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RESEARCH ARTICLE

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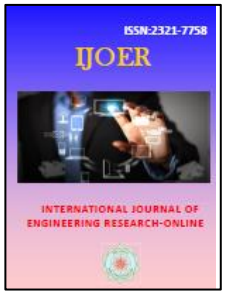
PREVENTION OF BELT CONVEYOR HAZARDS

M.KAVIARASAN, Dr.M.K.ARAVINDAN, V.SUGUMARAN



ABSTRACT

A number of accidents involving conveyor belt attributes accessibility to conveyor area as danger zone. The majority of accidents occur during maintenance activities with conveyors still operation and danger zone unprotected. There number of reasons for running a safe operation and it's the right thing to do. right from the design stage, worker exposure to hazards must be controlled by reducing the frequency of under conveyor clean ups, conveyor maintenance , removing jams, etc., preventive measure must be implemented in order that work on or near conveyors can be performed safely. Safety is a much talked about throughout Mettur thermal power plant station . In this project work all probable risks have been foreseen, analyzed and preventive measures suggested for implemented.

1.INTRODUCTION

Thermal power plants are the pillars of power generation in our country. Our economy and natural wealth depend upon the industrial growth & agriculture output which mainly depend upon power. So uninterrupted power generation is required for continuous output. To achieve the above and to ensure the survival and substantial growth of the organization, emphasis is to be placed in the areas of safe generation and improvement.

Effective management of safety is very critical and important requirement in any industry, as even a minor unsafe working condition or unsafe work performance can bring out serious consequence, if allowed to prevail, they may have cascading effects and slide of disaster.

Evan though accidents occurs et relatively lean frequency, considering the severity of the consequences of the accident, most of the studies have been focused on the study of conveyor belts, identification of hazards in conveyor system at coal handling plant ant its control measures.

1.2.CONVEYOR SYSTEM

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries. Many kinds of conveying systems are available, and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power, free and hand pushed trolleys.

1.3 TYPES OF CONVEYOR

This type of conveyors is installed for the life of the plant they are used in main line, slope, long overland installation, preparation plants and stockpiles.

1.3.1 PORTABLE

These are characterised by relative ease of assembling and disassembling to facilitate advances and recovery in development and retreat operations in underground mining.

1.3.2 SHIFT ABLE

Used in continuous surface mining this type of conveyor is mounted on skid or supporting structures aligned together and the whole can shifted transversely to follow the advancing working face.

1.3.3 HIGH ANGLE CONVEYOR

These are special type of conveyor belt arrangement used for negotiating angle of inclination. Such belts can work in slope up to 70-80degree. Sandwich belt conveyor is a type of such belt conveyor.

1.3.4 CABLE BELT CONVEYOR

Where the belt is carried on moving wire ropes and the tractive force is applied through the rope to the belt is known as cable belt conveyor.

1.3.5 PIPE BELT CONVEYOR

The belt is made to from a pipe while running the main length of the conveyor. At the receiving and discharge end the belt is like troughed belt conveyor. They are suitable for having spillage for having spillage free transportation and free from of polluting the environment.

1.3.6 MOBILE TRANSFER CONVEYOR

Mobile transfer conveyors are installed between bucket wheel/chain excavators and the shift able bench conveyor allowing multi block and multi bench operations to increase the block width and the block height. Thus increasing the time between two shifting operations of the bench conveyor – result in a higher utilization of the mining system.

1.3.7 GRASSHOPPER STYLE MOBILE TRANSFER CONVEYOR

Installed as a chain like one connected to the other are part of waste dumping. This can eliminate dump trucks from mines.

1.4 COMPONENTS OF A BELT CONVEYOR

The principal conveyor components are defined below and illustrated in Figures 1-1 to 1-3. The numbers in the Figures correspond to the numbers in the legend and in the definitions that follow.

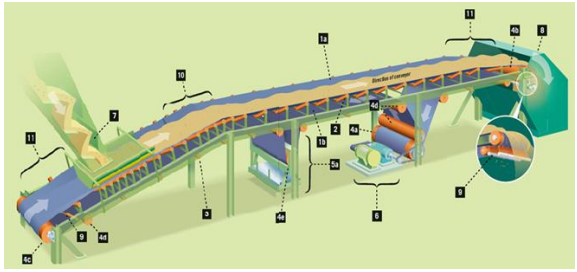


Fig 1. COMPONENT OF A CONVEYOR

1.4.1. BELTS

Belts convey or transport material:

1a load (upper) strand

1b return (lower) strand

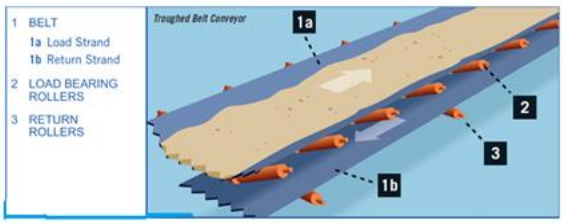


Fig 2.CONVEYOR BELT AND ROLLER

1.4.2. LOAD BEARING ROLLERS

Load bearing rollers support the belt and reduce its resistance to movement of the load. Some load carrying rollers may also be impact-reducing, self-aligning or trough forming (see Figure 1-2), or may be able to change the inclination of the belt.

1.4.3. RETURN ROLLERS

Return rollers support the belt and reduce resistance to movement. Some return rollers may also be self-aligning or may be able to change the inclination of the belt.

1.4.4. DRUMS (PULLEYS)

Drums drive a belt or re-orient the direction of travel.

Types of drums include:

4a drive drum – drives the belt by being itself driven by a motor

4b head drum – returns the belt to the lower strand (and may also serve as a drive drum)

4c tail drum – returns the belt to the upper strand

4d snub drum – aligns the entering or exiting strand with the lower strand or ensures the required arc of contact with the drive drum

4e tensioning drum – maintains proper belt tension by way of a take-up system

1.4.5. TAKE-UP SYSTEMS

Take-up systems ensure proper belt tension. Types of systems include:

5a gravity system – a guided weight pulls the tensioning drum (see Figure 1-1, also 4e, above) to provide the tension

5b manual or self-adjusting system – adjustment screws or automatic

control systems provide the required tension

1.4.6. POWER TRANSMISSION MOVING PARTS

Power transmission moving parts produce and transmit the required energy to the drive drum for moving or restraining the belt. Many combinations are possible:

- a geared motor may be mounted directly to the drive drum shaft or integrated into the drive drum
- the motor and speed-reducing units may be connected by couplings
- chains, belts or couplings may be used between the motor and the drive drum shaft

1.4.7. LOADING SYSTEMS

Loading systems guide and control the load feed on the belt (see Figure 1-3). There are many possible systems, including hoppers, chutes, automatic loaders, pushers, etc. Hoppers usually contain the following parts:

7a hopper assembly – guides, contains and sometimes controls the bulk load feed

7b skirt board – centres the load on the belt or redirects the load; the skirt (7c) is bolted onto it

7c skirt – stops loose material from leaking off the belt

7d impact systems – impact systems/plates are put on a conveyor system below the feed hopper to ensure the belt does not sag from the excess weight and cause spillage

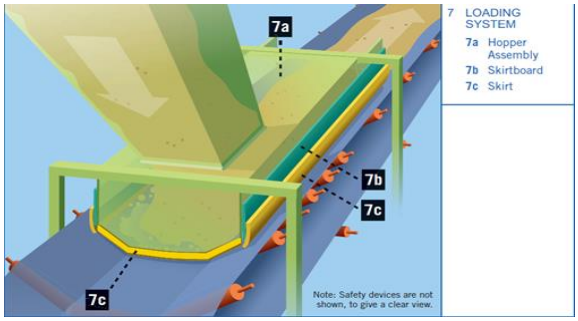


Fig 1.3 LOADING SYSTEM

Fig 1.4 IMPACT IDLER SYSTEM

1.4.8. UNLOADING SYSTEMS

Unloading systems guide the load exiting the conveyor system. Various devices may be used, including chutes, slides, automated systems, ejectors, packagers, etc.

1.4.9. BELT AND DRUM CLEANING SYSTEMS

Belt and drum cleaning systems remove material accumulation from belts and drums. These are often scrapers and brushes.

A scraper that is working properly can:

- save many hours of clean-up, thus increasing efficiency
- reduce possible damage to the belt from build-up underneath
- reduce worker exposure to hazard

1.4.10. CURVED ZONE

The curved zone is the area of the conveyor where the belt is vertically curved.

1.4.11. TRANSITION ZONE

The transition zone is the conveyor area where the profile (cross) of the belt changes from troughed to flattened and vice versa.

2. FAILURE ANALYSIS OF CONVEYOR PULLEY SHAFT-2013 BY ABDULMOHSIN.

The shaft of a conveyor belt drive pulley failed in service. An investigation was performed in order to determine the failure root cause and contribution factors. Investigation methods included visual examination, optical and scanning electron microscope analysis, chemical analysis of the material and mechanical tests. A finite element analysis was also performed to quantify the stress distribution in the shaft. It was concluded that the shaft failed due to fatigue and that the failure was caused by improper reconditioning of the shaft during routine overhaul.

The drive pulley of a conveyor was replaced with an over-hauled unit during scheduled maintenance. After approximately seven days of operation, the pulley shaft failed in the shoulder at the coupling between the shaft and gearbox. The conveyor drive unit is schematically illustrated. The gearbox is rated to deliver 1803 Nm torque at 79.45 rpm. The gearbox and motor are not mounted on a firm foundation, but are instead suspended between the conveyor pulley shaft and a hinge point The combined mass of the motor and gearbox is 230

kg–this load is shared between the conveyor pulley shaft and the mounting hinge pin.

2.1 FAILURE ANALYSIS OF BELT CONVEYOR DAMAGE CAUSED BY THE FALLING MATERIAL. PART II: APPLICATION OF COMPUTER METROTOMOGRAPHY-2013 BY GABRIEL FEDORKO.

Damage of a conveyor belt by impact of sharp material is referred to as breakdown. By conveyor belt breakdown it occurs to perforation of its individual layers. Identification of this type of damage is relatively simple by the help of visual control. However in practice it often occurs due to the impact of sharp material to local anomalies that are not recognizable as a breakdown because there is not fulfilled the basic condition of perforation for all layers of conveyor belt. Based on the visual control, this conveyor belt cannot be unequivocally determined to be damaged or suitable for operating condition. The paper presents analysis of the sample of the conveyor belt with local anomaly which was formed during the experimental measurements for determination of the dependence among the weight of sharp material falling on the conveyor belt, shatter height and force conditions in the conveyor belt. This is a type of damage, which is very often encountered in real conditions. The method of computer metro tomography is applied for the analysis in combination with the software Volume Graphics VG Studio MAX 2.2. The presented results could be applied in practice as a support tool for identification of conveyor belt damage

3. HAZARDS IN CONVEYOR SYSTEM

Hazards associated with conveyors are principally mechanical in nature and other are hazards generated by neglecting ergonomic principles in machine design, or by breakdown-related or security-related control system malfunctions, electricity, heat, fire or explosions.

3.1 POWER TRANSMISSION MOVING-PART HAZARDS

These hazards are associated mainly with the power transmission parts between the motor and the drive (live) drum. They include shafts, couplings, pulleys and drive belts, chains and sprockets Dragging, crushing or entanglement on contact with rotating parts or pinch points can result in serious injuries.

3.2 HAZARDS ASSOCIATED WITH OTHER MOVING PARTS OF A CONVEYOR

These are associated with the moving conveyor belt and in-running nips when in contact with rollers and drums, and to falling return rollers dislodged from worn fasteners. These hazards can result in injuries to a worker from being dragged into in-running nips, or in abrasion and friction burns from rubbing against the belt, or in injuries from being struck by a ruptured belt or a falling roller.

3.3 CONFINEMENT AREA HAZARDS

Injuries result from shearing and crushing between the load, the conveyor belt and a fixed object, for example, hopper, skirt board or skirting

3.4 MOVING-LOAD HAZARDS

Injuries result from shearing and crushing between the load and a fixed object. Injuries can also be caused by falling loads or impacts with loads

3.5 HAZARDS GENERATED BY POOR ERGONOMIC DESIGN

Equipment must be designed so that operators and other users need not assume constraining work postures, overexert themselves or carry out repetitive movements. Control devices must be grouped near workstations to allow easy access for operators and other users. Such devices must be located outside danger zones so that activating them does not create hazards and so that workers do not have to enter the danger zones to access them. They must be positioned to prevent unexpected start-ups, and protected.

Every workstation or intervention area must be provided with adequate lighting for the nature of the work being done or for the nature of the work environment.

3.6 HEAT-RELATED HAZARDS

Where conveyed products or any part of the equipment may cause burns, take the following precautions:

- Prevent contact with conveyed loads and hot surfaces by using screens or fixed surrounding or barrier guards.
- Reduce the temperature of hot surfaces.

3.7 FIRE AND EXPLOSION HAZARDS

The use of a conveyor can present a fire and explosion hazard. This hazard can be caused by the use of the conveyor itself or by the load (for

example, combustible particles) the conveyor is carrying. Such hazards may be amplified by tunnels or by the stack effect. Preventive measures that may be implemented, Fire and Explosion Hazards, of the OH&S Code. These preventive measures prohibit smoking, open flame and all other ignition sources.

3.8 INAPPROPRIATE PERSONAL PROTECTIVE EQUIPMENT AND UNSAFE ACTS

Based on the hazard assessment of the work site, adequate personal protective equipment, including clothing, footwear and respirators, must be selected and worn by workers in accordance, Personal Protective Equipment, of the OH&S Code.

Unsafe acts such as climbing over or under a conveyor, or stepping over, walking on or riding on a conveyor, must not be tolerated.

4. STATISTICS OF AREAS WHERE ACCIDENT OCCURRED IN BELT CONVEYOR

Based on information collected from 85 serious or fatal accidents* involving conveyor belts, the majority of accidents (55%) involved head or tail drums or drive mechanisms (table 1-1)

Table 1 Serious or Fatal Accidents by Areas of Occurrence in conveyor system

Conveyor belt area where accident occurred	%
Between the live drum, head drum or tail drum and the belt, inside one of these drums, or between one drum and another	48
Other areas (for example, between electromagnets and other parts)	13
Motor-to-drum drive mechanism	13
Between a load carrying or return roller and the belt	7
Between a take-up drum and the belt	5
Between a jammed tool and the belt or the conveyor chassis	2

A large number of these accidents occurred during cleaning (30%) or during the maintenance of or near a conveyor belt in motion (26%). Accidents occurring during normal production activities (sorting, packaging, etc.) were less frequent (12%) (table 1).

These statistics illustrate the diversity and scope of hazards associated with conveyor belts, regardless of the nature of worker activities.

5. SAFEGUARDS AGAINST CONTROL SYSTEM FAILURES OR MALFUNCTIONS

5.1 START-UP

Start-up of equipment must require a voluntary action. Equipment start-up must be prevented in the following situations:

- during the closing of a guard
- during the actuation of an operation mode selector
- during the resetting of an emergency stop device
- during the resetting of a thermal protection device

In conveyors designed to supply loads to other conveyors, start-up of the supply conveyors must be linked with the receiving conveyors, using appropriate interlock devices. These devices must control and ensure sequential start-up, and must prevent conveyor overloading (whether the conveyor is fully loaded, or not in use).

For automatic or remote control start-up conveyors as well as for conveyors where the worker(s) cannot see the entire conveyor, a visible or audible warning device shall announce the starting of the conveyor

To prevent unexpected start-up, replace two-stable position (toggle) switches (start-stop) with Self-powered or single-stable position control devices. These switches will bring the controls to an off-circuit mode (open contacts) should there be a power outage or conveyor failure.

5.3 EMERGENCY STOP DEVICE

The emergency stop device of a conveyor to which workers have access comprises several control devices located at the loading and unloading areas, as well as along the length of the conveyor. these devices have the following features:

- they are easily visible;
- one single action activates them;
- they are clearly identified.

Emergency stop devices must be installed at a height of between 0.6 and 1.7 meters from the floor. In addition, the device must have the following features:

- one or more push button switches
- one or more emergency stop pull-cords if required, along the full length of the conveyor

- a conveyor power-disconnect device, if the distance to the disconnect device is less than 10 metres from any conveyor access point

An emergency stop device must allow equipment to shut down in the safest possible way. This can be achieved by slowing down moving parts at an optimal rate, as follows:

- by an immediate interruption of power to the motors
- by a controlled stop (motors remain energized to bring the equipment down to a progressive stop and power is interrupted once the equipment has come to halt)

The resetting of an emergency stop device must not by itself cause the start-up of the machine unless the conveyor is a slow-moving type which workers can access safely. Start-up must be confirmed by a manual action (manual resetting).

The emergency stop command has priority over all other commands. Emergency stop devices must stop any upstream or downstream conveyors which may pose a safety risk to workers. The emergency stop device must not be used to bring the conveyor to an all-stop state. The emergency stop must not be used as a regular stop.

Remember that an emergency stop device does not replace appropriate protection devices. As well, emergency stop devices must not replace equipment lockout procedures during maintenance requiring access to danger zones.

5.4 EMERGENCY STOP PULL-CORDS

If workers can access a conveyor in operation, it must be equipped with an emergency shutdown device along the full length of conveyor.

A sheathed metal strand cable shut-down device (pull-cord) must function as an emergency stop switch, whatever direction the cable is pulled in, or when the emergency stop switch is broken. A spring failure must also trigger an emergency stop.

A horizontal force of less than 125 N, when applied midway between two support rings and perpendicularly to the cable, must be sufficient to activate an emergency cable. Lateral movement of the cable (between the position while at rest and the activation point) must not exceed 300 mm. The cable must be able to resist a tension force 10 times greater than the tension required to activate the emergency shut-down switch, when such force is applied perpendicularly to the cable.

The cable must move freely within its supports, particularly at bends. Cables must not be twisted nor suffer the risk of being twisted during use. If a belt width is 800 mm or less, a single central cable may be used above the belt.

Maximum cable length and other characteristics must conform to manufacturers' recommendations (for support rings and pulley protection, freeze-up prevention, variation in length due to temperature changes, etc.)

Other appropriate cable devices, as determined by the hazard assessment, may be used where activation of the switch is done by pressure, compression, torsion or tension applied to the cable. This method is best suited to complex cable runs and to dusty or heavy-vibration environments.

5.5 LOCKOUT PROCEDURES

The goal of lockout procedures is to allow workers to carry out their tasks (maintenance, repairs, cleaning, etc.) on a conveyor and its accessories (bumpers, ejectors, etc.) without risk. Lockout procedures involve the following basics:

- Bringing the machine to a complete stop.
- Disconnecting all the machine's sources of power: electric, pneumatic, hydraulic, mechanical and thermal.
- Dissipating all accumulated energy (purging reservoirs, removing counterweights, unloading springs, etc.) and checking for absence of energy.
- Padlocking of energy disconnect devices by each worker accessing the work area.
- Double-checking to ensure that the equipment is in fact disconnected (e.g., running a start-up test).

6. CONCLUSION

This project will help to know about the hazards and safety requirement in belt conveyor system of the plant. This may also help to know about the unsafe condition in the working environment, importance of guarding of rotating parts, good housekeeping and knowledge of other hazard, fire and explosion hazard. The safe guard against control system failures and safe guard during maintenance were listed. The statistics of occurrence of accident in conveyor system and the

details of consequence due to the improper maintenance, some special attention to the development of safe working procedure and the training of personnel will create safety awareness and motivate employees to identify and eliminate all unsafe condition and unsafe acts.

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