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Plastics — Determination of ignition temperature using a hot-air furnace

Plastiques — Détermination de la température d'allumage au moyen d'un four à air chaud

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ISO/FDIS 871

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Contents

	Page
Foreword.....	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Principle	2
5 Apparatus	2
5.1 Option 1 — Setchkin furnace.....	2
5.2 Option 2 – ISO 1182 refractory tube furnace.....	4
6 Location of thermocouples	9
7 Test specimens	9
8 Procedure	10
8.1 Flash-ignition temperature (FIT).....	10
8.2 Spontaneous-ignition temperature (SIT).....	11
9 Precision	12
10 Test report	12
Annex A (informative) Results obtained by interlaboratory trials using Option 1 (Setchkin furnace)	13
Annex B (informative) Typical designs of test apparatus	15
Bibliography	17

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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.

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).

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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*.

This fourth edition cancels and replaces the third edition (ISO 871:2006), which has been technically revised.

The main changes compared to the previous edition are as follows.

- An option to use a modification of the equipment used for ISO 1182 to assess ignitability has been added.
- Mandatory information have been added throughout the document.

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.

Plastics — Determination of ignition temperature using a hot-air furnace

1 Scope

1.1 This document specifies a laboratory method for determining the flash-ignition temperature and spontaneous-ignition temperature of plastics using a hot-air furnace. It is one of a number of methods in use for evaluating the reaction of plastics to the effects of ignition sources.

NOTE Information on additional ignition methods can be found in ISO 10093.

1.2 This method does not give a direct measure of the combustibility or rate of burning of a material or any definition of the safe upper limit of temperature for the plastics in use, and it is inappropriate to use it alone to describe or appraise the fire hazard or fire risk of materials, products or assemblies under actual fire conditions. However, results of this test are suitable for use as elements of a fire hazard or fire risk assessment which takes into account all of the factors pertinent to an assessment of the fire hazard of a particular end use.

1.3 Tests made under conditions of this method are potentially of considerable value in comparing the relative ignition characteristics of different materials. Values obtained represent the lowest ambient air temperature that has the potential to cause ignition of the material under the conditions of this test. Test values are expected to rank materials according to ignition susceptibility under actual use conditions.

1.4 The results of this test method are not intended for fire safety engineering calculations.

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 1182, *Reaction to fire tests for products — Non-combustibility test*

ISO 13943, *Fire safety — Vocabulary*

IEC 60584-1, *Thermocouples Part 1 EMF Specifications And Tolerances*

IEC 60584-2:1982, *Thermocouples — Part 2: Tolerances*

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 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
flash-ignition temperature
FIT

minimum temperature at which, under specified test conditions, sufficient flammable gases are emitted to ignite momentarily on application of a pilot flame

3.2
spontaneous-ignition temperature
SIT

minimum temperature at which, under specified test conditions, ignition is obtained by heating in the absence of any additional ignition source

3.3
glowing combustion

combustion of a material in the solid phase without flame but with emission of light from the combustion zone

4 Principle

A specimen of the material is heated in a hot-air ignition furnace using various temperatures within the heated chamber, and the flash-ignition temperature is determined with a small pilot flame directed at the opening in the top of the furnace to ignite evolved gases.

The spontaneous-ignition temperature is determined in the same manner as the flash-ignition temperature, but without the pilot flame.

NOTE The results from using Option 1 or Option 2 can potentially be different.

5 Apparatus

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5.1 Option 1 — Setchkin furnace

5.1.1 Hot-air ignition furnace, similar to that shown in [Figure 1](#), consisting primarily of an electrical heating unit and a specimen holder.

5.1.2 Furnace tube, with an inside diameter of $100 \text{ mm} \pm 5 \text{ mm}$ and a length of $240 \text{ mm} \pm 20 \text{ mm}$, made of a ceramic that is suitable for use at a temperature of at least $750 \text{ }^\circ\text{C}$. The tube shall be positioned vertically so that it stands on the furnace floor above a plug for the removal of accumulated residue.

5.1.3 Inner ceramic tube, capable of withstanding at least $750 \text{ }^\circ\text{C}$, with an inside diameter of $75 \text{ mm} \pm 2 \text{ mm}$, a length of $240 \text{ mm} \pm 20 \text{ mm}$ and a thickness of approximately 3 mm , placed centrally inside the furnace tube and positioned $20 \text{ mm} \pm 2 \text{ mm}$ above the furnace floor on three small refractory spacer blocks. The top shall be covered by a disc of heat-resistant material with a $25 \text{ mm} \pm 2 \text{ mm}$ diameter opening in the centre which is used for observations and allows the passage of smoke and gases. The pilot flame shall be located immediately above the opening.

5.1.4 Outside air source, to supply clean air near the top of the annular space between the ceramic tubes through a copper tube at a steady and controllable rate. The air shall be heated and circulated in the space between the two tubes and enter the inner ceramic tube at the bottom. The air flow shall be metered by a rotameter or other suitable device.

5.1.5 Electrical heating unit, made of 50 turns of $1,3 \text{ mm} \pm 0,1 \text{ mm}$ nichrome wire or equivalent. The wires, contained within a mineral-fibre sleeve, shall be wound around the furnace tube and shall be embedded in heat-resistant cement.

5.1.6 Insulation, consisting of a layer of mineral-fibre wool approximately 60 mm thick, and covered by a sheet- iron jacket.

5.1.7 Pilot igniter, consisting of a copper tube of nominal inside diameter $1,8 \pm 0,3 \text{ mm}$ attached to a supply of 94 % minimum purity propane and placed horizontally $5 \text{ mm} \pm 1 \text{ mm}$ above the top surface of the disc cover. The pilot flame shall be adjusted to $20 \text{ mm} \pm 2 \text{ mm}$ in length and centred above the opening in the disc cover.

5.1.8 Specimen support and holder, consisting of a metal specimen pan made of $0,7 \text{ mm} \pm 0,3 \text{ mm}$ thick stainless steel and measuring $40 \text{ mm} \pm 2 \text{ mm}$ in diameter by $15 \text{ mm} \pm 2 \text{ mm}$ in depth, having a rounded bottom and held in a ring of approximately 2 mm diameter stainless-steel welding rod. The ring shall be welded to a length of the same type of rod extending through the cover of the furnace, as shown in [Figure 1](#). The bottom of the specimen pan shall be located $185 \text{ mm} \pm 2 \text{ mm}$ down from the lower edge of the pilot igniter.

5.1.9 Thermocouples, $0,5 \text{ mm}$ in diameter, chromel-alumel (type K) or iron-constantan (type J), for temperature measurement, connected to a calibrated recording instrument with a tolerance not exceeding $\pm 2 \text{ }^\circ\text{C}$. The thermocouple tolerance shall be in accordance with IEC 60584-2:1982, Table A.1; class 2 or better. They shall be installed as in [Clause 6](#).

5.1.10 Heating control, consisting of a suitable variable transformer or an automatic controller connected in series with the heating coils.

5.1.11 Timing device, having an accuracy of 1 s or better.

5.2 Option 2 – ISO 1182 refractory tube furnace

5.2.1 The apparatus shall consist of a **refractory tube furnace** insulated and surrounded by a heating coil. The furnace specified in ISO 1182 shall be used. A cone-shaped airflow stabilizer shall be attached to the base of the furnace and a draft shield to its top. Details are shown in [Figure 2](#).

- 5 heating coils
- 6 draft shield
- 7 heat resisting steel rod for insertion device
- 8 disc cover
- 9 thermocouple TC₂
- 10 support rod
- 15 seal
- 16 stabilizer cone
- 17 draft screen (metal sheet)
- 18 pilot flame
- 19 specimen pan

Figure 2 — Test apparatus for Option 2 (ISO 1182 refractory tube furnace)

- 5.2.1.1 Two furnace thermocouples shall be provided as specified in ISO 1182 and indicated in 6.3.2.
- 5.2.1.2 A thermal sensor shall be used to measure the furnace temperature along its central axis.
- 5.2.1.3 Unless stated otherwise, all dimensions shall have a 5 % tolerance.

5.2.2 Test furnace

5.2.2.1 The furnace tube shall be constructed of a refractory material, as specified in Table 1, of density $2\ 800\text{ kg/m}^3 \pm 300\text{ kg/m}^3$. The furnace tube shall be $150\text{ mm} \pm 1\text{ mm}$ high with an internal diameter of $75\text{ mm} \pm 1\text{ mm}$ and a wall thickness of $10\text{ mm} \pm 1\text{ mm}$.

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Table 1 — Furnace tube refractory material for apparatus, Option 2 (ISO 1182 refractory tube furnace)

Material	Composition % (kg/kg mass)
Alumina (Al ₂ O ₃)	>89
Silica and alumina (SiO ₂ , Al ₂ O ₃)	>98
Ferric oxide (Fe ₂ O ₃)	<0,45
Titanium dioxide (TiO ₂)	<0,25
Manganese oxide (Mn ₃ O ₄)	<0,1
Other trace oxides (sodium, potassium, calcium and magnesium oxides)	The balance

5.2.2.2 The top of the draught shield shall be covered by a disk of heat-resistant material with a $25\text{ mm} \pm 2\text{ mm}$ diameter opening in the centre that is to be used for observation and passage of smoke and gases. The pilot flame shall be located immediately above the opening.

5.2.2.3 The furnace tube shall be surrounded by an annular space of the following dimensions: 150 mm high and of 10 mm wall thickness.

5.2.2.4 The annular space shall be fitted with top and bottom plates, recessed internally to locate the ends of the furnace tube.

5.2.2.5 The annular space shall be insulated with a 25 mm layer of an insulating material having a thermal conductivity of $0,04\text{ W/(m}\cdot\text{K)} \pm 0,01\text{ W/(m}\cdot\text{K)}$ at a mean temperature of $20\text{ }^\circ\text{C}$. Magnesium oxide powder of a nominal bulk density of $170\text{ kg/m}^3 \pm 30\text{ kg/m}^3$ is a suitable material for this use.

5.2.2.6 The furnace tube shall be provided with a single winding of 80/20 nickel/chromium electrical resistance tape, $3\text{ mm} \pm 0,1\text{ mm}$ wide and $0,2\text{ mm} \pm 0,01\text{ mm}$ thick.

5.2.2.7 An open-ended cone-shaped air-flow stabilizer shall be attached to the underside of the furnace. The air-flow stabilizer shall be 500 mm long and shall be reduced uniformly from an internal diameter of 75 mm \pm 1 mm at the top to an internal diameter of 10,0 mm \pm 0,5 mm at the bottom. The air flow stabilizer shall be manufactured from 1 mm thick sheet steel, with a smooth finish on the inside. The joint between the air flow stabilizer and the furnace shall have an airtight fit, with an internal smooth finish. The upper half of the air flow stabilizer shall be insulated with a 25 mm layer of an insulating material having a thermal conductivity of 0,04 W/(m·K) \pm 0,01 W/(m·K) at a mean temperature of 20 °C (68 °F). Mineral fibre insulating material with a nominal thermal conductivity of 0,04 W/(m·K) \pm 0,01 W/(m·K) at a mean temperature of 20 °C is a suitable material for this use.

5.2.2.8 A draft shield, constructed of the same material as the air flow stabilizer, shall be provided at the top of the furnace. It shall be 50 mm high and have an internal diameter of 75 mm \pm 1 mm. The draft shield and its joint with the top of the furnace shall have smooth internal finish. The exterior shall be insulated with a 25 mm layer of an insulating material having a thermal conductivity of 0,04 W/(m·K) \pm 0,01 W/(m·K) at a mean temperature of 20 °C. Mineral fibre insulating material with a nominal thermal conductivity of 0,04 W/(m·K) \pm 0,01 W/(m·K) at a mean temperature of 20 °C is a suitable material for this use.

5.2.2.9 The assembly, consisting of the furnace, air flow stabilizer cone and draft shield, shall be mounted on a firm horizontal stand, with a base and draft screen attached to the stand, to reduce drafts around the bottom of the stabilizer cone. The draft screen shall be 550 mm high, and the bottom of the air flow stabilizer cone shall be located 250 mm above the base plate.

5.2.3 Specimen support and holder. The specimen pan shall consist of a metal specimen pan of 0,7 mm \pm 0,3 mm thick stainless steel, measuring 40 mm \pm 2 mm in diameter by 15 mm \pm 2 mm in depth, having a rounded bottom. The specimen pan is held in a ring of approximately 2,0 mm diameter stainless steel welding rod. The ring shall be welded to a length of the same type of rod extending through the cover of the furnace. The bottom of the specimen pan shall be located 145 mm \pm 5 mm down from the lower edge of the pilot igniter.

5.2.3.1 The location of the test specimen in the Option 2 (ISO 1182 refractory tube furnace) shall be as indicated in [Figure 3](#).