



SLOVENSKI STANDARD

SIST EN 1839:2013

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SIST EN 1839:2003

Ugotavljanje mej eksplozivnosti plinov in hlapov

Determination of explosion limits of gases and vapours

Bestimmung der Explosionsgrenzen von Gasen und Dämpfen

Détermination des limites d'exposivité des gaz et vapeurs
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Ta slovenski standard je istoveten z: ~~SIST EN 1839:2012~~ **EN 1839:2012**

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ICS:

13.230 Varstvo pred eksplozijo Explosion protection

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EUROPEAN STANDARD

EN 1839

NORME EUROPÉENNE

EUROPÄISCHE NORM

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English Version

Determination of explosion limits of gases and vapours

Détermination des limites d'exposivité des gaz et vapeurs

Bestimmung der Explosionsgrenzen von Gasen und
Dämpfen

This European Standard was approved by CEN on 27 July 2012.

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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

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COMITÉ EUROPÉEN DE NORMALISATION
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Contents

Page

Foreword.....	4
1 Scope	6
2 Normative references	6
3 Terms and definitions	6
4 Test Methods.....	7
4.1 Method T ("tube" method)	7
4.1.1 Principle.....	7
4.1.2 Reagents and Materials.....	7
4.1.3 Apparatus	8
4.1.4 Preparation of the test mixture.....	10
4.1.5 Procedure	10
4.2 Method B ("bomb" method).....	11
4.2.1 Principle.....	11
4.2.2 Reagents and materials	11
4.2.3 Apparatus	11
4.2.4 Preparation of the test mixture.....	13
4.2.5 Procedure	13
4.3 Recording of results.....	15
4.4 Test report	15
Annex A (normative) Method for determination of the explosion limits of substances that are difficult to ignite	17
A.1 Background	17
A.2 Explanation.....	17
A.3 Apparatus	17
A.4 Safety equipment.....	18
A.5 Preparation of the test mixture.....	18
A.6 Procedure	18
Annex B (informative) Examples to describe flame detachment	20
Annex C (informative) Example of recommended evaporator equipment	21
Annex D (normative) Safety measures	23
D.1 General.....	23
D.2 General safety measures	23
D.3 Additional safety measures concerning the tube method	23
Annex E (informative) Example of a form expressing the results¹ Test report	24
Annex F (normative) Verification.....	25
Annex G (informative) Conversion of the values for the explosion limits	27
G.1 Abbreviations and symbols.....	27
G.2 Substance characteristics of air	27
G.3 Definitions	28
G.4 Mixture preparation	28
G.5 Conversion	29

Annex H (informative) Significant Changes between this European Standard and EN 1839:2003	31
Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 94/9/EC	32
Bibliography	33

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SIST EN 1839:2013

<https://standards.iteh.ai/catalog/standards/sist/6c10c492-ee03-4f98-8561-e32ddffde3df/sist-en-1839-2013>

EN 1839:2012 (E)**Foreword**

This document (EN 1839:2012) 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 March 2013, and conflicting national standards shall be withdrawn at the latest by March 2013.

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

This document supersedes EN 1839:2003.

The significant changes between this European Standard and EN 1839:2003 are given in Table H.1.

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 94/9/EC.

For relationship with EU Directive(s), 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, 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. To do so, the explosion limits (also known as "flammability limits") 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.

To obtain reliable and comparable results it is necessary to standardise the conditions for determining the explosion limits (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 determined by the two methods can vary by up to 10 % relative.

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

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EN 1839:2012 (E)**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. An air/inert gas mixture (volume fraction of the oxygen < 21 %) can be used as the oxidizer instead of air. In this European Standard, the term “air” includes such air/inert mixtures.

This European Standard applies to gases, vapours and their mixtures at atmospheric pressure for temperatures up to 200 °C.

2 Normative references

Not applicable.

3 Terms and definitions

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

**3.1
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]

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**3.2
lower explosion limit
LEL**

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lowest concentration of the explosion range at which an explosion can occur

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

[SOURCE: EN 13237:2012, 3.19.1]

**3.3
upper explosion limit
UEL**

highest concentration of the explosion range at which an explosion can occur

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

[SOURCE: EN 13237:2012, 3.19.2]

**3.4
explosion criterion — flame detachment**

in method T, the criterion for an explosion (self-propagating combustion) is the upward movement of the flame from the spark gap for at least 100 mm or 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 B). 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.

3.5**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

3.6**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.

3.7**oxidizer**

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

3.8**sample**

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

3.9**test substance**

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

3.10**test mixture**

mixture of test substance and air

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4 Test Methods

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4.1 Method T (“tube” method)**4.1.1 Principle**

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. The test substance content of the test mixture is varied stepwise until the *LEL* or the *UEL* (explosion criterion — flame detachment) have been determined or until it is established that there is no explosion range.

4.1.2 Reagents and Materials

4.1.2.1 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.

4.1.2.2 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.

4.1.2.3 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. In the case of a process sample of unknown composition, the sample shall be defined as well as possible process conditions.

EN 1839:2012 (E)

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.

4.1.2.4 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 must be taken of the difference in composition.

4.1.3 Apparatus**4.1.3.1 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 must be free of any catalytic effect and resistant to corrosion from the test mixture or the reaction products.

4.1.3.2 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 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 the ignition of the test mixture, the test may be repeated with a spark discharge time of up to 0,5 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.

4.1.3.3 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 or additional 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 C);

— mixing vessel for homogenizing the test mixture.

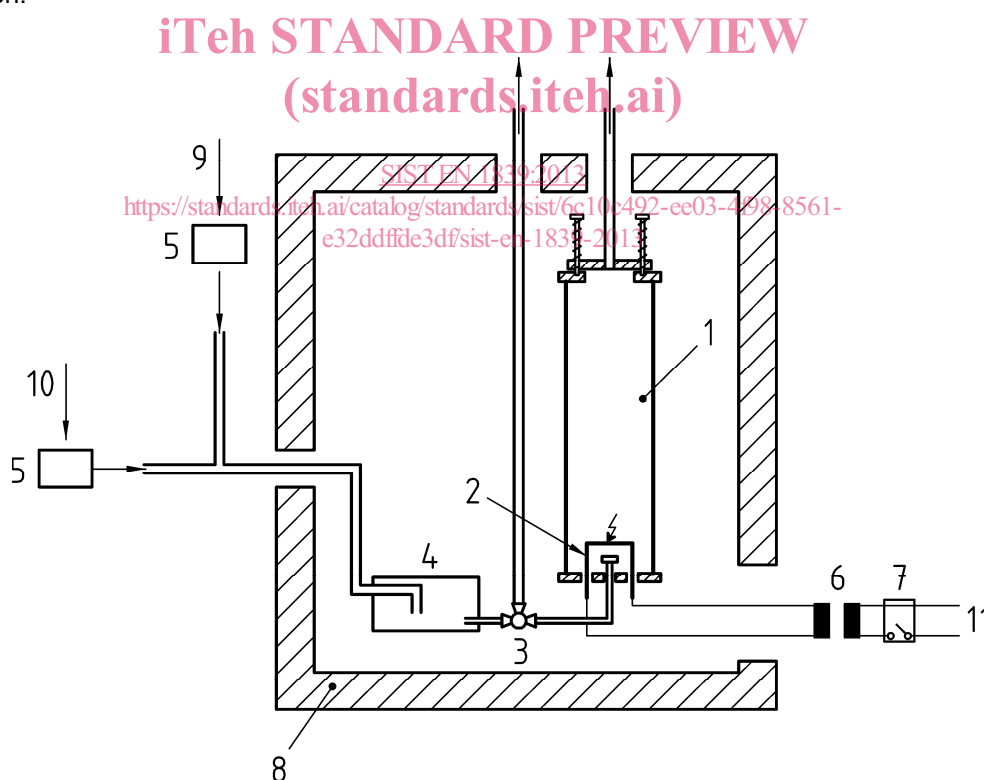
The metering devices and the equipment for preparing the test mixture have to be designed in such a way that the uncertainty of measurement of the test substance content in the test mixture is not higher than the data given in Table 1.

Table 1 — Maximum permissible uncertainty of measurement for the amount of test substance in the test mixture

molar amount of test substance %	maximum uncertainty of measurement %	
	relative	absolute
≤ 2	± 10	
> 2		± 0,2

4.1.3.4 Temperature regulating system.

For measurements at temperatures above ambient temperature, the apparatus requires a temperature regulating system. When this is used, it has to be ensured that the temperature difference inside the test vessel is not more than 10 K. This has to be checked when initially setting up the apparatus, whenever parts are renewed and at every verification.



Key

- | | |
|----------------------------|--|
| 1 test vessel | 7 timer |
| 2 electrodes | 8 facility for keeping the temperature |
| 3 three-way valve | 9 flammable substance |
| 4 mixing vessel | 10 air |
| 5 metering devices | 11 power supply |
| 6 high-voltage transformer | |

Figure 1 — Scheme of the 'tube' apparatus for determining the explosion limits

EN 1839:2012 (E)

4.1.3.5 Safety equipment.

The safety measures specified in Annex D shall be followed.

4.1.4 Preparation of the test mixture

When evaporating liquid samples, it is important to remember that the mixture composition of the gaseous phase in equilibrium with a liquid phase ("vapour") generally differs from the mixture composition of the liquid phase itself. Furthermore, the mixture compositions of the liquid and the vapour phases may change when removing material from the vapour phase. Allowance for this is necessary when determining explosion limits for flammable liquids, when handling liquid samples and when preparing test mixtures by evaporating liquid samples. To avoid error, the method of dynamic total evaporation is used. An example of a suitable evaporator set up is described in Annex C. When liquids are metered, it has to be ensured that bubbles are not formed in any component carrying the liquid (e.g. pipes). To achieve complete homogenization, the test mixture flows through a mixing vessel, preferably made of glass. For a mixing vessel with no built-in elements, a volume of at least 600 ml is recommended. It is expedient to introduce the test mixture tangentially. The mixing vessel is not necessary if homogenization is effectively achieved by the metering device. The temperature of the mixing vessel and of all parts carrying the test mixture is kept constant to prevent the test substance from condensing. It is recommended that the components carrying the test mixture are heated along with the test vessel.

4.1.5 Procedure

If the explosion limits are to be determined at elevated temperature, preheat the test vessel and all parts carrying the test mixture to the required temperature. For liquid samples, the temperature of the test mixture shall be at least 25 K higher than the condensation temperature. Prior to each ignition attempt, it has to be ensured that the temperature in the test vessel differs by no more than 5 K from the required value.

The determination of the explosion limits consists of a series of ignition tests which are carried out with test mixtures whose test substance content is varied.

For safety reasons, the initial ignition tests are carried out using a test mixture with test substance content which, if possible, lies outside the expected explosion range.

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. The temperature dependence of the *LEL* 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*.

Prior to each ignition attempt, the test vessel is purged with the test mixture. The purging volume has to be at least ten times the volume of the test vessel. When purging is complete, the inlet to the test vessel is sealed. The test mixture then by-passes the test vessel and flows directly into the exhaust system. An ignition is attempted using the induction spark under quiescent conditions (i.e. after a 6 s to 10 s delay). It is observed whether a flame detaches from the ignition source (see Annex B).

It is recommended that the ignition testing is carried out without interruption of the production of the test mixture. If restarting, it will take a finite time to produce a test mixture of constant composition even if the adjustment has not been changed.

If an ignition is observed, the test substance content in the test mixture is iteratively varied until no further flame detachment follows. Close to the explosion limits, the incremental change of test substance content is selected so that it is almost equal to the relative deviation given in Table 1. The test mixture with which a further flame detachment just fails has to be repeated four times. The determination is terminated when all five tests have taken place with no observed flame detachment. If flame detachment does occur, the test substance content has to be further changed, i.e. for determination of the *LEL*, the test substance content has to be reduced by one increment; for the *UEL*, it has to be increased by one increment. Five tests are carried out at the new test substance content. When it is established that a given test mixture will not ignite, it is recommended that the composition of the non-