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Adoption of Encoder with PLC based System for Stock Level Indication and Control of Blast Furnace

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Abstract-- This paper represents the design of a model based on Encoder and PLC to control the stock level (SL) indication system of a Blast Furnace. In blast furnace the screened raw material is taken in and stored at upper level and simultaneously hot metal production is taking place at its lower level. To know the storage level (range) of raw material in the blast furnace stock level indicators are used. The Cam-limit switches of Drive system consist of levels to indicate ranges in blast furnace. As cam-limit switches are old and inaccurate in operation they are replaced by the advance technology equipments encoder and PLC.

Index Terms-- Encoder, programming logic controller (PLC), counter weight, Limiting switches, Blast Furnace (BF), Stock level (SL) indicators.

1 INTRODUCTION

The Paper is to design and develop the "Adoption of Encoder and PLC based system for stock level indication and control of Blast Furnace". The purpose of this project is adopting the encoder system where this system can control SL (stock level) system by using PLC as a controller. This project is combination of Encoder, PLC and 4digit seven segment display.

The blast Furnace itself is controlled by a power process control PLC which controls all the equipment including the stock level indicator. The stock level indicator is critical equipment for sensing the position of raw material inside the blast furnace.

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Then process PLC takes signal from rotary cam type limit switches to sense position, indicate the position on the computer and adjust speed reference accordingly. This project envisages an upgraded, more accurate and less maintenance intensive system compared to the existing rotary cam switch position sensor. The concept is to utilize another smaller programmable controller to work as pulse computer analog signal driver to augment the main process control PLC.

A programmable logic controller, commonly known as PLC, is a solid state, digital, industrial computer. Applications of PLCs in automation are in the field of sequence control, motion control, process control, data management, and communication. Majority of the PLC applications are still utilized in machine control, material handling, sequence control applications; however power PLCs have been developed to control large processes [1]. Apart from performing basic functions like sequential operation, timing and counting, PLCs can perform arithmetic operations. PLCs can provide information on alarm limit detection, alarm messages, machine malfunction, production summary, machine status, etc [2].

Encoder delivers a defined number of electrical pulses for each rotation, which represent the measurement of the distance or angle moved. Encoders are available with a choice of outputs. Incremental encoders generate a series of pulses as they move [3]. These pulses can be used to measure speed, or be fed to a counter to keep track of position. Absolute encoders generate multi-bit digital words that indicate actual position directly.

The mechanical part of the project consists of mechanical drawing, measuring while electrical part consists of electrical wiring, electrical equipments, layouts and programming. The software S7-200 (STEP SEVEN) Micro/WIN used in programming to fulfill the objective of this project.

2. METHODOLOGY

The methodology of the project is characterized in to two sections:

1. Present working principle of SL(stock level) system
2. Adoption(Implementation) of Encoder and PLC based method to present SL system

Adoption of Encoder and PLC based method further classified into two parts:

a. Hardware Design
b. Software Design

Hardware Design consists of:

i) Stock level indication panel
ii) PLC System

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iii) Relays
iv) Timer
v) RS-232 to USB converter cable
vi) Power supply

Software Design consists of:
i) PLC programming through S7-200
ii) Micro-win software

2.1 Present operation of SL system:

Presently VISL plant has got a capacity of 530cu.M. blast furnace [4]. The rated output is 750tonnes of hot metal at 350tonnes hot metal per day. The blast furnace has three stoves that are fire brick lined steel shells. At the bottom of the furnace Blasts of air injected through nozzles, called tuyers. Raw materials required for production are carried from locos (train) through conveyer to the raw material houses called screen house I and II where raw materials are screened [5]. To know the level of raw material in blast furnace stock level indicator SLI1 and SLI2, counter weight are used. The counter weight is connected to gear system through rope. Gear system and stock level indicator is operated by DC motor [6]. Each SL has 16 limiting switches, each switch indicate particular position (range) of counter weight of Blast furnace. The counter weight is operated up to 4m to measure the level of raw materials. During operation normally the park of counter weight is maintained between 1 and 2m for good results. As the raw materials in the Blast furnace reduces, the counter weight moves downwards (descends) until it touches charges. Simultaneously this park position is indicated by the particular limiting switch. This process is continued until counter weight reaches the predefined position.

3. HARDWARE DESIGNS

Hardware Design consists of:
i) Stock level indication panel
ii) PLC System
iii) Relays
iv) Timer
v) Encoder
vi) RS-232 cable
vii) Power supply

4. SOFTWARE DESIGN

In PLC programming in order to change or create a program, the following items are needed:
- PLC-S7-200
- Programming Device- Personal Computer
- Programming Software-Step 7 –micro /WIN
- Connector Cable-RS-232(PC/PPI cable) [PPI-Point to Point interface]

5. FLOW CHART

The flow chart of SL (stock level) system shown in fig 1.Before programming the PLC the control supply status is checked. The PLC program is allowed to run mode for counter action of the PLC system. The counter weight is set to defined value to charge the raw materials. Each position entered by the counter weight is recorded until it reaches the predefined value. When it encounters the defined value the counter weight moved to park position to charge raw materials in to Blast Furnace again.

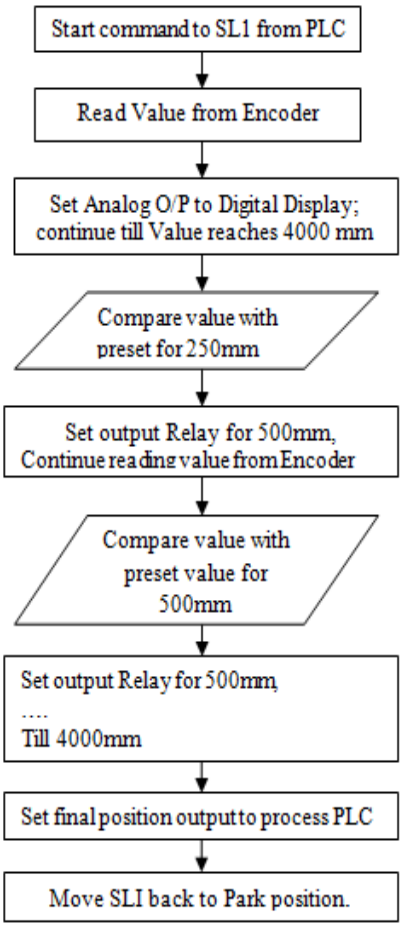

Fig 1: Flow chart of stock level system

6. RESULTS

The counting taken by the Encoder with respect to PLC program for each SL indication points is listed in table 1.

TABLE 1

SL INDICATION POINTS	COUNTS
0.5m	790
0.75m	1185
1.0m	1580
1.25m	1975
1.5m	2370
1.75m	2765
2.0m	3160
2.5m	3950
3m	4740
4m	6320

Here the PLC program is developed for 4m inward movement of counter weight in the blast furnace. For example when the counter weight is at 0.5m in the blast furnace, the number of pulses developed by the encoder with respect to PLC is 790 and this value indicated in the programming device by activating the allotted relay. In this way when counter weight descends continuously by passing each predefined position of the blast furnace, in turn the encoder develops counts by activating the particular relay.

7. CONCLUSION

This paper involves the Encoder and S7-200 PLC to control a SL system. Position control and maintenance of counter weight is achieved and the operation is very reliable, sufficiently high efficient. The basic functional controls of the SL system have been reached through encoder with a high accuracy. In case of malfunction the counter weight can be easily handled through PLC. The maintenance of SL system is very easy when compared to present system. A hardware design for input/output has been developed and Checked for different status of the SL system.

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