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Third edition
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Plastics — Simple heat release test using a conical radiant heater and a thermopile detector

Plastiques — Essai simple pour la détermination du débit calorifique au moyen d'un radiateur conique et d'une sonde à thermopile

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Foreword

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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 document 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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 13927:2015), which has been technically revised.

The main changes are as follows:

— the normative references have been updated to the latest editions (see Clause 2);

— use of mass flow rate of methane gas corresponding to the net heat of combustion for calibration of the thermopile has been added in Clause 9;

— a new Annex D giving an example of thermopile calibration has been added and subsequent annex has been renamed as Annex E.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Fire is a complex phenomenon; its behaviour and effects depend upon a number of interrelated factors. The behaviour of materials and products depends upon the characteristics of the fire, the method of use of the materials, and the environment in which they are exposed (see also ISO 13943).

A test, such as the one specified in this document, deals only with a simple representation of a particular aspect of the potential fire situation, typified by a radiant heat source, and it cannot alone provide any direct guidance on the behaviour or safety in fire (see ISO/TS 3814). A test of this type can, however, be used for comparative purposes or to ensure the existence of a certain quality of performance (in this case, heat release from a composite material or an assembly) considered to have a bearing on fire performance generally. It would be wrong to attach any other meaning to performance in this test. The attention of all users of this test is drawn to the warning that immediately precedes Clause 10.

Plastics — Simple heat release test using a conical radiant heater and a thermopile detector

1 Scope

This document specifies a method suitable for the production control or product development purposes for assessing the heat release rate of essentially flat products exposed in the horizontal orientation to controlled levels of radiant heating with an external igniter. The heat release rate is determined by the use of a thermopile instead of the more accurate oxygen consumption techniques. The time to ignition and sustained flaming are also measured in this test. The mass loss of the test specimen can also be measured optionally.

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, *Plastics — Standard atmospheres for conditioning and testing*

ISO 5660-1, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement)*

ISO 13943, *Fire safety — Vocabulary*

ISO 14697, *Reaction-to-fire tests — Guidance on the choice of substrates for building and transport products*

ISO 14934-3, *Fire tests — Calibration and use of heat flux meters — Part 3: Secondary calibration method*

3 Terms and definitions

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

ISO and IEC maintain terminology 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
flat surface
surface whose irregularity from a plane does not exceed ±1 mm

3.2
ignition
onset of *sustained flaming* (3.7)

3.3
material
single substance or uniformly dispersed mixture, for example, metal, stone, timber, concrete, mineral fibre or polymer

3.4
orientation
plane in which the exposed face of the *test specimen* (3.6) is located during testing either vertical or horizontal face upwards

3.5
product
material (3.3), composite or assembly, about which information is required

3.6
test specimen
representative piece of the *product* (3.5) which is to be tested together with any substrate or surface treatment

Note 1 to entry: The test specimen may include an air gap.

3.7
sustained flaming
existence of flame on or over the surface of the *test specimen* (3.6) for a period of over 10 s

3.8
transitory flaming
existence of flame on or over the surface of the *test specimen* (3.6) for a period of between 1 s and 10 s

4 Symbols

t_{ig} time to ignition (onset of sustained flaming), expressed in seconds (s)

$\dot{q}''_{180}$ heat release rate per unit area at 180 s after ignition, expressed in kilowatts (kW/m^2)

$\dot{q}''_{300}$ heat release rate per unit area at 300 s after ignition, expressed in kilowatts (kW/m^2)

$\dot{q}''_{max}$ maximum heat release rate per unit area, expressed in kilowatts (kW/m^2)

5 Principle

The heat release rate is assessed by measurement of the output of a thermopile located in a chimney situated above a burning test specimen that is subjected to a known heat flux from a conical heater. The output (in mV) is converted into heat release rate per unit area (in kW/m^2) by use of a calibration graph obtained previously by burning methane gas of known heat of combustion in the same apparatus. Guidance is given in Annex B. The specimen mass loss rate during the test can also be measured by continuously recording the specimen load cell output. Guidance is given in Annex C.

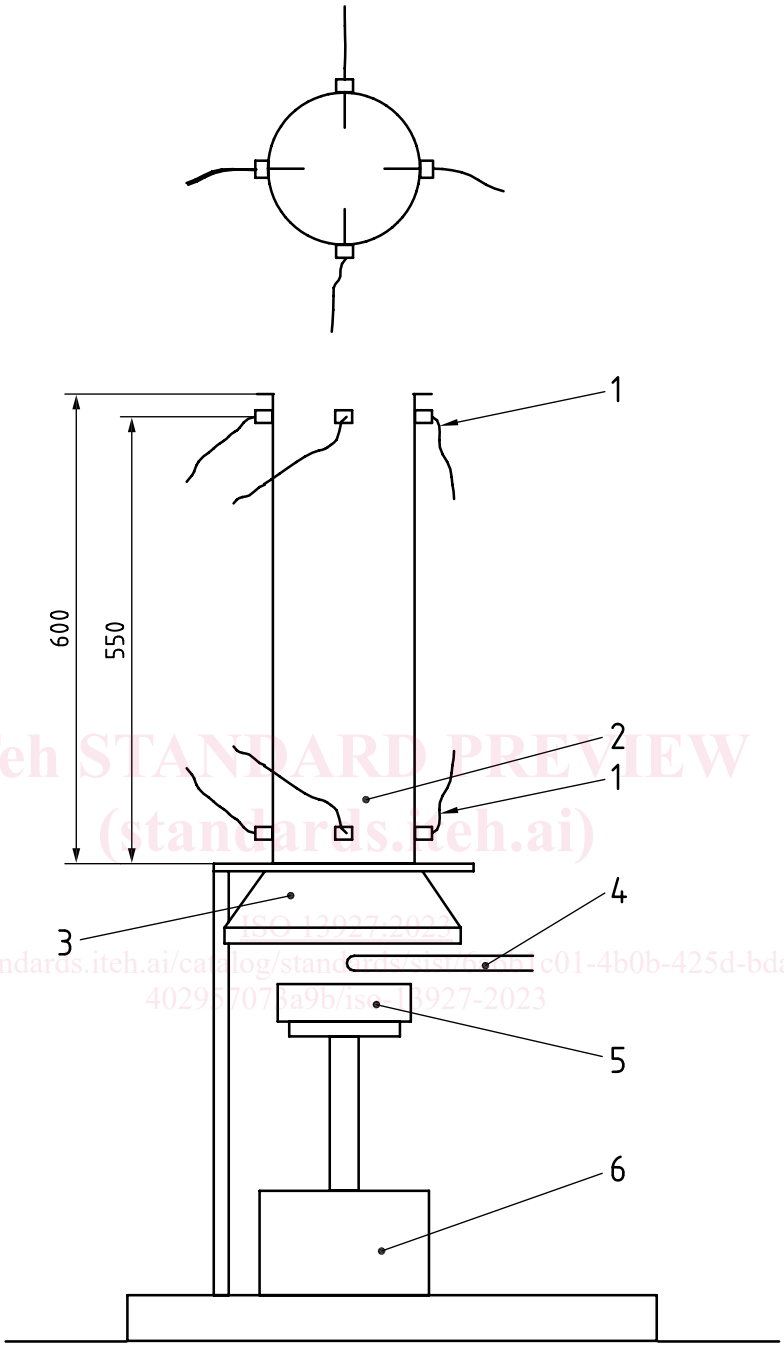
6 Apparatus

6.1 General

The test apparatus shall consist essentially of the following components: a cone-shaped radiant heater, a chimney housing a thermopile, a load cell, a specimen holder, and a fume extraction system. A schematic representation of the assembly is given in Figure 1. The individual components are described in this clause.

Intoleranced dimensions are recommended values. Accrual dimensions of apparatus should be close to the dimensions as much as practicable.

Dimensions in millimetres



Key

1 thermopile
2 chimney
3 cone heater
4 spark igniter
5 specimen
6 load cell (optional)

Figure 1 — Schematic drawing of apparatus

6.2 Cone-shaped radiant electrical heater

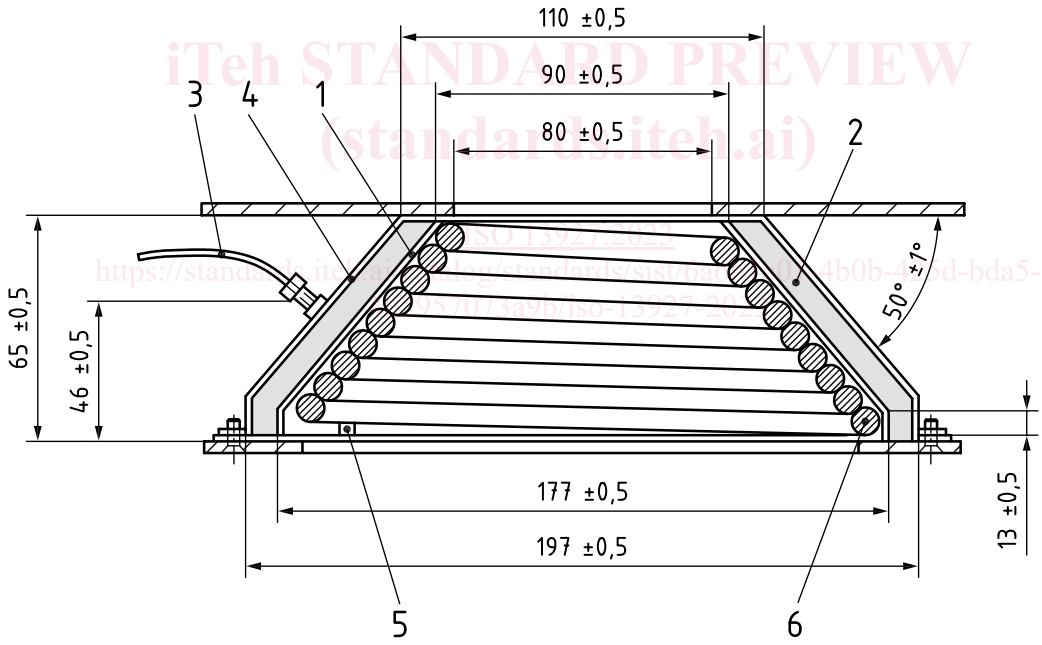
The active element of the heater shall consist of an electrical heater rod, capable of delivering 5 000 W at the operating voltage, tightly wound into the shape of a truncated cone (see Figure 2). The heater shall be encased on the outside with a double-walled, stainless-steel cone filled between the walls with a refractory blanket of nominal thickness 13 mm and nominal density 100 kg/m^3. The heat flux from the heater shall be maintained at a pre-set level by controlling the average temperature of three thermocouples (type K stainless-steel sheathed thermocouples have provided suitable), symmetrically disposed and in contact with, but not welded to, the heater element (see Figure 2). 1,0 mm to 1,6 mm outside diameter sheathed (unearthed) thermocouples with an unexposed hot junction may be used. The heater shall be capable of producing heat fluxes on the surface of the specimen of up to 75 kW/m^2. The heat flux shall be uniform within the central 50 mm × 50 mm area of the exposed specimen surface to within ±2 % for an irradiance of 50 kW/m^2.

The cone heater shall be provided with a removable radiation shield to protect immediately the specimen from heat prior to the start of the test.

6.3 Heat flux controller

The heat flux control system shall maintain the average temperature of the heater element steady to within ±2 °C.

Dimensions in millimetres



Key

1 inner shell
2 refractory-fibre packing
3 thermocouple
4 outer shell
5 spacer block
6 heating element

Figure 2 — Cross-sectional view through heater

6.4 Chimney and thermopiles

A circular cross-section chimney 600 mm ± 2 mm long and 115 mm ± 2 mm internal diameter constructed from 1 mm-thick stainless steel shall be used to house the thermopiles. This shall be fixed on top of the top-plate of the cone heater. The axis of the chimney shall coincide with the axis of the cone heater.

Each thermopile shall consist of four 1,6 mm ± 0,2 mm outside diameter type K sheathed thermocouples. The tips of the thermocouples shall be fixed 17 mm from the centreline of the chimney. The four thermocouples shall be connected in series and the two ends shall be connected to the data collection system.

A thermopile shall be housed within the chimney at a height of 550 mm above the cone top-plate and the chimney penetration points shall be equally distributed about the circumference of the chimney.

Another thermopile shall be housed 275 mm above the cone top-plate and the chimney penetration points are equally distributed across, about the circumference of the chimney.

The arrangement of the chimney and thermopiles is shown in Figure 1.

Both thermopiles shall be calibrated individually according to Clause 9.

6.5 Specimen holder

The specimen holder is shown in Figure 3.

The specimen holder shall have the shape of a square pan with an opening of (106 ± 1) mm × (106 ± 1) mm and a depth of 25 mm. The holder shall be constructed from stainless steel with a thickness of (2,4 ± 0,15) mm. It shall include a handle to facilitate insertion and removal and a mechanism to ensure central location of the specimen under the heater and proper alignment with the weighing device. The distance between the bottom surface of the cone heater and the top of the specimen shall be adjusted to 25 mm, except when testing dimensionally unstable materials, in which case, the distance shall be adjusted to 60 mm ± 1 mm. All tests shall be conducted with the retainer frame shown in Figure 4. Details of specimen and specimen holder preparation are given in 8.3.

6.6 Retainer frame

The frame shall be constructed of stainless steel with a thickness of (1,9 ± 0,1) mm in the shape of a box with an inside dimension of each side (111 ± 1) mm and a height of (54 ± 1) mm. The opening for the specimen face shall be (94,0 ± 0,5) mm^2 as shown in Figure 4. The retainer frame shall have an appropriate means to secure it to the specimen holder with a specimen in position.

Dimensions in millimetres

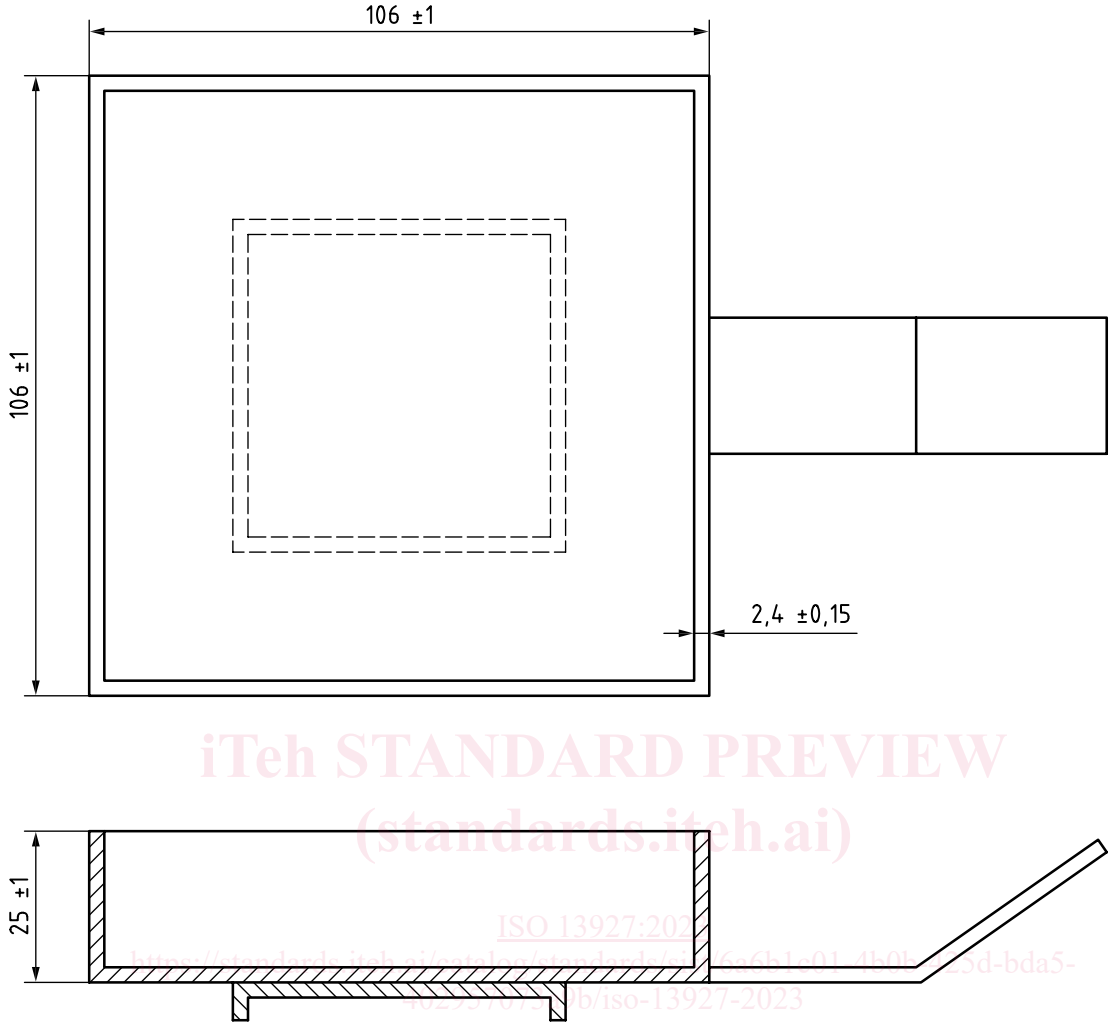


Figure 3 — Specimen holder