INTERNATIONAL STANDARD

ISO 4589-2

Second edition
2017-04

Plastics — Determination of burning behaviour by oxygen index —

Part 2: Ambient-temperature test

Plastiques — Détermination du comportement au feu au moyen de l'indice d'oxygène —
Partie 2: Essai à la température ambiante

Reference number
ISO 4589-2:2017(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Contents

Page

Foreword ..... **v**
Introduction ..... **vi**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Principle **2**
5 Apparatus **2**
5.1 Test chimney 2
5.2 Test specimen holder 2
5.3 Gas supplies 6
5.4 Gas control devices 7
5.5 Oxygen analyser 7
5.6 Flame igniter 7
5.7 Timing device 7
5.8 Fume extraction system 8
5.9 Tool for preparing rolled film 8
6 Calibration of equipment **8**
7 Preparation of test specimens **8**
7.1 Sampling 8
7.2 Test specimen dimensions and preparation 9
7.3 Marking of test specimens 11
7.3.1 General 11
7.3.2 Marks for testing by top surface ignition 11
7.3.3 Marks for testing by propagating ignition 11
7.4 Conditioning 11
8 Procedure for determination of oxygen index **12**
8.1 General 12
8.2 Setting up the apparatus and test specimen 12
8.3 Igniting the test specimen 13
8.3.1 General 13
8.3.2 Procedure A — Top surface ignition 13
8.3.3 Procedure B — Propagating ignition 13
8.4 Assessing the burning behaviour of individual test specimens 13
8.5 Selecting successive volume fractions of oxygen 14
8.6 Determining the preliminary volume fraction of oxygen 15
8.7 Volume fraction of oxygen changes 15
9 Calculations and expression of results **16**
9.1 Oxygen index 16
9.2 Determination of ***k*** ***17***
9.3 Standard deviation of oxygen volume fraction measurements 17
9.4 Precision of results 18
10 Comparison with a specified minimum value of the oxygen index (short procedure) **19**
10.1 General 19
10.2 Setting up the apparatus and test specimen 19
10.3 Igniting the test specimen 19
10.4 Assessing the burning behaviour of the test specimens 19
10.5 Expressing of results 19
11 Test report **19**
Annex A (normative) **Calibration of equipment** **20**

Annex B (normative) **Calculation of volume fraction of oxygen** **22**
Annex C (informative) **Typical test results sheet** **23**
Annex D (informative) **Results obtained by interlaboratory trials on type VI specimens** **25**
Annex E (informative) **Precision data obtained from an interlaboratory trial carried out in 1978-1980** **26**
Bibliography **27**

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

This second edition cancels and replaces the first edition (ISO 4589-2:1996), which has been technically revised. It also incorporates the Amendment ISO 4589-2:1996/Amd.1:2005.

A list of all parts in the ISO 4589 series can be found on the ISO website.

Introduction

Oxygen index (OI) results obtained using the methods described in this document can provide a sensitive measure of the burning characteristics of materials under certain controlled laboratory conditions, and hence may be useful for quality control purposes. The results obtained are dependent upon the shape, orientation and isolation of the test specimen and the conditions of ignition. For particular materials or applications, it may be necessary or appropriate to specify different test conditions. Results obtained from test specimens of differing thickness or by using different ignition procedures may not be comparable and no correlation with flammability behaviour under other fire conditions is implied.

Results obtained in accordance with this document are not applicable to describe or appraise the fire hazard presented by a particular material or shape under actual fire conditions, unless used as one element of a fire risk assessment that takes into account all of the factors pertinent to the assessment of the fire hazard of a particular application for the material.

For assessing the flame propagation properties of cellular materials of density < 100 kg/m^3, attention is drawn to the method described in ISO 3582.

Plastics — Determination of burning behaviour by oxygen index —

Part 2: Ambient-temperature test

1 Scope

This document specifies methods for determining the minimum volume fraction of oxygen, in admixture with nitrogen, that will support combustion of small vertical test specimens under specified test conditions. The results are defined as oxygen index (OI) values.

Methods are provided for testing materials that are self-supporting in the form of vertical bars or sheets up to 10,5 mm thick. These methods are suitable for solid, laminated or cellular materials characterized by an apparent density 100 kg/m^3 or greater. The methods might also be applicable to some cellular materials having an apparent density of less than 100 kg/m^3. A method is provided for testing flexible sheets or film materials while supported vertically.

For comparative purposes, a procedure is provided for determining whether or not the OI of a material lies above some specified minimum value.

NOTE It might not be possible to apply these methods satisfactorily to materials that exhibit high levels of shrinkage when heated, e.g. highly oriented thin film.

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.

ISO 291:2008, *Plastics — Standard atmospheres for conditioning and testing*

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 2859-2, *Sampling procedures for inspection by attributes — Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection*

ISO 4589-1, *Plastics — Determination of burning behaviour by oxygen index — Part 1: General requirements*

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 7823-1, *Plastics — Poly(methyl methacrylate) sheets — Types, dimensions and characteristics — Part 1: Cast sheets*

ISO 13943, *Fire safety –Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4589-1 and ISO 13943 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Principle

A small test specimen is supported vertically in a mixture of oxygen and nitrogen flowing upwards through a transparent chimney. The upper end of the specimen is ignited and the subsequent burning behaviour of the specimen is observed to compare the period for which burning continues, or the length of specimen burned, with specified limits for such burning. By testing a series of specimens in different volume fractions of oxygen, the OI is estimated (see 8.7).

Alternatively, for comparison with a specified OI, three test specimens are tested using the relevant volume fraction of oxygen, at least two of which are required to given an “O” response (see 8.4) in order to meet the specified OI.

5 Apparatus

5.1 Test chimney

The test chimney shall consist of a heat-resistant glass tube supported vertically on a base through which oxygen-containing gas mixtures can be introduced (see Figure 1).

The recommended dimensions of the chimney are 450 mm to 500 mm height and 75 mm to 100 mm inside diameter.

The upper outlet shall be restricted as necessary by an overhead cap having an outlet small enough to produce an exhaust velocity of at least 90 mm/s from that outlet. The flow rate shall be calculated by using the formula found in A.2.

NOTE 1 Measurement of flow rate or flow speed at the specimen position helps for checking gas leaks.

NOTE 2 A cap converging to an outlet of 40 mm diameter at a level at least 10 mm above the top of the cylindrical chimney has been found satisfactory.

Chimneys of other dimensions, with or without restricted outlets, are suitable for use, if shown to give equivalent results. The bottom of the chimney, or the base upon which the chimney is supported, shall incorporate a device for evenly distributing the gas mixture entering the chimney. The preferred device comprises a diffuser and a mixing chamber with metal foil (honeycomb) or glass beads. Other devices, such as radial manifolds are suitable for use, if shown to give equivalent results. The mounting of a porous screen below the level of the specimen holder is helpful to prevent falling combustion debris from fouling the gas entry and distribution paths. One option is to construct the chimney in such a way that it can be divided in half, so as to make the setting of samples and cleaning easier.

The use of a levelling device and indicator incorporated within the chimney support will aid vertical alignment of the chimney and of a test specimen supported therein. If a dark background is provided, this will aid the observation of flames within the chimney.

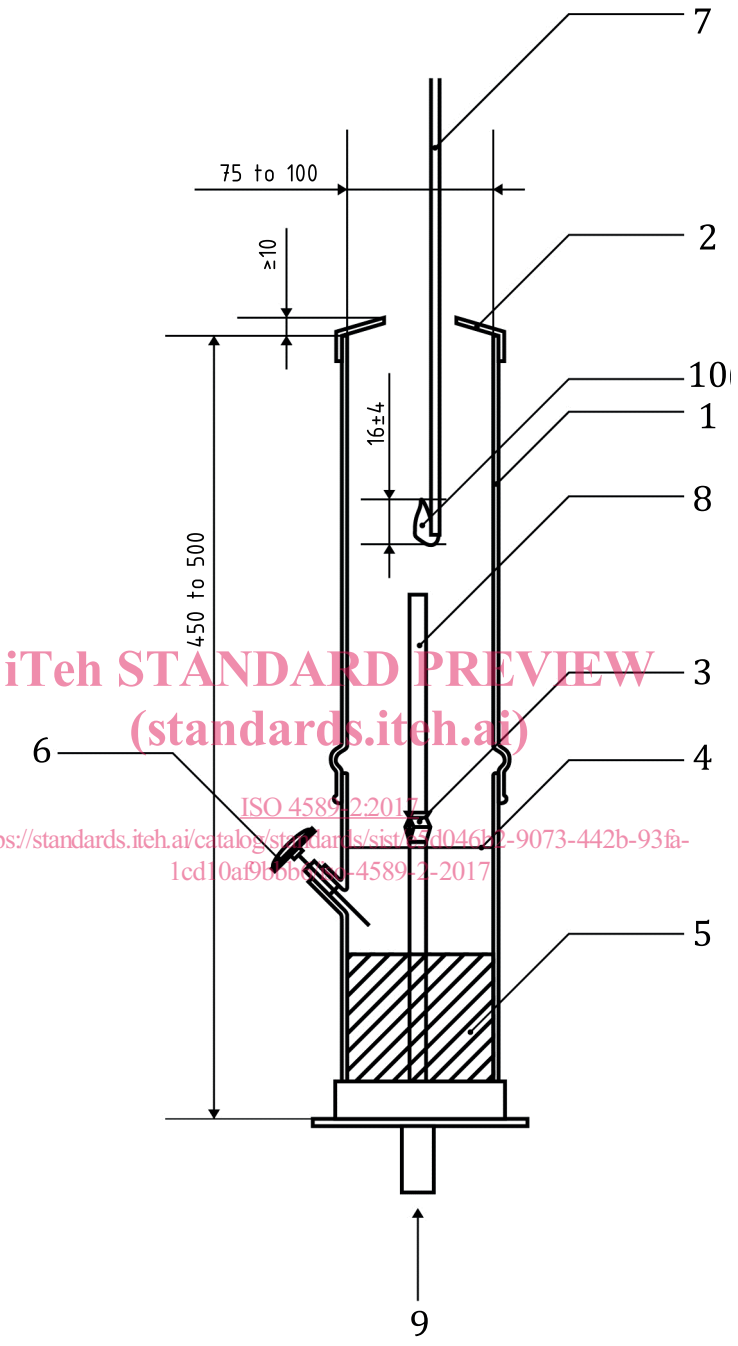
5.2 Test specimen holder

The specimen holder shall be suitable for supporting a specimen vertically in the centre of the chimney.

For self-supporting materials, the specimen shall be held by a small clamp, which is at least 15 mm away from the nearest point at which it is possible that the specimen will burn before the extent-of-burning criterion is exceeded. For supported film or sheet test specimens, the specimen shall be supported by both vertical edges in a frame equivalent to that illustrated by Figure 6, with reference marks at 20 mm and 100 mm below the top of the frame.

It is recommended that the profile of the holder and its support is smooth to minimize induction of turbulence in the rising flow gas.

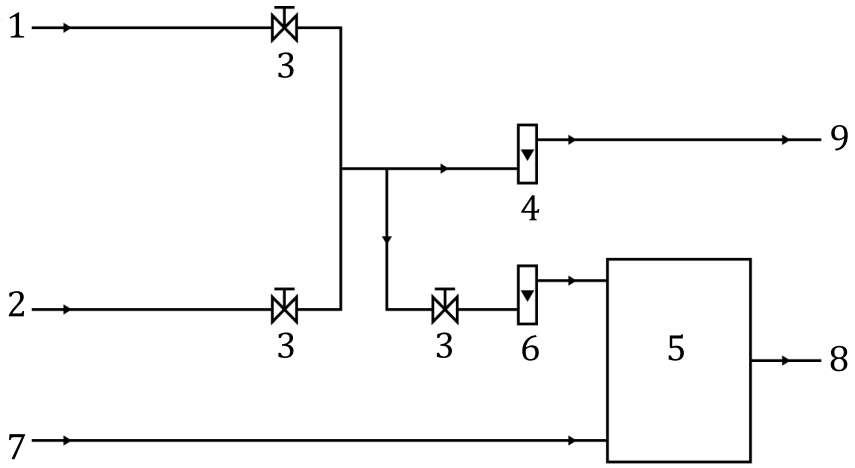
Dimensions in millimetres



Key

1 chimney
2 chimney cap
3 specimen holder
4 wire-mesh debris screen
5 diffuser and a mixing chamber
6 optional temperature measurement device
7 tube
8 test specimen
9 oxygen/nitrogen mixture
10 flame igniter

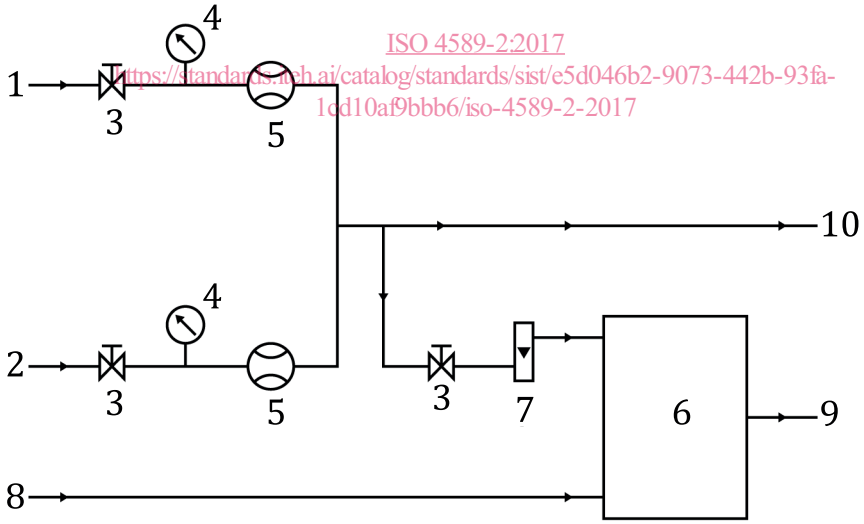
Figure 1 — Typical apparatus for determination of oxygen index



Key

1	oxygen	6	flow meter
2	nitrogen	7	reference gas
3	needle valve	8	to exhaust
4	calibrated flow meter	9	to chimney
5	oxygen analyser		

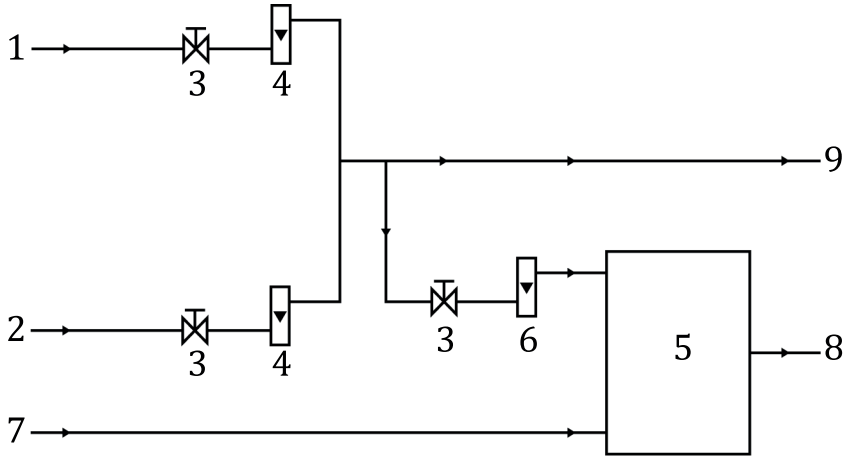
Figure 2 — Typical flow system incorporating the elements described in 5.4, a)



Key

1	oxygen	6	oxygen analyser
2	nitrogen	7	flow meter
3	needle valve	8	reference gas
4	pressure gauge	9	to exhaust
5	calibrated orifice	10	to chimney

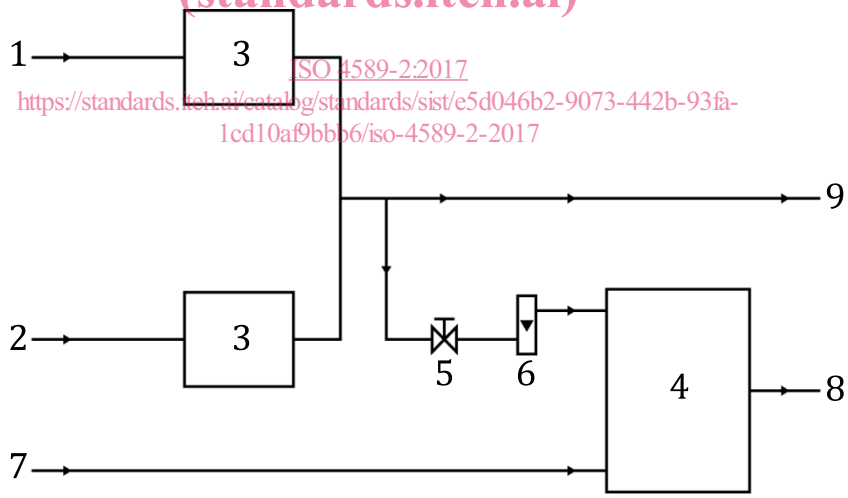
Figure 3 — Typical flow system incorporating the elements described in 5.4, b)



Key

1	oxygen	6	flow meter
2	nitrogen	7	reference gas
3	needle valve	8	to exhaust
4	calibrated flow meter	9	to chimney
5	oxygen analyser		

Figure 4 — Diagram of typical flow system incorporating the elements described in 5.4, c)

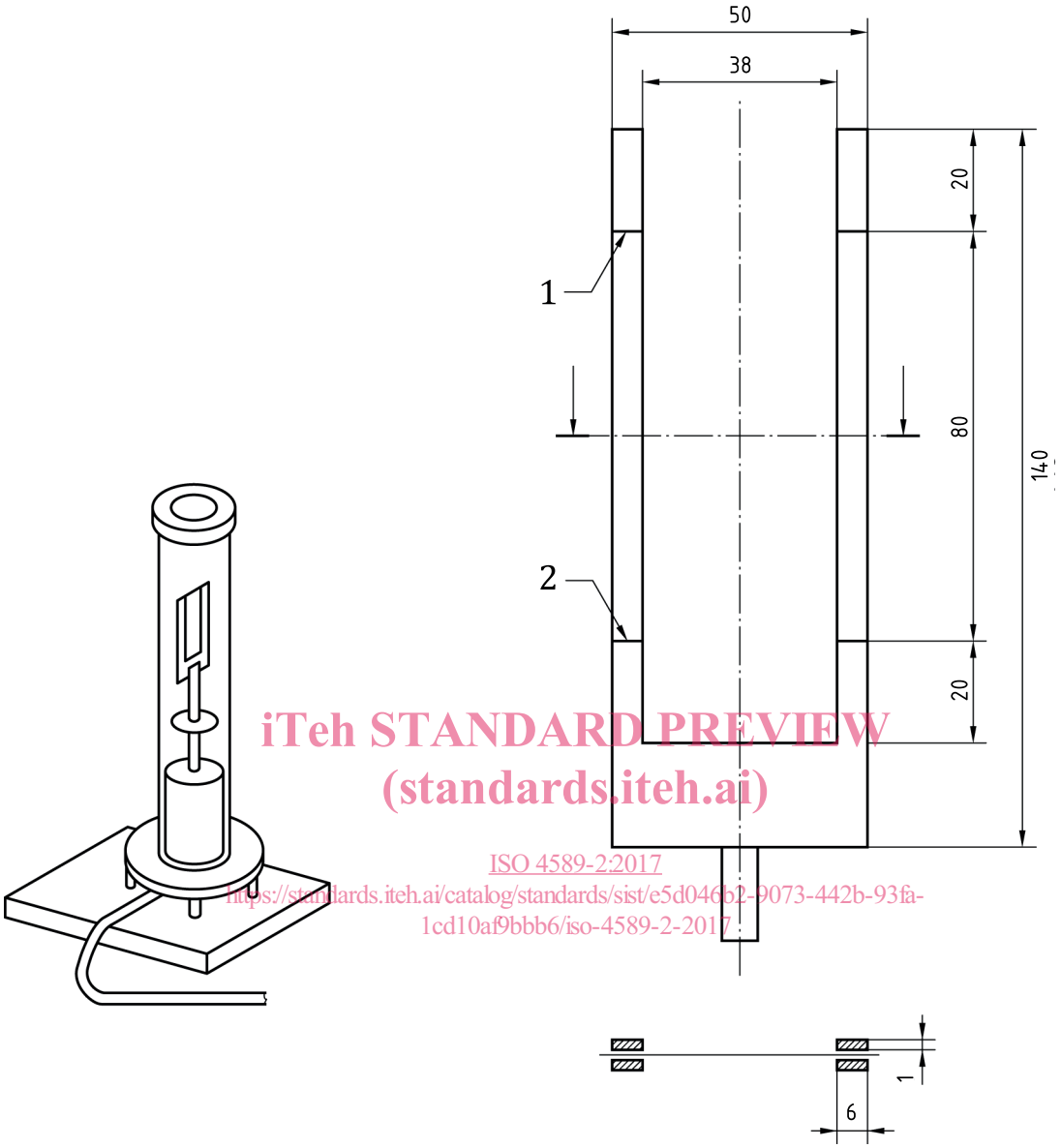


Key

1	oxygen	6	flow meter
2	nitrogen	7	reference gas
3	calibrated mass flow controller	8	to exhaust
4	oxygen analyser	9	to chimney
5	needle valve		

Figure 5 — Typical flow system incorporating the elements described in 5.4, d)

Dimensions in millimetres with tolerances ± 0,25 mm



Key

1 upper reference mark

2 lower reference mark

NOTE The test specimen is held securely along both upright edges between forks made of stainless steel.

Figure 6 — Support frame for non-self-supporting test specimens

5.3 Gas supplies

The gas supplies shall comprise pressurized sources of oxygen and/or nitrogen not less than 98 % (mass fraction) pure and/or clean air [containing 20,9 % (volume fraction) oxygen], as appropriate.

The moisture content of the gas mixture entering the chimney shall be < 0,1 % (mass fraction), unless the results have been shown to be insensitive to higher moisture levels in the gas mixture. The gas supply system shall incorporate a drying device, or provision for monitoring or sampling the gas supply for moisture content, unless the moisture content of the gas supplies is known to be acceptable.

