Automation of Coal Sorting and Metal Detection using PLC and SCADA

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Abstract—The main objective of this paper is to focus on implementation of modern PLC technology in coal transportation area where, coal level detection is an important aspect to improve coal handling system in thermal power plants and coal mining areas. The coal handling and segregation of coal impurity from coal and safety operation are summed up and the whole system is monitored and controlled by PLC technology. It consists of two parts, first consisting of software which contains ladder logic programming used to program PLC that controls the whole process of the project systematically according to input data sequence. Second is the hardware part which consists of conveyors for transporting the coal, Inductive proximity sensors for sensing the metals mixed with coal, Electromagnet for removal of metallic impurities from coal conveyor, Pneumatic piston to sort the large size coal, IR sensor for coal level detection in storage tanks and DC motors to drive the conveyor belt. In this proposed automation system all parameters are processed, controlled, and monitored with the help of OMRON PLC and SCADA WONDERWARE INTOUCH.

Keywords: Automation, Conveyor, Sorting, OMRON PLC, SCADA (Supervisory Control and Data Acquisition).

I. INTRODUCTION

This paper desires in designing a real time application which helps in sorting the weighted coal and separate the metal using PLC. The modules interfaced with the PLC for this system are IR sensor for detect the coal storage level, Pneumatic piston for sorting the coal, Inductive proximity sensor for detecting metal piece. PLC is used to make up communication between sensors for measuring continuously to monitor the real time process. This work introduces an automatic system with a combination of PLC having a high impact on coal sorting and fault detection. The main feature of the project is to automate the process of coal transport to the storage area using Sensors and PLC. The proposed system reduces the labour and working time and eliminate the fault.

II. CURRENT SCENARIO OF COAL MINING AREA

Thermal power plants and coal mining areas have storage tanks, bunkers and stockpiles where coal is stored. The actual present situation in most of the mining areas is, due to lack of infrastructure and automation, human workforce is continuously engaged in separating impurities from coal and keeping continuous watch on coal level storage tank. In the coal mining areas large amount of expenditure is spent on the coal quality monitoring. The surrounding atmosphere near the coal mining area contains hazardous chemicals and gases which are harmful to the health of the labour. During digging coal from the earth, metal particles get mixed up in the coal. Also, while transporting coal, the coal dealers introduced other impurities to it for increasing the weight of the coal for gaining profit which ultimately reduces the quality of the coal. When metals get introduced into the coal crusher, it draws large amount of current to increase the torque, this large current into the windings may cause excessive heating and there are possibilities of burning of the winding causing heavy damage to the motor. So, it is very important to provide good quality coal to the crusher and furnace.

III. SYSTEM BUILDING AND OPERATION

The coal transported to the coal hopper consists of two sensor – A high level and a lower level sensor. When the low sensor detects the absence of coal, the feeder comes into action i.e. it gets turned
When the hopper gets filled, DC motor and the higher level sensors get turned on moving the coal to the boiler, through the conveyor belt. The coal passes through an IR sensor and Inductive proximity sensor which is used for the detection of the nearby objects without any contact. In order to remove the metallic impurities in the coal electromagnets are placed above the conveyor belt. The next step is reduction in size of the coal, if the size is larger than required, it is picked up from the conveyor belt and crushed before it is sent to the boiler using pneumatic piston. Finally, the coal is sent to the boiler for further processing.

Flow chart of sorting process

IV. BLOCK DIAGRAM

V. HARDWARE DESCRIPTION

A. OMRON PLC CP1E N40/N30

Omron PLC is used in the desired system. It consists of 24 input pins and 16 output pins. The operating voltage range is 24 V DC. It is an industrial based control system that continuously monitors the input devices and makes decision based on the ladder program to control the output devices. The first PLC offered relay functionality, thus replacing original hardwire relay logic, which used electrically operated device to mechanically switch electrical circuits. They met the requirement of modularity, expandability, programmability and ease of use in an industrial environment. PLC wiring can be easily understood and installed, use less space. The input device status is continuously monitored by controller based on ladder logic program and the processor controls the output devices.

B. Proximity sensor

A proximity sensor can detect the presence of the nearby object without any physical contact. It continuously emits an electromagnetic field or a beam of electromagnetic radiation and identifies the changes occurring in the original field emitted. Different proximity sensors are available in market for various material detection. This project uses Dolphin India M30 inductive proximity sensor having sensing range of 30mm to detect the metal in the coal. It is used for the purpose of any metal object is present in the conveyor belt. Controller takes required action if sensor detects any metallic parts.
C. IR sensor

A Infra-Red sensor (IR sensor) is an electronic device that can detect motion by receiving infrared radiation. The detection distance range is 2 to 30 cm. Its operating voltage range is 3-5V DC. This project uses it to monitor the coal storage level. If it energizes, the conveyor motor is switched off due to overflow of the boiler.

D. Electromagnet

It is a magnet in which magnetic field is created by the flow of electric current. The magnetic field disappears when the current stops. Electromagnets avail the advantages of controlled holding power and on command release. Through the application of controlled DC electrical current, an electromagnet has the ability to attract and hold ferrous materials with varying degrees of forces, and to release the item as required. Electromagnets are used for the removal of metallic impurities from the coal. The metal is detected by inductive proximity sensor and controller energize the electromagnet and it attracts the metal particles in the coal conveyor belt.

E. DC Motor

This project uses 100 RPM Johnson DC motor with a torque of 10 kg/cm. The DC motor controls the conveyor belt operations and when the coal is loaded, it rotates continuously. If the coal storage is fully loaded, IR sensor gets turned ON and DC motor is turned OFF.

F. Conveyor Belt

The sensors and other electronic system are attached to the conveyor. The conveyor belt takes the objects to the Pneumatic piston, where the objects are separated and the sensing and sorting operations are done simultaneously. The DC motor is controls the conveyor belt operation.

VI. SOFTWARE DESCRIPTION

A. PLC Software

This project uses CX PROGRAMMER FOR CP1E for OMRON type PLC software. It can create, save, simulate, document and transfer circuit diagrams to OMRON controller. Built in simulation capabilities are used to test the validity of the program. It offers additional functionality and programming ease for picoGFX controller. For higher models RSLogix is used as a programming software.

B. Ladder Diagram

Ladder logic is a graphical programming language. Ladder logic can be thought of as a rule-based language rather than procedural language. A rung in a ladder represents a rule, when implemented in PLC, the rules are typically executed sequentially by software in continues loop (scan). Ladder logic has contact that makes or breaks circuit to control coils. The coils may represent a physical output which operates some devices connected to PLC. Ladder program processes inputs at the beginning of a scan and output at the end of the scan. Each rung on ladder diagram represents an operation on control process. The processor scans the ladder program and evaluates the logical continuity of each rung referring the input condition. If the input conditions are met then output will turn on (1) and if condition are not met then output will turn off (0).
C. SCADA

SCADA (Supervisory Control And Data Acquisition) is a monitoring system that communicates and operates over special communication channel. SCADA is the technology that enables a user to collect data from one or more distance facilities and send limited control instruction to these facilities. It allows operator in centrally wide distributed area such as an oil or gas field area to operate the valves switches from single control room. SCADA system is accompanied with master terminal units and remote terminal units and proper communication channel. The master terminal unit presents the data to the operator by collecting the data from the remote terminal units located at the remote site over a communication channel.

The WONDERWARE INTOUCH SCADA software used for Simulation Purposes and it simulates on the coding of WINDOW SCRIPT running the process.

VII. CONCLUSION

Thus, with the adaption of modern PLC technology the coal level in the storage tanks can be well controlled by the PLC without introducing the external human errors. The main objective behind the project is to avoid the use of human workforce in the hazardous remote field and hence though the project model is designed keeping in mind about the need for mining area and thermal power plant, the use of this technology can also be extended for implementing in the other process industries and further research application as well.

VIII. APPLICATION

Many other Mechanical, Production industries also requires conveyor system which should be strong enough to carry maximum load at low power. Cutting and crushing machines by using PLC, works faster than earlier ones. Also, complex coding system and tedious relay wiring have been overcome by ladder logic diagram. Piping Industries, Water Purification Industries have huge use of this system in their business.

IX. REFERENCES


