INTERNATIONAL STANDARD

ISO 1716

Fourth edition
2018-05

Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value)

Essais de réaction au feu de produits — Détermination du pouvoir calorifique supérieur (valeur calorifique)

Reference number
ISO 1716:2018(E)

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

Published in Switzerland

Contents

Page

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 92, *Fire safety*, Subcommittee SC 1, *Fire initiation and growth*.

This fourth edition cancels and replaces the third edition (ISO 1716:2010), which has been technically revised.

Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value)

WARNING — The attention of all persons concerned with managing and carrying out this test is drawn to the fact that fire testing may be hazardous and that there is a possibility that toxic and/or harmful gases may be evolved during the test. Operational hazards may also arise during the testing of specimens, such as the possibility of an explosion, and during the disposal of test residues.

WARNING — An assessment of all the potential hazards and risks to health should be made and safety precautions should be identified and provided. Written safety instructions should be issued. Appropriate training should be given to relevant personnel. Laboratory personnel should ensure that they follow written instructions at all times.

1 Scope

This document specifies a method for the determination of the gross heat of combustion (Q_{PCS}) of products at constant volume in a bomb calorimeter.

This method is intended to be applied to solid products.

NOTE Liquids can be tested with similar equipment and using conditions described in ASTM D240[1], as described in IEC 61039[2] using ISO 1928[3] test equipment.

Annex A specifies the calculation of the net heat of combustion, Q_{PCI}, when required.

Information on the precision of the test method is given in Annex B.

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 554, *Standard atmospheres for conditioning and/or testing — Specifications*

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

3 Terms and definitions

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

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

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

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

3.1
product
material, element or component about which information is required

3.2
material
single basic substance or uniformly dispersed mixture of substances

EXAMPLE Stone, timber, concrete, mineral wool with a uniformly dispersed binder and polymers.

3.3
homogeneous product
product (3.1) consisting of a single *material* (3.2) having uniform density and composition throughout the *product* (3.1)

3.4
non-homogeneous product
product (3.1) that does not satisfy the requirements of a *homogeneous product* (3.3) and which is composed of more than one component, substantial or non-substantial

Note 1 to entry: If a non-homogeneous product cannot be easily separated into its component parts, the individual components shall be provided separately by the sponsor.

3.5
non-substantial component
material (3.2) that does not constitute a significant part of *a non-homogeneous product* (3.4) and that has a layer with a mass/unit area below 1,0 kg/m^2 and a thickness below 1,0 mm

Note 1 to entry: If the non-substantial layers do not comply with the above requirements, together they shall be considered to be substantial.

Note 2 to entry: Two or more non-substantial layers that are adjacent to each other (i.e. with no substantial component(s) in between the layers) are regarded as one non-substantial component when they collectively comply with the requirements for a layer being a non-substantial component.

3.6
substantial component
material (3.2) that constitutes a significant part of a *non-homogeneous product* (3.4) and that has a layer with a mass/unit area more than or equal to 1,0 kg/m^2 or a thickness more than or equal to 1,0 mm

Note 1 to entry: Two or more non-substantial layers that are adjacent to each other (i.e. with no substantial component(s) in between the layers) are regarded as one substantial component when they collectively comply with the requirements for a layer being a substantial component.

3.7
internal non-substantial component
non-substantial component (3.5) that is covered on both sides by at least one *substantial component* (3.6)

3.8
external non-substantial component
non-substantial component (3.5) that is not covered on one side by a *substantial component* (3.6)

3.9
heat of combustion
DEPRECATED: calorific value
Q
thermal energy produced by combustion of unit mass of a given substance

Note 1 to entry: The heat of combustion is expressed in megajoules per kilogram.

[SOURCE: ISO 13943:2008, 4.174, modified — The Note 1 to entry was changed.]

3.10
gross heat of combustion
Q_{PCS}
heat of combustion (3.9) of a substance when the combustion is complete and any produced water is entirely condensed under specified conditions

Note 1 to entry: The gross heat of combustion is expressed in megajoules per kilogram.

Note 2 to entry: The acronym PCS is derived from the French term “pouvoir calorifique supérieur”.

3.11
net heat of combustion
Q_{PCI}
heat of combustion (3.9) of a substance when the combustion is complete and any produced water is in the vapour state under specified conditions

Note 1 to entry: The net heat of combustion may be calculated from the gross heat of combustion.

Note 2 to entry: The net heat of combustion is expressed in megajoules per kilogram.

Note 3 to entry: The acronym PCI is derived from the French term “pouvoir calorifique inférieur”.

3.12
latent heat of vaporization of water
q
heat which is required to change water from a liquid to a gas

Note 1 to entry: The latent heat of vaporization is expressed in megajoules per kilogram.

3.13
surface density
mass per unit area

Note 1 to entry: The surface density is expressed in kilograms per square metre.

4 Principle

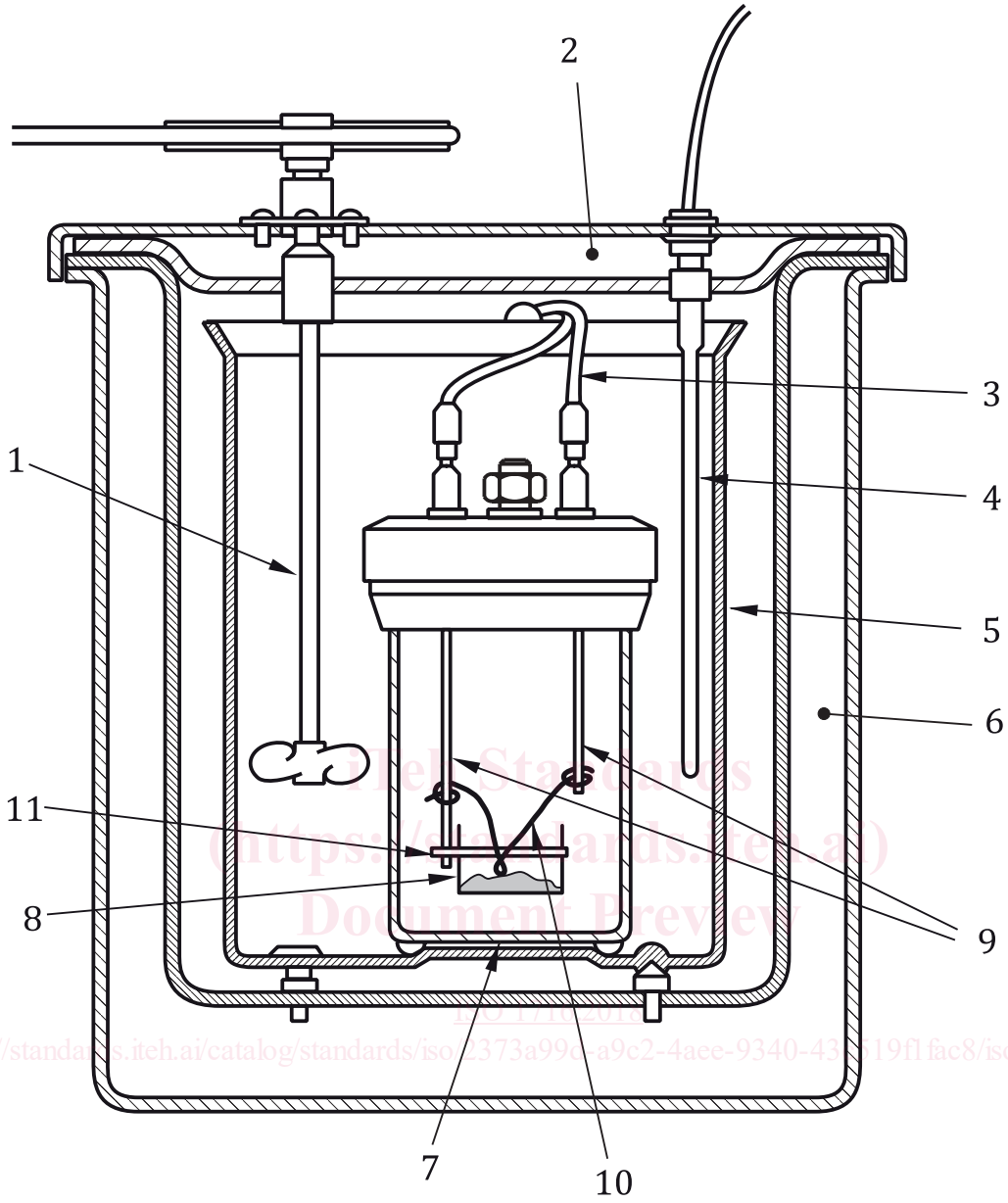
In this test, a test specimen of specified mass is burned under standardized conditions, at constant volume, in an atmosphere of oxygen, in a bomb calorimeter calibrated by combustion of certified benzoic acid. The heat of combustion determined under these conditions is calculated on the basis of the observed temperature rise, taking account of heat loss and the latent heat of vaporization of water.

This is a test method for determining an absolute value of the heat of combustion for a product and it does not take into account any inherent variability of the product.

5 Test apparatus

The test apparatus (bomb calorimeter) shall be as illustrated in Figure 1, and as detailed in 5.1 to 5.4. Additional equipment shall be in accordance with 5.5 to 5.10.

Equipment described in 5.1 to 5.4 could also be available as automatic or semi-automatic apparatuses. Any deviation from these subclauses has to be evaluated by the user according to requirements of subsequent subclauses.



Key

1	stirrer	7	calorimetric bomb
2	jacket lid	8	crucible
3	ignition leads	9	electrodes
4	temperature measuring device	10	firing wire
5	calorimetric vessel	11	crucible holder
6	jacket		

Figure 1 — Test apparatus

5.1 Calorimetric bomb.

The calorimetric bomb shall be constructed with the following characteristics:

a) volume: (300 ± 50) ml;

b) mass not greater than 3,25 kg;

c) casing thickness at least 1/10 of the inner diameter of the body:

The lid is intended to receive the crucible and the electric firing device. The lid, including any seals, shall be capable of withstanding an internal pressure of 21 MPa.

NOTE These conditions define a bomb in which 1 g of coal under an initial oxygen pressure no greater than 3 MPa (pressure gauge method) is able to withstand, with a sufficient coefficient of safety, the maximum amount of pressure created under combustion, without a need for a calorimetric bomb of overlarge mass.

The inner surface of the bomb shall be resistant to attack by products of combustion and, even when "fuels" rich in sulfur are used, it shall resist pitting and inter-crystalline corrosion by acids produced during combustion.

5.2 Calorimeter.

5.2.1 Jacket.

The jacket shall consist of a double-walled container, which is thermally insulated together with an insulated lid. The jacket is filled with water. The dimensions of the jacket shall be such that there is at least 10 mm space around the calorimetric vessel. The calorimetric vessel shall be supported on an as small as possible area of non-conducting material, preferably a 3-point support.

For an adiabatic calorimeter system, a heater and thermometer system shall be incorporated into the vessel such that the water temperature in the jacket is maintained at the same temperature as the water in the calorimetric vessel.

For an isothermal calorimeter system, the temperature of the water in the jacket shall be kept constant. For an isothermal calorimeter, the necessary corrections shall be made (see 9.2).

5.2.2 Calorimetric vessel.

The calorimetric vessel shall consist of a polished metal container designed to accommodate the bomb. The dimensions shall be such that the bomb can be immersed in water (see 8.3.8).

5.2.3 Stirrer.

The stirrer shall be driven by a constant-speed motor. To prevent the transfer of heat to and from the calorimeter, the driving shaft of the stirrer shall have a thermally insulated section in a gasket between the jacket lid and the jacket. A magnetic stirring device with a similar performance is an acceptable alternative.

5.3 Temperature measuring device.

The temperature measuring device shall be capable of giving a resolution of 0,005 K. When using a mercury thermometer, this shall have at least 0,01 K graduations with a device, e.g. a lens, for taking readings to within 0,005 K. A mechanical vibrator shall also be used to gently tap the thermometer to ensure that the mercury column does not stick.

5.4 Crucible.

The crucible shall be made of metal, such as platinum, nickel, stainless steel or silica, with a flat base, 25 mm in diameter (maximum dimension if it is truncated) and 14 mm to 19 mm high. The following wall thickness is recommended:

— metal: 1,0 mm;

— silica: 1,5 mm.

NOTE Several shapes of crucible have proved satisfactory.

5.5 Timing device.

The timing device shall be capable of recording the time elapsed to the nearest second and accurate to within 1 s in 1 h.

5.6 Electric power source.

The electric power source shall be designed with the voltage to the firing circuit not exceeding 20 V for the firing.

NOTE An ammeter can be added to the circuit to indicate the breaking of the firing wire. A circuit breaker is a useful addition to the supply circuit.

5.7 Pressure gauge and needle-valve.

A pressure gauge and a needle valve shall be attached to the oxygen-supply circuit to show the pressure in the bomb while it is being filled; this pressure shall be indicated with a resolution of 0,1 MPa.

5.8 Balances.

Two balances shall be used with the following characteristics:

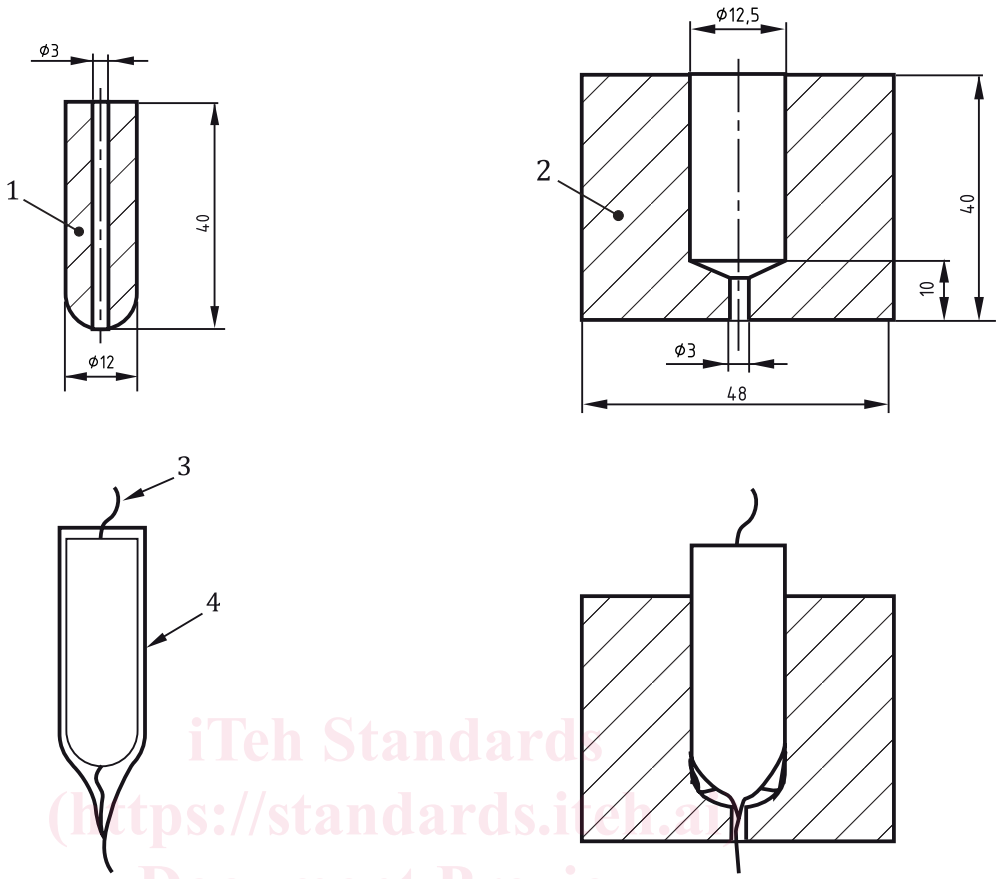
— one is an analytical balance with a resolution of 0,1 mg;

— the other is a balance with a resolution of 0,1 g.

5.9 Device for making the "cigarette".

The device shall be designed as shown in Figure 2, and comprise a mould and a metallic mandrel (not aluminium).

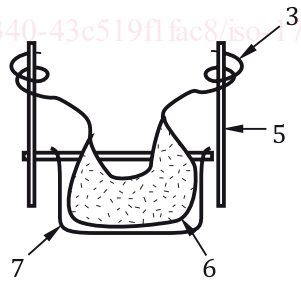
Dimensions in millimetres



a) Shaping the paper over the mandrel

b) Paper in position in the mould after the mandrel has been removed, ready to be filled

c) Cigarette completed



d) Cigarette placed in the crucible

Key

1	mandrel	3	firing wire	5	electrode	7	crucible
2	mould	4	paper	6	cigarette		

NOTE 1 The paper is kept in place by gluing an overlap of the paper using the preglued cigarette-making paper.

NOTE 2 The two ends of the paper are twisted.

NOTE 3 The “cigarette” is put in the crucible and the firing wire is wrapped tightly around the line of the electrodes.

Figure 2 — Method for preparing the “cigarette”