SLOVENSKI STANDARD

SIST EN 14034-2:2006

01-september-2006

Ugotavljanje eksplozijskih znaļ ilnosti oblakov prahu - 2. del: Ugotavljanje najveļ je hitrosti naraġļ anja tlaka eksplozije (dp/dt)max oblakov prahu

Determination of explosion characteristics of dust clouds - Part 2: Determination of the maximum rate of explosion pressure rise (dp/dt)max of dust clouds

Bestimmung der Explosionskenngrößen von Staub/Luft-Gemischen - Teil 2: Bestimmung des maximalen zeitlichen Druckanstiegs (dp/dt)max von Staub/Luft-Gemischen

Détermination des caractéristiques d'explosion des nuages de poussiere - Partie 2: Détermination de la vitesse maximale de montée en pression d'explosion (dp/dt)max des nuages de poussiere

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

Détermination des caractéristiques d'explosion des nuages de poussière - Partie 2: Détermination de la vitesse maximale de montée en pression d'explosion (dp/dt)max des nuages de poussière

Bestimmung der Explosionskenngrößen von Staub/Luft-Gemischen - Teil 2: Bestimmung des maximalen zeitlichen Druckanstiegs (dp/dt)max von Staub/Luft-Gemischen

This European Standard was approved by CEN on 20 April 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, 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.

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Foreword

This document (EN 14034-2:2006) 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 November 2006, and conflicting national standards shall be withdrawn at the latest by November 2006.

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 Directives.

For relationship with the EU Directive 94/9/EC, see informative Annex ZA, which is an integral part of this document.

This European Standard is one of a series of standards as listed below:

EN 14034 "Determination of explosion characteristics of dust clouds"

– Part 1: Determination of the maximum explosion pressure p_{max} of dust clouds;

– Part 2: Determination of the maximum rate of explosion pressure rise $(dp/dt)_{max}$ of dust clouds;

– Part 3: Determination of the lower explosion limit LEL of dust clouds;

– Part 4: Determination of the limiting oxygen concentration LOC of dust clouds.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, 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.

Introduction

This European Standard specifies a method for experimental determination of the maximum rate of explosion pressure rise of dust clouds. The maximum rate of explosion pressure rise is the maximum value of the pressure rise per unit time during explosions of explosive atmospheres in the explosion range of a combustible dust in a closed vessel. The measurement of the maximum rate of explosion pressure rise forms the basis for explosion protection by design and construction of equipment, protective systems and components to reduce the explosion effects.

Therefore this document gives added values to the following clauses of the EU directives:

— Directive 94/9/EC of the European Parliament and the Council of March 23, 1994 on the approximation of the laws of the member states concerning equipment and protective systems intended for use in potentially explosive atmospheres.

  Annex II, Clause 1.0.1

— Directive 98/37/EC of the European Parliament and the Council of June 22, 1998 on the approximation of the laws of the member states relating to machinery

  Annex I, Clause 1.5.7

1 Scope

This standard describes a test method for the determination of the maximum rate of explosion pressure rise of dust clouds in a closed vessel under defined initial conditions of pressure and temperature.

This method is not suitable for use with recognised explosives, like gunpowder and dynamite, explosives which do not require oxygen for combustion, pyrophoric substances, or substances or mixtures of substances which may under some circumstances behave in a similar manner. Where any doubt exists about the existence of hazard due to explosive properties, expert advice should be sought.

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 14460, *Explosion resistant equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
dust
small solid particles in the atmosphere which settle out under their own weight, but which may remain suspended in air for some time (includes dust and grit, as defined in ISO 4225)

NOTE Generally maximum particle size will not exceed 500 µm.

3.2
combustible dust
dust able to undergo an exothermic reaction with air when ignited

NOTE The terms “flammable” and “combustible” are used synonymously.

3.3
explosion pressure
p_{ex}
highest overpressure occurring during an explosion of a dust cloud in a closed vessel

3.4
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable (combustible) substances in the form of gases, vapours, mists or dusts, in which, after ignition has occurred, combustion spreads to the entire unburned mixture

3.5
ignition delay
t_v
time between the initiation of the dust dispersion and the activation of the ignition source

3.6
initial pressure
p_i
pressure in the explosion vessel at the moment of ignition

3.7
initial temperature
T_i
temperature in the explosion vessel at the moment of ignition

3.8
K_{max}, K_{St}
dust specific, volume independent characteristic which is calculated using the cubic law equation

$$(\mathrm{d}p/\mathrm{d}t)_{max} \cdot V^{1/3} = \text{const.} = K_{St} = K_{max}$$

3.9
rate of explosion pressure rise
$(\mathrm{d}p/\mathrm{d}t)_{ex}$
the maximum slope of the pressure/time curve during an explosion of a dust cloud in a closed vessel

3.10
maximum rate of explosion pressure rise
$(\mathrm{d}p/\mathrm{d}t)_{max}$
maximum value of the pressure rise per unit time during explosions of all explosive atmospheres in the explosion range of a combustible substance in a closed vessel under specified test conditions and standard atmospheric conditions

NOTE This parameter when determined in the 1 m^3 vessel is numerically identical with the parameters K_{max} (EN 26184-1) and K_{St} (VDI 2263-1) but the units of the latter are bar · m · s^{-1} whereas the unit of the $(\mathrm{d}p/\mathrm{d}t)_{max}$ is bar · s^{-1}.

4 Test apparatus

4.1 General

The standard test apparatus to determine the maximum rate of explosion pressure rise $(\mathrm{d}p/\mathrm{d}t)_{max}$ of dust clouds is an explosion pressure resistant vessel of 1 m³, as used for the determination of the maximum explosion pressure and the lower explosion limit of dust clouds as well as the limiting oxygen concentration of dust/air/inert gas mixtures.

The main components of the test apparatus are

— explosion vessel;

— dust dispersion system;

— ignition source;

— control unit;

— pressure measuring system.

NOTE The 20 l sphere apparatus is an alternative explosion vessel for these determinations (see Annex C).

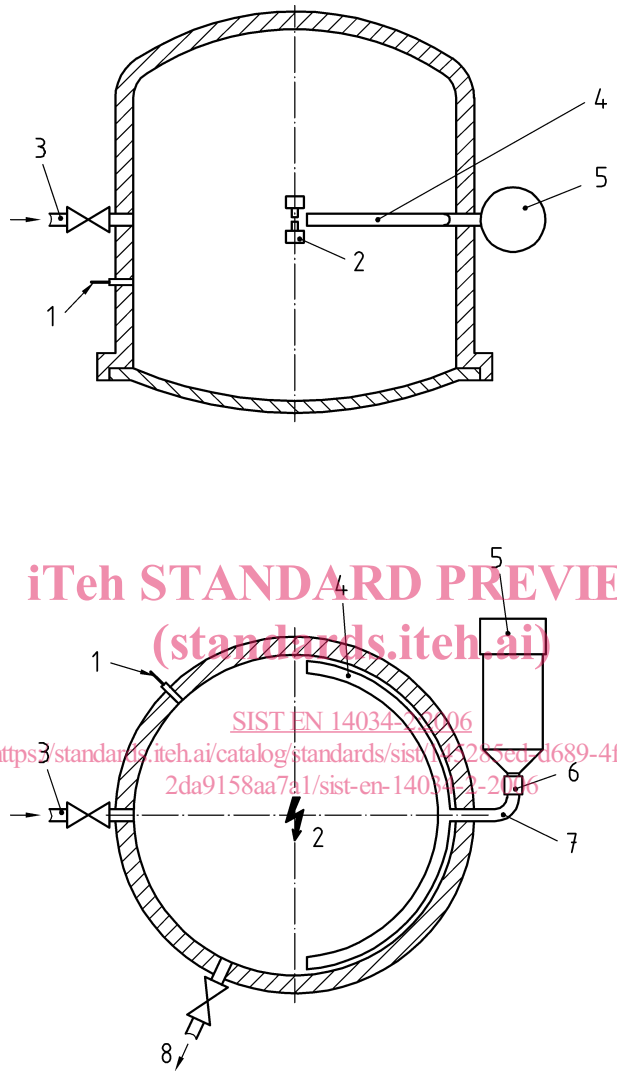
4.2 Explosion vessel

The standard explosion vessel is an explosion pressure resistant, spherical or cylindrical vessel having a volume of 1 m³ in accordance with EN 14460. The aspect ratio of the cylindrical vessel shall be 1:1 ± 10 % (see Figure 1).

NOTE It is recommended that the explosion vessel be designed to withstand an overpressure of at least 20 bar.

The apparatus shall be fitted with electrical and/or mechanical cut-offs as far as possible to ensure that any openings in the vessel (e.g. main door, instrument ports, inlet or outlet) are properly closed before a test procedure can start.

The apparatus shall also be equipped as far as possible to ensure that any residual pressure inside the vessel is vented before the vessel can be opened.



Key

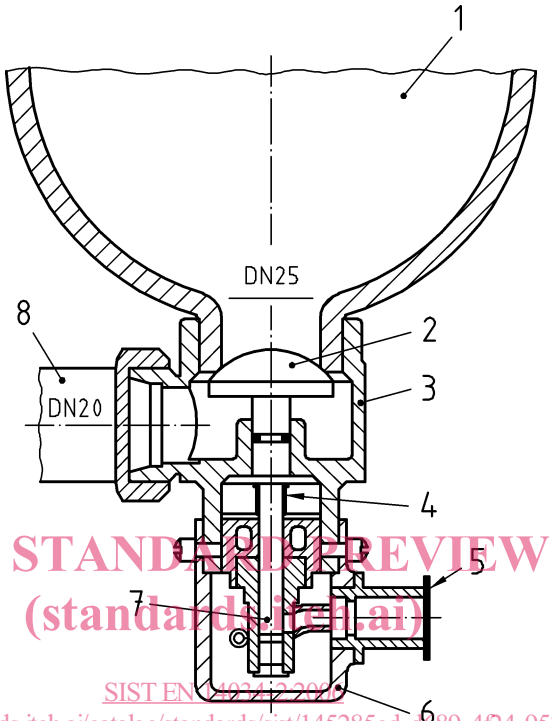
1	pressure sensor	5	dust container
2	chemical igniters	6	fast acting valve
3	inlet for purge air	7	connecting tube
4	dust disperser	8	outlet for exhaust gas

Figure 1 — 1 m³ vessel (schematic)

4.3 Dust dispersion system (dust container, fast acting valve, connecting tube, dust disperser)

The dust to be dispersed is charged into a dust container having a volume of 5,4 dm³. Its aspect ratio is 3:1. It is designed to withstand an overpressure of at least 20 bar (see Figure 2).

The dust container has an outlet at the base, through which the dust leaves the container. This outlet is closed by a fast acting valve activated by a blasting cap. The valve has a mushroom-shaped seal. The seal is held in position against the pressure in the dust container by a small ring. The ring is destroyed by firing a blasting cap and the valve opens due to the pressure inside the dust container (see Figure 2). The valve shall be designed so that it opens in less than 10 ms. For alternative valves see Annex A. The fast acting valve is connected to the side of the explosion vessel. The connecting tube between the fast acting valve and the dust disperser shall be not longer than 350 mm (see Figure 1).



Key

1	dust container	5	protective hood
2	mushroom shaped seal	6	protective hood
3	seal housing	7	blasting cap
4	support ring	8	connecting tube

Figure 2 — Dust container with blasting cap activated valve as commonly used for explosion suppression (schematic; it is commercially available)

For dispersing the dust, a perforated semicircular spray pipe (dust disperser) is mounted inside the explosion vessel, concentric with its wall. The spray pipe, with an internal diameter of 21,7 mm[1)] is fitted with 13 holes of a diameter of 6 mm (incl. one hole in each end cap) which are located as shown in Figure 3 (see also Figure 1).

For coarse, voluminous, fibrous or poorly flowing dust samples, it may not be possible to properly discharge the dust through the dust dispersers detailed in Figures 3 and B.1. It may, therefore, be necessary to use special dust dispersers, examples of which are given in Figures B.2 and B.3. In such cases, the dust disperser used shall be described in the test report.

NOTE If other dust dispersing systems than those described in this standard are used, a propagation of the explosion from the explosion vessel into the dust container, cannot be excluded. For this case, additional safety measures should be employed, e. g. higher pressure resistance of the dust container.

1) (e.g. EN ISO 1127, DN 20, 3/4")