INTERNATIONAL STANDARD

ISO 10156

Third edition
2010-04-01

Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets

Gaz et mélanges de gaz — Détermination du potentiel d'inflammabilité et d'oxydation pour le choix des raccords de sortie de robinets

Reference number
ISO 10156:2010(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 10156 was prepared by Technical Committee ISO/TC 58, *Gas cylinders*, Subcommittee SC 2, *Cylinder fittings*.

This third edition of ISO 10156 cancels and replaces ISO 10156:1996 and ISO 10156-2:2005.

It gives updated data for flammability and oxidizing ability.

Introduction

ISO 5145 [1] and other related standards establish practical criteria for the determination of outlet connections of cylinder valves. These criteria are based on certain physical and chemical properties of the gases. In particular, the flammability in air and the oxidizing ability are considered.

One of the potential complications that prompted the development of this International Standard is that whilst there are abundant data in the literature relating to pure gases, differences can be found, depending upon the test methods employed; in the case of gas mixtures, data in the literature are often incomplete or even non-existent.

The initial aim of this International Standard was to eliminate the ambiguities in the case of differences in the literature, and above all, to supplement existing data (mainly in the case of gas mixtures).

Subsequently, this International Standard was used for other purposes than the selection of cylinder valve outlets, such as establishing flammability and oxidizing potential data for labelling according to international transport regulations and dangerous substances regulations, under the umbrella of the Globally Harmonized System (GHS).

Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets

1 Scope

This International Standard specifies methods for determining whether or not a gas or gas mixture is flammable in air and whether a gas or gas mixture is more or less oxidizing than air under atmospheric conditions.

This International Standard is intended to be used for the classification of gases and gas mixtures including the selection of gas cylinder valve outlets.

This International Standard does not cover the safe preparation of these mixtures under pressure and at temperatures other than ambient.

2 Terms, definitions, symbols and units

2.1 Terms and definitions

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

2.1.1
gas or gas mixture flammable in air
gas or gas mixture that is ignitable in air at atmospheric pressure and a temperature of 20 °C

2.1.2
lower flammability limit in air
minimum content of a gas or gas mixture in an homogeneous mixture with air at which a flame just starts to propagate

NOTE 1 The lower flammability limit is determined at atmospheric conditions.

NOTE 2 The term “flammability limit”, as used in this International Standard, is sometimes called “explosion limit”.

2.1.3
upper flammability limit in air
maximum content of a gas or gas mixture in an homogeneous mixture with air at which a flame just starts to propagate

NOTE 1 The upper flammability limit is determined at atmospheric conditions.

NOTE 2 The term “flammability limit”, as used in this International Standard, is sometimes called “explosion limit”.

2.1.4
flammability range
range of concentration between the lower and upper flammability limits

NOTE The term “flammability range”, as used in this International Standard, is sometimes also called “explosion range”.

2.1.5
gas or gas mixture more oxidizing than air
gas or gas mixture that is able, at atmospheric pressure, to support the combustion more than a reference oxidizer consisting of 23,5 % oxygen in nitrogen

2.1.6
oxidizing power
OP
oxidizing potential
dimensionless number that compares the oxidizing capability of a gas mixture to that of oxygen

NOTE OP is calculated as the sum of the products of the mole fraction(s) of each oxidizing component times its coefficient of oxygen equivalency, C_i.

2.2 Symbols

A_i	molar fraction of the i^{th} flammable gas in a gas mixture, in %
B_k	molar fraction of the k^{th} inert gas in a gas mixture, in %
C_i	coefficient of oxygen equivalency
F_i	i^{th} flammable gas in a gas mixture
I_k	k^{th} inert gas in a gas mixture
n	number of flammable gases in a gas mixture
p	number of inert gases in a gas mixture
K_k	coefficient of equivalency of an inert gas relative to nitrogen (see Table 1)
A_i'	equivalent content of a flammable gas
L_i	lower flammability limit in air of a flammable gas
T_{ci}	maximum content of flammable gas which, when mixed with nitrogen, is not flammable in air, in %
x_i	molar fraction of the oxidizing component, in %
He	helium
Ar	argon
Ne	neon
Kr	krypton
Xe	xenon
N_2	nitrogen
H_2	hydrogen
O_2	oxygen
CO_2	carbon dioxide
SO_2	sulfur dioxide
N_2O	nitrous oxide
SF_6	sulfur hexafluoride
CF_4	carbon tetrafluoride
C_3F_8	octafluoropropane
CH_4	methane

2.3 Units

For the purposes of this International Standard all gas percentages (%) are given as molar fractions (mol. %) which are equivalent to volume fractions (vol. %) under normal atmospheric conditions.

3 Flammability of gases and gas mixtures in air

3.1 General

Subclauses 3.2 and 3.3 give a test method and a calculation method for determining whether a gas or gas mixture is flammable in air.

The test method (given in 3.2) may be used in all cases but shall be used when T_{ci} (or L_i) values are not available.

The calculation method (given in 3.3) may only be used if reliable T_{ci} (or L_i) values are available.

3.2 Test method

3.2.1 Key points concerning safety

Tests shall be carried out by trained and competent personnel working in accordance with authorized procedures (see also 3.2.4). The reaction tube and flowmeter shall be adequately screened to protect personnel in the event of an explosion. Personnel shall wear personal protective equipment including safety glasses. During the ignition sequence, the reaction tube shall be open to the atmosphere and isolated from the gas supply. Care shall also be taken during the analysis of the test gas or mixture.

3.2.2 Principle

The gas or gas mixture is mixed in the desired proportions with air. In the quiescent test mixture, an ignition is initiated using an electric spark, and it is observed whether or not a flame propagates through the reaction tube.

3.2.3 Test apparatus and materials

The apparatus (see Figure 1) includes:

— a mixer;

— a tube in which the reaction takes place;

— an ignition system;

— a system of analysis to determine the test-gas composition.

NOTE Alternative equivalent apparatus may be used, as described in standard test methods for the determination of explosion limits, e.g. EN 1839 [2] and ASTM E 681 [3].

3.2.3.1 Preparation

3.2.3.1.1 Test gas

The test gas shall be prepared to represent the most flammable composition that can occur in the normal course of production. The criteria to be used in establishing the composition of the test gas are manufacturing tolerances, i.e. the test gas shall contain the highest concentration of flammable gases encountered in the normal manufacturing process and the moisture content shall be less than or equal to 0,01 %. The test gas shall be thoroughly mixed and carefully analysed to determine the exact composition.

3.2.3.1.2 Compressed air

The compressed air shall be analysed and the moisture content shall be less than or equal to 0,01 %.

3.2.3.1.3 Test gas/air mixture

The compressed air and the gas to be tested are mixed in a blender, controlling the flowrates. The air-flammable gas mixture shall be analysed using a chromatograph or a simple oxygen analyser.

3.2.3.2 Reaction tube

The test vessel is an upright cylinder of thick glass (e.g. 5 mm) having a minimum inner diameter of 50 mm and a minimum height of 300 mm. The ignition electrodes are separated by a distance of 5 mm and are placed 50 mm to 60 mm above the bottom of the cylinder. The cylinder is fitted with a pressure-release opening. The apparatus shall be shielded to restrict any explosion damage.

3.2.3.3 Ignition system

A spark generator capable of supplying high voltage sparks (e.g. 15 kV, 30 mA, a.c.) with energy of 10 J shall be used. The spark gap (distance between the electrodes) shall be 5 mm, the spark duration 0,2 s to 0,5 s.

3.2.4 Procedure

When carrying out flammability tests, care shall be taken to avoid explosion. This can be done by commencing the experimental work at a known “safe” concentration of 1 % test gas in air. Subsequently, the initial gas concentration can be increased in small steps by 1 % until ignition occurs.

Prior to each ignition attempt, the test vessel shall be purged with the test mixture. The purging volume shall be at least ten times the volume of the test vessel. Then, an ignition is attempted with the induction spark when the test mixture is quiescent, and it is observed visually whether or not a flame detaches from the ignition source and propagates.

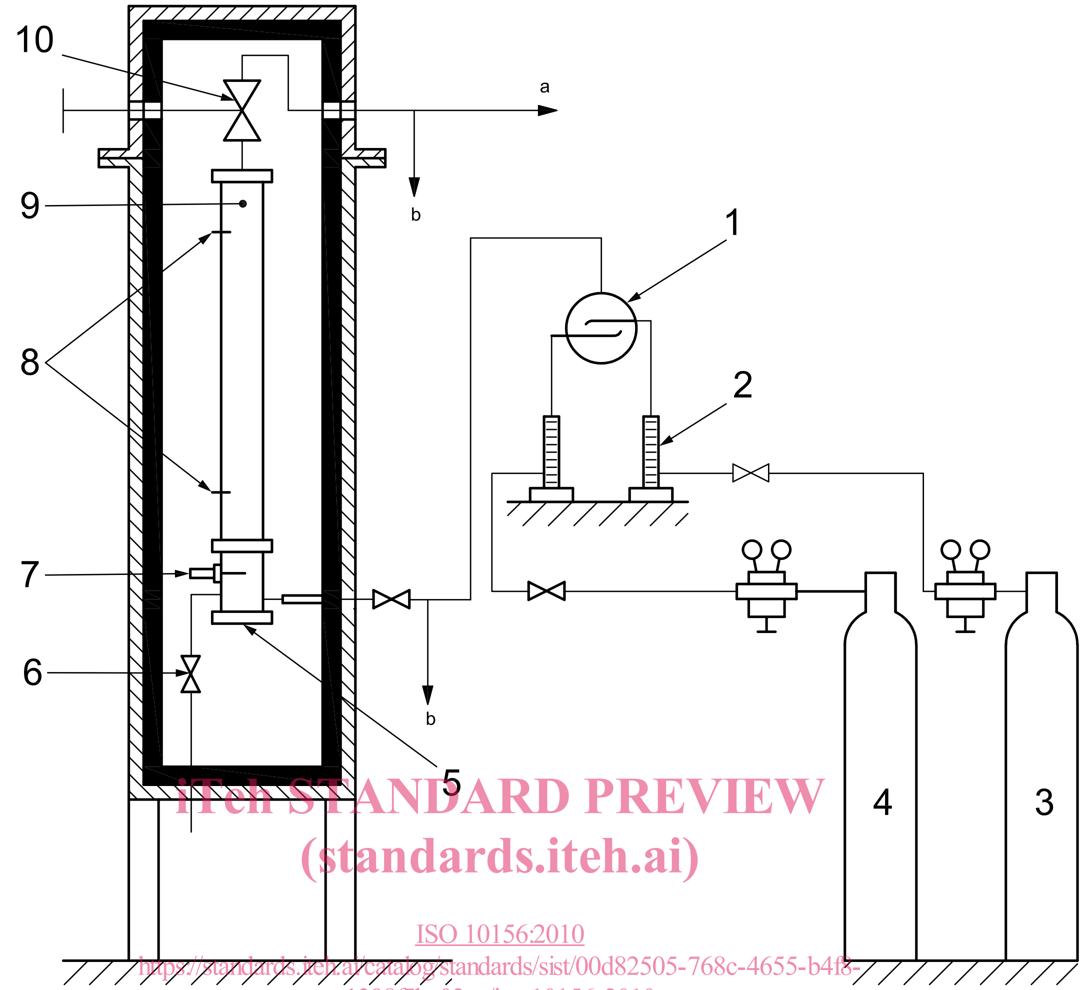
If a flame detachment and an upwards propagation of at least 100 mm is observed, the test substance shall be classified as flammable.

If the chemical structure of the gas indicates that it would be non-flammable and the composition of the stoichiometric mixture with air can be calculated, only mixtures in the range from 10 % (absolute) less than the stoichiometric composition to 10 % greater than this composition need be tested in 1 % steps.

NOTE With mixtures containing hydrogen, the flame is almost colourless. In order to confirm the presence of such flames, the use of temperature-measuring probes is recommended [see Figure 1a)].

3.2.5 Results for pure gases

A list of flammable gases is given in Table 2 together with T_{ci} values and L_i values. These values have been obtained using test equipment similar to that described in 3.2.3.



a) Apparatus using Pyrex tube and temperature-measuring probes

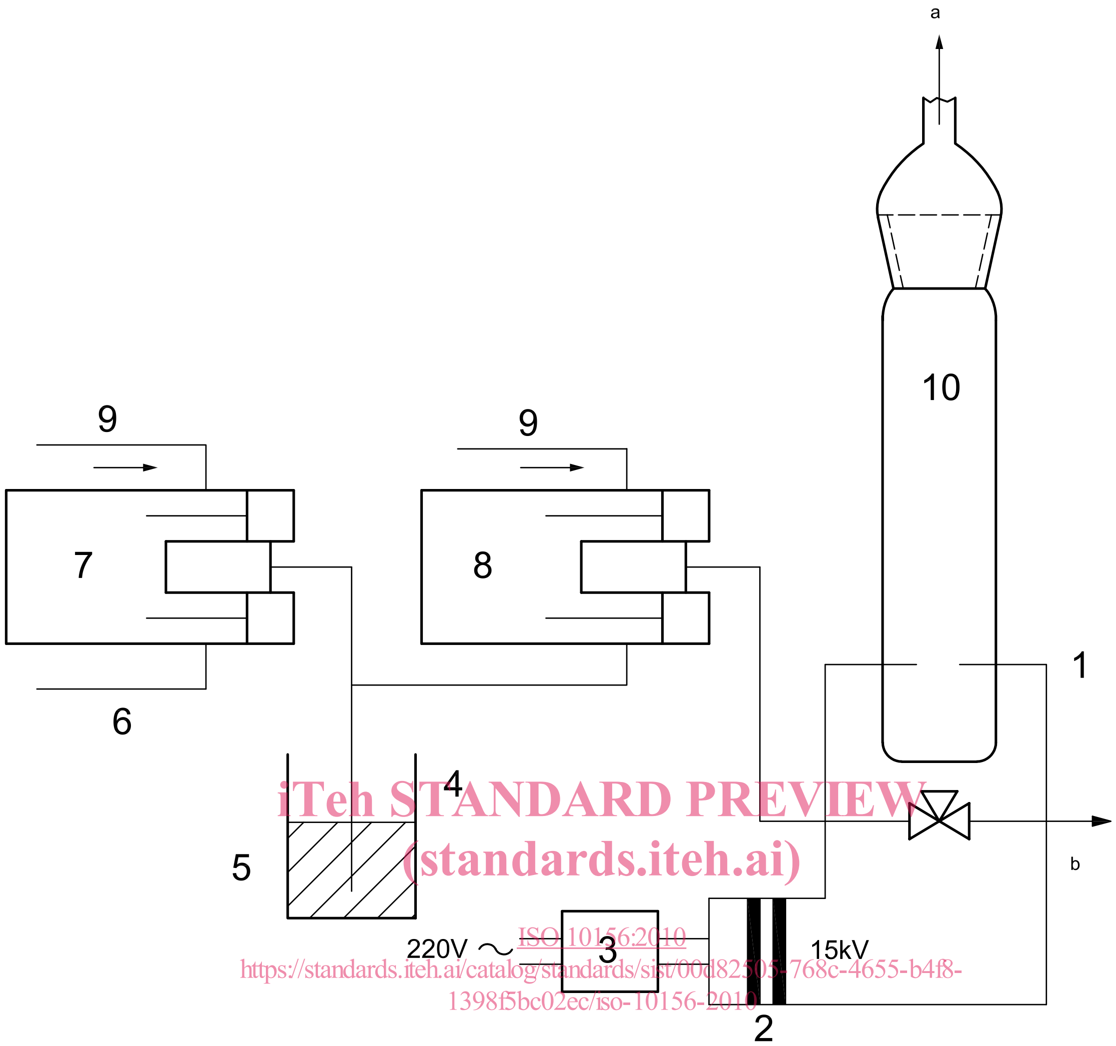
Key

1 mixer
2 flowmeter
3 test gas
4 compressed air
5 safety device (pressure relief valve)
6 valve
7 spark plug
8 thermocouples
9 Pyrex tube, length 1 m, internal diameter 50 mm
10 valve

a Gas mixture vented to atmosphere.

b Gas mixture analysed.

Figure 1 (*continued*)



b) Apparatus suitable for testing a mixture of gases

Key

1 ignition electrodes
2 high-voltage transformer
3 timer switch
4 mixture containing x % test gas
5 buffer vessel
6 test gas
7 metering pump 1, x %
8 metering pump 2, y %
9 air
10 mixture containing (xy/100)% test gas

a Gas mixture analysed and vented to atmosphere.
b Gas mixture vented during test.

Figure 1 — Examples of apparatus for determination of flammability limits of gases at atmospheric pressure and ambient temperature