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Flameless explosion venting devices

Einrichtungen zur flammenlosen Explosionsdruckentlastung

Dispositifs de décharge d'explosion sans flamme

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Foreword

This document (EN 16009:2011) 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of an identical text or by endorsement, at the latest by January 2012, and conflicting national standards shall be withdrawn at the latest by January 2012.

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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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies the requirements for flameless explosion venting devices used to protect enclosures against the major effects of internal explosions arising from the rapid burning of suspended dust, vapour or gas contained within. It includes the requirements for the design, inspection, testing, marking, documentation, and packaging. This standard is applicable to flameless explosion venting devices which are put on the market as autonomous protective systems.

Explosion venting devices are protective systems comprised of a pressure sensitive membrane fixed to, and forming part of, the structure that it protects. They are designed to intervene in the event of an explosion at a predetermined pressure, to immediately open a vent area sufficient to ensure that the maximum pressure attained by an explosion within the enclosure does not exceed the maximum pressure the structure is designed to withstand.

Flameless explosion venting devices typically consist of an explosion venting device in combination with a flame quenching element to avoid the transmission of flames into the surroundings. They are used to allow explosion venting in situations where otherwise the hazards of flames and pressure resulting from the venting would harm personnel or damage structures.

The application and specification of explosion venting devices is outlined for dust explosion protection in EN 14491 and for gas explosion protection in EN 14994.

This European Standard covers the flameless explosion venting of dust, vapour and gas explosions.

This European Standard does not cover details for the avoidance of ignition sources from detection devices or other parts of the flameless explosion venting devices.

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

EN 14491, *Dust explosion venting protective systems*

EN 14797:2006, *Explosion venting devices*

EN 14994, *Gas explosion venting protective systems*

EN ISO 16852:2010, *Flame arresters — Performance requirements, test methods and limits for use (ISO 16852:2008, including Cor 1:2008 and Cor 2:2009)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13237, EN 14491, EN 14994, EN 14797 and the following apply.

3.1
flameless explosion venting
explosion venting protective measure which will in addition prevent the transmission of flames and reduce the external explosion effects

NOTE Examples of external explosion effects are; temperature, pressure and dust/combustion products.

3.2
flameless explosion venting device
device which protects a vessel or other closed volume by flameless explosion venting

3.3
flame quenching element
part of the flameless explosion venting device that prevents flame transmission and reduces the external explosion effects

Table 1 — Symbols and their descriptions

Symbol	Description	Units
$V_{\text{max, FV}}$	largest volume that can be protected by one single flameless venting device	m^3
$p_{\text{red, V}}$	the highest reduced explosion pressure for venting only	bar
$p_{\text{red, FV}}$	the highest reduced explosion pressure for flameless venting	bar

4 Requirements

4.1 General requirements

Flameless explosion venting devices consist of an explosion venting device and a flame quenching element as a minimum. Flame quenching elements shall be suitable for the intended use (e.g. temperature range, mechanical strength, fuel type).

Explosion venting devices shall be designed according to EN 14797. Material used for the parts of explosion venting devices shall be selected on the basis of their suitability with regard to the chemical and physical conditions to which they will be subjected in service.

Dust leaking from the process into the flame quenching element can impair the efficiency of the venting, which shall be avoided.

The performance capability of a flameless explosion venting device can be influenced by e.g.:

a) the fuel characteristics (gas, vapour, dust):

   1) minimum ignition temperature (MIT), minimum ignition energy (MIE) (dusts);

   2) maximum experimental safe gap (MESG) (gases, vapours);

   3) the maximum K_G or K_{St}-values specified by the manufacturer;

   4) the heat of combustion liberated during the explosion event;

   5) flame temperature;

   6) particle size and distribution, shape (dusts);

7) melting characteristics (dusts);

NOTE 1 During the venting process, burnt, unburnt dust or explosion products can partially block the flame quenching element, which can lead to reduced venting efficiency. Specific testing to determine this effect can be necessary.

b) the maximum reduced explosion overpressure $p_{red, max}$ specified by the manufacturer;

c) the venting efficiency E_f of the combination flame quenching element and venting device;

d) volume and L/D ratio.

Flameless explosion venting devices shall be designed to maintain their specified performance taking into account environmental, process and product conditions.

All parts of the flame quenching element shall resist the expected mechanical, thermal and chemical loads of the intended use. During or after the venting process, deformations of the flameless explosion venting device may occur. This shall not lead to gaps in the housing that could lead to flame transmission into the surrounding. The flame quenching capability of the device shall be demonstrated by tests according to 6.3.5.

It is mandatory to use detection devices sensing venting device function. The user shall use the signal to bring the plant process to a safe status when the flameless venting device operates.

Gaskets or seals forming part of an explosion venting device shall be compatible with the chemical, thermal, mechanical and environmental demands of the application.

NOTE 2 Due consideration should be given to the external effects with particular attention to the risk of a secondary explosion external to the flameless venting device. For more information, see 6.4.

NOTE 3 Due consideration should be given to equipment related sources of ignition in the design and material specification of flameless explosion venting devices; e.g. static electricity, heating and detection devices. Requirements for equipment-related sources of ignition in electrical and non-electrical equipment should apply as specified in EN 1127-1.

4.2 Flameless explosion venting system design

Flameless explosion venting system shall be sized according to EN 14491 or EN 14994 taking into account the efficiency as determined in Clause 6. Unique to the use of flameless venting devices is that the effective vent area will be adversely impacted by flow resistance and possible blockage.

The use of flameless explosion venting devices for applications other than described in EN 14491 or EN 14994 shall be carefully evaluated and where appropriate their suitability shall be confirmed by tests.

The maximum volume to be protected by a single flameless explosion venting device shall be limited to the volume of the test vessel the device was tested on during type testing, see also Clause 6.

If a single flameless explosion venting device is not sufficient to protect a volume due to this limitation, multiple flameless explosion venting devices of the same type and the same dimension shall be used. If the volume to be protected is n times $V_{max, FV}$, at least n devices shall be used, for a calculated example see Annex B. The protected volume shall be maximum 4 times $V_{max, FV}$.

NOTE For more information on the maximum volume to be protected, see 6.3.2.

5 Types of flameless explosion venting devices

Flameless explosion venting devices consist of an explosion venting device in combination with a flame quenching element and, where fitted, an integrated particle retention element (for dusts). The explosion venting device can be of various types, outlined in EN 14797. Examples of flame quenching elements are

- ribbon type,
- parallel plate,
- mesh or gauze,
- ceramic.

NOTE Examples of different types are included in Annex A.

6 Testing of flameless explosion venting devices

6.1 General

The manufacturer shall specify the intended use and the devices to be tested:

- process conditions;
- range of nominal sizes of the device;
- p_{stat} of the explosion venting device;
- maximum intended volume to be protected;
- maximum intended volume to be protected by one single device;
- $p_{red, max}$;
- dust and/or gas characteristics;
- any limitations with respect to orientation;
- type and construction of the device (e.g. material specification, physical dimensions) and other parameters relevant for production quality control.

Flameless explosion venting devices shall be subject to type testing for a given dust (see 6.2.1), gas/vapour or mixture thereof to determine

a) external effects;

b) mechanical integrity;

c) venting efficiency;

d) static activation pressure of the venting device according to EN 14797;

e) flame quenching;

f) ignition hazards introduced by the device, before and during the venting process;

g) functional safety of the detection device to sense vent function;

NOTE The functional safety of a detection device to sense vent function is not considered to be part of this standard, for further information see e.g. EN 15233, EN 61508-series, EN 62061 and EN ISO 13849-1.

h) volume limitations (single device, multiple devices);

i) the effect of any cover or insulation.

The flameless explosion venting devices shall be mounted on the test vessel either directly or by means of an appropriate adapter. The vent area of the explosion venting device shall not be larger than the vent opening in the test vessel. The device shall be mounted in the recommended orientation advised by the manufacturer. This shall be in the worst-case orientation in which the device is allowed to be used.

6.2 Dust and gas characteristics

6.2.1 Dust for functional testing

Flame transmission can be affected by MIE, MIT, p_{max} and K_{St} of the dust. Flame quenching can be assumed for dusts having MIE, MIT values higher than the test dust and p_{max} and K_{St} values lower than the test dust.

Flame transmission tests will also provide information on the venting efficiency of the flameless explosion venting device. Venting efficiency of the flameless explosion venting device can be adversely affected by

— blockage of the flame quenching element due to

  — coarse dust,

  — fibrous dust,

  — melting dust,

  — other characteristics which can lead to blockage,

— overheating as a result of high combustion temperatures or the extended exposure of the flame quenching device.

To extend the intended use beyond the test dust, comparative tests shall be performed in a volume of choice.

To confirm the applicability of flameless venting for a metal dust, the device shall be tested with that specific dust in a volume and at a p_{red} which are representative for the application.

6.2.2 Gases for functional testing

Gases for functional testing shall represent the intended use with respect to MESG and explosion group (IIA1, IIA, IIB1, IIB2, IIB3, IIB, IIC).

See EN ISO 16852:2010, Table 2.

6.3 Functional testing

6.3.1 General

The tests shall be carried out in accordance with EN 14797. Additional requirements result from the following subclauses.

6.3.2 Volume of test vessel and $V_{max, FV}$

The test vessel size shall limit the volume on which a single flameless venting device can be used.

For intermediate sizes that are not tested (see EN 14797), the largest volume that can be protected is given by:

$$V_{\text{max, FV, 2}} = V_{\text{max, FV, 1}} \times \frac{A_2}{A_1} \tag{1}$$

where

A_1 is the vent area of the tested size;

A_2 is the vent area of the non tested size of identical design than the tested device with $A_2 < A_1$;

$V_{\text{max, FV, 1}}$ is the largest volume that can be protected by one device with vent area A_1 (from testing);

$V_{\text{max, FV, 2}}$ is the largest volume that can be protected by a non tested size with vent area A_2.

6.3.3 Venting device and p_{stat}

The venting device which is an integral part of the flameless explosion venting device or explosion venting devices approved for use in combination with the flame quenching device element shall be listed and tested for static activation pressure according to EN 14797.

For re-usable devices the static activation pressure shall be retested after each explosion test. In addition the leak tightness of the explosion venting device shall be verified.

6.3.4 Explosion testing for mechanical integrity

The mechanical integrity of the flameless explosion venting device, including items such as covers, shall be assessed by explosion tests according to EN 14797.

6.3.5 Explosion testing for flame transmission

All tests shall be optically recorded. In order to ascertain whether a flame transmission occurred, at least two cameras shall be used to capture different views of the test. If flame transmission occurs, the flameless venting device fails the test. If burning/glowing particles are observed, then restrictions for the intended use must be given (see Clause 7).

For gases, the pre-volume flame arrester test according to EN ISO 16852:2010, 7.3.2.3. shall be carried out.

6.3.6 Venting efficiency of flameless explosion venting devices

The venting efficiency of the complete flameless explosion venting device, including all added elements, such as covers, shall be assessed by explosion tests according to EN 14797.

To determine the lowest venting efficiency of the flameless venting device, tests shall be carried out at the highest p_{red} and across a range of concentrations as the optimum concentration for K_{St} may not represent the worst case for blockage, see Annex C.

The pressure generated ($p_{red, max}$) in all tests shall be minimum p_{stat} + 100 mbar.

6.4 External effects

In order to confirm or determine the safety distance and external effects, the following shall be measured and documented, as a minimum with the largest test vessel and highest reduced explosion pressure for flameless venting ($p_{red, FV}$):

— outside surface temperature of the flameless explosion venting device (e.g. by infrared recording);

— local gas temperature outside of the device, for the full duration of the event (e.g. by thermocouples);