



SLOVENSKI STANDARD

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Nadomešča:

SIST EN 14756:2007

SIST EN 1839:2013

Ugotavljanje mej eksplozivnosti plinov in hlapov ter ugotavljanje mejne koncentracije kisika (LOC) za vnetljive pline in pare

Determination of explosion limits of gases and vapours and determination of the limiting oxygen concentration (LOC) for flammable gases and vapours

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Bestimmung der Explosionsgrenzen von Gasen und Dämpfen und Bestimmung der Sauerstoffgrenzkonzentration (SGK) für brennbare Gase und Dämpfe

SIST EN 1839:2017

Détermination des limites d'exposivité des gaz et vapeurs et détermination de la concentration limite en oxygène (CLO) des gaz et des vapeurs inflammable

Ta slovenski standard je istoveten z: EN 1839:2017

ICS:

13.230 Varstvo pred eksplozijo Explosion protection

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EUROPEAN STANDARD
NORME EUROPÉENNE
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English Version

**Determination of the explosion limits and the limiting
oxygen concentration(LOC) for flammable gases and
vapours**

Détermination des limites d'explosivité des gaz et
vapeurs et détermination de la concentration limite en
oxygène (CLO) des gaz et des vapeurs inflammables

Bestimmung der Explosionsgrenzen und der
Sauerstoffgrenzkonzentration (SGK) für brennbare
Gase und Dämpfen

This European Standard was approved by CEN on 7 November 2016.

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European foreword

This document (EN 1839:2017) 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 document supersedes EN 14756:2006, and EN 1839:2012.

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of an identical text or by endorsement, at the latest by July 2017, and conflicting national standards shall be withdrawn at the latest by January 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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 Directives, see informative Annex ZA, which is an integral part of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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Introduction

The hazard of an explosion can be avoided by preventing the formation of explosive mixtures of gases and/or vapours with air. To do so, the explosion limits (also known as “flammability limits”) or the limiting oxygen concentration of the flammable substance need to be known. These limits depend mainly on:

- the properties of the flammable substance;
- temperature and pressure;
- size and shape of the test vessel;
- ignition source (type, energy);
- the criterion for self-propagating combustion;
- the inert gas (in case of the limiting oxygen concentration).

To obtain reliable and comparable results it is necessary to standardize the conditions for determining the explosion limits resp. the limiting oxygen concentration (i.e. apparatus and procedure). However, it is not possible to provide one single method that is suitable for all types of substances. For practical reasons, it is preferable to use apparatus that can also be used for the determination of other explosion characteristics. This European Standard, therefore, details two methods, namely, the tube method (method T) and the bomb method (method B). In general, the tube method gives a wider explosion range. Differences in the explosion limits and limiting oxygen concentration determined by the two methods can vary by up to 10 % relative.

For substances which are difficult to ignite, only a modified tube method is suitable. This is described in Annex A.

1 Scope

This European Standard specifies two test methods (method T and method B) to determine the explosion limits of gases, vapours and their mixtures, mixed with air or an air / inert gas mixture (volume fraction of the oxygen < 21 %) and the limiting oxygen concentration. This European Standard applies to gases, vapours and their mixtures at atmospheric pressure for temperatures up to 200 °C.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13237:2012, *Potentially explosive atmospheres - Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

3 Terms and definitions

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

3.1

flammable substance

substance in the form of gas, vapour or mixtures of these, able to undergo an exothermic reaction with air or air / inert gas mixture when ignited

[SOURCE: EN 13237:2012, 3.37, modified]

3.2

explosion range

range of the concentration of a flammable substance or mixture of substances in air, within which an explosion can occur, respectively range of the concentration of a flammable substance or mixture of substances in mixture with air / inert gas, within which an explosion can occur, determined under specified test conditions

[SOURCE: EN 13237:2012, 3.22, modified]

Note 1 to entry: The explosion limits are not part of the explosion range

3.3

lower explosion limit

LEL

lowest concentration of the explosion range

[SOURCE: EN 13237:2012, 3.19.1, modified]

Note 1 to entry: Those concentrations are given at which an explosion just fails during the tests.

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upper explosion limit
UEL**

highest concentration of the explosion range

[SOURCE: EN 13237:2012, 3.19.2, modified]

Note 1 to entry: Those concentrations are given at which an explosion just fails during the tests.

**3.5
limiting air concentration
LAC**

maximum air concentration in a mixture of a flammable substance, air and an inert gas, in which an explosion will not occur

Note 1 to entry: *LAC* is usually expressed as molar fraction in % or volume fraction in % (for conversion of units see Annex B).

Note 2 to entry: The *LAC* does not depend only on the flammable gas or vapour, but also on the inert gas used.

**3.6
limiting oxygen concentration
LOC**

maximum oxygen concentration in a mixture of a flammable substance, air and an inert gas, in which an explosion will not occur

[SOURCE: EN 13237:2012, 3.49, modified]

Note 1 to entry: *LOC* is usually expressed as molar fraction in % or volume fraction in % (for conversion of units see Annex B)

Note 2 to entry: The *LOC* does not depend only on the flammable gas or vapour, but also on the inert gas used.

Note 3 to entry: *LOC* is calculated from the measured *LAC*

**3.7
inert gas**
gas that does not react with the test substance or oxygen**3.8
explosion region**

area inside the boundary curve formed by the explosion limits of a flammable substance in various mixtures with air and inert gas

[SOURCE: EN 13237:2012, 3.15, modified]

Note 1 to entry: In many cases the apex of the boundary curve corresponds to the limiting air concentration, *LAC*.

3.9**explosion criterion — flame detachment**

in method T there are two alternate criteria for explosion (self-propagating combustion): i) the detachment and upward movement of the flame from the spark gap for at least 100 mm, or ii) the formation of a halo which either reaches the top of the tube, or reaches a minimum height of 240 mm

Note 1 to entry: Throughout the duration of the ignition spark, test mixtures, whose test substance content lies just outside the explosion range, may exhibit a luminous phenomenon (referred to as a “halo”) above the spark gap which does not detach from the latter (see Annex C). For some test substances (e.g. halogenated hydrocarbons), this luminous phenomenon can occupy a large portion of the test vessel. The formation of a halo alone is not considered to count as an ignition of the test mixture unless it reaches the top of the tube or a minimum height of 240 mm.

3.10**explosion criterion — pressure rise**

in method B, the criterion for an explosion (self-propagating combustion) is the generation of explosion overpressure which is equal to or greater than the overpressure created by the ignition source alone in air plus $(5 \pm 0,1)$ % of the initial pressure

3.11**vapour**

gaseous phase emanating or being emanated from a liquid

Note 1 to entry: If not otherwise mentioned, the term “gas” in this standard also includes such vapours but not mists.

3.12**oxidizer**

air or an air / inert gas mixture (volume fraction of the oxygen < 21 %)

3.13**sample**

substance or mixture of substances for which explosion limits are to be determined

3.14**test substance**

sample in the gaseous state; in the case of liquid samples, after complete evaporation

3.15**test mixture**

mixture of test substance and air or air / inert gas

4 Test methods**4.1 General**

The determination consists of a series of ignition tests which are carried out with test mixtures whose test substance content is varied when determining the explosion limits and with test mixtures whose test substance content and inert gas content is varied when determining the limiting oxygen concentration..

For organic substances which consist exclusively of carbon, hydrogen and oxygen (with the exception of peroxides), the *LEL* can be roughly estimated. At 20 °C, the *LEL*, in many cases, is approximately half the test substance content of the stoichiometric composition in air. The temperature dependence of the *LEL*

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has to be taken into account. Up to 200 °C, the *LEL* decreases more or less linearly between 30 % and 50 % of the value estimated for 20 °C.

There is currently no method which readily estimates the *UEL*.

When it is established that a given test mixture will not ignite, it is recommended that the quantitative composition of the non-ignited test mixture flowing out of the test vessel is analysed in order to determine whether any errors have arisen either with the metering devices or due to leakage.

4.2 Method T (“tube” method)**4.2.1 Detailed method**

The test mixture flows through the cylindrical test vessel from the bottom upwards to the top until the contents previously in the test vessel have been completely replaced. Then, under quiescent conditions, an ignition is initiated using a series of induction sparks. It is observed whether or not flame detachment occurs. When determining the *LEL* or the *UEL* (explosion criterion — flame detachment) the test substance content of the test mixture is varied stepwise until an ignition of the mixture just fails or until it is established that there is no explosion range.. When determining the *LOC* the test substance content of the test mixture as well as the inert gas content is varied stepwise until an ignition of the mixture just fails.

4.2.2 Reagents and materials**4.2.2.1 Air, which shall be free of water ($\leq 0,1$ mol% water vapour absolute) and oil ($\leq 0,1$ g / m³ oil)**

If synthetic air is used, it has to be stated in the report.

4.2.2.2 Inert gases, 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.

4.2.2.3 Flammable substances, which may be either a single substance or a defined mixture of substances or a process sample (of known or unknown composition)

When a single substance or a defined 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. For a process sample with unknown composition, the sample shall be defined as precisely as possible (e.g. process conditions).

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. When large volumes of the gas are removed, 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.

4.2.2.4 Heat-resistant, chemically inert material for gaskets and adhesive mountings

Sample containers shall be kept closed before and after sampling to avoid changes in the sample composition within the container (e.g. loss of volatile components from mixtures). If a sample container contains a mixture with both gaseous and liquid phases present, the mixture composition of the two phases will be different. Under such conditions, it is recommended that the test substance sample be removed from the liquid phase. If the sample is taken from the gaseous phase, account shall be taken of the difference in composition.

4.2.3 Apparatus

4.2.3.1 Test vessel

The test vessel is an upright cylindrical vessel made of glass or other transparent material (e.g. polycarbonate) with an inner diameter of (80 ± 2) mm and a minimum length of 300 mm.

The vessel is equipped with an inlet pipe with a three-way valve for the test mixture, located at the bottom, and an outlet pipe and pressure vent in the upper part.

The bottom and top may be made of other material. However, the material shall be free of any catalytic effect and resistant to corrosion from the test mixture or the reaction products.

4.2.3.2 Ignition source

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

The electrodes shall end (60 ± 1) mm above the bottom of the test vessel.

Stainless steel is a suitable material for the electrodes. The electrodes shall be pointed rods with a diameter of maximum 4 mm. The angle of the tips shall be $(60 \pm 3)^\circ$. The distance between the tips shall be $(5 \pm 0,1)$ mm. The electrodes shall be mounted in the vessel so that they are gas tight at the highest explosion pressures generated during the test. The mounting shall be resistant to both heat and the test mixture, and also 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.

The power of the induction sparks is dependent 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.

4.2.3.3 Equipment for preparing the test mixture

The test mixture is prepared by mixing flows of gaseous components. This requires the following equipment:

- metering device for air, gaseous samples, inert gases (e.g. mass flow controller, volume flow controller, metering pump for gases);
- metering device for liquid samples (e.g. volumetric metering pumps);
- evaporator equipment in the case of a liquid sample (for example see Annex D);
- mixing vessel for homogenizing the test mixture.

The metering devices and the equipment for preparing the test mixture have to be designed in such a way that the uncertainty of measurement of the test substance content in the test mixture is not higher than the data given in Table 1.