ISO/IEC 80079-20-1

Edition 1.0 2017-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data

Atmosphères explosives – Partie 20-1: Caractéristiques des produits pour le classement des gaz et des vapeurs – Méthodes et données d'essai

ISO/IEC 80079-20-1:2017-12(en-fr)

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EXPLOSIVE ATMOSPHERES –

Part 20-1: Material characteristics for gas and vapour classification – Test methods and data

FOREWORD

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International Standard ISO/IEC 80079-20-1 has been prepared by subcommittee 31M: Non-electrical equipment and protective systems for explosive atmospheres, of IEC technical committee 31: Equipment for explosive atmospheres.

This first edition of ISO/IEC 80079-20-1 cancels and replaces IEC 60079-20-1:2010. It constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

The classifications for the temperature class or equipment group were changed in the informative Annex B for the following materials: CAS-No. 64-17-5; 78-93-3; 107-31-3:

- For dry Ethanol (CAS-No. 64-17-5), equipment group remains IIB, but for Ethanol in air with ≥4% water vapour, as in common atmospheres, a second line has been added to indicate IIA;

- For 2-Butanone (CAS-No. 78-93-3), re-measurement indicated change from IIB to IIA was needed; and

- For Formic Acid Methyl Ester (CAS-No. 107-31-3), re-measurement indicated change from T2 to T1 was justified.

No significant changes were made with respect to the normative text of IEC 60079-20-1:2010.

It is published as a double logo standard.

The text of this standard is based on the following documents:

FDIS	Report on voting
31M/122/FDIS	31M/126/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60079 series, under the general title: *Explosive atmospheres*, as well as the International Standard 80079 series, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

The contents of the corrigendum of July 2018 have been included in this copy.

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EXPLOSIVE ATMOSPHERES –

Part 20-1: Material characteristics for gas and vapour classification – Test methods and data

1 Scope

This part of ISO/IEC 80079 provides guidance on classification of gases and vapours. It describes a test method intended for the measurement of the maximum experimental safe gaps (MESG) for gas-air mixtures or vapour-air mixtures under normal conditions of temperature and pressure (20 °C, 101,3 kPa) so as to permit the selection of an appropriate group of equipment. This document also describes a test method intended for use in the determination of the auto-ignition temperature (AIT) of a vapour-air mixture or gas-air mixture at atmospheric pressure, so as to permit the selection of an appropriate temperature class of equipment.

Values of chemical properties of materials are provided to assist in the selection of equipment to be used in hazardous areas. Further data may be added as the results of validated tests become available.

The materials and the characteristics included in a table (see Annex B) have been selected with particular reference to the use of equipment in hazardous areas. The data in this document have been taken from a number of references which are given in the bibliography.

These methods for determining the MESG or the AIT may also be used for gas-air-inert mixtures or vapour-air-inert mixtures. However, data on air-inert mixtures are not tabulated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

IEC 60050-426, *International Electrotechnical Vocabulary − Part 426: Electrical apparatus for explosive atmospheres* (available at http://www.electropedia.org/)

IEC 60079-11, *Explosive atmospheres − Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-14, *Explosive atmospheres − Part 14: Electrical installations design, selection and erection*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-426 and the following apply.

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- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
auto-ignition
reaction which is evidenced by a clearly perceptible flame and/or explosion, and for which the ignition delay time does not exceed 5 min

Note 1 to entry: See 7.2.2 for a test method.

3.2
ignition delay time
time between the completed injection of the flammable material and the ignition

3.3
auto-ignition temperature
AIT
lowest temperature (of a surface) at which under specified test conditions an ignition of a flammable gas or vapour in mixture with air or air-inert gas occurs

Note 1 to entry: See Clause 7 for a test method.

3.4
maximum experimental safe gap
MESG
maximum gap of a joint of 25 mm in width which prevents any transmission of an explosion during tests made under the conditions specified in this document

Note 1 to entry: See Clause 6 for a test method.

3.5
minimum igniting current
MIC
minimum current in a specified test circuit that causes the ignition of the explosive test mixture in the spark test apparatus according to IEC 60079-11

Note 1 to entry: See 5.1.6 for the test circuit.

3.6
flammable limits
lower flammable limit (LFL) and upper flammable limit (UFL) of gas in a gas-air mixture, between which a flammable mixture is formed

Note 1 to entry: The term “explosive limits” is used especially in European standardization and regulations interchangeably to describe these limits.

Note 2 to entry: The concentration can be expressed as either a volume fraction or a mass per unit volume.

3.6.1
lower flammable limit
LFL
concentration of flammable gas or vapour in air, below which an explosive gas atmosphere does not form

Note 1 to entry: For the purposes of Ex Equipment, this was previously referred to as the lower explosive limit (LEL).

Note 2 to entry: The concentration can be expressed as either a volume fraction or a mass per unit volume.

3.6.2
upper flammable limit
UFL
concentration of flammable gas or vapour in air, above which an explosive gas atmosphere does not form

Note 1 to entry: For the purposes of Ex Equipment, this was previously referred to as the upper explosive limit (UEL).

Note 2 to entry: The concentration can be expressed as either a volume fraction or a mass per unit volume.

3.7
equipment grouping
classification system of equipment related to the explosive atmosphere for which they are intended to be used

Note 1 to entry: IEC 60079-0 identifies three equipment groups:

Group I – equipment for mines susceptible to fire damp;

Group II, which is sub-divided into groups IIA, IIB and IIC – equipment for all places with an explosive gas atmosphere other than mines susceptible to fire damp;

Group III, which is sub-divided into groups IIIA, IIIB and IIIC – equipment for all places with an explosive dust atmosphere other than mines susceptible to fire damp.

3.8
flash point
FP
lowest liquid temperature at which, under specified test conditions, a liquid gives off vapours in quantity such as to be capable of forming an ignitable vapour-air mixture

3.9
gas
gaseous phase of a substance that cannot reach equilibrium with its liquid or solid state in the temperature and pressure range of interest

Note 1 to entry: This is a simplification of the scientific definition, and merely requires that the substance is above its boiling point or sublimation point at the ambient temperature and pressure.

3.10
vapour
gaseous phase of a substance that can reach equilibrium with its liquid or solid state in the temperature and pressure range of interest

Note 1 to entry: This is a simplification of the scientific definition, and merely requires that the substance is below its boiling point or sublimation point at the ambient temperature and pressure.

4 Classification of gases and vapours

4.1 General

Equipment Group I addresses mines susceptible to firedamp.

NOTE Firedamp consists mainly of methane, but always contains small quantities of other gases, such as nitrogen, carbon dioxide, and hydrogen, and sometimes ethane and carbon monoxide. The terms firedamp and methane are used frequently in mining practice as synonyms.

Equipment Group II addresses flammable gases and vapours other than in mines susceptible to firedamp. Equipment Group II gases and vapours are classified according to their MESG and/or MIC ratio into equipment groups IIA, IIB and IIC.

All flammable materials are classified according to their AIT into temperature classes.

4.2 Classification according to the maximum experimental safe gap (MESG)

Gases and vapours may be classified according to their MESG into Equipment Groups IIA, IIB or IIC, based on the determination method described in this document. In order to ensure standardized results the MESG apparatus is dimensioned to avoid the possible effects of obstruction on the safe gaps.

NOTE 1 The standard method for determining MESG is described in 6.2, but where determinations have been undertaken only in an 8 l spherical vessel with ignition close to the flange gap these can be accepted provisionally.

NOTE 2 The design of the test apparatus for safe gap determination, other than that used for selecting the appropriate equipment group of enclosure for a particular gas, may need to be different to the one described in this document. For example, the volume of the enclosure, flange width, gas concentrations and the distance between the flanges and any external wall or obstruction may have to be varied. As the design depends on the particular investigation which is to be undertaken, it is impracticable to recommend specific design requirements, but for most applications the general principles and precautions indicated in this document will still apply.

NOTE 3 In IEC 60079-14 minimum distances of obstruction from the flameproof flange joints related to the equipment group of the hazardous area are given.

For the purpose of classification the MESG limits are:

Equipment Group IIA: MESG ≥ 0,90 mm.

Equipment Group IIB: 0,50 mm < MESG < 0,90 mm.

Equipment Group IIC: MESG ≤ 0,50 mm.

Determination of both the MESG and MIC ratio is required when 0,50 < MESG < 0,55. Then the equipment group is determined by MIC ratio,

NOTE 4 For gases and highly volatile liquids, the MESG is determined at 20 °C.

NOTE 5 If it was necessary to do the MESG determination at temperatures higher than ambient temperature a temperature 5 K above that needed to give the necessary vapour pressure or 50 K above the flash point is used and this value of MESG is given in the table and the classification of the equipment group is based on this result.

4.3 Classification according to the minimum igniting current ratio (MIC ratio)

Gases and vapours may be classified according to the ratio of their minimum igniting currents (MIC) to the ignition current of laboratory methane into Equipment Groups IIA, IIB or IIC. The purity of laboratory methane shall be not less than 99,9 % by volume.

NOTE The standard method of determining MIC ratios is with the apparatus described in IEC 60079-11, but where determinations have been undertaken in other apparatus these can be accepted provisionally.

For the purpose of classification the MIC ratios are:

Equipment Group IIA: MIC > 0,80.

Equipment Group IIB: 0,45 ≤ MIC ≤ 0,80.

Equipment Group IIC: MIC < 0,45.

Determination of both the MESG and MIC ratio is required when 0,70 < MIC < 0,90 or 0,40 < MIC < 0,50. Then the equipment group is determined by MESG.

4.4 Classification according to the similarity of chemical structure

When a gas or vapour is a member of a homologous series of compounds, the classification of the gas or vapour can provisionally be inferred from the data of the neighbouring members of the series.

The classification according to the similarity of chemical structure is not allowed if the classification of one of the neighbouring members is based on MESG and the other on MIC ratio.

4.5 Classification of mixtures of gases

Mixtures of gases should generally be allocated to an equipment group only after a special determination of MESG or MIC ratio. One method to estimate the equipment group is to determine the MESG of the mixture by applying a form of Le Châtelier's principle:

$$MESG_{\text{mix}} = \frac{1}{\sum_i \left(\frac{X_i}{MESG_i} \right)}$$

Where X_i is the percentage by volume of material i and $MESG_i$ is the MESG of material i.

This method should not be applied in case of exceptions to the Le Châtelier's principle and to mixtures and/or streams that have:

a) acetylene or its equivalent hazard (e.g. self-decomposition properties);

b) oxygen or other strong oxidizer as one of the components;

c) large concentrations (over 5 % by volume) of carbon monoxide. Because unrealistically high MESG values may result, caution should be exercised with two component mixtures where one of the components is an inert, such as nitrogen.

For mixtures containing an inert such as nitrogen in concentrations less than 5 % by volume, use an MESG of infinity. For mixtures containing an inert such as nitrogen in concentrations 5 % by volume and greater, use an MESG of 2.

NOTE An alternate method that includes stoichiometric ratios is presented in the essay "Maximum experimental safe gap of binary and ternary mixtures," by Brandes and Redeker.

5 Data for flammable gases and vapours, relating to the use of equipment

5.1 Determination of the properties

5.1.1 General

The compounds listed in this document are in accordance with Clause 4, or have physical properties similar to those of other compounds in that list.

5.1.2 Equipment group

The equipment groups are the result of MESG or MIC ratio determination except where there is no value listed for MESG or MIC ratio. For these, the equipment group is based on chemical similarity (see Clause 4).

NOTE If it was necessary to do the MESG determination at temperatures higher than ambient temperature, a temperature 5 K above that needed to give the necessary vapour pressure or 50 K above the Flash Point is used. This value of MESG is given in Table B.1 and the classification of the equipment group is based on this result.

5.1.3 Flammable limits

Determinations have been made by a number of different methods, but the preferred method is with a low energy ignition at the bottom of a vertical tube. The values (in percentage by volume and mass per volume) are listed in Table B.1.

If the flash point is high, the compound does not form a flammable vapour air/mixture at normal condition of temperature (20 °C). Where flammability data are presented for such compounds the determinations have been made at a temperature sufficiently elevated to allow the vapour to form a flammable mixture with air.

5.1.4 Flash point (FP)

The value given in Table B.1 is the "closed cup" measurement. When this data was not available, the "open cup" value is quoted and indicated by (oc). The symbol < (less than), indicates that the flash point is below the value (in degree Celsius) stated, this probably being the limit of the apparatus used.

5.1.5 Temperature class

The temperature class of a gas or vapour is given according to IEC 60079-14, as shown in Table 1:

Table 1 – Classification of temperature class and range of auto-ignition temperatures

Temperature class	Range of auto-ignition temperature (AIT) °C
T1	> 450
T2	300 < AIT ≤ 450
T3	200 < AIT ≤ 300
T4	135 < AIT ≤ 200
T5	100 < AIT ≤ 135
T6	85 < AIT ≤ 100

5.1.6 Minimum igniting current (MIC)

The apparatus for the determination of minimum igniting current is defined in IEC 60079-11. The test apparatus shall be operated in a 24 V d.c. circuit containing a (95 ± 5) mH air-cored coil. The current in this circuit is varied to a minimum value until ignition of the most easily ignited concentration of the specific gas or vapour in air is obtained.

5.1.7 Auto-ignition temperature (AIT)

The value of auto-ignition temperature depends on the method of testing. The preferred method and data obtained is given in Clause 7 and in Annex A.

If the compound is not included in these data, the data obtained in similar apparatus, such as the apparatus described by ASTM E659, is listed.

NOTE Results from using the apparatus described in ASTM D2155 (now replaced by ASTM E659) were reported by C.J. Hilado and S.W. Clark. The apparatus is similar to the one used by Zabetakis. If there is no determination by either the IEC apparatus, nor similar apparatus, the lowest value obtained in other apparatus is listed. A more comprehensive list of data for auto-ignition temperature, with the reference to sources, is given by Hilado and Clark.

5.2 Properties of particular gases and vapours

5.2.1 Coke oven gas

Coke oven gas is a mixture of hydrogen, carbon monoxide and methane. If the sum of the concentrations (Vol. %) of hydrogen and carbon monoxide is less than 75 % by volume of the total, flameproof equipment of Equipment Group IIB is recommended; otherwise, equipment of Equipment Group IIC is recommended.

5.2.2 Ethyl nitrite

The auto-ignition temperature of ethyl nitrite is 95 °C, above which the gas suffers explosive decomposition.

NOTE Ethyl nitrite is not be confused with its isomer, nitroethane.

5.2.3 MESG of carbon monoxide

The MESG for carbon monoxide relates to a mixture with air saturated with moisture at normal ambient temperature. This determination indicates the use of Equipment Group IIB equipment in the presence of carbon monoxide. A larger MESG may be observed with less moisture. The lowest MESG (0,65 mm) is observed for a mixture of CO/H_2O near 7:1 mole ratio. Small quantities of hydrocarbon in the carbon monoxide-air mixture have a similar effect in reducing the MESG so that Equipment Group IIB equipment is required.

5.2.4 Methane, Equipment Group IIA

Industrial methane, such as natural gas, is classified as Equipment Group IIA, provided it does not contain more than 25 % by volume of hydrogen. A mixture of methane with other compounds from Equipment Group IIA, in any proportion, is classified as Equipment Group IIA.

6 Method of test for the maximum experimental safe gap (MESG)

6.1 Outline of method

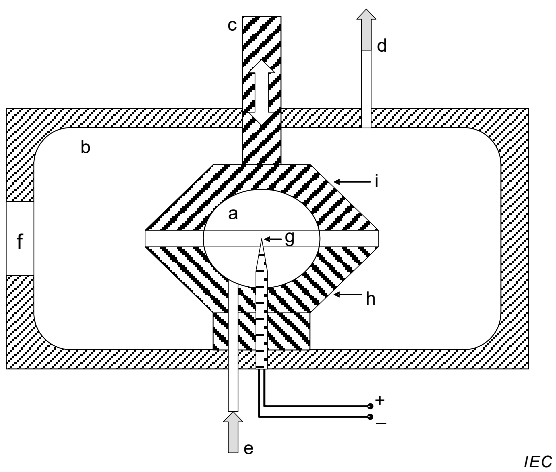
The interior and exterior chambers of the test apparatus are filled with a known mixture of the gas or vapour in air, under normal conditions of temperature and pressure (20 °C, 101,3 kPa) and with the circumferential gap between the two chambers accurately adjusted to the desired value. The internal mixture is ignited and the flame propagation, if any, is observed through the windows in the external chamber. The maximum experimental safe gap for the gas or vapour is determined by adjusting the gap in small steps to find the maximum value of gap which prevents ignition of the external mixture, for any concentration of the gas or vapour in air.

NOTE An exception is made for substances with vapour pressures which are too low to permit mixtures of the required concentrations to be prepared at normal ambient temperatures. For these substances, a temperature 5 K above that needed to give the necessary vapour pressure or 50 K above the flash point is used.

6.2 Test apparatus

6.2.1 General

The apparatus is described in the following subclauses and is shown schematically in Figure 1. It is also possible to use an automatic set-up when it is proven that the same results are obtained as with a manual apparatus.



Key

[a] interior spherical chamber
[b] exterior cylindrical enclosure
[c] adjustable part
[d] outlet of mixture
[e] inlet of mixture
[f] observation windows
[g] spark electrode
[h] lower gap plate, fixed
[i] upper gap plate, adjustable

Figure 1 – Test apparatus