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Dust Extraction and Suppression in Lignite Handling System Using Programmable Logic Controller

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ABSTRACT

The research work is "Dust extraction and suppression in lhs using plc". It deals with the automation of the entire Lignite Handling System in Thermal Power Station-I expansion, Neyveli. The current trend in the TS-I expansion LHS involves manual supervision of the entire dust extraction and suppression system. The manual extraction process involves the operator to be present at the locality of the extraction system machinery. This can be a very cumbersome job for the operator and also any carelessness from the operator's part can lead to disaster. To minimize such problems, a fully automated dust extraction system is proposed. In the LHS, the lignite from the mines is processed through the LIG.CON.10 and Slew conveyers to the over ground storage bunker house. Here, the dust from the processing chambers till the previous stage of the bunker is extracted and suppressed

Keywords: Automation, Conveyer belt, PLC, Mines

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INTRODUCTION

Neyveli, home of Neyveli Lignite Corporation Limited is today India's Energy Bridge to the 21st century and fulfillment of PANDIT NEHRU'S vision. Neyveli Lignite Corporation was registered as a company on 14th Nov 1956. The mining operation in Mine-I was formally inaugurated on 20th May 1957 by Prime Minister Pandit Jawaharlal Nehru. It is a symbol of indo-soviet co-operation in the field of economy and technology.
Neyveli Thermal Power Stations are South Asia's first and only lignite fired Thermal Power Stations and also the first pit-head power stations in India. Today NLC Power Stations are generating about 2490 MW of Power. NLC's Power Stations are maintaining very high level Plant Load Factor (PLF) when compared to the National average. NLC is registered as one of the best profit making public sector industries with a net profit around 1000 crosses per annum.

EXPOSED SYSTEM

The current trend in the ts-1 expansion lhs involves manual supervision of the entire dust extraction and suppression system. The manual extraction process involves the operator to be present at the locality of the extraction system machinery. This can be a very cumbersome job for the operator and also any carelessness from the operator's part can lead to disaster.

DISADVANTAGES OF EXISTING SYSTEM

- Cross section of conveyor belts.
- Harmful to the human.

PROPOSED SYSTEM

To overcome huge disasters and safety health to human and avoid the wastage of lignite material, the dust from processing chambers till the previous stage of the bunkers is extracted and suppressed using plc

ADVANTAGES OF PROPOSED SYSTEM

- Health and safety to the workers.
- To overcome the wastage of lignite material by recycling.

PROGRAMMABLE LOGIC CONTROLLERS

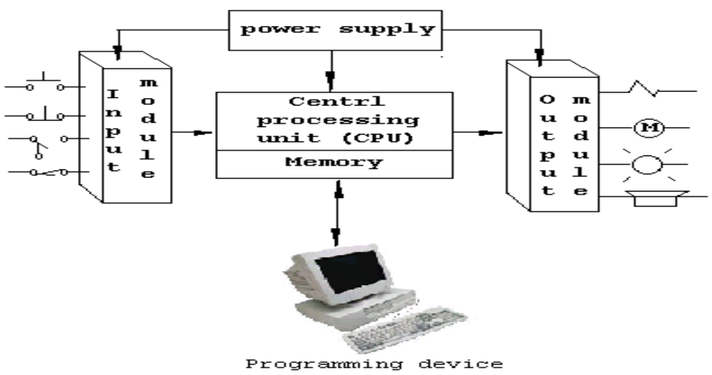


Fig (1) Block diagram of PLC

A programmable logic controller (PLC) is a solid-state device designed to perform logic functions previously accomplished by electromechanical relays. Programmable logic controllers are used for the control and operation of a manufacturing process equipment and machinery. As shown in fig (1) The programmable logic controller is basically a computer designed for use in machine control. Unlike a computer it has been designed to operate in the industrial environment and is equipped with special input / output interfaces and a control programming language.

FUNCTIONAL UNITS OF PLC

The basic components of PLC are

- Central processing units
- Input / Output (I/O) section.
- Power Supply
- Programming device

Parts of PLC

Architecture

The power supply supplies dc power to other modules that plug into the rack. For large PLC systems this power supply does not normally supply power to the field devices. With Larger systems power to field devices is provided by external alternating current (ac) or direct current (dc) supplies. For small and micro PLC systems, the power supply is used to power field devices.

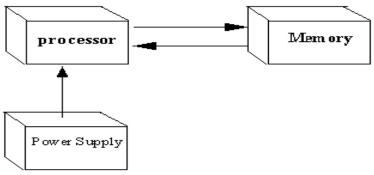


Fig (2) Architecture of PLC

Central processing unit

The CPU houses the processor-memory module(s), communications circuitry, and power supply. The power supply may be located inside the CPU enclosure or may be a separate unit mounted next to the enclosure. As shown in fig (2) Depending upon the type of memory, volatile or nonvolatile, the power supply could also include a backup battery system. The CPU executes the turns on the appropriate outputs.

Associated with the processor unit will be a number of status LED indicators to provide system diagnostic information to the operator. Also a key switch may be provided that allows you to select one of the following three modes of operation (otherwise these modes must be accessed from the programming device): RUN, PROG, and REM.

RUN Position:

- Place the processor in the Run mode
- Executes the ladder program and energizes output devices.
- Prevents us from performing online program editing in this position.
- Prevents us from using a programmer / operator interface device mode

PROG Position:

- Place the processor in the Program mode
- Prevents the processor from scanning or executing the ladder program, and the controller outputs are de-energized
- Allows us to perform program entry and editing

- Prevents us from using programmer / operator interface device to change the processor mode

REM Position:

- Place the processor in the Remote mode: either the Remote Run, Remote Program, or Remote Test mode
- Allows us to change the processor mode from a programmer / operator interface device
- Allows us to perform online program editing.
- The processor module also contains circuitry to communicate with the Programming device.

Input / Output section:

The I/O section consists of an I/O rack and individual I/O modules. Input interface modules accept signals from the machine or process devices and convert them into signals that can be used by the controller. Output interface modules convert controller signals into external signals used to control the machine or process.

The I/O System provides an interface between the hard-wired components in the Field and the CPU.A chassis is a physical hardware assembly that houses devices such as I/O modules, Processor modules and power supplies. A logical rock is an addressable unit consisting of input points and output points. A rack uses 8 words in the output image table file and its corresponding word in the input image label file are called an I/O group. A rack can contain a maximum of 8 I/O groups (numbered from 0 through 7) for up to 128 discrete I/O.

Discrete I/O modules

The most common type of I/O interface module is the discrete type. This type of interface connects field input devices of the ON/OFF nature such as selector switches, pushbuttons, and limit switches. Output control is limited to devices such as lights, small meters, solenoids, and motor starters that require simple ON/OFF switching.

Analog I/O modules

Analog input interface modules contain the circuitry necessary to accept analog voltage or current signals from analog field devices. These inputs are converted from an analog to a digital value by an analog-to-digital (A/D) converter circuit. The conversion value, which is proportional to the analog signal, is expressed as a 12-bit binary or as a 3-digit binary-coded decimal (BCD) for use by the processor. Analog input sensing devices include temperature, light, speed, pressure, and position transducers.

Power supply

The power supply supplies dc power to other modules that plug into the rack. For large PLC systems, this power supply does not normally supply power to the field devices. With larger systems, power to field devices is provided by external alternating current (ac) or direct current (dc) supplies. For small and micro PLC systems, the power supply is used to power field device.

Programming devices

The programming device provides the primary means by which the user can communicate with the circuits of the controller. The programming unit can be a liquid crystal display (LCD) hand-held terminal, a single-line LED display unit, or a keyboard and video display unit. The programming unit communicates with the processor via a serial or parallel data communications link.

The programming device allows the user to enter, change, or monitor a PLC controller program. A personal computer is currently the most commonly used programming device.

A computer can program any brand of PLC that has software available for it. This makes it possible to carry out the programming away from the programmable controller. When the program is complete, it is saved to some form of mass storage and downloaded to the programmable controller when required.

Advantages of PLC over pc:

The PLC is designed to operate in the industrial environment with wide range of ambient temperature and humidity. The hardware and software of PLCs are designed for easy use by plant electricians and technicians. The PLC comes in programmed relay ladder logic or other easily learned languages. The PLC comes with its program language built into its permanent memory whereas a personal computer requires a disk operating system (DOS).Troubleshooting is simplified by the design of most PLCs because they include fault indicators and written fault information displayed on the programmer screen. The modular interfaces for connecting the field devices are actually a part of the PLC and are easily connected and replaced.

LIGNITE HANDLING SYSTEM

Lignite is received outside plant boundary through mine feed-in conveyor LIG.CON.10 and Slew conveyor. This can feed the lignite either to conveyor no:11A or 11B.The lignite received on conveyor 11A or 11B conveyed to over ground storage bunker house and distributed in it through reversible shuttle conveyor RSC1A or RSC1B. The bunker house of RCC construction of continuous length slotted opening. The bunker has storage capacity of 10,000 tons of lignite, with thirteen slotted bunkers installed with one level switch in each slotted bunker. Two numbers of belt weighing scales BS-1A and BS-1B installed on conveyors 11A and 11B measure the quantity of lignite received from the mines. Two numbers of inline over band magnetic separator MS1A and MS1B are installed on conveyor 11A and 11B at head end to separate tramp iron pieces. Paddle feeders reclaim lignite from over ground storage bunkers. Two numbers of paddle feeders have been provided on each side of the slotted bunkers. Paddle feeders PF1A and PF2A feed to conveyor 12A and Paddle feeders PF1B and PF2B are feeding to conveyor 12BSimilarly RC1B receives lignite from conveyor 12B which in turn discharges lignite on to reversible feeder conveyor RFC1A or RFC1B for feeding to either screen 1B /Crusher 1B or directly on unidirectional shuttle conveyors USC2B.The under size from the screen SR1A and the crushed lignite from CR1A is fed to Unidirectional shuttle conveyor USC2A. Whereas the under size from screen SR1B and crushed lignite from CR1B is fed to unidirectional shuttle conveyor 2B. The USC2A and USC2B feed the crushed/screened lignite either to conveyor 13A or 13B. Two numbers of Weighing scales, BS2A and BS2B installed on conveyor 13A and 13B measure rate and the quantity of lignite supplied to boiler bunkers. Two number over band magnetic separators MS3A and MS3B are installed on conveyor 13A and 13B.A bypass to crusher and screen has been provided in each circuit. In this case it is possible to feed conveyor USC2A and USC2B directly from reversible feeder conveyor RFC1A and RFC1B respectively.

DUST EXTRACTION

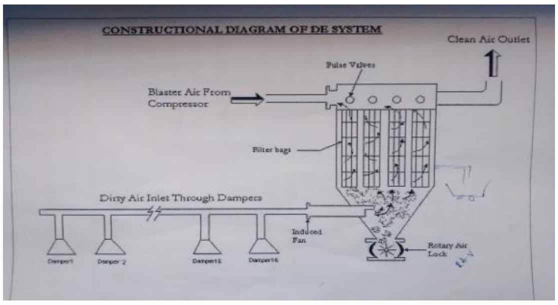
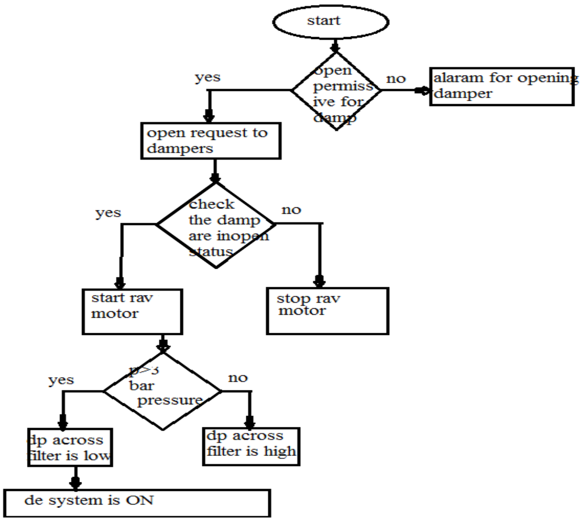


Fig (3) Block diagram of Dust Extraction

Dust extraction system is provided for the dust generating points like crusher, screen, Boiler bunker, Conveyor transfer points etc., 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 as shown above the fig (3) and the clean air is let out to atmosphere through stack.

FLOW CHART



The cleaning of Filter bags carried out automatically and in a sequential manner, there are four main components involved in effective cleaning.

- Sequential controller.
- Solenoid valve
- Pulse valve.
- Compressed air piping and venture
- Induced fan.
- Rotary air valve.

The cleaning of the bags is done with the help of a solid state electric programmed sequential controller. The programmed sequence controller gives signal based on fixed time basis, which actuates the solenoid valve, which intern opens the pulse valve. The blast of compressed air is admitted at the top of the bag through a compressed air pipe and venture. This is followed by the OFFTIME after which the second row is cleaned with a pulse a pulse of compressed air. The operation is repeated till all the rows are cleaned. The time during which the pulse is operated is generally called pulse duration or ONTIME. The off time is the time between two consecutive ON time, known as pulse frequency.

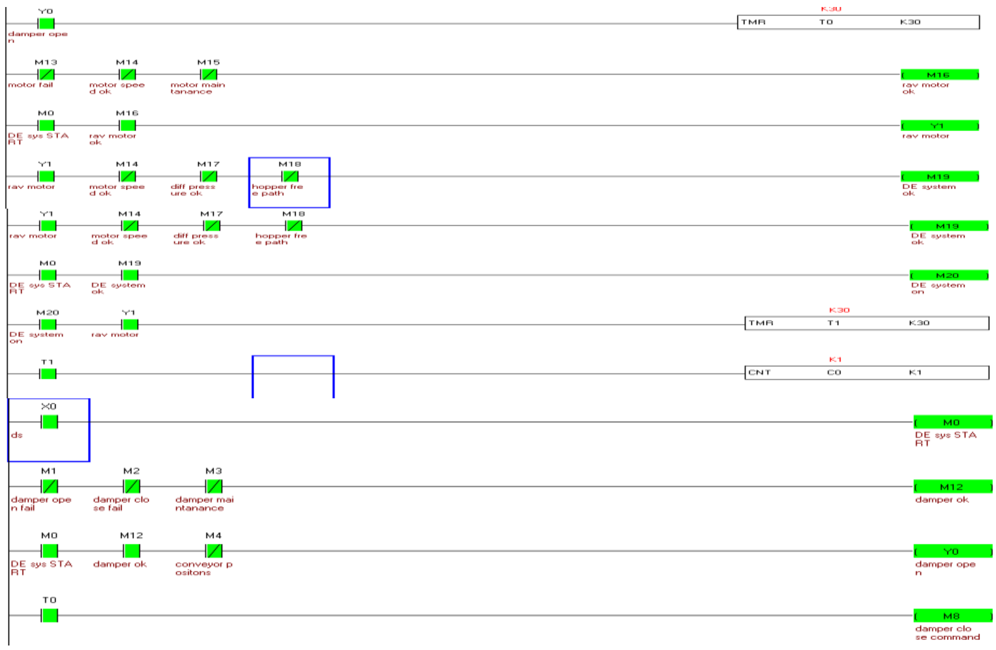
TYPES OF BAG FILTERS

In an industrial system of gas cleaning using bag filters the fabric is made into either an envelope or a tube. These envelopes or tubes are called FILTER ELEMENTS of a bag filter or bag house.

Bag filters can be classified into 3 types

- **Shaker Type**
- **Pulse Jet**
- **Reverse Type**

Ladder diagram for dust extraction system



Step 1: Check input status

First the PLC takes a look at each input to determine if it is ON or OFF.

Step 2: Execute program

Next the PLC executes one instruction at a time. If the first input is on, it should turn on the first output. Based on the status of the input it will store the execution results for later use during the next step.

Step 3: Update Output states

Finally the PLC updates the status of outputs. It updates the outputs based on which inputs were ON during the first step and the results of executing program during the second step. For example it would turn ON the first output when the first input was ON and program lay to turn ON the first output when this condition is true. After the third step the PLC goes back to step 1 and repeats the steps continuously. Scan time is defined as the time it takes to execute the steps listed above. The input should be ON for at least one input delay time + one scan time

DUST SUPPRESSION

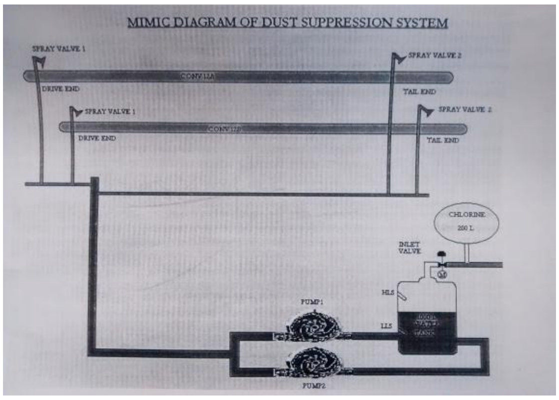


Fig (4) Block diagram of dust suppression

If the selector switch is in remote, the pump will start in auto if all the following conditions.

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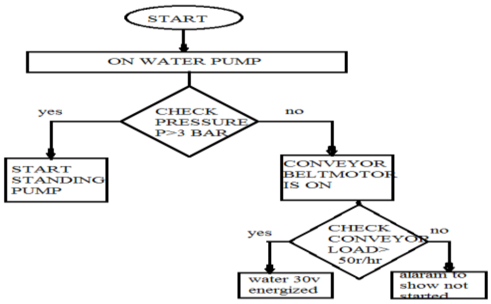

- SP1A is selected as the operating pump/SP1B in standby.
- Level in water tank is above the permissible level as sensed by permissible level switch.
- Over load has not acted on the pump motor.

Pump will trip automatically if any one of the following conditions is satisfied:

- Over load acted.
- Water tank level is very low.
- System stop push button pressed.
- Emergency push button operated.

The given fig (4) will be shown. The solenoid valves on the spray lines opens if the corresponding conveyor is running and loaded (under belt switch acted) and Closes if the corresponding conveyor is not loaded or not running.

Ladder diagram for dust suppression system

Hardware kit for dust extraction and suppression system

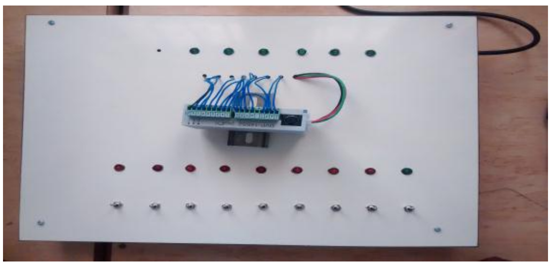

Fig (5) In stop condition

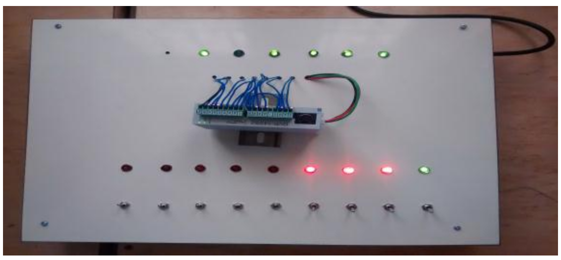

Fig (6) Run condition

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CONCLUSION

Ladder programming is user friendly and supports online editing and loading. We learned about the existing dust extraction and suppression system of LHS and developed an automated PLC program for it. PLC provides the following advantages.

Flexibility: One single Programmable Logic Controller can easily run many machines.

Correcting Errors: In old days, with wired relay-type panels, any program alterations required time for rewiring of panels and devices. With PLC control any change in circuit design or sequence is as simple as retyping the logic. Correcting errors in PLC is extremely short and cost effective.

Space Efficient: Today's Programmable Logic Control memory is getting bigger and bigger this means that we can generate more and more contacts, coils, timers, sequencers, counters and so on. We can have thousands of contact timers and counters in a single PLC.

Low Cost: Prices of Programmable Logic Controllers vary from few hundreds to few thousands. This is nothing compared to the prices of the contact and coils and timers that you would pay to match the same things. Add to that the installation cost, the shipping cost and so on.

Testing: 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.

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