ISO/~~TC 61/SC 4~~

~~Date: 2023-03-21~~

~~ISO/DIS~~FDIS 23948~~:2022(E)~~

ISO/TC 61/SC 4

Secretariat:- BSI

Date: 2023-07-17

Plastics- — Intumescence properties of PVC materials and products — Test method for the measurement of expansion with the cone calorimeter

Plastiques- — Propriétés ~~intumescentes~~d'intumescence des matériaux et produits en PVC — Méthode d'essai pour mesurer ~~le taux d'expansion~~l'expansion à l'aide ~~du cône~~d'un calorimètre à cône

FDIS stage

ISO ~~Copyright Office~~ copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: + 41 22 749 01 11

~~Email:~~ ~~copyright@iso.org~~
E-mail: copyright@iso.org
Website: ~~www.iso.org~~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 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).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at ~~www.iso.org/patents~~www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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

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~~www.iso.org/iso/foreword.html.

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

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.

Field Code Changed

Introduction

Polyvinyl chloride (PVC) is an example of an intumescent material that leaves much of the original carbon content as a solid residue. The presence of chlorine in PVC exerts its influence in two ways, causing an increase in:

— ~~—~~hydrogenated char formation (meaning that less flammable decomposition products are formed~~)~~);

— ~~—~~generating HCl, which then acts as a gas phase scavenger slowing down further reactions of flammable products in the gas phase. [- CH_2 – CHCl- → - CH = CH - + HCl]

The expansion formed has two positive effects regarding fire safety:

— ~~—~~it is a barrier between the source of heat and the unaffected polymer material leading to a reduction of its rate of decomposition;

— ~~—~~it reduces the release of flammable gas.

ISO TR 20118 provides information on fire properties of PVC materials.

The intumescent properties of PVC materials and products are likely, however, to be affected by their exact formulation and by the use of specific chemical species~~,~~ (e.g. intumescent chemicals~~)~~), as processing aids or other components of the specific material. The aim of this document is to propose a test method to characterize the intumescence properties of PVC materials and products, by using the cone calorimeter heater as defined in standards ISO 5660-1, ISO 13927 and ISO 17554.

In this test method, the expansion of PVC materials and products is determined by the measurement of the height increase of a specimen when exposed to the radiated heat produced by an electrical conical heater. Intumescence is a property given to, or pre-existing in, some materials and used in fire safety as a way to increase fire performance and protect materials or products with regard to either reaction-to-fire or fire resistance.

Plastics — Intumescence properties of PVC materials and products — Test method for the measurement of expansion with the cone calorimeter

1 Scope

This document specifies a test method for assessing the expansion of PVC materials and products during their combustion under the effect of heat radiation.

This test method is also applicable to products and materials made from blends and mixtures of PVC with other polymers, such as PVC-SAN (where PVC is blended with a copolymer of styrene and acrylonitrile (PVC-SAN).

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*

ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

ISO 1043-4, *Plastics — Symbols and abbreviated terms — Part 4: Flame retardants*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

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 13927, *Plastics — Simple heat release test using a conical radiant heater and a thermopile detector*

ISO 13943[1], *Fire safety — Vocabulary*

ISO 14934-2, *Fire tests — Calibration and use of heat flux meters — Part 2: Primary calibration methods*

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

ISO 17554, *Reaction to fire tests — Mass loss measurement*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1043-1, ISO 1043-4, ISO 13943 and the following apply.

[1] Stage at the date of publication: ISO/PRF 13943:2023.

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~~https://www.iso.org/obp

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

3.1
intumescence
~~The~~ formation of a swelling/foaming substance in response to heat that insulates the underlying substrate~~.~~

Note ~~1~~ to entry: ~~Definition is adapted from ISO 13943.~~

Note ~~2~~ to entry: ~~Intumescence is used to achieve passive fire protection for such applications as firestopping, fireproofing, gasketing and window casings.~~

[SOURCE: ISO 13943:—, 3.268, modified — Note to entry has been added.]

3.2
flame retardant
substance added, or a treatment applied, to a material in order to suppress or delay the appearance of a flame and/or reduce the flame spread rate~~.~~

Note ~~1~~ to entry: ~~Flame retardants are activated by the presence of an ignition source and are intended to prevent or slow the further development of ignition by a variety of different physical and chemical methods. Various species of flame retardants, including smoke suppressants, alone or in combination, can lead to consistent lowering of heat release, flame spread, ignitability, (by increasing the time to ignition or the minimum heat flux for ignition), or smoke release.~~

Note ~~2~~ to entry: ~~Adapted from ISO 13943 with the addition of Note 1.~~ ISO 1043-4 lists the various categories of flame retardants.

[SOURCE: ISO 13943:—, 3.192, modified — Notes to entry have been replaced.]

4 Symbols

e_{im} average initial thickness of the specimen, mm

e_{of} overall final thickness of the specimen, mm

E_p expansion rate of the product, %

E_s expansion rate of the specimen, %

5 Principle

The test method detailed in this document consists in measuring the rate of expansion of a PVC test specimen during heating and/or combustion under the effect of radiative heat generated by an electrical cone calorimeter heater.

The method is based on the observation that a PVC specimen exposed horizontally to incident radiative heat generally results in an increase of its volume, due to intumescence.

Test specimens are exposed to heat under ambient air conditions, while being subjected to a predetermined external heat flux of 50 kW/m². Measurements of the thickness of the test specimen are made before and after the test.

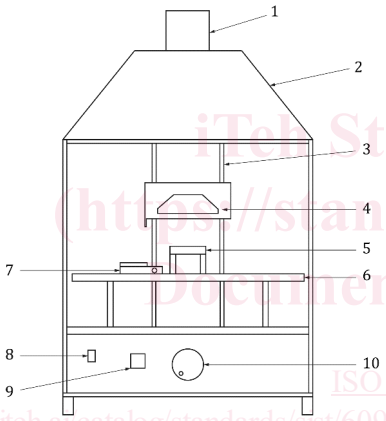
The expansion rate quantifies the intumescence property of the PVC test specimen and is calculated as the percentage of thickness increase before and after the test.

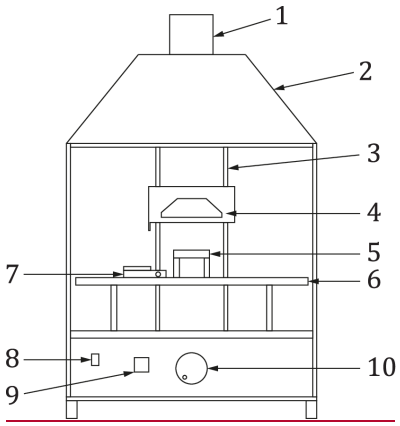
6 Test equipment

6.1 General

An example of schematic representation of test equipment is given in ~~Figure 1.~~Figure 1. The individual components are described in detail in ~~6.2~~6.2 to 6.9.

Test equipment conforming with either ISO 5660-1, ISO 17554~~,~~ or ISO 13927, is suitable to conduct a test according to this document, although some of the measuring device components of the test equipment will not need to be used.





Key

1	extraction duct	6	support plate
2	hood	7	carrousel
3	guiding column	8	power switch
4	cone-shaped radiant electric heater	9	PID governor
5	specimen holder and support	10	handwheel

Figure 1 — Example of suitable test equipment

6.2 Cone-shaped radiant electrical heater

The active element of the heater shall consist of an electrical heater rod, capable of delivering 5 kW at the operating voltage, tightly wound into the shape of a truncated cone conforming with either ISO- 5660-1, or ISO 17554, or ISO 13927, and highlighted as ~~Figure 2.~~Figure 2. The heater shall be encased, from the outside, within a double-wall stainless steel cone, filled with a refractory fibre blanket of nominal thickness 6 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 proven suitable, but the use of other high-performance alloy materials is also acceptable), symmetrically disposed and in contact with, but not welded to, the heater element. Either 3,0 mm outside diameter sheathed thermocouples, with an exposed hot junction, or 1,0 mm to 1,6 mm outside diameter sheathed thermocouples, with an unexposed hot junction, shall be used.

The heater shall be capable of producing an incident heat flux on the surface of the specimen of up to at least 70 kW/m^2. The heat flux shall be uniform within the central 50 mm~~ x~~ × 50 mm area of the exposed specimen surface, to within ±2 % for an incident heat flux level (at the centre) of 50 kW/m^2.

Dimensions in ~~mm~~millimetres