SLOVENSKI STANDARD
SIST EN 13673-1:2003

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Ugotavljanje najvišjega tlaka eksplozije in največje hitrosti naraščanja tlaka plinov in hlapov - 1. del: Ugotavljanje najvišjega tlaka eksplozije

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

Verfahren zur Bestimmung des maximalen Explosionsdruckes und des maximalen zeitlichen Druckanstieges für Gase und Dämpfe - Teil 1: Bestimmungsverfahren für den maximalen Explosionsdruck

Détermination de la pression maximale d'explosion et de la vitesse maximale de montée en pression des gaz et vapeurs - Partie 1: Détermination de la pression maximale d'explosion

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This European Standard was approved by CEN on 2 January 2003.

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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 Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 13673-1:2003) 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of an identical text or by endorsement, at the latest by October 2003, and conflicting national standards shall be withdrawn at the latest by October 2003.

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(s).

For relationship with EU Directive(s), see informative annex ZA which is an integral part of this document.

Annexes B, C and D are informative.

Annex A is normative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard describes a test method for the determination of the explosion pressure and the maximum explosion pressure of a flammable gas/air/inert mixture at ambient temperature and pressure.

Explosion pressures and maximum explosion pressures are used in the design of explosion protection techniques, such as explosion resistant and explosion shock resistant construction. These are particularly influenced by :

— size and shape of the vessel;

— type and energy of the ignition source;

— temperature and pressure.

So it is important that they are measured at standardised conditions.

1 Scope

The standard test method is designed to produce measurement of the explosion pressure and the maximum explosion pressure of a quiescent flammable gas/air/ inert mixture in an empty closed volume at ambient temperature and pressure. In this European Standard the term “gas” includes vapours, but not mists.

This European Standard does not consider mixtures that contain an increased content of oxygen; or mixtures that will react spontaneously at ambient temperature and pressure. Detonation and decomposition phenomena are not considered in this European Standard.

The pressures measured by the procedures specified in this European Standard are not applicable to flameproof enclosures, that is enclosures intended to withstand an internal explosion and not to transmit it to an external explosive atmosphere, or any other closed volume where the internal geometry can result in pressure piling. Even in an enclosure of relatively simple geometry the disposition of the internal components can lead to explosion pressures significantly higher than those measured using this European Standard. Flameproof enclosures should be constructed and tested in accordance with the requirements contained in EN 50018 for electrical equipment and prEN 13463-3 for non-electrical equipment.

2 Terms and definitions

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

2.1
explosion pressure, P_{ex}
highest pressure occurring in a closed vessel during the explosion of a specific mixture of flammable gases with air or air and inert gases determined under specified test conditions

2.2
maximum explosion pressure, P_{max}
maximum value measured in the tests for explosion pressure when the content of the flammable gas in the mixture is varied

NOTE For the purpose of this European Standard, all pressures are expressed in bar absolute.

3 Test method

3.1 Principle

An explosive test mixture is ignited by a defined ignition source which is positioned in the centre of a test vessel. By means of a pressure measuring system, the highest pressure P_{ex} developed following the ignition of the test mixture is measured.

The maximum explosion pressure P_{max} is determined during measurements of the explosion pressure P_{ex} by varying stepwise the content of flammable gas in the mixture, until the maximum value of P_{ex} is found.

3.2 Apparatus

3.2.1 General

The test apparatus consists of :

— a test vessel;

— equipment for preparing the test mixture;

— an ignition system;

— a pressure measuring system;

— a temperature measuring device;

— safety equipment.

3.2.2 Test vessel

The test vessel shall be spherical or cylindrical. The internal volume of the test vessel shall be equal to or greater than 0,005 m^3. If a cylindrical vessel is used, the length to diameter ratio shall be equal to 1.

The test vessel and any equipment (valves, igniter, transducer,...) fitted on the vessel shall be designed to withstand a maximum pressure of at least 20 bar.

The vessel shall be made of stainless steel or any material free of any catalytic effects and resistant to corrosion from the initial gas mixture and the products of combustion.

The test vessel shall be fitted with sufficient ports to allow filling, evacuating and purging.

3.2.3 Equipment for preparing the test mixture

The test mixture can be prepared by a partial pressure method or mixing together flows of the component substances. This can be done in the test vessel or outside.

If the test mixture is prepared by a partial pressure method, the vessel used for the preparation of the mixture shall be fitted with :

— a vacuum pump and a vacuum gauge;

— pressure gauges or manometers;

— a means of achieving a uniform test mixture (e.g. a stirrer).

If the test mixture is prepared by mixing flows, the necessary components are :

— flow meters (mass or volume flow meters);

— a means of achieving a uniform test mixture (e.g. mixing chamber);

— an evaporator if liquid samples are used (see annex C for an example).

The equipment for preparing the test mixture has to be designed in such a way that the flammable gas content in the test mixture is measured with a maximum uncertainty of measurement of ± 10 % relative for a flammable gas content up to 2 % mol or ± 0,2 % absolute for a flammable gas content above 2 % mol.

3.2.4 Ignition system

3.2.4.1 General

The igniter shall be positioned in the centre of the test vessel. Recommended ignition systems are the induction spark and the fusing wire. The test report shall state which ignition source was used.

For some special mixtures it may be necessary to use a different ignition system in order to achieve ignition of the mixture. If an alternative ignition source is used it shall be fully described in the test report. It is also recommended that specialist advice is sought on the interpretation of the results.

3.2.4.2 Induction spark

A series of induction sparks between two electrodes is used as the ignition source.

Stainless steel is a suitable material for the electrodes. The electrodes shall be positioned at the centre of the vessel. They shall be pointed rods with a maximum diameter of 4 mm. The angle of the tips shall be 60°. The distance between the tips shall be (5 ± 0,1) mm. The electrodes shall be mounted in the vessel so they are gas tight at the highest pressures generated during the test. The mounting shall be resistant to heat and the test mixture, and provide adequate electrical resistance from the test vessel body.

A high voltage transformer, with a root mean square of 13 kV to 16 kV and a short circuit current of 20 mA to 30 mA, shall be used for producing the ignition spark. The primary winding of the high voltage transformer shall be connected to the mains via a timer set to the required discharge time.

The spark discharge time shall be adjusted to 0,2 s. If a spark discharge time of 0,2 s does not result in ignition of the test mixture, the test may be repeated with a spark discharge time of up to 0,5 s.

NOTE The power of the spark depends on the gas mixture and its pressure. In air at atmospheric conditions according to calorimetric and electric measurements such a source gives a spark with a power of approximately 10 W.

3.2.4.3 Fusing wire

NOTE 1 This ignition device generates an electric arc by passing an electrical current along a length of straight fusing wire connected between two metal rods.

NOTE 2 The electrical power for melting the wire and generating the arc is supplied from an isolating transformer. The ignition energy delivered by the arc depends on the duration of the arc and the power rating of the isolating transformer. The energy delivered shall be in the range 10 J to 20 J, as over this range of energies there is no significant effect on the explosion pressure. This is achieved by limiting the power rating of the isolating transformer to between 0,7 kVA and 3,5 kVA and by the use of a phase control technique. The latter is a chopping technique that allows only part of the AC waveform from the transformer secondary windings to energise the wire.

Brass or stainless steel are suitable materials for the rods. The rods shall be parallel to each other with a separation distance of (5 ± 1) mm. For the fusing wire a straight length of NiCr wire (diameter 0,05 mm to 0,2 mm) shall be soldered to the tips of the metal rods. The rods shall be positioned in the test vessel so the fusing wire is at the centre of the vessel. The electrodes shall be mounted in the vessel so they are gas tight at the highest pressures generated during the test. The mounting shall be resistant to heat and the test mixture, and provide adequate electrical resistance from the test vessel body.

To reduce the time required for replacing the fusing wire after a test, the rods may be mounted in a plug that can be screwed into the test vessel wall.

The cross-section of the wires connecting the transformer to the rods shall be between 2,5 mm^2 and 7 mm^2. The length of the wires shall be less than 5 m. The diameter of the rods shall be between 1,5 mm and 5 mm.

If for practical reasons the diameter of the rods has to be less than 3 mm additional mechanical support may be necessary.

3.2.5 Pressure measuring system

The pressure measuring system consists of a pressure transducer; an amplifier and recording equipment. To ensure reliability, two pressure measuring systems may be used.

The pressure transducer(s) shall be fitted in the test vessel, with the head flush with the internal wall.

The pressure transducer(s) shall have a resonance frequency greater than 10 kHz.

The pressure transducer(s) shall be able to measure pressures up to 20 bar. Pressure transducers of lower range may be used if lower explosion pressures are expected.

The pressure measuring system shall have an accuracy such that the initial and explosion pressures are measured to ± 0,05 bar or better.

The pressure measuring system shall have a time resolution of at least 1 ms.

3.2.6 Temperature measuring device

Any suitable thermocouple with appropriate recording equipment may be used.

3.2.7 Safety aspects

Precautions shall be taken to safeguard the health of personnel conducting the tests against the different hazards that may occur during the test e.g.:

— to prevent a leak of the mixture or waste gases outside the vessel, the gas tighteners of the vessel shall be checked;

— to prevent rupture of the test vessel, it shall be designed to withstand a maximum pressure of at least 20 bar (see 3.2.2), as this can be assumed to be higher than the maximum explosion pressure likely to be generated during a test;

— if the test mixture is prepared in a separate vessel, this vessel and the connecting line shall be designed to withstand the maximum explosion pressure;

— to prevent injuries to the operator from flying fragments, all parts of the apparatus that may contain an explosive mixture shall be adequately shielded;

— adequate ventilation shall be provided to prevent the build up of an explosive atmosphere in the laboratory as a result

  — of purging of the apparatus;

  — exhaust from the vacuum pump;

  — or leaks from the apparatus.

— all electrical connections shall be adequately shielded to prevent electrocution or shock to personnel;

— measures shall be taken prior to preparing the mixture to ensure that the substances can be mixed without risk

— measures shall be taken to prevent hazards arising from the handling of toxic flammables gases or combustion products;

— the handling of flammable liquids shall be carried out in such a manner that the risk of a fire is minimised;

— the handling of gas cylinders shall be carried out in such a manner that the risk of an explosion is minimised.

3.3 Preparation and preservation of test samples

The components of the test mixture shall fulfil the following requirements :

Air: the air shall be free of water and oil. If synthetic air is used, it shall to be stated in the report.

Inert: the purity of the inert, or the mixture of inerts, shall be 99,8 % mol or better. If a mixture of inerts is used, the composition of the mixture shall be stated in the test report.

Flammable gas: the flammable gas may be derived from:

a) a single substance or a mixture of substances,

b) a process sample (of known or unknown composition).

When a single substance or a mixture of substances is used, the purity of each substance shall be 99,8 % mol or better. In the case of a mixture of substances or a process sample of known composition, the precision of the

composition shall be stated in the test report. In the case of a process sample of unknown composition, the sample shall be defined as well as possible (e.g. process conditions, lower explosion limit).

If the flammable gas is derived from a liquid containing more than one component, the gas phase composition can differ from the composition of the liquid phase and when large quantities of the gas are drawn off, the composition of both the liquid and gas phases can change with time. For these reasons, the test sample shall be taken from the liquid phase.

3.4 Procedure

3.4.1 Preparation of the test mixture

3.4.1.1 General

If liquefied gases or liquids are used, it is necessary to ensure that there is no condensation.

NOTE Condensation can be prevented by checking the vapour pressure of the substances and by local heating to prevent cooling at certain parts of the apparatus (e.g. valves).

The test mixture may be prepared by the method of partial pressures or by the method of mixing flows, either inside or outside the test vessel.

3.4.1.2 Preparation of the text mixture by partial pressures

If the preparation of the test mixture includes evacuating the vessel, the amount of air remaining shall be taken into account when calculating the pressures of combustible substances and air required. In preparing the test mixture, precautions may be necessary to prevent condensation.

The mixture components are sequently introduced into the vessel to give the required partial pressure. The partial pressure measuring system shall have an accuracy of ± 0,005 bar or better. It is necessary to ensure that the mixture in the vessel is thoroughly mixed during the introduction of each component. If the volume of the feed lines is not negligible compared to the volume of the vessel, they also shall be evacuated or purged.

NOTE For practical reasons, air is often introduced as the last component, especially if atmospheric air is used.

3.4.1.3 Preparation of the test mixture by mixing flows

The test mixture is prepared by thoroughly mixing metered flows of the gaseous components.

If liquid components are used, they shall be vaporised totally before mixing.

NOTE It is recommended that if possible the composition of the test mixture is also measured, to check the metering devices and that there are no leaks in the mixing system.

3.4.2 Determination of the explosion pressure P_{ex} and the maximum explosion pressure P_{max}

3.4.2.1 Test procedure

If the test mixture is not prepared in the test vessel, fill the vessel with the test mixture either by preliminary evacuation or by purging.

The test vessel and the feed lines shall be evacuated to a pressure of 5 mbar or less before filling. Purging shall be done in such a way that the test vessel atmosphere is totally replaced. This is achieved by purging with a volume that is at least ten times the vessel volume.

Once the test mixture has been introduced into the test vessel, the inlet and outlet valves shall be closed. The test mixture shall be left for a period of at least two minutes to ensure it is quiescent. The test mixture is then ignited and the pressure-time curve of the explosion recorded.