SIST

SLOVENSKI STANDARD
SIST EN 16020:2011

01-oktober-2011

Preusmerjevalniki eksplozij

Explosion diverters

Explosionsschlote

Dispositifs déviateurs d'explosion

Ta slovenski standard je istoveten z: **EN 16020:2011**

ICS:

13.230	Varstvo pred eksplozijo	Explosion protection

SIST EN 16020:2011 **en,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16020

July 2011

ICS 13.230

English Version

Explosion diverters

Dispositifs déviateurs d'explosion

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 16020:2011: E

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Foreword

This document (EN 16020:2011) 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of an identical text or by endorsement, at the latest by January 2012, and conflicting national standards shall be withdrawn at the latest by January 2012.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

An explosion diverter is used to divert explosions propagating through ducts, thus preventing flame jet ignition and pressure piling in connected protected enclosures. It will reduce the risk of flame transmission.

This European Standard describes the basic design of a pipe-in-pipe diverter and specifies the testing requirements and the application of explosion diverters.

This European Standard covers:

— a test method for assessing the efficacy of explosion diverters;

— design rules for a type of pipe-in-pipe diverter;

— demands to venting device on diverter;

— installation requirements;

— maintenance requirements;

— marking.

This European Standard considers dust/air explosive atmospheres only.

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 14034-1, *Determination of explosion characteristics of dust clouds — Part 1: Determination of the maximum explosion pressure* p_{max} *of dust clouds*

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

EN 14460:2006, *Explosion resistant equipment*

EN 14491: *Dust explosion venting protective systems*

EN 14797, *Explosion venting devices*

EN 15089:2009, *Explosion isolation systems*

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 14797, EN 14491 , EN 15089:2009 and the following apply.

3.1
explosion venting device
part of the explosion diverter which opens under explosion conditions in a controlled manner

3.2
explosion diverter
passive mechanical device typically installed in a duct preventing flame jet ignition, pressure piling and reducing the probability of flame transmission into connected equipment

3.3
flame velocity
S_f
velocity of a flame front relative to a fixed reference point

[EN 15089:2009, 3.14]

3.4
pressure piling
condition during deflagration in which pressure increases in the unreacted medium ahead of the flame front as a result of the deflagration

3.5
flame jet ignition
ignition of unreacted pre-compressed and turbulent medium in an enclosure by a flame with a large surface area and high energy

3.6
installation distance
distance between the vessel and the connecting flange of the diverter

3.7
optimum explosion pressure
p_{opt}
explosion pressure in the vented or unvented vessel of the primary explosion which causes maximum flame velocity in the pipe at the inlet of the connected vessel, without diverter

4 Explosion Diverters

4.1 General

Explosion diverters are inline passive protective systems, installed in processes involving dust. They respond to and by means of internal explosion pressure in the duct in which they are installed.

The most common design of explosion diverters can be described as pipe in pipe arrangements (see Figure 1) causing a change of flow direction and fitted with an explosion venting device (see Figure 1 a) and Annex A). This type of diverter will typically have an inner inlet pipe and an outer outlet pipe. Other types of explosion diverters are described in Annex B.

In most cases, the installation of explosion diverters is closely related to pre-arranged planning and engineering. Subsequently, the installation will be executed as per agreed-upon general arrangement and detail drawings of the system of which the explosion diverter becomes a part.

In the case of an explosion propagating through a duct, the venting device opens and diverts flame and pressure. This shall be done into a safe area (see Figure 1 b)).

Explosion diverters shall ensure as a minimum that pressure piling and flame jet ignition are prevented beyond the diverter. They cannot completely stop the flame and pressure propagation under all conditions.

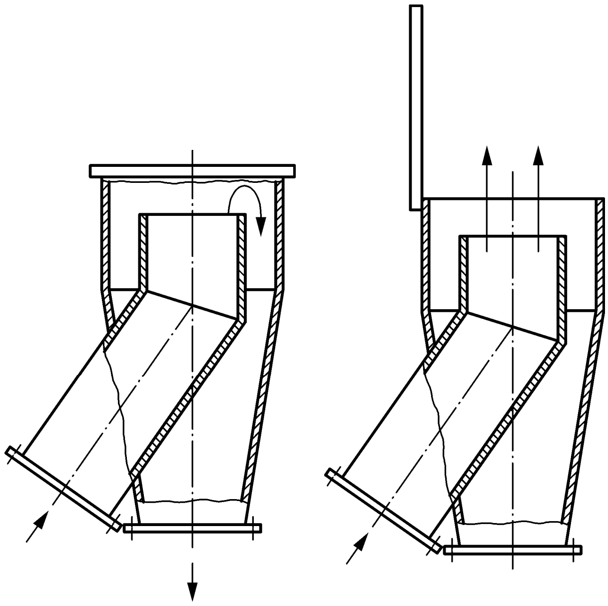


Figure 1 — Example of a pipe-in-pipe explosion diverter

4.2 Special requirements to explosion diverters

4.2.1 Explosion venting device

Venting devices shall comply with EN 14797 with the exception of the determination of the efficiency of the device. In addition, tests according to Clause 5 shall be undertaken to demonstrate their suitability for intended use on explosion diverters.

4.2.2 Mechanical integrity

Depending on the intended use, the loads caused by internal explosions will to a great extent depend on equipment connected to the device (vessel size, length of interconnecting pipes) and explosion properties of the dust (intended range of K_{St}, p_{max}).

Any part of an explosion diverter not designed to rupture shall be constructed such that it can withstand the loads imposed by any internal explosion that can be expected in accordance with its intended use, without rupturing. The construction can be either explosion-pressure resistant or explosion-pressure shock-resistant (see EN 14460).

If parts of or the entire explosion venting device detach during the explosion, the explosion diverter shall include a restraining arrangement e.g. a cage. The restraining arrangement is an integral part of the explosion diverter. The requirements pertaining to mechanical integrity include the elements of the restraining arrangement.

5 Verification of efficacy and mechanical integrity of the diverter by experimental testing

5.1 General

The testing shall reflect the intended use.

As a minimum the following information is necessary prior to testing:

- a general type description;
- intended use;
- installation and operating instructions (maximum allowable length of the pipes between explosion diverter and interconnected vessels and the presence of bends/pipe restrictions, location and position of the explosion diverter);
- part list;
- design and manufacturing drawings and layouts of parts etc.;
- results of design calculations made, examinations carried out, test reports;
- ambient and process conditions;
- dust type (K_{St}, p_{max}, metal dust yes/no);
- explosion resistance of the device;
- static activation pressure (p_{stat}) of the venting device;
- maximum explosion pressure in the connected vessels.

The smallest and largest size for devices with geometrical similarity (with respect to the material specifications, welding specifications and wall thickness) shall be tested. If the diameter ratio of largest to smallest size exceeds 5, an intermediate size shall be tested.

5.2 Test Modules

5.2.1 General

Two modules are available for experimental testing. The modules are referenced to as Module A and Module B. The mechanical integrity and explosion resistance of the diverter is tested in either of these two modules.

The test pressure required to prove the mechanical integrity and explosion resistance according to the intended use is material dependant and shall be according to EN 14460:2006, 6.3. Permanent deformation of the diverter body is allowed provided it does not fail in its function and will not give rise to dangerous effects to the surrounding. If permanent deformation is observed, the explosion resistance shall be documented as the explosion pressure shock resistance according to EN 14460.

5.2.2 Module A: Mechanical integrity testing

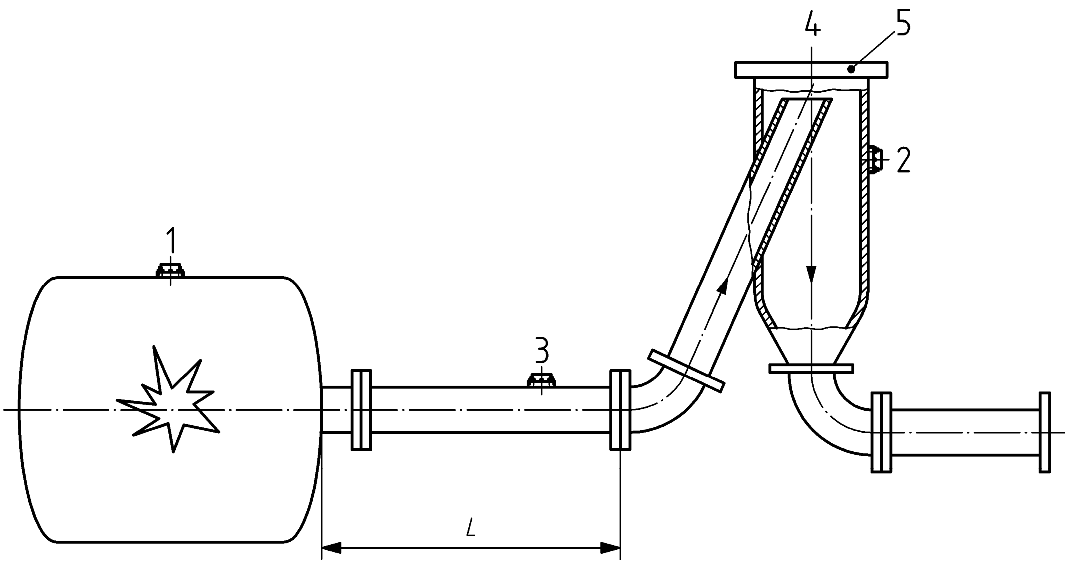
5.2.2.1 General

Module A (mechanical integrity testing only) is used for testing:

- pipe-in-pipe diverters according to Annex A;
- any other type of diverter which was previously tested and approved according to Module B but which did undergo changes which can affect the mechanical integrity and explosion resistance of the diverter. Changes to the geometry for instance will require retesting according to Module B. Furthermore, modification of the venting device or the introduction of a restraining cage needs testing according to Module B.

5.2.2.2 Test set-up

The explosion diverter shall be tested with a test rig as shown in Figure 2.



Key

1,2,3 pressure transducer (Pt)

4 explosion diverter body (ED)

5 explosion diverter venting device

L installation distance

Figure 2 — Test arrangement for mechanical and explosion resistance testing

The dimensions of the pipe (length and diameter), the pipe arrangement (e.g. horizontal/vertical), the volume of the test vessel, the maximum reduced explosion pressure in the test vessel and the explosion characteristics of the explosive atmosphere shall reflect the intended use of the diverter (see 5.1).

The length to diameter ratio of the vessel shall be equal to or smaller than 2,5 and the pipe volume up to the explosion diverter shall be smaller than the volume of the vessel. The explosion pressure generated within the diverter shall reflect the maximum allowable explosion pressure according to the intended use of the diverter.

If the intended use includes scenarios in which the explosion can propagate in both directions, the testing shall be repeated with the diverter reversed such that the outlet now becomes the inlet.

5.2.2.3 Measuring technique

The following parameter shall be measured:

— Pressure

The explosion pressure shall be measured by installing transducers in the explosion enclosure, the diverter and the interconnecting duct (see Figure 2). The pressure transducer shall have a sufficient short response time.

5.2.2.4 Testing method

Sufficient explosive dust shall be injected in the test vessel to generate an explosive dust/air mixture in the duct to support flame propagation into the diverter.

The generation of the dust cloud inside the test vessel shall be carried out according to EN 14034-1 and EN 14034-2.

Testing shall be carried out at maximum p_{red}, K_{St} and longest installation distance at which the maximum allowable explosion pressure as per the intended use of the diverter is reached.

Calibration tests shall be carried out without explosion diverter in the test rig according to Figure 2 to define the test parameters (dust concentration, ignition delay time, venting area) necessary to achieve the optimum explosion pressures (p_{opt}) according to the intended use and flame transmission and acceleration throughout the pipe (worst case condition). Dust injection in the duct can be necessary.

a) Number of tests

Only 1 test is required for mechanical integrity testing.

b) Evaluation of test

The mechanical integrity testing is successful if the diverter has withstood the intended explosion pressure and did not generate any flying parts.

5.2.3 Module B: Functional testing

5.2.3.1 General

Module B (functional testing) shall assess the efficacy of the explosion diverter according to the intended use as specified by the manufacturer and determine the maximum permissible length of the pipes L_1 and L_2 (Figures 3 and 4): maximum installation distances.

Module B has 4 subsets B1, B2, B3 and B4 depending on the intended use (see Table 1).