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Explosiv atmosfär – Skydd och förebyggande åtgärder mot brand och explosion för skopelevatorer

Fire and explosion prevention and protection for bucket elevators

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TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

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English Version

Fire and explosion prevention and protection for bucket elevators

Prévention et protection contre l'incendie et l'explosion des élévateurs à godets

Brand- und Explosionsschutz für Becherwerke

This Technical Report was approved by CEN on 13 July 2015. It has been drawn up by the Technical Committee CEN/TC 305.

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European foreword

This document (CEN/TR 16829:2016) has been prepared by Technical Committee CEN/TC 305 "Potentially explosive atmospheres – Explosion prevention and protection", the secretariat of which is held by DIN.

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1 Scope

This European Technical Report applies to bucket elevators that may handle combustible products capable of producing potentially explosive atmospheres of dust or powder inside the bucket elevator during its operation. The precautions to control ignition sources will also be relevant where the product in the bucket elevator creates a fire risk but not an explosion risk.

For the purposes of this report, a bucket elevator is defined as an item of bulk material handling equipment that carries material in powder form or as coarse products such as whole grain, wood chips or flakes, in a vertical direction by means of a continuous movement of open containers.

This Technical Report specifies the principles of and guidance for fire and explosion prevention and explosion protection for bucket elevators.

Prevention is based on the avoidance of effective ignition sources, either by the elimination of ignition sources or the detection of ignition sources.

Explosion protection is based on the application of explosion venting, explosion suppression or explosion containment and explosion isolation rules specifically adapted for bucket elevators. These specific rules may be based on agreed test methods.

This European Technical Report does not apply to products that do not require atmospheric oxygen for combustion.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1127-1:2011, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 13237, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

EN 13463-1, *Non-electrical equipment for use in potentially explosive atmospheres — Part 1: Basic method and requirements*

EN 13463-5, *Non-electrical equipment intended for use in potentially explosive atmospheres — Part 5: Protection by constructional safety 'c'*

EN 13463-6, *Non-electrical equipment for use in potentially explosive atmospheres — Part 6: Protection by control of ignition source 'b'*

EN 14373, *Explosion suppression systems*

EN 14460, *Explosion resistant equipment*

EN 14797, *Explosion venting devices*

EN 14491, *Dust explosion venting protective systems*

EN 15089, *Explosion isolation systems*

EN 60079-10-2, *Explosive atmospheres — Part 10-2: Classification of areas — Combustible dust atmospheres*

EN ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100)*

ISO 281, *Rolling bearings — Dynamic load ratings and rating life*

IEC/TS 60079-32-1, *Explosive atmospheres — Part 32-1: Electrostatic hazards, Guidance*

VDI 2263-1, *Dust fires and dust explosions; hazards, assessment, protective measures; test methods for the determination of the safety characteristic of dusts*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13237, EN 15089 and the following apply.

Note 1 to entry: The zones for the classification of hazardous areas are defined in Directive 1999/92/EC.

3.1
volume
3.1.1
bucket elevator leg volume
internal volume of pipe section connecting head to the boot

3.1.2
bucket elevator head volume
internal volume above the leg connection, including outlet section and excluding the volume of the pulley

Note 1 to entry: Attached chutes are not included.

3.1.3
bucket elevator boot volume
internal volume below the leg connection, including inlet section and excluding the volume of the pulley

3.2
vent spacing
distance between vents measured from centre to centre

3.3
bucket spacing
distance between buckets measured from centre to centre

3.4
combustible dust
finely divided solid particles, 500 µm or less in nominal size, which may be suspended in air, may settle out of the atmosphere under their own weight, which can burn or glow in air, and may form explosive mixtures with air at atmospheric pressure and normal temperatures

4 Bucket elevators

4.1 General

Bucket elevators are described as bulk materials handling equipment, conveying material in a vertical direction by means of a continuous movement of open containers. A bucket elevator consists of three main parts: the boot where the material enters the equipment, the leg or legs where the material is transported upwards and the head where the material is discharged. The most common type of bucket elevators generally use open containers fixed to a moving belt or chains. In case of a single leg bucket elevator the belt moves upwards and returns in the same leg. In a twin-leg bucket elevator the returning of the belt occurs in a second leg.

Bucket elevators require special attention since they have been involved in dust explosions and they have many potential ignition sources. The most common ignition sources are due to mechanical problems, for example due to friction between the belt and the casing, heating up of mechanical rotating parts on elevator head and boot, impact of damaged buckets or foreign objects. These mechanical problems may also create explosive atmospheres: impact or vibrations will cause dust deposits in the legs to fall down and create an explosive atmosphere. Therefore if, during normal operation, there is no explosive dust-air mixture present inside a bucket elevator, mechanical problems are still likely to cause an explosion.

NOTE Maintenance related ignition sources like hot work are also very common.

Even if an ignition source does not cause an explosion it may result in a fire and spread quickly because the leg of a bucket elevator acts as a chimney.

Fire and explosion protection of bucket elevators requires special attention. A bucket elevator might be considered as two volumes (head and boot) between which there are one or two long ducts (the legs). The information (see EN 14491) for flame accelerations inside a long duct, however, cannot be applied. The buckets do affect flame acceleration: especially metal buckets which will cool the flame (and reduce flame acceleration). But the buckets also form repeated obstacles which cause increased turbulence and hence promote flame accelerations. Plastic buckets may become part of the fuel for a fire.

4.2 Bucket elevator types

There are many types of bucket elevators. Casing types include twin leg, single leg, and “Z” type. The buckets can be attached to either a belt or a chain and can be made from metal or plastic.

Typical examples of the different types of bucket elevators are included in Annex A.

The Technical Report will focus on vertical bucket elevators. Z type bucket elevators operate at low velocities and thus reduced dust generation and risk of ignition. Measures can be reduced in this case and will not be dealt with in the following.

5 Fire and explosion hazards

5.1 General

A fire or explosion inside a bucket elevator is a large hazard due to the flame and/or pressure effects to the surroundings which may lead to damage to the bucket elevator itself and can lead to damage to the connected equipment, surroundings of the equipment and to personnel.

Consequences of ignition can be a smouldering fire, fire with flames, explosion and a propagating explosion. Following a dust explosion a fire is likely to continue inside or outside the bucket elevator.

If an explosion occurs inside a bucket elevator, it will tend to accelerate, because of the large L/D ratio. Without adequate protection this may cause failure of the bucket elevator and endanger the surroundings: adjacent equipment, buildings and personnel.

When no precautions are included to prevent fire propagation, a highly hazardous situation can occur where a fire or explosion may spread to adjacent sections of the installation, such as silo cells. With explosion propagation, increased turbulence, pre-compression and jet ignition may trigger very violent secondary explosions in these installations.

For a fire or an explosion to occur the following conditions must coincide:

— combustible dust is either deposited or whirled up within the explosion limits;

— sufficient presence of oxygen;

— an effective ignition source.

In bucket elevators the explosion hazard depends very strongly on the bulk material conveyed. In particular the fine fraction of the bulk material with particle sizes less than 500 µm and the dustiness (how easy a dust cloud is formed) play a decisive role here.

If a bulk material contains relevant fractions of dust, an explosion hazard is to be assumed.

Even in the case of low dust concentrations, in time dust can adhere to the bucket elevator casing forming layers inside the bucket elevator that can be a few mm thick. The adhered dust layers are not in themselves explosive mixtures but do form a continuous potential for an explosive mixture: e.g. due to a malfunction of a bucket elevator (belt misalignment) the casing may start vibrating and the adhered dust could become whirled-up and dispersed as an explosive dust cloud.

5.2 Explosion hazards

5.2.1 Presence of explosive atmospheres

The possibility of formation of an explosive atmosphere is very dependent on the product involved and operational conditions either running full or empty.

NOTE External explosive atmospheres can also influence the atmosphere in the elevator. For example the following situations can exist:

Example A	Example B
The bucket elevator is conveying a combustible product with an average particle size smaller than 500 µm or a dusty product containing a considerable amount of fines (here fines are defined as particles less than 100 µm). This implies that during **normal operation** dust clouds may arise frequently inside the bucket elevator and are likely to be above the lower explosion limit (LEL). For this situation it is assumed that a potential explosive atmosphere is frequently present.	The bucket elevator is conveying a coarse product (typically > 1 000 microns) with a very limited amount of fines. For this situation it is assumed that a potential explosive atmosphere is likely to occur occasionally during normal operation.

The process conditions and specific product properties like moisture content, friability, granulometry, flow characteristics and impurities will influence the occurrence of explosive atmospheres A or B.

In both situations dust can stick to the inner surfaces of the bucket elevator. Such dust deposits can pose a fire hazard depending on the burning characteristics. In time these dust layers may accumulate sufficient quantity of material to form an explosive atmosphere should they become dispersed by the action of vibration, shaking etc. For most situations a layer with a thickness of 0,1 mm is sufficient to create a potential explosive atmosphere. Since vibrations and other mechanical movements can be expected, those dust layers can be disturbed to create a potential explosive atmosphere.