sensors are connected through the input modules in the PLC. These modules detect a change in the state of input signals and provide a stored image to input elements in ladder logic. The input elements simulate the actions of relay contacts within the Programmable Logic Controller. In turn, output elements are "energized," which produces desired output signals to drive loads such as motor controllers, contactors, solenoids, and pilot lights, via the output modules in the I/O's. As a general rule, each instruction in ladder logic requires one word of memory. Each instruction is programmed so that series contacts are ANDed and parallel contacts are Red.

- *Design of PLC control system software*

The control device of the self-adaptive control system of coal mine underground belt conveyor is mainly consist of programmable controller PLC, A/D and D/A converter and so on. The control function is mainly implemented by programmable controller PLC. Control system software is mainly implemented by programmable controller ladder diagram program. The program mainly includes display refresh, the load signal acquisition, control operation and control of output and some other operations. Figure given below is the PLC‟s adaptive frequency control and speed regulation control software flow chart.

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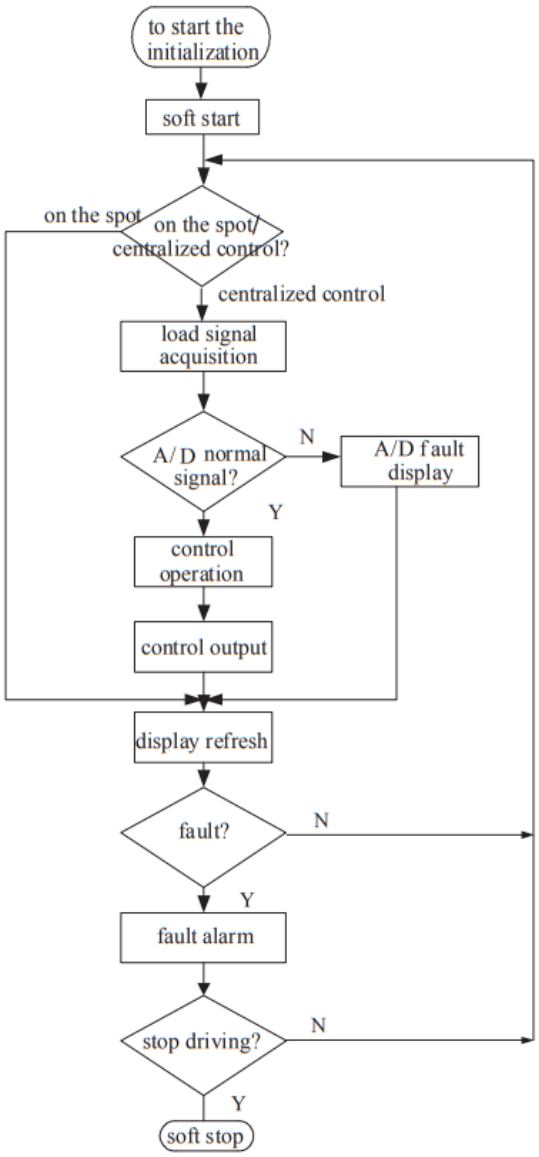

Fig: Flow diagram of software of process control

The control device part possesses the self-diagnosis function of A/D and D/A convert module work state. When the A / D and D / A converter fail, the fault controller's instrument display will display the stoppage. The ZJT series frequency converter runs in two ways: local manual and long-range control. The switch of the two ways is decided by the internal parameter settings. The frequency converter has the function of self- diagnosis, which can convey fault signal to the control device in time. converter runs in two ways: local manual and long-range control. The switch of the two ways is decided by the internal parameter settings. The frequency converter has the function of self-diagnosis, which can convey fault signal to the control device in time. When the system fails, the frequency converter conveys fault signal to the controller, and the controller output the failure alarm signal and stop conveys fault signal to the controller, and the controller output the failure alarm signal and stop.

IV. TYPE OF PLC USED IN THE PROJECT

The PLC we are using for the project is the DC to DC PLC. The reason behind is given below

1. The DC/DC converters supply 24 V output voltages at rated output currents from 0.375 to 10A
2. The industry standard DIN rail-mounted devices are connected, for example, to battery buffered power supply networks for safety-relevant applications. These include applications in industry, power plants, water treatment plants and vehicle on board.

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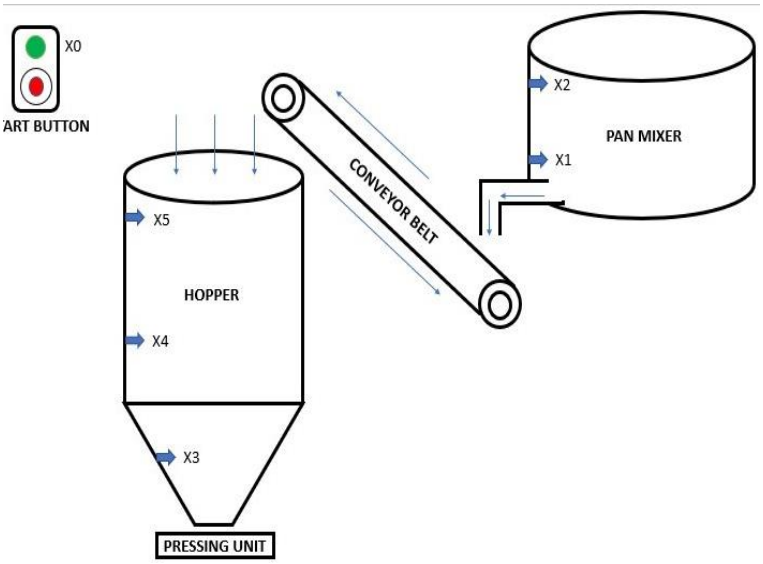
3. To supply an uninterruptible 24 V DC input voltage this PLC offers DC-UPS systems with maintenance-free, lead-gel batteries or long-life capacitors for energy storage.
4. DC/DC converters with 12 V DC output voltage.
• Output voltage adjustable between 12 and 14 V DC
• Extremely slim construction
• Simple DIN rail mounting
• Input voltage 24 V DC

V. INPUT AND OUTPUT OF PLC



The above diagram helps to understand the ladder diagram in detail. In the diagram, Inputs and Outputs are given by-

INPUTS-	OUTPUTS-
X_0- Start Push Button	Y_0-Outlet Valve of a Pan Mixer
X_1- Lower level of a pan mixer	Y_1- Conveyor Motor
X_2- Upper Level of a Pan Mixer	Y_2- Outlet Valve of a Hopper
X_3- Upper Level of a Hopper	
X_4-Middle Level of a Hopper	
X_5-Lower Level of a Hopper	

In the PLCs, there are memory bits to store the Inputs and Outputs. For the project, the memory bits used in the ladder diagram are as follows:
M0- Stores input X0 (Start Push Button).
M1- Stores positive edge triggering of input X2 (Lower Level of a Pan Mixer).
M2- Stores output Y0 and Y1.
M3- Stores positive edge triggering of input X5 (Lower Level of a Hopper). It also shut outputs Y0 and Y1.
M4- Stores negative edge triggering of input X4 (Middle Level of a Hopper).
M5- Stores negative edge triggering of input X1 (Lower Level of Pan Mixer) M6- Stores negative edge triggering of input X3 (Upper Level of a hopper).

VI. LADDER DIAGRAM

The figure below shows the Ladder Diagram of the program that we have to write to PLC so that the automation process begins.
For the simulation of the Ladder Diagram, we have used a PLC Delta-WPL Software. The reason to use this software is the presentation it applies to the ladders i.e. the ladder appears neat and tidy unlike other software.
Ladder diagram are to be made according to the process we desire. A slight mistake in the ladder will ruin the whole program and the program will not work properly.
A sneak peek of the process of program is given-
• A Start Button(X0) is pushed and the system starts. Workers manually start filling the Pan Mixer with raw materials.

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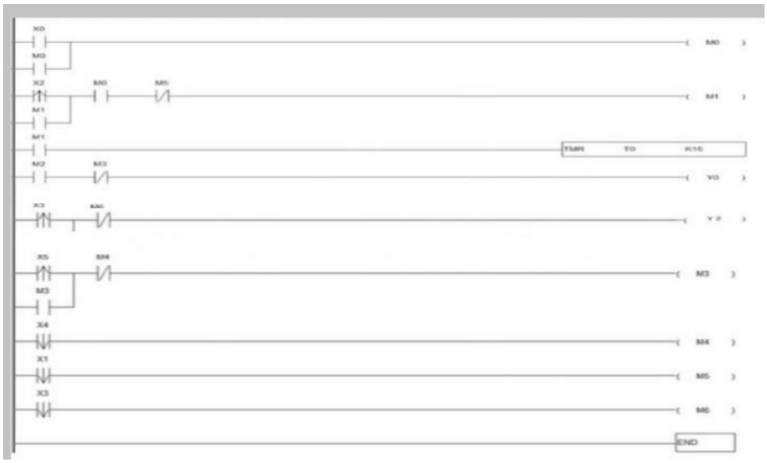
• When the raw materials mixture reaches Upper Level of Pan Mixer, the TIMER starts for set time and the mixture is prepared. After the timer stops the outlet valve (Y0) opens. This leads to starting of Conveyor motor (Y1) and the mixture get transfer to the Hopper via Conveyor belt.
• The Hopper starts filling with the mixture. When Lower level of Hopper (X3) receives the positive trigger, the Outlet valve (Y2) opens. When the mixture reaches Upper Level of Hopper (X5) it shuts down Outlet of Pan Mixer (Y0) and Conveyor Motor(Y1).
• When X4 receives negative trigger the Outlet Valve (Y0) and Conveyor Motor (Y1) starts



VII. PLC PROGRAM EXPLANATION

Here, the detailed explanation is given of the ladder diagram of PLC.
• The start push button which is N.O. switch is when pushed the system operation begin.
• The Start Button is the input X0. Now, even after releasing the button the system should be working ,therefore, latching is needed.
• That is, for the process to remain continue, we store it in a memory bit M0 in PLC and latched it.
• Now the workers start filling the pan mixer manually with all the raw materials needed.
• When the raw material reaches the upper level of pan mixer i.e. input X2, the timer starts for the set time and the mixture is prepared.
• For the above purpose, we took the positive edge level trigger of input X2 and stored it in a memory bit M1 and latched it.
• This memory bit M1 stocked by input X2 i.e. upper level of a pan mixer is now set for a particular time as per the requirement.
• Now, as soon as the timer stops, the output valve of a pan mixer i.e. output Y0 opens and simultaneously start the conveyor motor (output Y1) operating the conveyor belt.
• That is why, output Y0 (outlet valve of a pan mixer) and output Y1 (conveyor motor operating a conveyor belt) are stored in the memory bit M2.
• Further, as the conveyor motor starts, the raw material mixture via conveyor belt is transferred to the hopper and it start filling.
• As the hopper starts filling and reaches the lowest level of hopper i.e. input X3, it opens the outlet valve of hopper (output Y2) only when the input X3 senses the positive trigger.
• When the mixture reaches the upper level of hopper that is when input X5 receives the positive edge triggering it stops the operation of conveyor motor (output Y1) as well as closes the output valve of a pan mixer (output Y0) simultaneously.
• The positive edge triggering of input x5 is stored in memory bit m3.
• To close the output Y0 and Y1, we therefore connected N.C. of M3 to memory bit M2.
• To make this process keep going, input X5 is therefore latched.
• As the level of hopper begin to decrease and reaches the middle level of hopper i.e. input X4 and when this input senses the negative edge trigger it will stop all the action that is being done by memory bit M3.
• The above means that, it will start the outputs Y0 and Y1 again simultaneously which were earlier stopped by the memory bit m3.
• Memory bit M4 is used to store the negative triggering of input X4 (middle level of hopper) and N.C. of memory bit M4 is used to stop the working process of memory bit M3.

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- Coming to the pan mixer again, as the input X1 (lower level of a pan mixer) receives negative trigger it will stop the timer totally.
- It is because when input X1 will sense negative trigger there will be no material in a pan mixer to make a mixture and that is why, there will be no need of timer.
- This negative triggering of input X1 is stored in memory bit M5 and the N.C. of this bit is given to memory bit M1 that is stocked by all the activities of input X2.
- Lastly, when the input X3 (lower level of a hopper) receives negative triggering it will shut the outlet valve of hopper i.e. output Y2.
- In the programming, negative triggering of input X3 is stored in memory bit m6.
- And therefore, N.C. of bit M6 is used to close the operation of output Y2.
- And the last ladder proclaims it is an end of the program.

A simulation will be done and the program will be transferred to DC to DC PLC (Write to PLC). That PLC will be installed in the BOSE BRICKS AND BLOCK INDUSTRY‟ and the process of automation will start. So, this way the program will work resulting in Automation of Conveyor Belt by using PLC.

VIII. STATEMENT FOR CONCLUSION

After successful installation of PLC, the main objective of increasing the efficiency and productivity of "BOSE BRICKS AND BLOCKS INDUSTRY" will be acquired in following manner:
Because of the automation process, the number of labors in the industry will reduce.
As a number of labors decreases, their wages will be saved which will surely affect the financial statement of the industry in a good way.
Considering that, the industry could increase their efficiency further resulting in professionalism.
The automation will also reduce the operating time which will help the industry to increase their productivity as well.

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