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Explosion Risk Assessment for Bucket Elevators

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Summary

Intro and standard

Bucket elevators represent one of the main equipment used for the transport of bulk solids in various types of installations: grain handling, breweries, feed mills, feed mills or the food industry, among others.

Furthermore, bucket elevators represent one of the main equipment used for the transport of bulk solids in various types of installations: grain handling, breweries, feed mills or the food industry, among others.

In addition to the above, elevators represent one of the main explosion risks in industries where flammable dusts are handled, mainly due to their high propensity to generate ignition sources of different origin.

This is why it is really important to carry out a correct assessment of explosion risks in installations that use this type of equipment, with the aim of reducing the probability of an explosion occurring, and if it does occur, that its consequences are minimal, avoiding material and human damage.

There are several standards used at international level to be able to carry out a correct risk assessment, the most important of which include:

- The European Technical Report CEN/TR-16829: Fire and explosion prevention and protection for bucket elevators, deals exclusively with prevention and protection in bucket elevators, based on several studies carried out.
- The German standard VDI-2263, part 8: Dust fires and dust explosions, Hazards-assessment-protective measures, Fire and explosion protection in elevators, 2008, aims to be a guide for the prevention and protection of bucket elevators according to the European directives 2014/34/EU and 1999/92/EC taking into account both the manufacturer and the end use
- The American standard NFPA 61: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities, has a section that deals exclusively with prevention and protection measures in bucket elevators.

Fig.1 Explosion of bucket elevator (ref. https://siouxcityjournal.com)

Explosion risk assessment

A proper explosion risk assessment must include at least the following points:

- Classification of explosion risk areas.
- Assessment of effective ignition sources.
- Probability of an explosion occurring.
- Consequences of an explosion on equipment and installations.

Classification of potentially explosive areas in bucket elevators

It is common to consider the equipment as an indoor area due to its high operating speed and high probability of continuous generation of dust clouds in flammable concentration but also due to the possibility of accumulation of dust layers adhering to the walls that may become suspended.

Effective ignition sources: Sources of ignition produced by the hoist itself, such as:

- Hot surfaces, due to:
  - ✓ Belt friction with the carcass due to belt misalignment.
  - ✓ Friction of the belt with the pulley due to slippage if belt tension is insufficient.
  - ✓ Friction of loose parts (buckets, pulley parts) with moving parts.
  - ✓ Bearing failures as bearings are in dusty ambient conditions and in many cases high temperatures, these conditions are not conducive to long bearing life, so if a defective bearing continues to run rough, heat will be generated.

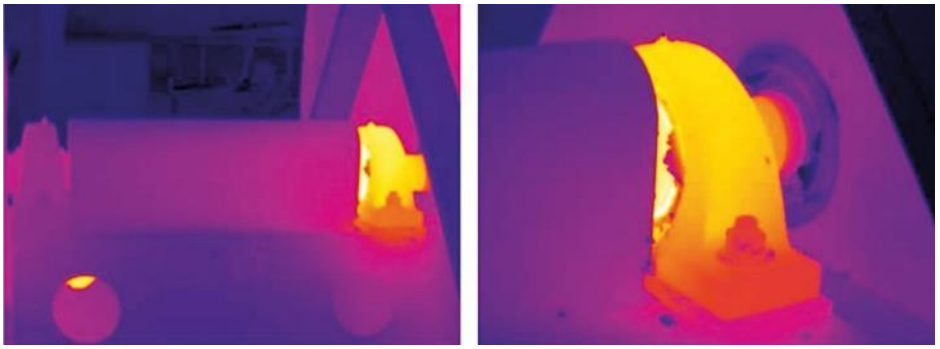

Fig. 2. Hot bearing surfaces (ref. https://bulkhandlingtoday.co.za)

- Mechanical sparks, due to:
  - ✓ To impact of buckets with the casing (due to insufficient belt tension, defective belt, buckets falling) or with the elevator outlet.
  - ✓ Belt misalignment.
- Electrical equipment, due to:
  - ✓ Incorrect or damaged equipment.
  - ✓ Incorrect earthing or lack of continuity.
- Electrostatic discharges, due to:
  - ✓ Charging due to separation processes between belt and pulley.
  - ✓ Charging of the buckets due to induction.
  - ✓ Charging of any other ungrounded component.

1. Ignition sources introduced from other equipment which is interconnected, e.g. hot particles or explosions in other equipment as well as ignition sources produced by electrical equipment outside the lift.
2. External ignition sources due to maintenance, welding, cutting (hot work), smoking in the installation or deflagrations from other equipment. Such ignition sources are prevented by organisational measures.
3. Ignition sources produced by the product to be transported itself, e.g. due to self-combustion of dust accumulations inside the lift.

Recommended prevention and protection measures

In view of the possible presence of explosive atmospheres on an almost continuous basis and the variety of ignition sources that can be effective, the probability of an explosion occurring in an elevator is high and its consequences can be catastrophic for installations and persons.

This is why both explosion prevention and explosion protection measures are considered necessary in this equipment, among which we must consider:

Prevention measures

- Prevention of explosive atmospheres:
  - ✓ Dust collection systems at the head and foot.
  - ✓ Periodic cleaning.
- Prevention of ignition sources:
  - ✓ Installation of magnets or grids to prevent ingress of foreign bodies.
  - ✓ Belt deflection detectors.
  - ✓ Control of rotation in the motor shaft of the foot.
  - ✓ Jam detector at the product discharge point.
  - ✓ Temperature detection in bearings.
  - ✓ Correct earthing and equipotentiality, band of antistatic material when the EMI of the product is low (< 10 mJ)

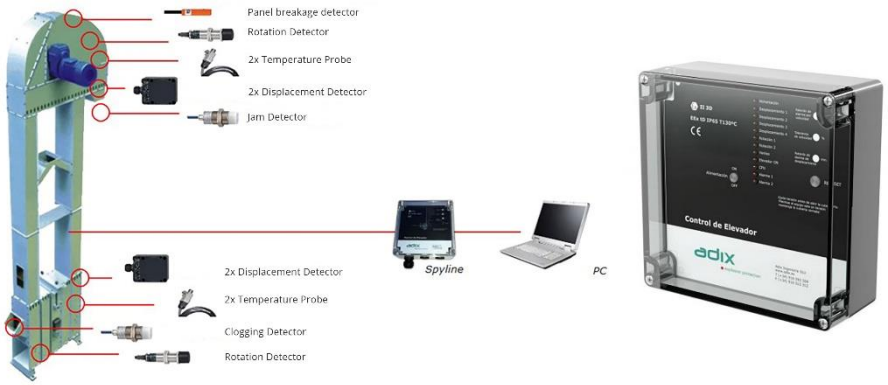

Fig. 3 Elevator ignition source control system (Spyline ADIX)

Protection measures

- Explosion vent panels installed on the foot, head and shanks, following the configuration indicated in recognised standards or guides (e.g., CEN/TR 16829).
- Flameless venting in case the equipment is located indoors.
- Explosion suppression.

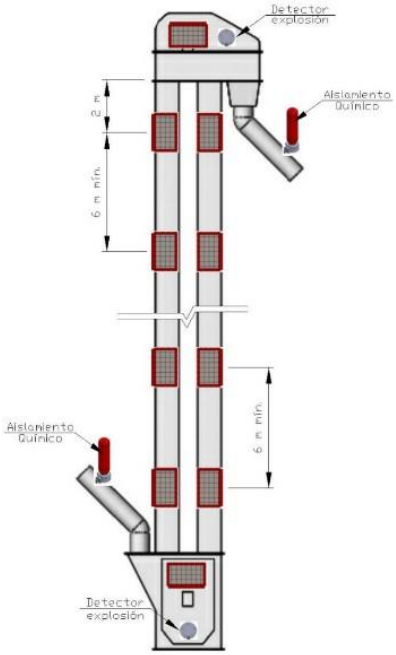

Fig. 3. Flameless venting on elevator

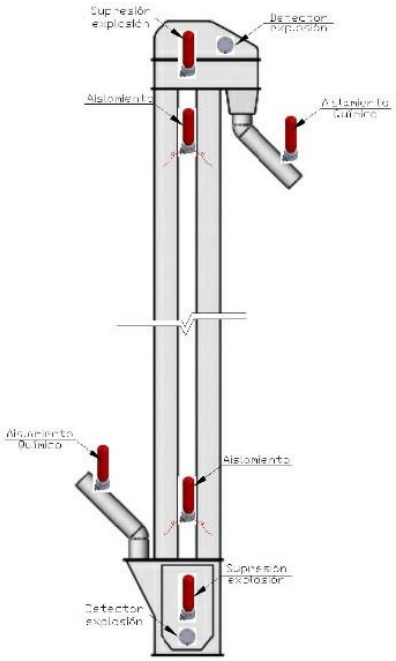

Fig. 4. Elevator suppression system

- Explosion isolation:
    - ✓ Rotary valves certified as isolation system (according to ATEX Directive 2014/34/EU or NFPA 61) installed at product inlet and outlet.
    - ✓ Chemical isolation system (chemical barriers), installed at the product inlet and outlet.
    - ✓ Mechanical isolation by means of a flap valve installed in the dust suction line.

Fig. 5. Flameless venting on elevator

Fig. 6. Elevator suppression system

Note: The implementation of protection systems on bucket elevators should follow a recognised standard or guide (e.g., technical report CEN/TR 16829, VDI 2263 or NFPA 61).

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