SLOVENSKI STANDARD
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Sistemi za razbremenitev tlaka plinskih eksplozij

Gas explosion venting protective systems

Schutzsysteme zur Druckentlastung von Gasexplosionen

Systemes de protection par évent contre les explosions de gaz

Ta slovenski standard je istoveten z: EN 14994:2007

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Gas explosion venting protective systems

Systèmes de protection par évent contre les explosions de gaz

Schutzsysteme zur Druckentlastung von Gasexplosionen

This European Standard was approved by CEN on 15 December 2006.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 14994:2007) 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of an identical text or by endorsement, at the latest by August 2007, and conflicting national standards shall be withdrawn at the latest by August 2007.

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 94/9/EC.

For relationship with EU Directive 94/9/EC, 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, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies the basic design requirements for the selection of a gas explosion venting protective system. This European Standard, EN 14797 and EN 14460 form a series of three standards which are used together.

NOTE 1 These three standards together represent the concept of gas explosion venting.

NOTE 2 To avoid transfer of explosions to other communicating equipment one should also consider applying prEN 15089.

This European Standard is applicable to:

— vent sizing to protect against the internal pressure effects of a gas explosion;

— flame and pressure effects outside the enclosure;

— recoil forces;

— influence of vent ducts;

— influence of initial temperature and pressure.

This European Standard does not provide design and application rules against effects generated by detonation reactions or runaway exothermic reactions including decomposition in the gas phase.

This European Standard is not applicable to:

— fire risks arising either from materials processed, used or released by the equipment or from materials that make up equipment and buildings;

— design, construction and testing of explosion venting devices, which are used to achieve explosion venting[1];

— protection against overpressures caused by events such as overfilling, overpressurisation, fire engulfment, overheating etc.

NOTE 3 Protection by venting against dust and hybrid explosions is specified in EN 14491.

2 Normative references

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

EN 1127-1:1997, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 13237:2003, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

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[1] This is covered by EN 14797.

EN 13673-1, *Determination of the maximum explosion pressure and the maximum rate of pressure rise of gases and vapours — Part 1: Determination of the maximum explosion pressure*

EN 13673-2, *Determination of maximum explosion pressure and the maximum rate of pressure rise of gases and vapours — Part 2: Determination of the maximum rate of explosion pressure rise*

EN 14797:2006, *Explosion venting devices*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1127-1:1997 and EN 13237:2003 and the following apply.

3.1
atmospheric conditions
conditions of the surrounding medium where the atmospheric pressure can vary between 80 kPa and 110 kPa and the temperature between – 20 °C and 60 °C

3.2
gas
for the purpose of this European Standard, gas, vapour or any mixture thereof at atmospheric conditions

3.3
compact enclosures
enclosures having a length (height) to diameter ratio of less than 2

[EN 14373:2005, 3.14.1]

NOTE The length L is calculated along the axis parallel to the main flow during the explosion, with D being the diameter measured perpendicular to this axis. For non-circular cross-sections, D is the diameter of a circle with the same area as the actual cross-sectional area.

3.4
elongated enclosures
enclosures with length (height) to diameter ratio of 2 to 10

[EN 14373:2005, 3.14.2]

NOTE The length L is calculated along the axis parallel to the main flow during the explosion, with D being the diameter measured perpendicular to this axis. For non-circular cross-sections, D is the diameter of a circle with the same area as the actual cross-sectional area.

3.5
pipe
construction with a ratio length (height) to diameter greater than 10

[EN 14373:2005, 3.14.3]

NOTE The length L is calculated along the axis parallel to the main flow during the explosion, with D being the diameter measured perpendicular to this axis. For non-circular cross-sections, D is the diameter of a circle with the same area as the actual cross-sectional area.

3.6
explosion venting device
device which protects a vessel or other closed volume by explosion venting

[EN 14797:2006, 3.4]

NOTE Examples of such devices are: bursting discs, vent panels and explosion doors.

3.7
effective vent area
A_E
product of the geometric vent area A_d and the venting efficiency E_f for the venting device.

NOTE It is the effective vent area that should be used in making up the vent area for explosion venting

[EN 14797:2006, 3.2]

3.8
gas explosion constant
K_G
maximum value of the pressure rise per unit time $(dp/dt)_{max}$ during the explosion of a specific explosive atmosphere in a closed vessel under specified test conditions normalised to a vessel volume of 1 m^3 multiplied by $V^{1/3}$

3.9
static activation pressure
p_{stat}
differential pressure at which the retaining element activates such that the venting element is able to open

[EN 14797:2006, 3.11]

3.10
turbulence
motion of a fluid having local velocities and pressures that fluctuate randomly

NOTE Turbulence is a very effective transporter and mixer, and generally causing an overall increase of combustion rates.

3.11
turbulence inducing elements
obstructions inside protected enclosures at which during an explosion turbulence is generated increasing the combustion rate

3.12
venting efficiency
E_f
dimensionless number used to define the efficiency of the explosion venting device

[EN 14797:2006, 3.14]

4 Venting of enclosures

Explosion venting is a protective measure preventing unacceptable high explosion pressure build-up inside enclosures.

Weak areas in the walls of the enclosure open at an early stage of the explosion, releasing un-burnt gas/vapour and combustion products from the opening so reducing the overpressure inside the enclosure.

Normally the explosion venting is applied such that the maximum reduced explosion pressure shall not exceed the known design pressure of the enclosure. All parts of the enclosure e.g. valves, sight-glasses, man-holes and ducts, which are exposed to the explosion pressure shall be taken into account when estimating the design pressure of the enclosure.

The vent area is the most important factor in determining the maximum reduced explosion pressure. Information required for calculation of the vent area includes the design pressure of the enclosure, the explosion characteristics of the gas, the shape and size of the enclosure, presence of turbulence inducing elements (including congestion) inside the enclosure, the static activation pressure and other characteristics of the venting device, and the condition of the explosive atmosphere inside the enclosure.

Venting does not prevent an explosion, it limits the explosion pressure. Flame and pressure effects outside the enclosure and flying debris shall be expected and in practice accounted for.

In a system consisting of two connected enclosures, a gas explosion ignited in one can propagate into the second. The propagation of this explosion generates turbulence, can cause pre-compression and can act as a large ignition source in the second enclosure. This combination can enhance the violence of the secondary explosion (see 5.6).

Turbulence inducing elements such as shelves in a drying oven may cause considerably more violent gas explosions. This will increase the venting requirements. As this mechanism is not covered by the general method presented in this standard, more intricate methods may need to be applied. In the informative Annex A rules are given when to apply the general method of the present standard and when one shall use more intricate methods if turbulence inducing elements are present. A general description of intricate methods is given in the informative Annex A together with requirements for the experimental validation of these methods.

5 Venting of isolated compact enclosures

5.1 General

Venting devices shall comply with the requirements of EN 14797. Two principle venting device parameters are p_{stat} and E_f, which is affected by values of vent cover inertia and enclosure volume.

Accurate sizing of vents is the most important aspect of vent design. Venting requirements depend in practice on the combustion characteristics of the gas, the state of the flammable mixture (concentration, turbulence, distribution), and the geometry of the enclosure (including the presence of turbulence inducing elements).

Combustion characteristics of flammable gases shall be measured according to appropriate methodologies. In this European Standard the combustion characteristics gas explosion constant K_G and maximum explosion pressure p_{max} are used. The gas explosion constant is derived from the maximum rate of pressure rise $(dp/dt)_{max}$. The latter characteristic and the maximum explosion pressure p_{max} shall be determined according to EN 13673-2 and EN 13673-1 respectively.

5.2 Venting of isolated compact enclosures

A method to size vent openings of compact enclosures is presented. The method applies to isolated enclosures essentially free from turbulence inducing elements (see 5.3.5). Appropriate measures (explosion isolation) shall have been taken to prevent explosion propagation to/and from other enclosures.

The method assumes that the explosive atmosphere inside the enclosure is essentially quiescent at the time of ignition.

According to this method the vent area shall be calculated using the following equation:

$$A = \left\{ \left[\left(0{,}1265 \lg \left(K_G \right) - 0{,}0567 \right) p_{red}^{\;-0{,}5817} \right] + \left[0{,}1754 \; p_{red}^{\;-0{,}5722} \left(p_{stat} - 0{,}1\, bar \right) \right] \right\} V^{2/3} \quad (1)$$

$$A_V = \frac{A}{E_f} \quad (2)$$

where

A is the geometrical vent area (E_f = 1), in m²;

A_v is the vent area of an explosion venting device with efficiency E_d < 1, in m²;

K_G is the gas explosion constant, in bar·m·s^{-1};

p_{red} is the reduced explosion overpressure, in bar;

p_{stat} is the static activation pressure of explosion venting device, in bar;

E_f is the venting efficiency of explosion venting device;

V is the volume, in m³.

Equations (1) and (2) are valid for:

— isolated enclosures essentially free from turbulence inducing elements;

— $K_G \leq 550$ bar·m/s;

— 0,1 bar $\leq p_{stat} \leq$ 0,5 bar;

— $p_{red} \leq 2$ bar;

— $p_{red} > p_{stat} + 0{,}05$ bar;

— $V \leq 1\,000$ m^3;

— $L/D \leq 2$;

— initial conditions: atmospheric;

— E_f = 1 for explosion venting devices with an area specific mass of less than 0,5 kg/m^2;

— E_f = 1 for explosion venting devices with an area specific mass greater than 0,5 kg/m^2 and smaller or equal to 10 kg/m^2 provided $A_v/V^{0{,}753} < 0{,}07$, where A_V is the vent area and V the vessel volume. This is valid for $p_{stat} \leq 0{,}1$ bar and 0,1 bar $< p_{red} <$ 2 bar;

— for all other conditions and for explosion venting devices with an area specific mass greater than 10 kg/m^2 the efficiency E_f has to be determined by tests (see EN 14797).

5.3 Situations outside the constraints of the basic method (turbulence inducing elements, partially filled enclosures)

5.3.1 General

The methods proposed in 5.3.2 to 5.3.4 apply to isolated compact enclosures essentially free from turbulence inducing elements.

5.3.2 Elevated initial pressure

The following equation shall be used for estimating reduced explosion pressures when the initial pressure is above atmospheric pressure:

$$p_{red2} = p_{red1} \left(p_2 + 1\right)^{\gamma} \quad (3)$$

where

p_2 is the elevated initial gauge pressure, in bar;