AUTOMATION OF MILL LUBRICATION SYSTEM USING PROGRAMMABLE LOGIC CONTROLLER

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1. Introduction

To study the complete operation of the mill and the lubrication oil system developed by the PLC program and during the programming phase, the difficulties are raised due to the presence of interdependent logics and conditions which were able to overcome successfully. The simulation a Trainer panel and implemented the program logic and tested it in the Ge Fanuc VersaPro (Version 2.0)

Keywords: Mill and lubrication oil system, PLC, Ge Fanuc Versa Pro.

System Description

The system description consists of External conveyor System Internal conveyor system shown in figure 1.1 & 1.2 respectively.

External Conveyor System

The External conveyor System is used to receive Lignite from Mine I through G7/R5 conveyor and storing it at RCC bunker and it is having the following.

- 11A,11B conveyors,
- RSC 1A, 1B Conveyors,
- Metal Detectors 1A, 1B,
- Magnetic Separators 1A, 1B,
- Dust Extraction System (DE2),
- Dust Suppression System (DSS),
- RCC Bunker and
The Internal conveyor System is used to transfer the Lignite from RCC Bunker to Boiler Bunker through equipments.

1) Paddle Feeder 1A, 2A, 1B, 2B
2) Dust Extraction-1 for Paddle Feeders.
3) 12A, 12B Conveyor & its Belt Scraper.
4) Magnetic Separator 2A, 2B in 12A, 12B Conveyor
5) Metal Detector 2A, 2B in 12A, 12B Conveyor
6) RC 1A, 1B Conveyors.
7) RFC 1A, 1B Conveyors
8) Screen A & Screen B
9) Crusher A & B
10) USC 2A, 2B and its Scraper Chain.
11) Dust Extraction System (3)
12) 13A, 13B Conveyor and its Belt Scappers.
13) Magnetic Separator 3A / 3B in 13A, 13B Conveyor
14) Metal Detector 3A / 3B in 13A, 13B Conveyor
15) SC 1A / 1B Conveyor
16) 14A / 14B – Conveyor.
17) RSC 3A / 3B Conveyor
19) Dust Suppression System (DSS).
20) Various hoists (both Electrical & Mechanical)

Fig: 1.1 External Conveyor Systems.
Different Modes of Separation

The automatic lignite handling system control architecture is described as below:

Two streams are provided as given below:

- External system: Group-I Conveyor 11A/11B and RSC1A/RSC1B.
- Internal system: Group-II Paddle feeder 1A/1B, 2A/2B up to Boiler bunker.

The system can be operated in four modes of operation using Selector Switch provided in control desk.

1. Local mode.
2. Remote manual mode.
3. Auto computer mode- SCADA.
4. Auto route matrix mode.

2. Components of LHS

Dust Extraction System

Dust extraction system is provided for the dust generating points like crusher, screen, boiler bunker, conveyor transfer points etc, and to control fugitive dust generation in the work zone. The dust laden air is sucked from the dust generating points through hoods and duct work and collected in the pulse jet bag filter. The dust collected in the bag filter is discharged to the nearby conveyor. And the clean air is let out to atmosphere through stack.

The DE system is provided for the following:
1. DE1 at each Paddle feeder.
2. DE2 at top ground bunker.
3. DE3 at crusher/screen house.
4. DE4 at junction tour JT1.
5. DE5 at boiler bunkers.

3. Equipments Required For Running the Conveyor

Each conveyor is equipped with the following switches for monitoring and protecting the equipment. These inputs were incorporated in the protection logic of the equipment and stop or trip the equipment.

- Zero speed switch: Monitoring the belt slip at tail end.
- Belt sway switch: Monitoring the belt swing.
- Chute Jam detector.
- Pull cord switch.
- Emergency stop switch.
- Local mode and remote mode selector.
- Conveyor motor ON feedback.

System Architecture

The PLC based control system is designed based on Allen Bradley state-of-the-art and latest PLC-5 Control Net processor (1785-L80c15). The Control Net network is a high speed, deterministic network used between PLC to I/O devices.

There are two redundant main PLC-5 Control Net processors housed in a separate I/O rack with power supply and both of them are connected through a Control Net network. Each unit is considered as node in a Control Net network. The required number of I/O modules is housed in an I/O rack and it is connected to the control net bus. Each I/O rack is considered as a node and main processor collects the I/O data through control net bus from I/O processor (1771-ACNR).

The above PLCs and I/O racks are enclosed in different panels located in the control room.

4. AIM and SCOPE of Present Investigation

The Overall View of Mill is shown in Figure 4.1
Disadvantages of Present System

The disadvantages of the present system for the control and operation of the mill lubrication oil system which make the implementation of this project beneficial are as follows.

1) The system is very complex as it requires the implementation of hard wired relay circuits to perform the logic.
2) The Pump selection cannot be done in Remote mode. There is a switch present in the local panel to select the main pump as P1 or P2.
3) Only the feedback of whether the system is working and the pump is running is available. But the status of which pump is running, which is the main pump, etc are not available.
   - Similarly the warning and trip signals are only given to the controller’s desk but the cause of the warning or trip situation is not given.
   - In case of any change the relay wiring has to be changed which is a tedious process
   - Reliability is less since the whole logic is dependent on the contact of relays.

Problems

Mill has some problems for the free flow of oil. The existing system gives 40% good results. These problems and their consequences were studied and listed in detail as below.
Manual Operation of Mill

Now the mill is operated manually whenever the oil supply is stopped. When the flow of oil rate is found to be low, when the system is tripped pump changeover is done manually by pressing the pushbutton switch. This has to be done in all the time when the system is tripped since the time of system trip can’t be determined. Also, it requires manpower in addition to the existing workforce.

5. Suggestion for Improvement of System

Mill lubrication can be done automatically using PLC programming. Another option is by checking the rate of flow of oil in oil filter (ΔF). If the ΔF is maximum, the pump has less oil feed rate. Therefore, the specific pump is stopped. Hence the corresponding alternative pump can be started using PLC programming.

Programmable Logic Controllers

![Image of PLC](image)

Fig: 5.1 Overall View of PLC.

6. Results and Discussion

Logic Diagram of Mill Lubrication

![Image of Logic Diagram](image)

Fig: 6.1 System Start/Stop.
Fig: 6.2 Pump P1 On.

Fig: 6.3 Pump P1 Off.

Fig: 6.4 Pump P2 On.
Fig: 6.5 Pump P2 Off.

Fig: 6.6 Pump Change Over.

Fig: 6.7 Alarms.
Input and Output of Lubrication Oil

Table 6.1: Inputs

<table>
<thead>
<tr>
<th>Input</th>
<th>Input Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local / Remote</td>
<td>I00001</td>
</tr>
<tr>
<td>P1 ON Push Button</td>
<td>I00002</td>
</tr>
<tr>
<td>Remote Start</td>
<td>I00003</td>
</tr>
<tr>
<td>Tank Level Low</td>
<td>I00004</td>
</tr>
<tr>
<td>P1/P2 Selected</td>
<td>I00005</td>
</tr>
<tr>
<td>Stop</td>
<td>I00006</td>
</tr>
<tr>
<td>P2 ON Push Button</td>
<td>I00007</td>
</tr>
<tr>
<td>Pressure &lt; 0.7 Pnom</td>
<td>I00008</td>
</tr>
<tr>
<td>P1 ON Feedback</td>
<td>I00009</td>
</tr>
<tr>
<td>P2 ON Feedback</td>
<td>I00010</td>
</tr>
<tr>
<td>Temp of the Oil after Cooler</td>
<td>I00011</td>
</tr>
<tr>
<td>Differential Pressure &lt; 4 bar</td>
<td>I00012</td>
</tr>
<tr>
<td>Oil Level Low in JB/ TB</td>
<td>I00013</td>
</tr>
</tbody>
</table>

Table: 6.2 Inputs

<table>
<thead>
<tr>
<th>Output</th>
<th>Output Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump 1 Start/Stop</td>
<td>Q00002</td>
</tr>
<tr>
<td>Pump 2 Start/Stop</td>
<td>Q00003</td>
</tr>
<tr>
<td>Warning Signal to Control Desk</td>
<td>Q00004</td>
</tr>
<tr>
<td>Trip Signal to Control Desk</td>
<td>Q00005</td>
</tr>
</tbody>
</table>
Ladder logic diagram

P1 on start/stop

Fig: 6.9 P1 Start/Stop

P2 ON Start/Stop

Fig: 6.10 P2 Start/Stop

Pump Change Over

Fig: 6.11 Pump Change Over

Level Sensing

Fig: 6.12 Level Sensing
PRESSURE SENSING

Fig: 6.13 Pressure Sensing

Temperature Sensing

Fig: 6.14 Temperature Sensing

Warning and Trip

Fig: 6.15 Warning and Signal

7. Conclusion & Advantages:

The complete operation of the mill and the lubrication oil system is studied and developed using the PLC program. The simulation of the process is done using a Trainer panel and implemented in the program logic and tested it in the Ge Fanuc Versa Pro (Version 2.00) PLC.

The advantages of the work is

- The pump selection can be done in remote operating mode also.
• The status of which pump is working is available in the controller's desk.

• The cause for the trip and warning signals is specific, with the help of individual indications for each warning.

• Because of the manifestation of PLC, any changes can be made in the logic easily.

• Trouble shooting is made easier with the help of fault indications.

• The complexity of the system is reduced because of the replacement of hard wiring by PLC to implement the logic.

• The reliability of the system is also enhanced due to the use of PLC.

References

1. Jianfeng Lu ; Yunjun Mu , Shuogong Zhang ,Online PLC monitoring and network administering system for steel tube mill, Proceedings of the IEEE International Conference, Page(s):720 – 723.


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