SIST

SLOVENSKI STANDARD
SIST EN 14460:2018

01-maj-2018

Nadomešča:
SIST EN 14460:2006

Eksplozijsko vzdržljiva oprema

Explosion resistant equipment

Explosionsfeste Geräte

Appareil résistant à l'explosion

Ta slovenski standard je istoveten z: EN 14460:2018

ICS:

13.230	Varstvo pred eksplozijo	Explosion protection
29.260.20	Električni aparati za eksplozivna ozračja	Electrical apparatus for explosive atmospheres

SIST EN 14460:2018 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14460

January 2018

ICS 13.230; 29.260.20

Supersedes EN 14460:2006

English Version

Explosion resistant equipment

Appareil résistant à l'explosion

Explosionsfeste Geräte

This European Standard was approved by CEN on 17 December 2017.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN 14460:2018 E

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European foreword

This document (EN 14460:2018) 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 European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 2018, and conflicting national standards shall be withdrawn at the latest by July 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14460:2006.

This document has been prepared under a standardization request 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.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

The principles of integrated explosion safety include the following measures the manufacturer needs 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 does not 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 will 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).

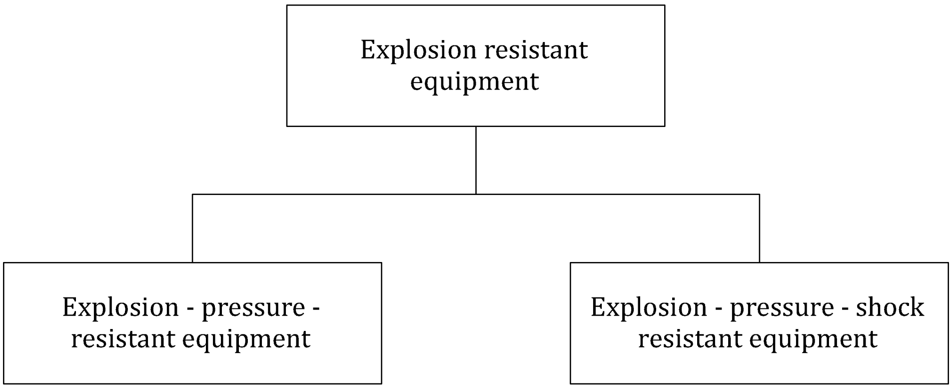

Figure 1 — Explosion resistant equipment

Explosion pressure resistant equipment is 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 13445-1 to -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 are applicable which are not covered by this standard.

It is not applicable to equipment which is designed according to type of protection, flameproof enclosures “d” (EN 13463-3 or EN 60079-1).

This standard does not apply to offshore situations.

This standard is only applicable for equipment where metallic materials provide 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 10204:2004, *Metallic products — Types of inspection documents*

EN 13018, *Non-destructive testing — Visual testing — General principles*

EN 13237:2012, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

EN ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature (ISO 6892-1)*

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13237:2012 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 will 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
maximum allowable explosion pressure
p_{exmax}
maximum explosion pressure which the equipment will withstand

4 Explosion pressure shock resistant equipment

4.1 General

This standard focusses on the requirements for explosion-pressure-shock resistant equipment.

With explosion-pressure-shock resistant equipment permanent deformation is allowed provided the equipment will not give rise to dangerous effects to the surroundings. The tolerable extent of effects on the surroundings depends on the intended use of the equipment. Formation of missiles or the rupture of individual parts of the equipment (e.g. gaskets) shall be considered as dangerous effects under any condition.

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

— design for the maximum explosion pressure;

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

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

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 Clause 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 single vessels 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 (see 5.3) 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.

5 Materials for pressure shock resistant design

5.1 General

Yield and rupture stress for materials may be taken from engineering tables. Alternatively, values from material certification according to EN 10204:2004, 3.1 may be used to define the permissible design stresses. The material certification may also be used to classify the material with respect to ductility.

Material certification is required for quality documentation depending on the chosen values (see Clause 7).

The material of gaskets or seals shall withstand the explosion pressure and impact of flames during explosion. This includes the avoidance of failure due to mechanical forces and the thermal impact of flames and hot gases. Dangerous effects to the surroundings shall be prevented.

5.2 Criteria for ductile materials

For explosion pressure shock resistant design, only materials shall be used which fulfil the mechanical, thermal and chemical requirements of the design and intended use of the equipment. Minimum requirements for the materials shall be valid over the complete range of temperatures for the intended use. Special attention shall be given to brittle behaviour at low temperatures.

Ductile materials in the sense of EN 14460 are:

a) steel (ferritic or austenitic) and spheroidal graphite castings with

   1) rupture elongation $A_5 \geq 14$ %, test temperature 20 °C; and

      NOTE 1 For further information on A_5 see EN ISO 6892-1.

   2) notch impact energy ≥ 27 J, ISO V-notch.

      The test temperature shall not be higher than the lowest intended operating temperature and shall not exceed 20 °C.

      NOTE 2 For further information on ISO V-notch see EN ISO 148-1.

   The term “steel” covers e.g. ferrite, austenitic and cast steel. The material properties of these shall be assessed against the given criteria for ductility.

b) aluminium with

1) rupture elongation $A_5 \geq 20$ %, test temperature 20 °C; and

2) notch impact energy not relevant.

5.3 Criteria for brittle materials

For materials not fulfilling the criteria of 5.2 the design stresses for brittle materials in 6.2.1 shall be used.

NOTE Typical brittle materials are flake graphite castings, cast aluminium G-Al Mg 5 and G-Al Si Mg wa.

For testing, brittle materials may be subdivided into two groups:

— materials with high notch impact energy: Materials with minimum notch impact energy of 14 J (mean value of three tests), single values shall not be less than 11 J;

— materials with low notch impact energy: Materials not fulfilling notch impact energy criteria.

6 Explosion pressure shock resistant design

6.1 General

Explosion pressure shock resistant equipment shall be designed such that it can withstand the maximum or reduced explosion pressure without rupturing, but may become permanently deformed [see 8.2 i)].

Explosion pressure shock resistant equipment shall be designed or tested either by

a) design according to 6.2, documentation of quality according to 7.2, 7.3 and 7.4 for each item, or

b) pressure or explosion test as a type test according to 6.3, documentation of quality according to 7.2, 7.3 and 7.4 for each item.

6.2 Design

6.2.1 Definition of permissible stresses

NOTE 1 During short durational loading, the yield stress of metals increases, but the ultimate strength is hardly effected. The actual increase in yield stress depends on the strain rate (1/s) and the characteristics of the metal involved. For explosion pressure resistant design the strain rate is typically in the order of 10^{-4} – 10^{-2} 1/s. For carbon steel only a minor increase in yield stress will arise at such loading rates ((0 – 15) %). However, the duration of the loading is rather long (typically 0,1 s – > 1 s) and the increase in yield stress will be even lower. As a consequence, for explosion protection, it is a correct and safe approach to apply the normal yield stress.

It is possible to use verification by engineering rules or finite element methods.

NOTE 2 See Bibliography for further references.

Detailed design features which can lead to cracking shall be avoided. This requires limitation of stress concentrations (for examples see Annex E).

If design is done according to technical standards (membrane or two-dimensional stress), the permissible stresses are as follows:

Ductile ferritic material $f_{df} = R_{p0,2}\left(\vartheta\right) / 1$

Ductile austenitic material $f_{da} = R_{2\%}\left(\vartheta\right) / 1$