Safely conveying hazardous materials in continuous bucket elevators

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Standard continuous bucket elevators don't always have the necessary features and protections that are required to move hazardous materials safely and with minimal risk unless the units are designed and built specifically for that purpose. This article examines the critical factors that operators should be aware of when using continuous bucket elevators to convey these harmful materials.

Many manufacturing facilities rely on continuous bucket elevators to convey hazardous materials through the production process. Unless these systems are customized and tailored for the job, however, standard continuous bucket elevators aren't equipped with the features and protections necessary to minimize risk and ensure operator health and plant safety while transporting these materials.

Hazardous materials include those that are extremely dusty, unstable, flammable, explosive, or toxic. This material category also includes applications where a safe material may be transformed into an unsafe one should it come into contact with another material or environmental "trigger" factor. Controlling and reducing the risks associated with handling these types of materials while achieving compliance with applicable regulations are key objectives that must be met in these hazardous applications.

Basics of bucket elevators

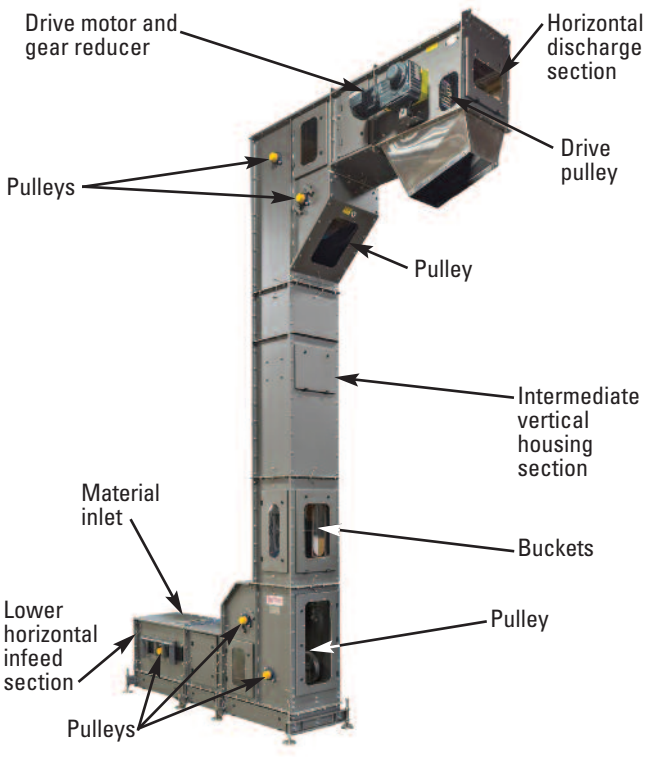
Continuous bucket elevators, as contrasted with centrifugal discharge elevators, are mechanical conveyors that gently transport bulk solid materials without breakage or spillage. A typical continuous bucket elevator, as shown in Figure 1, consists of a lower horizontal infeed section with a material inlet and pulley, one or more intermediate vertical housing sections, and an upper horizontal discharge section with an electric motor and set of drive pulleys. A drive belt or chain travels around the pulleys, with numerous plastic or steel buckets mounted on either belts or chains. The intermediate vertical section of the elevator connects the lower and upper horizontal sections and permits the movement of material from one elevation to another.

During operation, the motor turns the drive pulleys, which drives the belts or chains. The attached buckets collect material from the elevator infeed and carry it up through the vertical section to the upper horizontal section, where the material is discharged. Both the carry and return side of the buckets are contained in the same housing.

Each bucket is side-mounted between two drive chains or belts. The buckets pivot and remain level during transfer. (Nonpivoted-type conveyors incorporate

Figure 1

Continuous bucket elevator



specially shaped buckets that are joined together to hold material during the vertical and horizontal transfers.) Buckets then tip to empty only at the elevator's discharge point. The buckets interlock or overlap to prevent spillage during continuous material infeed, and the elevator design can be open, enclosed, or fully sealed to prevent material contamination or avoid emissions being released.

Key concerns of transporting hazardous materials

Conveying hazardous materials in a continuous bucket elevator raises two primary concerns — fugitive emissions and preventing and suppressing dust explosions.

Fugitive emissions. Fugitive emissions from a bucket elevator handling hazardous materials pose a special risk. Dust or combustible vapors that escape from the elevator can explode if exposed to an ignition source. In addition, if toxic fumes or vapors are released, they pose a hazard to both personnel and the environment.

Reducing fugitive emissions requires using an elevator that is — at the very least — fully enclosed. However, since fugitive emissions can occur from even a fully enclosed elevator, a better solution is to use a unit that is fully sealed as well as gas-tight. In contrast to fully enclosed elevators, fully sealed units employ gaskets to mechanically seal the joints between the frame sections and the cover panels. This gas-tight seal further lowers the risk that any fugitive emissions will escape from the unit. Fully sealed units also prevent moisture ingress into the conveyor, which is a key consideration when handling dangerous-when-wet materials.

Using grounding or earthing straps and implementing gasketing between sections and around access doors helps create an air-tight seal on a bucket elevator

Explosion prevention and suppression. Explosion prevention and suppression is the second concern that must be addressed. Dust explosions can occur when a sufficient concentration of combustible dust accumulates within the elevator and is exposed to an ignition source, such as a spark that results from a static discharge or the friction between moving parts. Should an explosion occur within the elevator, the equipment design should be capable of suppressing the explosion's effects, relieving the resulting overpressure, and safely venting any flame. Specific equipment features that can help achieve these objectives will be discussed later in this article.

From a risk-management perspective, since the ignition source is the trigger that sets off the explosion, controlling these sources through equipment design can reduce or eliminate the risk of an explosion ever occurring. Possible ignition sources include hot material particles resulting from chemical reactions or friction as material is conveyed, mechanically generated sparks inside the elevator, foreign materials blocked between moving contact surfaces, chemical reactions, and sparks from electric circuits used on the controls.

Regulations and the need for risk management

Recent regulatory changes within the US have placed increased emphasis on the need to manage and prevent dust explosions within processing facilities. In October 2015, the National Fire Protection Association (NFPA) published *NFPA 652: Standard on the Fundamentals of Combustible Dust.*[1] In publishing this standard, which has since been updated for the 2016 edition, the NFPA sought to address the lack of appreciation and understanding of combustible dust hazards present within industry. The standard was created to promote and define hazard analysis, awareness, management, and mitigation.

NFPA 652 introduced a new term — *Dust Hazards Analysis (DHA)*. The DHA is aimed at facilities whose processes generate combustible dusts collected by simple dust collectors. The DHA is a tool used to improve plant safety by identifying the specific combustible dust hazards associated with a process, allowing a review of the facility and its activities to determine potential risks and create a plan to minimize or mitigate those risks.

NFPA 652 rolls up the guidelines and standards that NFPA previously issued for various industries and

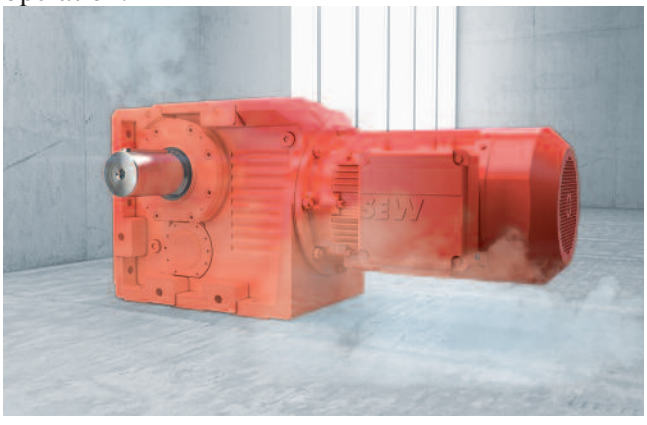
applications, including *NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities; NFPA 654: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids; NFPA 664: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities;* and others. By aggregating these various guidelines and standards, NFPA 652 has now become the primary US industry standard for combustible dust.

In Europe, ATEX directives[2] cover equipment that will be used in potentially explosive atmospheres. Under ATEX, production areas classified into zones (zones 0, 1, and 2 for hazardous gas-vapor-mist; zones 20, 21, and 22 for hazardous dusts or fibers) must be protected from effective sources of ignition. Equipment and protective systems intended to be used in zoned areas must meet the requirements of the ATEX directive. Certification ensures that the equipment or protection system is fit for its intended purpose and that adequate information is supplied to confirm that the equipment can be used safely.

Equipment design features for conveying hazardous materials

As noted above, intelligent continuous bucket elevator design and construction can address many concerns associated with safely conveying hazardous materials. Specific design features that help minimize the risks in moving hazardous materials include:

Fully enclosed and gas-tight sealed designs. Fully enclosed elevators can contain hazardous materials during their transit through the conveyor. However, these elevators may not prevent dangerous fugitive emissions from escaping from the unit. A fully sealed gas-tight construction is required to reduce dangerous toxic emissions from escaping from the elevator during operation.



Several different explosion-proof drive motors, such as the one pictured, are available to meet NFPA or ATEX specifications.

Explosion-proof drive motors. The drive motor used on an elevator is a potential explosion source. Drive motors installed in elevators intended for use in potentially explosive atmospheres should comply with NFPA standards, ATEX directives, or similar regulations.

Dust reduction and control. Direct connection of the elevator to a dust collection system helps prevent combustible dust from concentrating within the elevator where the dust could potentially ignite and explode. Similarly, interlocking (as opposed to overlapping) buckets greatly reduce spillage and material and fines accumulation within the elevator. Good design and control of the infeed to the elevator is also critical for preventing dusting and material accumulation.

Fully conductive drive assemblies. During operation, dangerous static charges that could trigger an explosion can accumulate within an elevator. To mitigate this risk, the elevator should be designed with a fully conductive drive assembly with a continuous electrical ground path that safely dissipates any accumulated static charge.

Explosion-relief vent panels. These panels safely relieve overpressure that can result from a dust explosion within the elevator. Flameless vent panels arrest the flames associated with an explosion and prevent those flames from exiting the equipment.

Safety monitoring sensors and devices. A broken or slipping drive belt as well as failed bearings can generate heat, which could lead to a fire or explosion. Sensors that monitor bearing temperature and belt alignment and slippage should be installed on the elevator to monitor for over-temperature conditions.

Fire-suppression systems. Detectors installed within the elevator can activate an installed fire-suppression system if an ignition source is sensed. Within milliseconds, the suppression system will signal extinguishing modules to release a flame-quenching medium, immediately dissipating the fire or explosion.

Stainless steel frame construction. Elevators made with full stainless steel construction eliminate the rust buildup that could lead to sparking.

Other components. Specific components can be installed to further ensure operator health and plant safety. These include rubber chains, plastic buckets, cleanout drawers, quick-access doors, and more.

Operators should always know the characteristics of the material being conveyed and its propensity to ignite, burn, or explode. Under the regulations discussed in this article, equipment operators are responsible for testing the materials being handled. Testing can determine a number of important material characteristics, such as its propensity to spontaneously combust, which helps determine the levels of protection you need on the elevator when conveying hazardous materials. **PBE**

References

1. The NFPA standards discussed in this article are available at www.nfpa.org.
2. ATEX directives are available from the European Commission at http://ec.europa.eu/growth/sectors/mechanical-engineering/atex_en.

For further reading

Find more information on this topic in articles listed under "Mechanical conveying" and "Combustible dust" in *Powder and Bulk Engineering*'s comprehensive article index in the December 2017 issue or the Article Archive on *PBE*'s website, www.powderbulk.com. (All articles listed in the archive are available for free download to registered users.)

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