BS EN 16009:2011

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Flameless explosion venting devices

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EXL/23, Explosion and fire precautions in industrial and chemical plant.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Einrichtungen zur flammenlosen Explosionsdruckentlastung

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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of an identical text or by endorsement, at the latest by January 2012, and conflicting national standards shall be withdrawn at the latest by January 2012.

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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 $p_{\text{red, max}}$ 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 $V_{\text{max, FV}}$, at least n devices shall be used, for a calculated example see Annex B. The protected volume shall be maximum 4 times $V_{\text{max, FV}}$.

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:

$$V_{\max,\mathrm{FV},2} = V_{\max,\mathrm{FV},1} \times \frac{A_2}{A_1} \quad (1)$$

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 $A_2 < A_1$;

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

$V_{\max,\mathrm{FV},2}$ 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);

— side-on blast pressure in direction of the exhaust flow;

— estimation of the size of the visible cloud emitting from the flameless explosion venting device from the video recordings during the explosion event.

The external overpressure and temperature shall be measured perpendicular to the vent at distances of typically 1 m, 5 m and 10 m. This information shall be used to define a safety perimeter surrounding the device including the pressure hazard and the thermal hazard.

NOTE 1 Pressure hazards to be considered are forces that will impact personnel and damage structures, including reflected and reaction forces. Pressures exceeding 70 mbar are unacceptable where personnel can be present. Lower pressures can impact structures and lead to secondary risks to personnel.

NOTE 2 Thermal hazards: Although the duration of the event is short, the released hot gases can present an exposure hazard.

6.5 Test report

The requirements in EN ISO/IEC 17025 shall be fulfilled. As a minimum the following shall be reported:

a) product characteristics:

   1) nature of the sample,

   2) sample pre-treatment,

   3) characteristics data for particle size distribution and moisture content (for dust only),

   4) type of fuel and all relevant safety characteristics (e.g., p_{max}, K_{max}, gas group);

b) characteristics of the test rig:

   1) dimensional sketch of the test rig,

   2) enclosure volume, aspect ratio, surface area,

   3) dust-dispersion system (for dust only),

   4) explosion characteristics of the fuel (sample) in the test enclosures,

   5) ignition delay time (turbulence index);

c) characteristics of the flameless explosion venting device:

   1) type and construction including, but not limited to;

      i) material specification,

      ii) physical dimensions,

      iii) parameters relevant for production quality control,

   2) static activation pressure of the venting device;

d) results:

   1) venting efficiency,

2) $p_{\text{red, max}}$,

3) surface temperature and external pressure,

4) result of flame transmission test,

5) observations on external effects;

e) additional information:

The report shall include a reference to this standard, all pertinent observations and information, which are not fully described above e.g. permanent deformation, change in burst pressure for reusable devices.

7 Information for use

Information for use, installation and maintenance of flameless explosion venting devices shall be issued by the manufacturer and shall include as a minimum the information according EN 14797:2006, Clause 8 and the pertinent design information resulting from Clause 4.

To ensure the safe operation of the flameless venting device, in particular the following shall be included:

a) The limits of application which are:

1) the fuel characteristics:

i) the dust characteristics according to 6.2.1,

ii) the gas characteristics according to 6.2.2,

2) $p_{\text{red, max}}$,

3) maximum volume to be protected with a single device;

b) flameless explosion venting efficiency;

c) maximum surface temperature;

d) information on external effects (such as temperature, pressure and external dust cloud) and safety distances;

e) any limitations with respect to installation, weather conditions (snow and ice) and orientation, for instance to limit the possibility to have dust accumulations on the process side of the venting device or the need for a protective cover;

f) procedures regarding re-use and inspection of reusable elements;

g) recommendations on regular inspection of the device for critical aspects affecting the functionality such as leakage of the explosion venting device, clogging of the flame quenching element;

h) proximity of personnel;

i) pressure build up in the room;

j) possibility of combustible mixtures exterior to the enclosure.

Flameless venting devices which do not retain particles are only permitted to be used when a restricted area around the device has been identified and access during operation of the protected equipment is prohibited.

This area is to be based on the external volume that can be filled with an explosive dust/air cloud during the venting process. Furthermore, there shall not be any effective ignition sources within this area.

The device shall not be used in areas where potentially explosive atmospheres can be generated if burning/glowing particles are observed emitting from the flameless explosion venting device in any of the tests.

The immediate area surrounding of the flameless explosion venting device vent can experience overpressure and radiant energy. Venting indoors has an effect on the building that contains the protected equipment due to increased pressurization of the surrounding volume. Expected overpressure as a result of flameless indoor venting shall be compared to the building design strength. The pressure effect shall be determined based on estimating the exhaust gas volume and temperature, see Annex D for more information.

In addition, the pressure load on structures, including recoil forces and the pressure decrease with distance shall be evaluated using the data obtained from testing.

8 Marking

The markings shall be permanent and shall not impair the performance of the explosion venting device and, where practicable, shall be such that they are visible after installation.

Each flameless explosion venting device shall be marked, preferably on an identification plate, securely attached to the device.

The marking shall include at least the following:

— name and contact details of the manufacturer;

— year of construction;

— designation of series or type, if any;

— serial or identification number;

— rating information (flange rating, static activation pressure);

— type of explosion venting device unless integrated.

9 Packaging

Flameless explosion venting devices or their parts shall be packed to prevent any damage which can impair their performance as specified in EN 14797.

Annex A
(informative)

Examples/types of flameless explosion venting devices

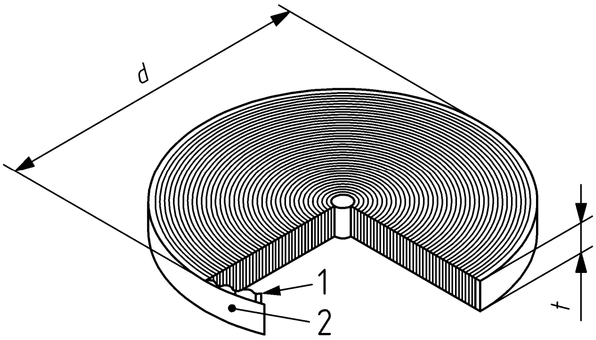
A.1 General

Flameless explosion venting devices typically consist of an explosion venting element 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 the hazards of flames resulting from the venting action are not acceptable.

Flame quenching elements used in this context prevent the propagation of a flame front from inside of a vessel to the outside (surroundings).

Flame quenching elements employ a medium, known as the matrix, inside a casing that extinguishes the flame.

A.2 Ribbon type flame quenching element



Key

1	crimped ribbon	d	element diameter
2	flat ribbon	t	element thickness (ribbon width)

Figure A.1 — Ribbon type flame quenching element

Ribbon type quenching elements are made of alternating layers of thin, corrugated metal ribbons and flat metal ribbons of the same width, which are wound together on a mandrel to form a many-layered cylinder of the desired diameter. The spaces between the corrugations and the flat ribbon provide multiple small passages of approximately triangular shape. Elements can be made in a variety of crimp heights and angles, ribbon and element thicknesses, and diameters.

A.3 Parallel plate type flame quenching element

These elements contain solid metal plates or rings arranged perpendicular to the gas flow direction and separated from each other by a small spacing. The spacing is maintained by gaskets or nubs on the plates.

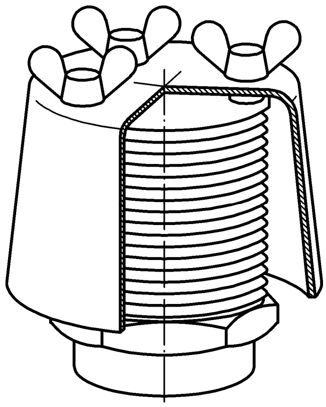
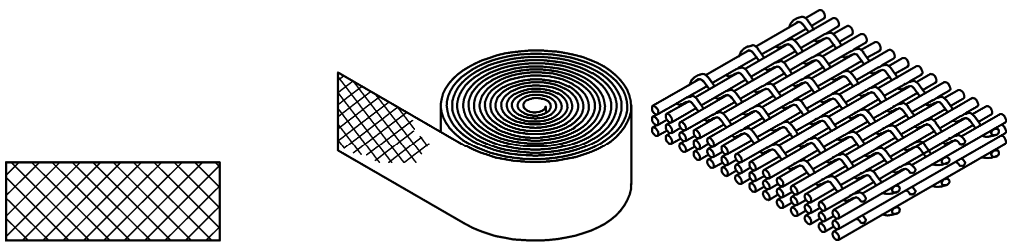


Figure A.2 — Parallel plate type flame quenching element

A.4 Mesh or gauze type flame quenching element

The mesh or gauze flame quenching element is consisting of several layers. The mesh material can vary of wire diameter and mesh size. Typically the mesh has a large wire surface to absorb the deflagration heat which is released by the venting device into the flame quenching element. By cooling down the heat below ignition temperature of the specific fuel the flame is not able to transit the element (quenching effect). In combination with this effect also a certain dust separation occurs in the flame quenching element depending on mesh size. This reduces the amount of burnable dust around the flame quenching element during the venting process and deletes also the possibility of flame transmission.

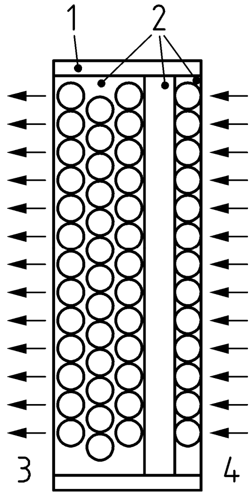


a) expanded-metal cartridge flame quenching element **b) wire gauze pack**

Figure A.3 — Mesh or gauze type flame quenching element

A.5 Ceramic type flame quenching element

The ceramic flame quenching element uses ceramic balls contained between stainless steel grid assemblies. An alternative type consists of several layers of high porous ceramic foam plates. Layer combinations with different pore width cool down deflagration flames below ignition temperature and retain most burnable dust particles which avoids flame transmission.



Key

1 cell housing

2 heat absorption into alumina ceramic media

3 protected side

4 flame front

Figure A.4 — Ceramic type flame quenching element with ceramic balls

Annex B
(informative)

Flameless venting example

In the absence of test data for the specific installation, sizing and selection of flameless venting devices should be based upon the calculation method given in EN 14491 for a vented dust explosion with the appropriate venting efficiency E_f of the flameless venting device.

EXAMPLE

Malt flour is handled inside a 20 m^3 bin which has an explosion pressure resistance of 0,5 bar. Due to its location inside a building, this vessel should be protected by flameless venting.

The dust has a K_{st} value of 106 bar m/s, p_{max} value of 8,3 bar and the bin has a L/D ratio of 1.

According to EN 14491 a vent area A of 0,41 m^2 is required to restrict the $p_{red,\ max}$ to 0,5 bar.

Selecting a flameless venting device with a type efficiency of 75 % for example, would result in a total area requirement of:

$$A_V = \frac{A}{E_f}$$

with

$$A_V = \frac{0{,}41}{0{,}75} = 0{,}55\,\text{m}^2$$

Assuming the flameless venting device is suitable for the dust category, the number of flameless venting devices required will be based upon the maximum volume a single device can protect.

If a device with vent area of equal to or greater than 0,55 m^2 exists which was successfully tested against explosions in a 20 m^3 or larger test vessel than one such unit can protect the bin. If, however, such a device does not exist, then multiple smaller units should be used. The protected volume should then be split in equal sized "partial volumes", each of them smaller than or equal to $V_{max,\ FV}$.

All this is best illustrated with an example: Assuming that the largest single device is tested in a 12 m^3 ($V_{max,\ FV}$ is 12 m^3) and that the vent area of this flameless venting device is 0,36 m^2. Now two of these devices, each capable of protecting up to 10 m^3 of partial volume can be used.

Annex C
(informative)

Flameless venting criteria

C.1 Nature of combustible dust, heat of combustion, flame temperature

The most common combustible materials in the process industry include:

— natural organic materials (grain, linen, sugar, etc.);

— synthetic organic materials (plastics, pigments, pesticides, etc.);

— coal and peat;

— metals (aluminium, magnesium, zinc, iron, etc.).

For the successful application of flameless venting, which in essence is cooling of the combustion flame, the heat of combustion of the material is an important parameter because it determines the amount of heat produced during combustion of that substance (see Table C.1).

Table C.1 — Heat of combustion (oxidation) of various substances per mol O_2 consumed

substance	**oxidation products**	**heat of combustion** kJ/mol O_2
Aluminium	Al_2O_3	1 100
Starch	CO_2 and H_2O	470
Carbon	CO_2	400
Coal	CO_2 and H_2O	400

Note that the heat of combustion per mol of oxygen for aluminium (metal dust) is about twice that of typical organic substances such as starch, but also coal. This is in accordance with the experience that flame temperatures of metal are much higher compared to organic dusts and coals. If the heat of combustion is too high, the amount of heat transferred will not be sufficient to provide flameless venting, and flame extinguishment will not be achieved.

Higher flame temperatures can also exceed maximum allowable temperatures for the flame quenching composing materials.

During the process of flameless venting, solid products can be discharged into the flame quenching element, thereby decreasing the venting efficiency through additional blockage of the flame quenching element. When solids continue to burn inside the flame quenching element local overheating can cause permanent damage resulting in failure to fulfil the flameless venting function. On the other hand, when hot particles are not retained within the flame quenching element an external explosion can be the result and flameless venting will not be achieved. These two latter phenomena are typical for metal dust explosions and application specific testing is required according to Clause 6.

C.2 Effect of flame quenching device blockage

The efficiency of flameless venting devices can be impaired if the dust loading on the flame quenching device becomes too high. The approximate nature of that restriction has been recognized and corrected by the volume requirement according to 4.2.

The efficiency E_f can be volume dependant (see Figure C.1).

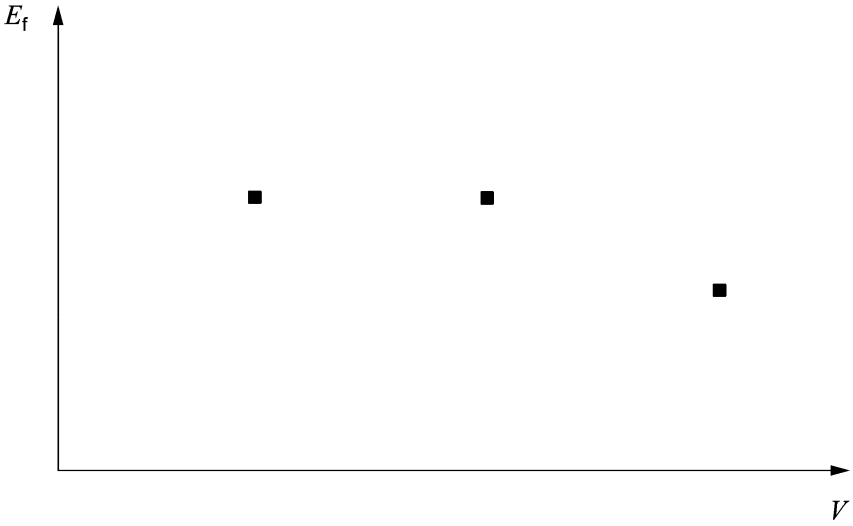
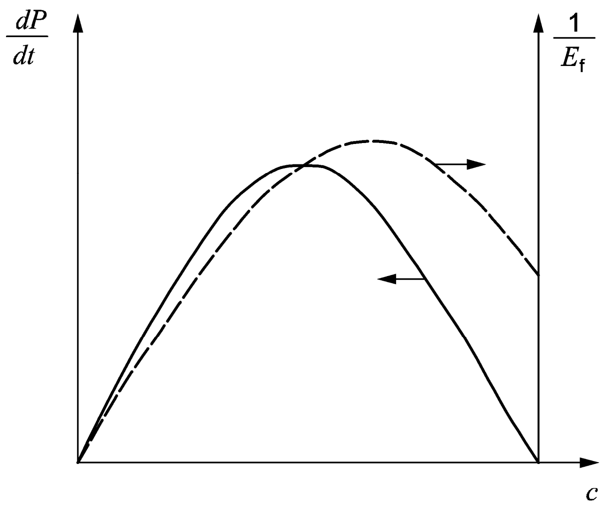


Figure C.1

With this information a volume dependant efficiency can be defined.

To investigate the effect of blockage, tests should be carried out at the highest p_{red} and across a range of concentrations as the optimum concentration for K_{St} does not always give the worst case for blockage, as indicated in 6.3.6.



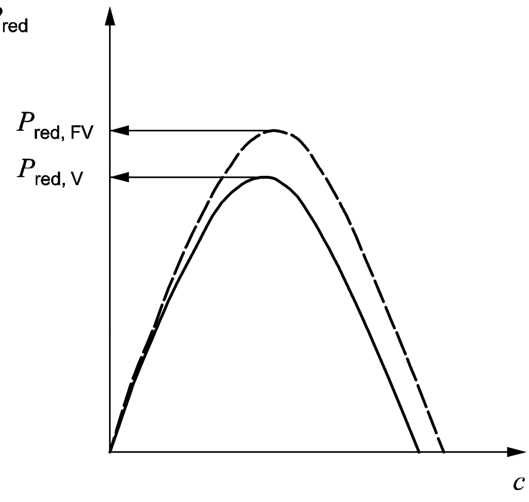


Figure C.2 **Figure C.3**

Figure C.2 illustrates that the lowest flameless venting efficiency $1 / E_f$ can be reached at a higher dust concentration than the concentration at which $(dp / dt)_{max}$ (K_{St}) is reached. This means that the concentration at which the highest p_{red} is reached can be higher for the flameless vented case than for venting only.

Therefore, testing at different concentrations is required to produce the highest p_{red} values ($p_{red,\ V}$ and $p_{red,\ FV}$ in Figure C.3) which shall be used to determine the venting efficiency of the flameless venting device according to EN 14797, with $p_{red,\ V}$ the highest reduced explosion pressure for venting only and $p_{red,\ FV}$ the highest reduced explosion pressure for flameless venting.

When flameless venting is applied to dusts with relatively low melting points such as resins, the powder can melt at the deflagration temperatures and on cooling, the solidified product would block the flame arresting elements. In an extreme case, this would prevent effective venting. Examples of such dusts are plastics, resins and some types of coal. One striking example is that of two different types of coal dust, similar in explosibility (K_{St}, p_{max}) but large scale testing showed a dramatic decrease in E_f of 25 %, attributed to the difference in particle size distribution (more coarse particle) and chemical composition (more tar which blocked the flame quenching device). A similar blockage effect can be observed when the dust is fibrous and coarse.

Examples of fibrous dust are flock, wood shavings mixed with fine wood dust, MDF.

Annex D
(informative)

Flameless venting - Pressurization of the surrounding volume

The immediate area surrounding the flameless explosion venting device vent can experience overpressure and radiant energy. Venting indoors has an effect on the building that contains the protected equipment due to increased pressurization of the surrounding volume. Expected overpressure as a result of flameless indoor venting should be compared to the building design strength.

This pressure effect should be determined based on estimating the exhaust gas volume and temperature.

The minimum volume required to prevent damage to a room containing a piece of equipment vented through a quenching device is to be determined according to a formula that relates the maximum pressure rise in the room/building, Δp, to the volume of the room/building, V_0, and the volume of the equipment, V:

$$\frac{V_0}{V} = \alpha \frac{p_0}{\Delta p}$$

where

p_0 is ambient pressure;

Δp is maximum pressure rise in the room/building;

α is expansion constant, empirically derived from the volume and temperature of the gases external to the protected equipment;

V_0 is volume of the room/building;

V is volume of the equipment.

Considering the typical design strength of standard industrial buildings is 0,01 bar, reinforcing or venting of the surrounding area (building/room) should be considered when this room or building is smaller than 300 times the vented volume, or a ratio which is determined by testing and/or calculation as per above.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 94/9/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 94/9/EC, *Equipment and protective systems intended for use in potentially explosive atmospheres (ATEX)*.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1— Correspondence between this European Standard and Directive 94/9/EC

Clause(s)/sub-clause(s) of this EN	Essential Requirements (ERs) of Directive 94/9/EC		Qualifying remarks/Notes
4	1.0.2	Design considerations	only third bullet of 1.0.2 covered
7	1.0.3	Special checking and maintenance conditions	EN 14797
6.3.5, 6.4	1.0.4	Surrounding area conditions	
8	1.0.5	Marking	
7	1.0.6	Instructions	
whole document	1.2.1	Technological knowledge of explosion protection for safe operation	EN 14491, EN 14994
6.4	1.2.7	Protection against other hazards	
4.1	1.4.2	Mechanical and thermal stresses and withstanding attack by existing or on foreseeable aggressive substances	
Whole document	3.1.5	Pressure relief systems	EN 14491, EN 14994

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

[1] EN 1127-1:2007:, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

[2] EN 13463-1:2009, *Non-electrical equipment for use in potentially explosive atmospheres — Part 1: Basic method and requirements*

[3] EN 13673-2:2005, *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*

[4] EN 13821, *Potentially explosive atmospheres — Explosion prevention and protection — Determination of minimum ignition energy of dust/air mixtures*

[5] EN 13980, *Potentially explosive atmospheres — Application of quality systems*

[6] EN 14034-1:2006+A1:2011, *Determination of the explosion characteristics of dust clouds – Part 1: Determination of the maximum explosion pressure* p_{max} *of dust clouds*

[7] EN 14034-2:2006+A1:2011, *Determination of explosion characteristics of dust clouds — Part 2: Determination of the maximum rate of explosion pressure rise* $(dp/dt)_{max}$ *of dust clouds*

[8] EN 60079-0, *Electrical apparatus for explosive gas atmospheres — Part 0: General requirements (IEC 60079-0:2004, modified)*

[9] EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989)*

[10] EN 61241-0, *Electrical apparatus for use in the presence of combustible dust — Part 0: General requirements (IEC 61241-0:2004, modified) + Corrigendum Nov. 2005)*

[11] EN 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

[12] EN 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061:2005)*

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[14] EN ISO 13849-1:2008, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2006)*

[15] IEC 61241-2-1:1994, *Electrical apparatus for use in the presence of combustible dust — Part 2: Test methods; section 1: Methods for determining the minimum ignition temperatures of dust*

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