TECH TALK

Volume 31

ALLIANZ GLOBAL CORPORATE & SPECIALTY®

CONVEYOR SYSTEMS

ALLIANZ RISK CONSULTING

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This Tech Talk discusses the potential fire and explosion hazards of conveyor systems and Allianz Risk Consulting (ARC) recommendations.

AT-A-GLANCE

- Conveyor systems are commonly used because of their efficiency in transporting products between different areas.
- The hazards associated with conveyor systems consist not only of the transported material and structure, but also the conveyor itself.
- An automatic fire protection system should be installed over most conveyor systems.
- An unplanned shutdown of a conveyor system could lead to a significant business interruption loss.

INTRODUCTION

Conveyor systems are commonly used in the mining, automotive, agricultural, food and beverage, bottling, manufacturing, warehouse and logistics, and packaging industries.

They are mainly used to transport granulated materials, such as cereals, coal, minerals, etc., often for loading or unloading trucks and bulk carriers. They are also useful in industries that handle heavy goods, bulk raw materials or mass manufactured products.

Light conveyor systems are used to supply components to assembly lines, remove waste from manufacturing processes, and as an aid in the transport of loads between buildings. They are also used in automated storage systems. Combined with computerized pallet-handling equipment, they allow more efficient retail, wholesale and manufacturing distribution.

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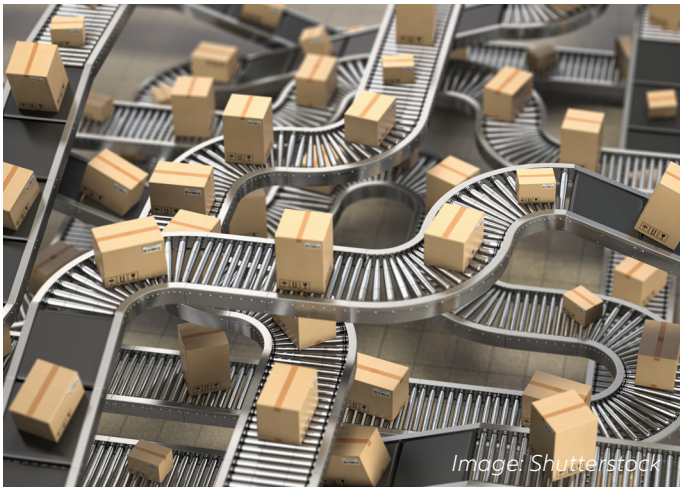
There are a wide variety of conveyor systems, which differ in their mode of operation, means and direction of transport, including vertical, horizontal and inclined conveyors. However, they usually consist of a frame that supports either rollers, wheels, or a belt, upon which materials move from one place to another. They may be powered by a motor, by gravity, or manually.

The most common types of conveyor systems are:

- **Belt conveyors:** use continuous belts to convey products or material. The belt is extended in an endless loop between two end-pulleys. Power is provided by motors that use either variable or constant speed reduction gears. The belts themselves can be made from numerous materials such as rubber, plastic, leather, fabric and metal. The conveyors can be operated horizontally or can be inclined. Belt conveyors are used for bulk or large materials.
- **Roller conveyors:** use parallel rollers mounted in frames to convey product either by gravity, manually, or even by powered rollers. Roller conveyors are used primarily in material handling operations such as on loading docks, for baggage handling or on assembly lines. Various drive types include belts, chains/sprockets and motorized rollers. Some of the uses of powered roller conveyors are food handling, steelmaking and packaging.
- **Bucket conveyors or elevators:** use multi-sided containers attached to cables, belts or chains to convey products or materials. The containers remain upright along the system and tip to release material. Bucket conveyors are used in applications such as bulk material or food processing. The conveyed material can be in liquid form or dry, such as sludge, sand, sugar and grain. The systems can be used horizontally, inclined or vertically, to change levels of the delivered products.
- **Pneumatic/vacuum conveyors:** use air pressure or a vacuum to transport materials, such as powders and small solid particles, through enclosed tubes or ducts, or along surfaces. Pneumatic/vacuum conveyors are used primarily in dust collection applications and in processes such as chemical, mineral, scrap and food. Materials for the conveyors can be metallic or non-metallic depending on the media being conveyed.
- **Screw conveyors:** consist of a helical screw element or steel auger that rotates around a central shaft, driving the work material according to the screw design and rotational direction. Manufacturers use screw conveyors to transport materials such as flakes, grains, powders, seeds and granules. Alternatively, these devices can be used to mix, agitate or blend materials or to maintain solutions. A screw conveyor can also transport wet, non-flowing and caking materials that might otherwise be difficult to move, such as concrete.



Cardboard boxes on conveyor belts and rollers in distribution warehouse

Other types of conveyor systems include slat belt conveyors, chain conveyors, overhead conveyors, vibrating conveyors, etc.

Conveyor systems can be installed indoors, mainly in manufacturing facilities or warehouses, or outdoors as conveyors in subgrade tunnels, surface conveyors or elevated galleries. Conveyor systems can be totally enclosed, partially enclosed or directly open.

WHAT ARE THE HAZARDS?

The fire hazards associated with conveyor systems consist not only of the conveyed material (combustible and/or flammable products), but also combustible deposits around the conveyor and the combustible conveyor components, such as rubber conveyor belts, plastic buckets, plastic covers, etc. The belt or bucket alone may provide sufficient combustible loading to spread the fire. When the materials being conveyed are also combustible, fires can be even more difficult to control.

Combustible belts are easily ignited, spread fire rapidly and emit dense, black, toxic smoke when ignited. This smoke, rapid belt movement and significant elevation above ground combine to make firefighting extremely difficult, especially in enclosed conveyors. A fully enclosed conveyor system will limit heat venting and prevent hose streams from reaching the fire inside the conveyor system. This increases the potential fire loss.

The mechanical and electrical systems driving a conveyor are typically the ignition source for a conveyor fire. Friction caused by a conveyor belt slipping, jammed rollers, malfunctioning brakes and bearings, or misalignment may generate enough heat to result in a flame being formed. Overheated motors or drive units can also generate enough heat to start a small fire.

De-icing systems using hot air or direct flame impingement onto a conveyor belt present an additional source of ignition along with hot work operations involving open flames, which can ignite conveyor belts, combustible deposits, combustible components, etc.

Systems with conveyors placed side-by-side and multi-tier arrangements in the same structure increase the combustible loading. Conveyor systems with elevated height are difficult to reach with hose streams and inclined conveyors may cause a flue effect thereby increasing the spread of the fire.

It is clear that if a conveyor fire is not controlled at an early stage, the fire can rapidly weaken the steel structure and cause it to collapse.

An explosion hazard may also exist in a conveyor system used to handle materials that can generate combustible dust. A small initial dust explosion can trigger secondary dust explosions that can propagate the entire length of the conveyor system. Most dust generated during conveyor operations occurs when material is being transferred from one conveyor to another. Refer to ARC Tech Talk Volume 10 - Combustible Dusts for more information.

A combination of these fire hazards can result in a process shutdown, especially when conveyors are the only economical and viable way of transporting materials.

Conveyor belt on fire

ARC RECOMMENDATIONS

The following recommendations are based on best engineering practices and should be considered after completing a hazard analysis of the conveyor system. Contact your local ARC representative to discuss your specific needs.

Construction and Location

- Use non-combustible materials for all components of the conveyor system whenever possible, especially in applications where there are combustible products or materials. Use fire retardant conveyors, if compatible with operating specifications.
- Provide non-combustible covers if an enclosure over the conveyor is needed. For outdoor conveyors, use non-combustible enclosures and insulation for conveyor galleries, tunnels or buildings.
- Avoid passing conveyors through firewalls. Where conveyors enter a building or pass through a firewall, automatic closing fire doors should be used to protect the conveyor openings.
- Avoid positioning one conveyor above another (either parallel or crossing over) when ceiling level automatic sprinkler protection is provided. This will prevent the creation of shielded areas.
- For outdoor conveyors, place warning markers and clearance signs on elevated galleries in high-traffic areas in order to prevent impact to exposed steel supports.

Safety Operation

- Provide conveyor alignment interlocks arranged to shutdown the conveyor if it becomes misaligned.
- Provide anti-rip detection devices for conveyors prone to longitudinal tearing. An alternative is to use high-tear resistant conveyors.
- Provide manual shutdown capability for the conveyor system with regular operator training.
- Arrange conveyors so that they can be run manually after they are shut down. This allows burning materials to be moved to an area accessible for firefighting.
- Provide appropriate electrical equipment in conveyor systems handling combustible dusts.
- Provide adequate grounding of the conveyor systems in order to prevent static electricity.
- Provide drive motor interlocks to shut down upon detection of overload, overcurrent condition, or if the conveyor is excessively slowing down. Interlock the contributing conveyors so that no running conveyor can discharge material to a stopped downstream conveyor.
- Provide interlocks to shut down the feed system or divert the feed of hot material if the material exceeds a safe temperature or if the conveyor or cooling system shuts down.
- Provide on-line monitoring of critical parameters (i.e. speed, bearing temperature, misalignment, etc.) for those conveyors that are considered business critical.

Fire Detection and Alarm

- Install a fire detection system. Note that if sprinkler protection is provided, automatic fire detection is not needed.
- Provide conveyor interlocks to shut down automatically on detection of fire (either by automatic fire detection or sprinkler protection).
- Arrange the alarms for the fire detection system and for any upset conditions to be monitored at a constantly attended location.

Automatic Fire Protection

- Provide automatic sprinkler protection over conveyor systems if any of the following applies:
  - Material being conveyed is combustible
  - Conveyor material is combustible
  - Enclosure housing the conveyor (totally or partially enclosed) is of combustible construction or if other combustibles, such as grouped electrical cables, are present
  - Multiple tier system
  - Limited manual fire fighting, such as totally enclosed systems and/or elevated structures above 12 m (40 ft)
  - Critical conveyor based on business interruption potential
- Install automatic fire protection designed in accordance with Factory Mutual Global Data Sheet 7-11, *Conveyors,* or equivalent.
- The sprinkler design drawings and hydraulic calculations should be reviewed by ARC prior to installation.
- Provide adequate drainage in order to prevent collapse of a conveyor gallery or system due to water weight from sprinkler discharge.

Manual Fire Fighting

- Update the fire emergency plan to include manual fire fighting operations involving the conveyor systems. A list of conveyed materials and their reaction to fire/water/extinguishing system agent should be included.
- Ensure there is clear access for the fire brigade to the conveyor systems for manual fire fighting.
- Provide hose stations near indoor conveyor systems. Keep in mind that manual fire fighting is likely needed to extinguish a fire.
- Provide adequate fire hydrant protection for outdoor conveyor systems. Fire hydrants should be clearly marked in the fire brigade plans.

Maintenance and Housekeeping

- Inspect, test and maintain the integrity of the conveyor system equipment, including structural integrity.
- Inspect, test, and maintain areas of the conveyor system considered common ignition sources due to friction and overheating, including bearings, motors and/or drive system components, misalignment of belts or drivers, etc.
- Perform infrared inspections (thermography) of the electrical equipment and frequent ignition zones, such as conveyor drive pulleys and drums at least annually.
- Inspect, test and maintain the fire detection and fire protection systems in accordance with applicable NFPA codes and standards.
- Conduct weekly self-inspections to ensure adequate housekeeping and avoid dust and waste accumulation around conveyor systems. Avoid combustible material storage under conveyors.
- Use the ARC Hot Work Management program (or equivalent) for all hot work activities carried out on or near the conveyor system.

Business Continuity

- Develop a business continuity plan for all business critical conveyor systems.
- Maintain a stock of routine spare parts, in order to reduce downtime in the event of a breakdown.

REFERENCES

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*

FM Global Data Sheet 7-11, *Conveyors*

FM Global Data Sheet 7-12, *Mining and Mineral Processing*

FM Global Data Sheet 7-76, *Prevention and Mitigation of Combustible Dust Explosions and Fires*

ARC Tech Talk Vol 10, *Combustible Dusts*

QUESTIONS OR COMMENTS?

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