Coal Conveyor Transportation Safety UsingAnalogue Addressable Fire Water Suppression System

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***Abstract*: Coal fired thermal power plant plays a major role in power generation and distribution. Coal is transported from storage area to bunker silo through belt conveyors. Belt conveyor is protectedby dust suppression system, conveyor safety switches and control instruments. In an open yard conveyor, the coal transportation arises to major fire hazards due to their high volatile matter of carbon. The outcome of this hazard will be production loss, property damage, burn injury, fatal etc. In this paper to overcome the hazards an innovative analogue addressable fire water suppression system is proposed over the yard conveyor of 1025 meters length. The purpose of this system to suppress the fire in particular hazard occurrence area, instead of suppressing the whole belt conveyor for effective water suppression system. The proposed system is compared with the existing fire water suppressing system used in the thermal power plants. The outcome of this system showed better results in terms of reduced fire hazards, conveyor down time and increased productivity.**

Keywords: Fire hazard, Water suppression system, SIL, Belt conveyor, Control instruments, Coal transportation I. Introduction

I. INTRODUCTION

In India power plants plays a vital role in generation & distribution. In notice that, thermal power plants are mostly installed in the India for easily available of fuel, Coal &other raw materials products related to it. In this paper, we proposedaninnovative idea for safety of coal transportation in coal fired thermal power plants, The transportation is done through through belt conveyor usually the coal has been imported through ship or by train to coal storage area. From coal storageareato the bunker silo, coal is transported through belt conveyor .The belt conveyor, setup are made up of dual redundancy operation if one conveyor fails means, other conveyor will automatically starts up by means of PLC Operation[2] . The Complete operation is controlled by the coal handling plant PLC Located in the control room near to crusher house .The boiler is operated by the combination of coal, fuel and other combustible particles. Power sector is one of the fastest growingsectors in India, which essentially supports the economic growth. The power sector needs to grow at the rate of 12% to maintain the present GDP growth of 8%. Presently the energy deficit is about 8.3% and thepower shortage during the peak period is about 12.5%. The total installed capacity of the power generating units is about 1,24,310 MW. Thermal powergenerating units contribute 66.4% of total installed capacity. The average plant load factor of the thermal power generating units is 74.8%. Some types of coal have the ability to self-combust under certain conditions. One of the worst of these is Powder River Basin coal which can self-ignite even in very small quantities and in very short time periods. Even with less volatile coal types measures that reduce the possibility of fire occurrence are by far the most economic.

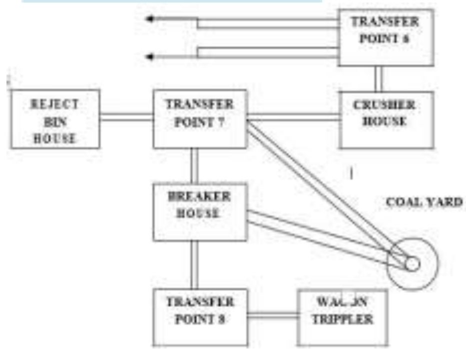

Fig 1 Stages in Coal Handling plant

Jason kirby(2002) Presented, Risk from fire exists anywhere significant amounts of coal are in transportation or storage.Coal in any form, is a combustible material, making it susceptible to a variety of ignition scenarios, and it should be treated with care. Bituminous Coal ignition temperature is 454degrees Celsius. Coal handling facilities typically suffer from fire risksdue to two sources of ignition that need to be considered. The first is coal itself (self-ignition); the second is the conveyor beltused in the transport of coal (hot burning coal, over-heating due to damaged bearings, roller, belt slip etc.). There are environmental issues caused by both, coal falling into natural water streams and burning coal. The trace elements contained incoal (and others formed during combustion) are a large group of diverse pollutants and can potentially cause a number of health and environmental effects.

Kara A. Teacoach(2009) Presented the suppression system which is able to suppress the fires in ten minutes to the point that a miner could extinguish it with a fire hose. However, in several of the tests, the fire re established itself a few minutes after thesprinkler water supply was cut off and quickly grew out of control. This report discusses the large scale experimental configuration, the installation specifications of the fire suppression system, and the results and conclusions regarding the effect ofair velocity, sprinkler activation temperature, and limited water application on the suppression system performance.

Patol Limited (2009), Number of years ago research wasconducted such as to find the ideal moving belt fire detector. This being undertaken when it became obvious that systems existing at that time, employing thermocouples and heat detectors in "heat collecting hoods" were unable to detectanything other than a very large fire. The reason why these methods can not detectsmall fires moving at speeds of up to 6m/s (20ft/s) is that they rely upon convicted and radiated heat. Insufficient heat energy can be transferred, even to the very low thermal

Mutmansky(2007), presented a test program to determine theeffectiveness of fire suppression systems on conveyor beltfires in entries with high-velocity air flow. Full-scale experiments evaluated the effectiveness of dry powder chemical suppression systems, water sprinkler systems, and water deluge systems in conveyor belt entries at air velocities of 0, 2.5 and 7.1 m/sec (0, 500, and 1400 ft/min). The data from this work will be used to develop guidelines for the installation and use of fire suppression systems in ventilated belt entries. In late 2007, the scope of this research was modified to include the recommendations made bythe Technical Study Panel on the utilization of belt air and the composition and fire retardant properties of belt materials in underground coal mining.

II. HAZARD IDENTIFICATION

Safety can be defined as "freedom from unacceptable risk". This definition is important because it highlights the fact that all industrial processes involve risk. Absolute safety, where risk is completely eliminated, cannever be achieved; risk can only be reduced to an acceptable level. [14] Therefore all risks should be dealt with on the ALARP basis, i.e. the target is to ensure that risk is reducedto As Low As Reasonably Practicable. Safety function with a specified Safety Integrity Level which is implemented by a SIS in order to achieve or maintain a safe state. A SIF's sensors, logic solver, and final elements act in concert to detect a hazard and bring the process to a safe state. Safety Methods employed to protect against or mitigate harm/damage to personnel, plant and the environment, and reduce risk include:

III. Changing the process or engineering design
IV. Increasing mechanical integrity of the system
V. Improving the Basic Process Control System (BPCS)
VI. Developing detailed training and operationalprocedures
VII. Increasing the frequency of testing of critical systemcomponents
VIII. Using a safety Instrumented System (SIS)
IX. Installing mitigating equipment

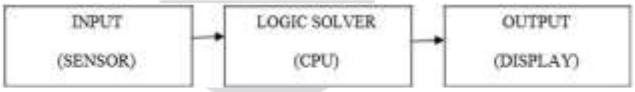

Fig 2 SIS Architecture

Generally, the first step in determining the levels of protectivelayers required involves conducting a detailed hazard and risk analysis. In the process industries a Process Hazards Analysis (PHA) is generally undertaken, which may range from a screening analysis through to a complex Hazard and Operability (HAZOP) study, depending on the complexity of operations and severity of the risks involved. The latter involves a rigorous detailed process examination by a multi- disciplinary team comprising process, instrument, electrical and mechanical engineers, as well as safety specialists and management representatives. Detailed cause and effect scenarios are considered and risks quantified for all process functions and operations. If the study determines that the mechanical integrity of a process and the process control are insufficient to protect against the potential hazard, a SIS may be required. The remainder of this article will focus on SISs and the applicable standards to establish best practice.

III. FIRE HAZARD IN BELT CONVEYOR

Fig 3 Conveyor belt fire incident

A primary fire hazard in a conveyor belt entry is the belt itself. The fire-resistant level of a conveyor belt will have a significant impact on the occurrence and extent of a belt entry fire, should one develop. The first line of defense in strictly limiting the propagation of fire involving a conveyor belt is to use a conveyor belt of high fire resistance. The safety measures discussed for conveyor belt fire protection and control are systems that encompass redundancy. Early detection of a fire is paramount to determining the nature of a important are all the other requirements and measures that address slippage and sequence switches, fire hose andwaterlines, automatic fire suppression equipment, cleanup of combustibles, proper maintenance, communications, and fire response and preparedness. The combination of all the safety elements discussed is intended to reducethe hazard of conveyor belt entry fires. The success in this endeavor will not only result from the regulations, policies and technologiesemployed, but also from the dedication of the mine operator and miners to belt entry fire safety.

Typical fires in belt entries develop in three distinct stages:

1. Early smoldering stages of coal heated, due to overheated equipment or friction, to the point of flaming;
2. Early flaming stages of a small coal fire, which ignites a stationary conveyor belt;
3. Combined coal and conveyor belt fire, which increases in intensity to the point of sustained belt flame spread.

The introduction of coal makes a fire highly probable. Many different types of fire detector have been tried for conveyors. These attempts, some going back many years, include:-

1. Collective reflectors (thermocouple hoods)
2. Ionization & optical point smoke detectors
3. Point Heat Detectors
4. Point Flame Detectors
5. Obscuration detectors employing infra-red beams
6. Pneumatic detectors with fusible bulbs

In every case, experience has shown that these devices are either unsuited to the environment producing unwanted alarmsdue to dust or fog, or are so insensitive that a fire can propagate and cover many metres of the length of the static conveyor before they are operated. The true solution has been determined to be Linear Heat Detection. (LHD)

IV. METHODOLOGY PROPSED

To reduce conveyor downtime and safe guard the conveyor from fire, Analogue addressable fire water suppression system is proposed over open yard conveyor. Usually ember fire detector installed in the belt conveyor at a distance of 50 meters. If fire detects means it gives an alarm signal to operator, and the operator will suppress the fire lag located the fire source[6]. In this yard conveyor identify the source fire area will takes plenty of time. To avoid fire in coal conveyor transportation and to enrich the performance from production lag. An analogue addressable fire water suppression system is installed at conveyor support to reduce conveyor downtime and safeguard conveyor from fire. Each fire detector having unique IP address by mentioning its location in control station. All fire detectors are grouped into the fire alarm addressing panel. Fromthis panel, the alarm willalert the operator and indicate the exact location of fire occurred nearby sensing detector throughPLC[1], In addition to this system it will used as a fire water suppression system tosupress the fire in particular area instead of suppress the water in whole conveyor. This may be used as effective water suppression system by ON/OFF solenoid coil box assembly[7]. This arrangement is shown in the Fig.5: Block diagram

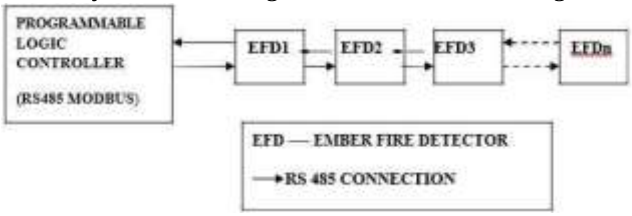

Fig 4 Addressable ember fire detector connection diagram

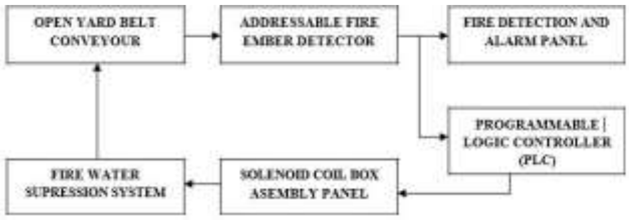

Fig 5 Systematic Block diagram

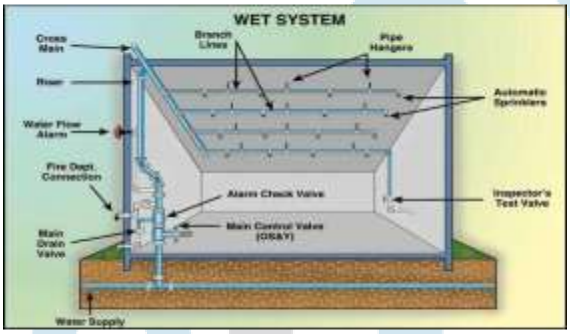

Fig 6 Conveyor Sprinkler system

Water Suppression System is meant to suppress the coal dust generated during transfer of coal at feed/discharge points of conveyors in various transfer towers. There are several existing methods of controlling dust but many areineffective,costly and have detrimental effects on plant and machinery. An effective system for the control of fugitive dust in industry should meet the following objectives.

1. Must be efficient to meet Health & Safety requirements.
2. Be practical and simple in operation.
3. Have low initial cost.
4. Have low operating costs.
5. No adverse effects on product quality or plant andmachinery should be created.

CONCLUSION

The identified hazards existing in the plant which may occurrence of fatal, severe injury & property damage. The design recommendations and safety precautions using control system for prevent this major hazard, to solve this issue, Analogue addressable fire suppression system should be installed on the yard conveyor with necessary detectors and sensors which consumes feasible cost. The control measures implemented in the system are Analogue addressable fire suppression system codedwith a unique address of fire detector integrated with PC system. This system will easily identify the exact location of the fire occurred in the conveyor belt (1025 M length) and suppress the fire to reduce the water consumption. Analogue addressable fire suppression system will be installed on the yard conveyor. This action will help to save the money and also increase the safety &health policy, plant performance, company policy and good public thoughts about the organization.

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