Coal Conveyor Belt Fault Detection and Control in Thermal power plant using PLC and SCADA

R.Keerthika, M.Jagadeeswari

Abstract— **Conveyors are seen virtually in the Coal Handling Plant (CHP). CHP are having number of conveyors. The control systems used for these conveyors are important for operating safe plant. In order to ensure the belt conveyor operation safe and reliable, centralized monitoring and control is necessary. The main objective of this proposed system is to monitor and detect the fault occurring in the coal conveyor belt using PLC and SCADA. Faults such as belt tear up fault, overloading fault and moisture content fault in the coal conveyor belt are not identified properly and thus leading to serious damage to the conveyor belt in Thermal Power Plant. In order to avoid this type of faults, different types of sensors are used in the operation of PLC and SCADA to provide proper protection for the coal conveyor belt. Manual control at present is more disadvantageous which leads to frequent tear up, in order to reduce these tear up and for increasing further enhancements, automation is used. In this proposed automation system all parameters are processed, controlled, and monitored with the help of DELTA PLC and SCADA WONDERWARE INTOUCH. SCADA is a centralized system used to supervise a complete plant and basically consists of data accessing features and controlling processes remotely.**

Index Terms— **Coal conveyor, Delta PLC (Programmable Logic Controller), SCADA (Supervisory Control and Data Acquisition system) Wonderware Intouch.**

I. INTRODUCTION

A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). Belt conveyor is the most economical and efficient material handling equipment which can be implemented in the thermal power plant for coal handling. Belt conveyors [1] are the most commonly used powered conveyors because they are the most versatile and the least expensive. Product is conveyed directly on the belt so both regular and irregular shaped objects, large or small, light and heavy, can be transported successfully. These conveyors should use only the highest quality premium belting products, which reduces belt stretch and results in less maintenance for tension adjustments.

Belt conveyors can be used to transport product in a straight line or through changes in elevation or direction. In certain applications they can also be used for static accumulation. It is used widely in industries such as the electro-mechanical assembly, food manufacturing, coal mining, etc. Belt conveyor is an preferred transfer system in industries compared to the robotic arm and pneumatic or hydraulic pick and place system because of its simple design, light weight, cost effective, requires less maintenance and the potential to achieve high efficiency. It is considered a labor saving system that allows large volumes to move rapidly through a process, allowing companies to ship or receive higher volumes with smaller storage space and with less labor expense. Rubber conveyor belts are used to convey items with irregular bottom surfaces, small items that would fall in between rollers (e.g. a sushi conveyor bar), or bags of product that would sag between rollers. Belt conveyors are generally fairly similar in construction consisting of a metal frame with rollers at either end of a flat metal bed. The belt is looped around each of the rollers and when one of the rollers is powered (by an electrical motor) the belting slides [4] across the solid metal frame bed, moving the product. In heavy use applications the beds which the belting is pulled over are replaced with rollers. The rollers allow weight to be conveyed as they reduce the amount of friction generated from the heavier loading on the belting. Belt conveyors can now be manufactured with curved sections which use tapered rollers and curved belting to convey products around a corner.

Belt conveyor, especially that of long distance, high power, and high belt speed, is one the most important transportation facilities in the production of coal. Commonly thermal power plants uses coal as the main source i.e. fuel for generating power. Raw coal is transported from coal mines to a power station site by trucks, barges, bulk cargo ships or railway cars. Generally, when shipped by railways, the coal cars are sent as a full train of cars. The coal received at site may be of different sizes [3]. The railway cars are unloaded at site by rotary dumpers or side tilt dumpers to tip over onto conveyor belts below. The coal is generally conveyed to crushers which crush the coal to about ¾ inch (19 mm) size. First the coal is transported up to the coal storage bunkers through conveyor belts where the raw feed coal from the coal storage area is first crushed into small pieces and then conveyed to the coal feed hoppers. The coal is next pulverized into a very fine powder. The pulverizers may be ball mills, rotating drum grinders, or other types of grinders. Finally crushed powder coal is then taken to the Boiler through coal pipes with the help of hot and cold air mixture.

They are more acceptable than other means of transporting bulk materials; they neither pollute the air nor deafen the ears. And also they operate quietly, often in their own enclosures, which when desirable can be located above the confusion and safety hazards [2] of surface traffic or in small tunnels out of

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sight and hearing. Belt conveyor is one of the main transport equipment in coal mine, driving drum and belt is its key part. Friction principle is used to initiate mechanical drive for belt conveyor. So friction is the driving force. In order to raise transportation efficiency of belt conveyor, driving force of drum must be increased. Energy saving and efficiency, friction, fire and safety, maintenance and inspection are the other key factors of belt conveyor design.

The project mainly tells about the identification of belt conveyor faults by sensing the conveyor by means of using four different types of sensors for (i) identifying the tear up of belt conveyor which can be occurred during overload condition and any other causes, (ii) identifying the moisture content level using humidity sensor, (iii) sensing the temperature level using temperature sensor (iv) identifying the overloading condition using proximity sensor. The automation will strongly enhance the safety, speed and control characteristics of belt conveyor in real time without any time delay. Due to the advent of PLC, automation can be done efficiently to satisfy flexibility, reliability and efficiency of conveyor. A Delta's DVP series programmable logic controllers offer high-speed, stable and highly reliable applications in all kinds of industrial automation machines. In addition to fast logic operation, bountiful instructions and multiple function cards, the cost effective DVP-PLC also supports various communication protocols, connecting Delta's AC motor drive, servo, human machine interface and temperature controller through the industrial network in to a complete "Delta Solution" for all users. For real time monitoring purpose SCADA wonderware intouch is used.

This paper is organized as follows: Section II describes the interlocking concept. Section III explains related work. Section IV deals with the coal handling system in thermal power plant using PLC and SCADA. Section V illustrates the experimental results and finally Section VI deals with conclusion.

II. Interlocking Concept

In thermal power plant the belt conveyor must be installed with a programmed interlocking protection system so that the damage to the belt can be reduced.

A. Interlocking protection to the belt conveyor

In programmed interlocking protection the sequence of startup of each conveyor is fixed, i.e., the last conveyor starts first and then the second last conveyor is started and so on. Similarly programmed interlocking protection provides the sequence of stopping of the belt conveyor, i.e., the first conveyor is stopped first and then the second one is stopped and so on. This is done to avoid the damage of belt due to loaded start-up and from getting extra loaded at the time of uneven start-up.

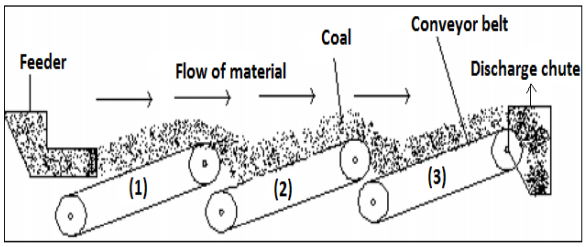

Fig.1. Interlocking Protection in belt Conveyor.

Interlocking protection can be understood from the Fig. 1. As the starting of the belt conveyor is done in the sequence, starting from conveyor 3, then conveyor 2 is started and then at last conveyor 1 is started. Similarly, the stopping of the belt is done in the sequence, first conveyor 1 is stopped, then conveyor 2 is stopped and then at last conveyor 3 is stopped. At the time of fault or at the time of any emergency then all the system is made to stop still and the conveyor with the fault or breakdown is started in counter-clockwise to make it unloaded. And then after rectification of problem the direction of the conveyor is again changed and the conveyor system again works normally according to the programmed interlock protection.

III. Related Work

Belt tear up can be found in belt conveyor after happened in it. It is one of the major disadvantages in present system. Damage occurred in the belt conveyor is identified only by the human working on conveyor. Immediate fault detection in the coal conveyor belt is not possible by the human working over there which this will lead to severe damage to the conveyor. The tear up in the conveyor is identified only by the speed variation. Speed will show variation only when the tear up is big. There is no monitoring system for temperature level, humidity level, belt overloading and belt tear up fault which leads to severe damage to the belt conveyor. In addition this system consumes more power.

IV. Coal Handling System Using Plc And Scada

This system will overcome the drawbacks of existing system by detecting faults using different types of sensors such as proximity sensor, IR sensor, temperature sensor and humidity sensor in the operation of Delta PLC and SCADA Wonderware intouch. In this method the tear up in the conveyor belt is detected using IR sensor, the increase in temperature is automatically detected by temperature sensor, the moisture content is measured by using humidity sensor, overloading of the conveyor belt is detected by proximity sensors, thus with the help of these sensor immediate fault detection is possible, so the damage occurring to the belt conveyor can be avoided. Therefore the proposed system gives the efficient way of automating the belt conveyor using delta series PLC along with SCADA for high accuracy, reliability, low power consumption and fast operation without delay. It consists of software modules to identify the belt conveyor faults.

V. Experimental Results

The experimental results of coal handling system using PLC and SCADA are discussed in this section. In this the

ladder diagram programming is done with Delta WPL Soft and for the real time monitoring purpose SCADA wonderware intouch is used.

A. PLC

Programmable Logic Controller (PLC) is a control system using electronic operations. It is also known as Industrial Computer which is the major component in the industrial automation sector [7]. They were designed for multiple arrangements of digital and analog inputs and outputs, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery backed-up or non-volatile memory. Due to its robust construction, exceptional functional features like PID controllers, sequential control, timers and counters, ease of programming, reliable controlling capabilities and ease of hardware usage. This PLC is more different than various types of PLCs from vast number of manufacturers are available in today's market. Early PLCs were designed to replace relay logic systems. These PLCs were programmed in "ladder logic" [6], which strongly resembles a schematic diagram of relay logic. Thus PLC is the best control processor for the belt conveyor in thermal power plant.

Delta's DVP series programmable logic controllers offer high-speed, low cost, stable and highly reliable applications in all kinds of industrial automation machines. PLC ladder diagram screenshots for the start up sequence and stopping sequence of the belt conveyor is shown in fig. 2 and 3 respectively. When the switch 1 is ON, then the starting of the belt conveyor is done in sequence, starting from conveyor 3, then conveyor 2 is started and then at last conveyor 1 is started as shown in fig. 2. Similarly, when the switch 1 is OFF then the stopping of the belt is done in the sequence first conveyor 1 is stopped, then conveyor 2 is stopped and then at last conveyor 3 is stopped as shown in fig. 3.

The temperature at normal level will not show any detection and the belt conveyor runs normally , when the temperature exceeds 70°C then an indication is given for high temperature and at the same time all the conveyors gets stopped as shown in fig. 4. When the humidity level exceeds the particular value then all the conveyor gets stopped automatically with an alarm indication. The IR sensor is used to detect the conveyor belt tear up by transmitting and receiving the signal continuously. If the tear up occurs in the belt conveyor, the sensor will not receive the signal, so all the conveyors gets stopped automatically and the corresponding indication is given as shown in fig. 5.The overloading of belt conveyor is detected by the proximity sensor, if there is a increase in load above a particular range, then the corresponding indication is given. In case of any emergency condition, emergency stop button is used; this will turn OFF the entire coal handling system.

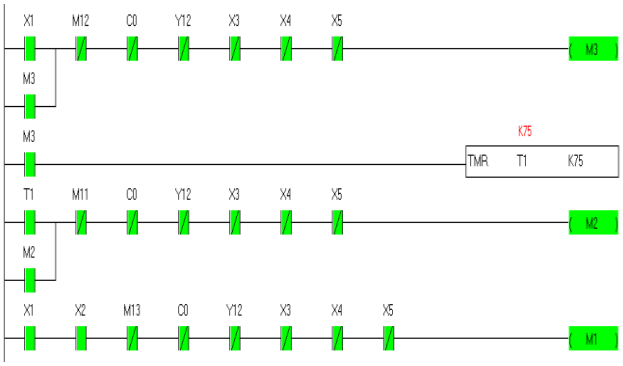

Fig. 2. Ladder diagram for startup sequence of the belt conveyor.

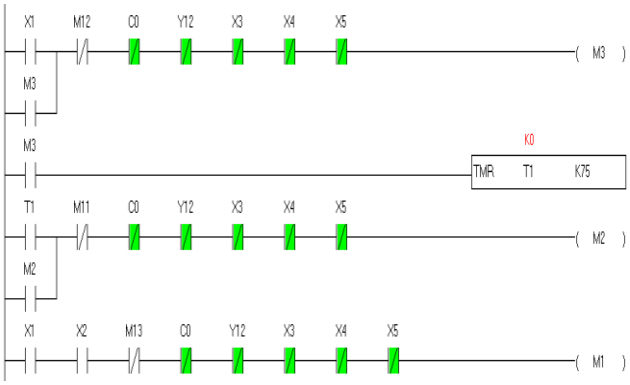

Fig. 3.Ladder diagram for stopping sequence of the belt conveyor.

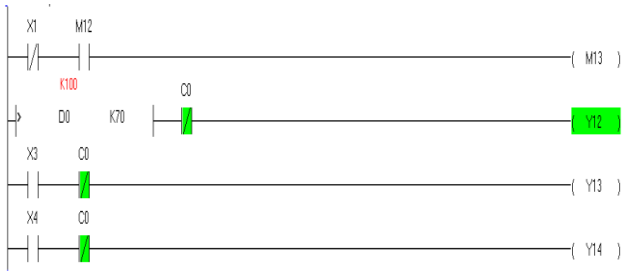

Fig. 4. Ladder diagram for high temperature detection.

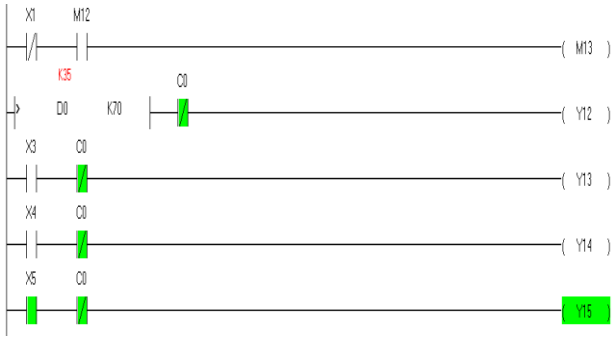

Fig. 5. Ladder diagram for conveyor belt tear up detection.

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B. SCADA

SCADA (Supervisory Control and Data Acquisition) is a centralized monitoring system used to supervise a complete plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation. A SCADA system gathers information (such as where a leak on a pipeline has occurred), transfers the information back to a central site, then alerts the home station that a leak has occurred, carrying out necessary analysis and control, such as determining if the leak is critical, and displaying the information in a logical and organized fashion. These systems can be relatively simple, such as one that monitors environmental conditions of a small office building, or very complex, such as a system that monitors all the activity in a nuclear power plant or the activity of a municipal water system. Traditionally, SCADA systems have made use of the Public Switched Network (PSN) for monitoring purposes.

Wonderware's world-famous InTouch [5] HMI software for visualization and industrial process control offers outstanding ease of use and simple-to-configure graphics. Powerful wizards enable users to quickly create and deploy customized applications that connect and deliver real-time information. The SCADA design for coal handling system in thermal power plant is shown in fig. 6. In this system different types of control parameters such as temperature control, humidity control, belt tear up control and belt overloading control are monitored.

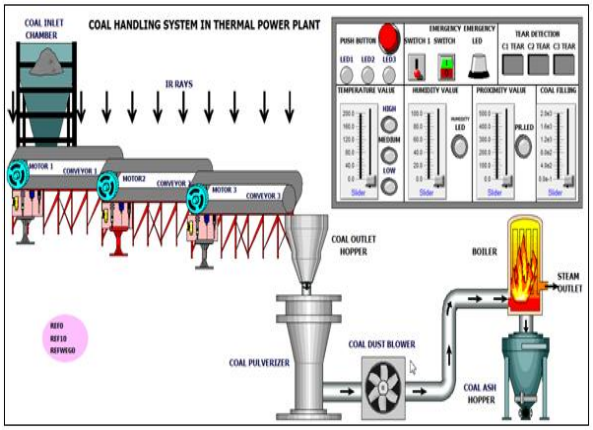

Fig. 6. SCADA design for Coal handling system in thermal power plant.

VI. CONCLUSION

Coal Conveyor belt fault detection in Thermal Power Plant are processed, controlled, and monitored with the help of Programmable Logic Controller, SCADA and various types of sensors. In the point of reducing human errors, PLCs are important part to design with high-speed and highly reliable control operations for conveyor. SCADA is used for the real time monitoring, thus proposed system gives better accuracy, time consuming, low power consumption, stable, highly reliable operation in Real-time where the human life is very important, it protects them from a major risk during fault condition. This proposal is automatic fault detector in the conveyor which is more effective and efficient one. By controlling and monitoring process the immediate fault detection is possible without any time delay to protect the coal conveyor belt tear up. Thus all the drawbacks of existing system are overcomed by the proposed system with the help of different types of sensors, DELTA series PLC and SCADA wonderware intouch.

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REFERENCES

[1] Chunsheng Yang; Dept. of Mech. & Electr. Eng., Jiangsu Coll. of Inf. Technol., Wuxi, China; Pingyuan Xi, "Dynamic simulation of the belt conveyor in neural network", Computer and Automation Engineering (ICCAE), The 2nd International Conference, vol. 2, pp 748–751, Feb. 2010.
[2] Qing- kui Cao; Sch. of Econ. & Manage., Hebei Univ. of Eng., Handan, China ; Jun-hu Ruan ; Kai- di Liu, "Fuzzy evaluation on the safety of belt conveying system based on membership degree transformation new algorithm M(1,2,3)" Computing, Communication, Control, and Management, CCCM 2009. ISECS International Colloquium., vol. 4, pp 19–23.
[3] Popescu, N.; Fac.of Electr. Eng., Univ. of Craiova, Craiova, Romania; Dinu, R.C.; Mircea, I.," The coal conveyor celts functioning modelling of the energy block by 330 MW" IEEE trans., Applied and Theoretical Electricity, International Conference on Oct. 2012.
[4] You Chunxia; Phys. & Electron. Eng. Inst., Xuzhou Normal Univ., Xuzhou, China; Chen Si., "A new detection device of belt longitudinal rip based on pressure monitoring" International Conference on Electronics, Communications and Control (ICECC), Sept. 2011.
[5] www.software.invensys.com/products/wonderware/hmi-and-supervisory-control/intouch/
[6] www.allaboutcircuits.com/vol_4
[7] www.elprocus.com

