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Explosion resistant equipment

Explosionsfeste Geräte

Appareil résistant à l'explosion

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Explosion resistant equipment

Appareil résistant à l'explosion

Explosionsfeste Geräte

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European foreword

This document (prEN 14460:2016) has been prepared by Technical Committee CEN/TC 305 “Potentially explosive atmospheres — Explosion prevention and protection”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 14460:2006.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Introduction

The principles of integrated explosion safety include the following measures the manufacturer has to take:

a) prevention of formation of explosive atmospheres;

b) prevention of the ignition of the explosive atmospheres and;

c) if an explosion nevertheless occurs, to halt it immediately and/or to limit the range of explosion flames and explosion pressures to a sufficient level of safety.

If the ignition hazard assessment of the equipment shows that the prevention of ignition sources doesn't fulfil the requirements of the category for the intended use of the equipment, it is essential that methods according to c) are used.

This standard specifies requirements for equipment that shall be explosion resistant. Explosion resistance is the term applied to the construction of an enclosure so that it can withstand an expected explosion pressure without rupture.

The term “explosion resistance” may be applied to equipment, components and protective systems.

1 Scope

This European Standard specifies requirements for explosion resistant equipment which shall be able to withstand an internal explosion without rupturing and will not give rise to dangerous effects to the surroundings. It is applicable to equipment (vessels and systems) where explosions are considered to be an exceptional load case.

There are two types of explosion resistant equipment: explosion pressure resistant and explosion pressure shock-resistant equipment (see Figure 1).

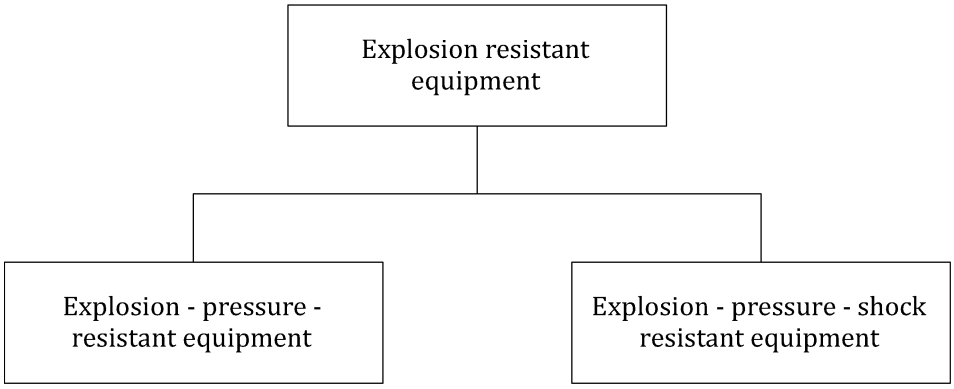

Figure 1 — Explosion resistant equipment

Explosion pressure resistant equipment should be designed to withstand the explosion pressure without permanent deformation and will not give rise to dangerous effects to the surroundings. Since the design and calculation methods for explosion pressure resistant equipment are similar to those described in EN 13445, Part 1 to Part 6 "Unfired pressure vessels" they are not repeated in this standard.

For explosion pressure shock resistant equipment permanent deformation is allowed provided the equipment will not give rise to dangerous effects to the surroundings. This design has been developed especially for explosion protection purposes. This standard focusses on the requirements for explosion pressure shock resistant equipment.

This standard is valid for atmospheres having absolute pressures ranging from 800 mbar to 1 100 mbar and temperatures ranging from −20 °C to +60 °C. This standard may also be helpful for the design, construction, testing and marking of equipment intended for use in atmospheres outside the validity range stated above, as far as this subject is not covered by specific standards.

This standard applies to equipment and combinations of equipment where deflagrations may occur and is not applicable to equipment and combination of equipment where detonations may occur. In this case, different design criteria for the required explosion resistance have to be applied which are not covered by this standard.

It is not applicable to individual items of equipment such as motors and gearboxes that may be designed to withstand an internal explosion, which is the subject of EN 13463-3.

This standard does not apply to offshore situations.

This standard should only be used for equipment where metal provides the explosion resistance. This standard does not cover fire risk associated with the explosions, neither with the materials processed nor with the materials used for construction.

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 ISO 9712, *Non-destructive testing - Qualification and certification of NDT personnel (ISO 9712:2012)*

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 10204:2004, *Metallic products - Types of inspection documents*

EN 13237:2013, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

EN ISO/IEC 80079-34, *Explosive atmospheres - Part 34: Application of quality systems for equipment manufacture (ISO/IEC 80079-34)*

ISO 8421-1:1987, *Fire protection — Vocabulary — Part 1: General terms and phenomena of fire*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13237:2013 and the following apply.

3.1
bolted structure
structures with bolted connections of which the design is not covered in published standards

Note 1 to entry: Bolted structures have to be distinguished from flanged structures which can be designed according to engineering standards. Examples for bolted structures in the sense of this standard are rectangular flanges, fixing of metal sheets with bolts to a steel frame or overlapping sheet constructions.

3.2
deflagration
explosion propagating at subsonic velocity

[SOURCE: ISO 8421-1:1987, 1.11]

3.3
detonation
explosion propagating at supersonic velocity and characterized by a shock wave

[SOURCE: ISO 8421-1:1987, 1.12]

3.4
explosion
abrupt oxidation or decomposition reaction producing an increase in temperature, pressure, or in both simultaneously

[SOURCE: ISO 8421-1:1987, 1.13]

3.5
maximum allowable explosion pressure
p_{exmax}
calculated maximum explosion pressure which the equipment will withstand

4 Explosion resistant equipment

4.1 General

Explosion resistant equipment shall be able to withstand an internal explosion without rupturing and will not give rise to dangerous effects to the surroundings.

The extent of effects which are dangerous to the surroundings depends on the intended use of the equipment. Formation of missiles or the complete rupture of individual parts of the equipment (e.g. gaskets) shall be considered as dangerous effects under any condition.

Components of the system can be either explosion-pressure-resistant or explosion-pressure-shock resistant.

Explosion pressure resistant equipment shall be designed to withstand the explosion pressure without permanent deformation and will not give rise to dangerous effects to the surroundings.

NOTE 1 Explosion pressure resistant equipment can be designed, manufactured and tested according to the state of the art with appropriate safety factors (see Bibliography). Since the design and calculation methods for explosion pressure resistant equipment are similar to those described in EN 13445, Part 1 to Part 6 “Unfired pressure vessels” they are not repeated in this standard.

NOTE 2 If explosions are part of the normal operation (allowed operation pressure) the design rules of this standard do not apply.

For explosion-pressure-shock resistant equipment permanent deformation is allowed provided the equipment will not give rise to dangerous effects to the surroundings. This design has been developed especially for explosion protection purposes. Therefore this standard focusses on the requirements for explosion-pressure-shock resistant equipment.

In general, a distinction is made between the following designs:

— design for the maximum explosion pressure (containment);

— design for the reduced explosion pressure in combination with explosion venting or explosion suppression.

4.2 Design procedure

The procedure for explosion pressure shock resistant design is as follows:

— define geometry;

— define design pressure, temperature and loads (see 4.3, 4.4, 4.5);

— choose materials (see 5);

— define safety factors for material properties (see 6.2.1);

— calculate according to state of the art with engineering standards or finite element methods or prove design by testing.

NOTE See additional information in Bibliography.

4.3 Design pressure

The design pressure shall not be less than the maximum gauge pressure occurring in the equipment, when subjected to explosion or reduced explosion conditions.

If the inside of the equipment is divided into sections (e.g. vessels connected by pipes or containing baffles or surge plates) and an explosion is initiated in one of the sections the pressure in the other sections of the equipment will be increased. As a result, an explosion in these sections will occur at an elevated initial pressure and/or a higher turbulence level. Explosion pressures will thus be higher than the value expected under atmospheric conditions. In the case of such arrangements, appropriate measures shall be taken, either explosion isolation techniques or explosion resistant design derived from representative explosion tests or validated explosion modelling (see informative Annex B).

NOTE 1 Pressures quoted are gauge pressures unless otherwise stated.

NOTE 2 If an explosion is initiated at pressures higher than atmospheric pressure, the maximum explosion pressure will rise proportionally to the initial pressure.

NOTE 3 For guidance on the derivation of design pressure for containment see Annex A, for interconnected vessels and pipes see Annex B. For explosion venting, the design pressure is derived from EN 14491 and EN 14994 for dust and gas explosions respectively. For explosion suppression, the design pressure is given by the manufacturer of the explosion suppression system according to EN 14373.

4.4 Design temperature

In case of an explosion the vessel walls will generally not heat up significantly. Therefore, the intended operating temperatures (minimum and maximum) at the initial pressure shall be used as the design temperatures.

The effect of higher gas temperatures caused by exothermic reactions (e.g. subsequent fire) should be considered for gaskets and bolts. Depending on the dimensions of the equipment fully contained light-metal dust explosions could give rise to elevated wall temperatures which should be assessed.

4.5 Additional loads

Loads which are due to an activation of a venting device, due to product load and/or to hydrostatic load shall be considered. In addition any other load that can occur at the same time as an explosion e.g. wind load, snow load, shall be considered.

If brittle material is used for pressure shock-resistant apparatus and components, care shall be taken to avoid excessive or uneven stressing during assembly.

4.6 Wall thickness allowance

Corrosion and/or erosion allowances shall be implemented according to the intended use (see Clause 8). This shall be deducted from the design wall thicknesses before design calculations are carried out.