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Plastics — Determination of burning behaviour of thin flexible vertical specimens in contact with a small-flame ignition source

Plastiques — Détermination du comportement au feu d'éprouvettes minces verticales souples au contact d'une petite flamme comme source d'allumage

Reference number
ISO 9773:1998(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9773 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 4, *Burning behaviour*.

This second edition cancels and replaces the first edition (ISO 9773:1990) which has been technically revised.

Annex A of this International Standard is for information only.

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Plastics – Determination of burning behaviour of thin flexible vertical specimens in contact with a small-flame ignition source

1. Scope

1.1 This International Standard specifies a small- scale laboratory screening procedure for comparing the relative burning behaviour of vertically oriented thin and relatively flexible plastics specimens exposed to a low-energy-level flame ignition source. These specimens cannot be tested using method B of ISO 1210 since they distort or shrink away from the applied flame source without igniting.

1.2 This method of test determines the afterflame and afterglow times of specimens.

1.3 The classification system described in annex A is intended for quality control and the preselection of component materials for products. The classification established by this method of test is applicable only to the material used for the specimens.

NOTE 1 - Test results are influenced by material components, e.g. pigments, fillers, fire-retardant concentrations.

2. Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 1043-1:1997, *Plastics — Symbols and abbreviated terms — Basic polymers and their special characteristics.*

ISO 1210:—[1], *Plastics — Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame (50 W) ignition source.*

ISO 5725-2:1994, *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 10093:—[2], *Plastics — Fire tests — Standard ignition sources.*

ASTM D 5207-91, *Standard practice for the calibration of 20 mm and 125 mm test flames for small-scale burning tests on plastic materials."*

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1) To be published. (Revision of ISO 1210:1992)
2) To be published. (Revision of ISO 10093:1994)

3. Definitions

For the purposes of this International Standard, the following definitions apply:

3.1 afterflame: A flame which, under specified test conditions, persists after the ignition source has been removed.

3.2 afterflame time: The length of time for which an afterflame persists.

3.3 afterglow: Persistence of glowing of a material, under specified test conditions, after cessation of flaming or, if no flaming occurs, after the ignition source has been removed.

3.4 afterglow time: The length of time for which an afterglow persists.

4. Principle

A test specimen having a nearly cylindrical form is supported vertically by one end and the free end is exposed to two successive applications of a specified gas flame. The burning behaviour of the specimen is assessed by measuring the afterflame and/or afterglow time,

5. Significance of test

5.1 Tests made on a material under the conditions specified in this standard can be of considerable value when comparing the relative burning behaviour of different materials, controlling manufacturing processes or assessing any change in burning characteristics prior to, or during, use. The results obtained from this method are dependent upon the shape, orientation and insulation of the specimen and the conditions of ignition. Correlation with performance under actual service conditions is not implied.

5.2 Results obtained in accordance with this standard shall not be used to describe or appraise the fire hazard presented by a particular material or shape under actual fire conditions. Assessment for fire hazard requires consideration of such factors as: fuel contribution, intensity of burning (rate of heat release), products of combustion and environmental factors such as the intensity of source, orientation of exposed material and ventilation conditions.

5.3 Burning behaviour as measured by this test method is affected by such factors as density, colour and anisotropy of the material and thickness of the specimen.

5.4 The effects on the burning behaviour of additives, deterioration, and possible loss of volatile components are measurable using this method. Results obtained using this method may serve for comparing the relative performance of materials and can be helpful in material assessment.

5.5 The burning behaviour of some plastic materials may change with time. It is accordingly advisable to make tests before and after oven conditioning by an appropriate procedure that is described in the test report. The preferred oven conditioning conditions shall be 7 days at 70°C. However, other oven conditioning times and temperatures may be used if agreed to by all parties.

6. Apparatus and materials

6.1 Laboratory fume hood (cupboard), having an internal volume of at least 0,5 m^3, which shall be used when testing the specimens. The chamber shall permit observation and shall be draught free while permitting normal thermal circulation of air past the specimen during burning. For safety and convenience, it is desirable that this enclosure (which can be completely closed) be fitted with an evacuation device, such as an exhaust fan, to remove products of combustion which may be toxic. However, it is important to turn off the device during the actual test and to start it again immediately after the test to remove the products of combustion.

6.2 Laboratory burner, as described in ISO 10093 as ignition source P/PF2 (50 W source), having a barrel length of 100 mm ± 10 mm and an inside diameter of 9,5 mm ± 0,3 mm. The barrel shall not be equipped with an end attachment such as a stabilizer. The burner shall be calibrated in accordance with ASTM D 5207.

6.3 Ring stand, with clamps or the equivalent, adjustable for positioning of the specimen.

6.4 Timing device, accurate to 0,5 s in one hour with a resolution of 0,1 s.

6.5 Measuring scale, graduated in millimetres.

6.6 Supply of technical-grade methane gas, of minimum purity 98 %, with regulator and meter for uniform gas flow.

NOTE 2 - Other gas mixtures having a heat content of 37 MJ/m^3 ± 1 MJ/m^3 have been found to provide similar results. However, technical-grade methane, having a minimum purity of 98 percent, shall be used in cases of dispute.

6.7 Desiccator, containing a suitable drying agent, capable of maintaining a relative humidity not exceeding 20 % at 23°C ± 2°C.

6.8 Conditioning room or chamber, capable of being maintained at 23°C ± 2°C and a relative humidity of (50 ± 5) % as specified in ISO 291.

6.9 Micrometer, capable of being read to 0,01 mm,

6.10 Specimen mandrel form, made from 13 mm ± 0,5 mm diameter rod.

6.11 Pressure-sensitive adhesive tape, of a commercially available type.

6.12 Stainless steel or nichrome wire, of diameter 0,2 mm to 0,5 mm.

6.13 Absorbent 100 % cotton wool.

6.14 Air-circulating oven, capable of being maintained at 70°C ± 2°C with a minimum of five air changes/hour.

6.15 Weighing scale or balance, having an accuracy and resolution of 0,01 g.

7. Specimens

7.1 All specimens shall be cut from a representative sample of the material (sheets or end-products). After any cutting operation, care shall be taken to remove all dust and any particles from the surface; cut edges shall have a smooth finish.

7.2 Standard specimens shall be 200 mm ± 5 mm long, 50 mm ± 2 mm wide and a maximum of 0,1 mm thick. Measure the thickness of each to the nearest 0,01 mm and note the measurements.

NOTE 3 - Tests made on specimens of different thicknesses or density may not be comparable and tests made in different directions of anisotropy or on different colours may also not be comparable.

7.3 Specimens shall be prepared by marking a line across the specimen width 125 mm ± 5 mm from one end (bottom) of the cut specimen. The longitudinal axis of the specimen shall be wrapped tightly around the longitudinal axis of the mandrel to form a lapped cylinder with the 125 mm line exposed. The overlapping portions of the specimens shall be secured within the upper 75 mm segment above the 125 mm mark and at the upper end of the tube with pressure-sensitive adhesive tape. The mandrel shall then be removed.

NOTE 4 - For stiff specimens, the pressure-sensitive tape may be reinforced or replaced by nichrome wire wound around the top 75 mm of the specimen (see figure 1).

7.4 A minimum of 20 specimens shall be prepared. It is advisable to prepare additional specimens for retest purposes if necessary.

8. Conditioning

Unless otherwise required by the material specifications, conditioning and testing shall be carried out under the following conditions:

8.1 Two sets of five specimens shall be preconditioned for at least 48 h at 23°C ± 2°C and (50 ± 5) % relative humidity. Testing shall be carried out in the laboratory atmosphere (see 9.1) within one hour of being conditioned.

8.2 Two sets of five specimens shall be preconditioned for 168 h at 70°C ± 1°C and then cooled in a desiccator for at least 4 h at room temperature, prior to testing. Once removed from the desiccator, the specimens shall be tested in the laboratory atmosphere (see 9.1) within one hour.

9. Test procedures

9.1 All specimens shall be tested in a laboratory atmosphere of 15°C to 35°C and 45 % to 75 % relative humidity.

9.2 Clamp the specimen from the upper 6 mm of its length with the longitudinal axis vertical by a heavy spring clamp or other device, so that the upper end of the tube is closed to prevent any chimney effects during the test. The lower end of the specimen shall be 300 mm ± 10 mm above a horizontal layer of 0,05 g to 0,08 g of cotton wool of area approximately 50 mm x 50 mm and maximum thickness 6 mm (see figure 2).

9.3 Obtain the desired burner flame by adjusting the supply and air ports of the burner until a yellow-tipped blue flame of height 20 mm ± 1 mm is produced. Increase the air supply until the yellow tip just disappears. Measure the height of the flame again and correct it to 20 mm ± 1 mm if necessary.

9.4 Apply the flame of the burner centrally to the middle point of the bottom edge of the unlapped section (see note 5) of the specimen so that the top of the burner is 10 mm ± 1 mm below that point of the lower end of the specimen, and maintain it at that distance for 3 s ± 0,5 s, moving the burner as necessary in response to any changes in the length or position of the specimen (see note 6). If the specimen drips molten or flaming material during the flame application, tilt the burner at an angle of up to 45° and withdraw it just sufficiently from beneath the specimen to prevent material from dropping into the barrel of the burner while maintaining the 10 mm ± 1 mm spacing between the centre of the outlet of the burner and the remaining portion of the specimen, ignoring any strings of molten material. After the application of the flame to the specimen for 3 s ± 0,5 s, immediately withdraw the burner at a rate of approximately 300 mm/s to a distance of at least 150 mm away from the specimen and simultaneously use the timing device to commence measurement, to the nearest second, of the first afterflame time t_1. Record t_1.

NOTE 5 - For specimens that flare and therefore are not lapped at their lower end when suspended from the pinched upper end, the longitudinal axis of the specimen material thus becomes the direction along which the flame is applied.

NOTE 6 - For specimens which move under the influence of the burner flame, the use of a small indicator rod attached to the burner (shown in figure 3) has been found to be helpful in maintaining the 10 mm distance between the top of the burner and the major portion of the specimen.

9.5 As soon as afterflaming of the specimen ceases, even if the burner has not been withdrawn to the full 150 mm distance from the specimen, immediately place the flame of the burner again under the specimen and maintain the burner at a distance of 10 mm ± 1 mm from the remaining portion of the specimen for 3 s ± 0,5 s while moving the burner clear of dropping material as necessary as described in 9.4. After this application of the flame to the specimen for 3 s ± 0,5 s, immediately extinguish the burner or remove it at a rate of approximately 300 mm/s to a distance of at least 150 mm from the specimen and simultaneously, using the timing device, commence measurement to the nearest second of the second afterflame time t_2 and the afterglow time t_3 of the specimen. Note t_2 and t_3. Note also whether the afterflame or afterglow progresses up to the 125 mm mark and whether the cotton wool layer below the specimen is ignited by material dropping from the specimen.

9.6 Repeat the procedure of 9.1 to 9.5 until at least five specimens have been tested.

10. Expression of results

10.1 For each specimen, calculate the total afterflame time using the equation:

$$t_{Fi} = t_1 + t_2$$

where

t_{Fi} is the total afterflame time for the individual specimen;
t_1 is the first afterflame time;
t_2 is the second afterflame time.

10.2 For each set of five specimens from both preconditioning treatments, calculate the total set afterflame time (t_{FS}) as

$$t_{FS} = \sum_{i=1}^{i=5} t_{Fi}$$

Where i is the individual specimen number and t_{Fi} is as defined above.

11. Precision

11.1 The precision data were determined from an inter-laboratory experiment conducted in 1986 involving six laboratories, four materials and two replicates. Each replicate was determined by averaging the values of five measurements. The results were analysed using ISO 5725-2 : 1994 and are summarized in table 1.

Table 1 - Precision data

Stage	Parameter	Time (s)			
		FEP[1)]	PI[1)]	PET[1)]	PVF[1)]
After first flame application	Average	0	0,5	2,5	6,0
	Repeatability	0	0,36	0,71	4,46
	Reproducibility	0	0,71	0,89	4,29
After second flame application plus glowing	Average	0	0	0,71	2,50
	Repeatability	0	0	0,71	3,93
	Reproducibility	0	0	1,25	5,18

1) Symbols for plastics materials are defined in ISO 1043-1.

NOTE 7 - Table 1 is only intended to present a meaningful way of considering the approximate precision of this test method for a range of materials. These data should not be rigorously applied to acceptance or rejection of material, as they are specific to the interlaboratory test and may not be representative of other lots, conditions, materials or laboratories.

12. Test report

The test report shall include the following information:

a) a reference to this International Standard;
b) the direction of any anisotropy relative to the test specimen dimensions;
c) the conditioning treatment;
d) any prior treatment before testing, other than cutting, trimming and conditioning;
e) full identification of the product tested, including the manufacturer's name, number or code;
f) the gas used for the burner;
g) the name and location of the test facilities;
h) the date of the test;
i) the individual test values, including:

1) specimen number (i),
2) specimen thickness,
3) first afterflame time (t_1),
4) second afterflame time (t_2),
5) total afterflame time (t_{Fi}),
6) total set afterflame time (t_{FS}),
7) afterglow time after the second flame application (t_3),
8) whether there was afterflame or afterglow up to the 125 mm mark,
9) whether the cotton wool indicator was ignited.

Annex A

(informative)

Classification system for determining the combustibility of vertical flexible specimens using a 20 mm flame source

A.1 General

This annex describes a classification system to characterize the burning behaviour of flexible materials tested in a vertical orientation using a 20 mm ignition source. The use of a category designation code is optional. Determine the category designation code by examining the test results of materials tested by this method. Each category code represents a preferred range of performance levels that simplifies description in material designations or specifications and may help certification bodies to determine compliance with applicable requirements.

A.2 Classification designations

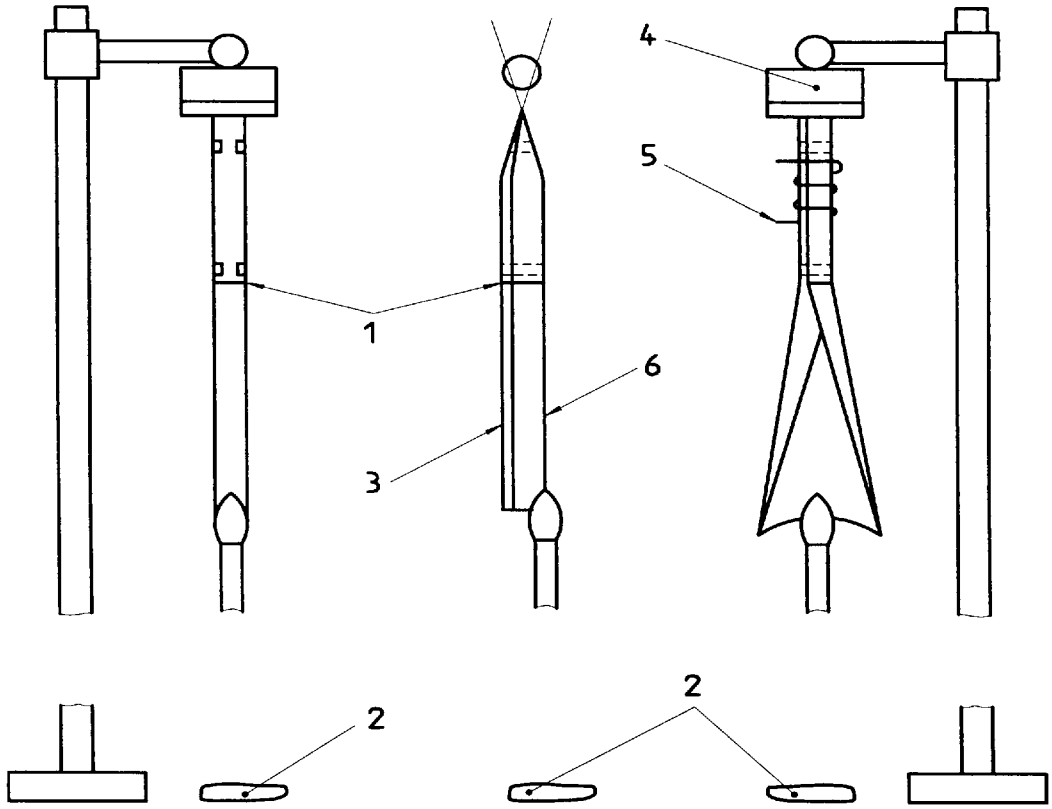
Using the data determined from this method, select the one category code that best matches the individual specimen performance using the criteria of Table A.1. Select the designation where each individual specimen complies with all the criteria specified. Optionally record the category code in the report.

Table A.1 – Criteria and categories for classifying burning behaviour

Requirements	**Category paths** [1]			
If: every individual afterflame time t_1 and t_2 is	≤10s	≤30s	≤30s	>30s
and: total set afterflame time (t_{FS}) is	≤50s	≤250s	≤250s	>250s
and: every individual afterglow time after the second flame application (t_3) is	≤30s	≤60s	≤60s	>60s
and: afterflame or afterglowing progresses up to the 125 mm mark	No	No	No	Yes
and: cotton indicator ignited by flaming particles or drops.	No	No	Yes	Yes or No
then: category is	VTM-0	VTM-1	VTM-2	2)

1) If only one specimen from a set of five specimens for a given conditioning treatment does not conform to the requirements for a category, another set of five specimens subjected to the same preconditioning shall be tested. All specimens from the second set shall conform to the appropriate requirements for the category.

2) Materials that cannot be categorized by this procedure. Use method A of ISO 1210 to categorize material burning behaviour.



a) Front view of specimen, lapped at lower end

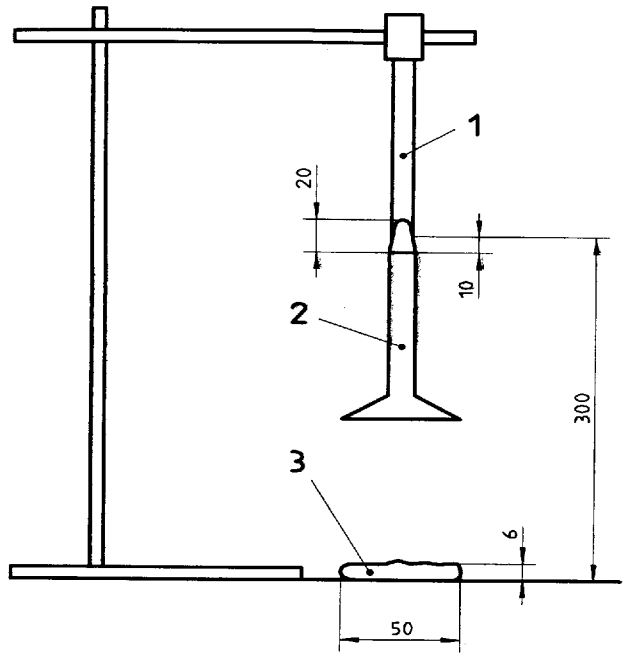
b) Side view of specimen, lapped at lower end

c) Back view of specimen, not lapped at lower end

1 125 mm mark
2 Cotton wool
3 Lapped section
4 Spring clamp
5 Nichrome wire closure
6 Unlapped section

Figure 1 — Specimen orientation

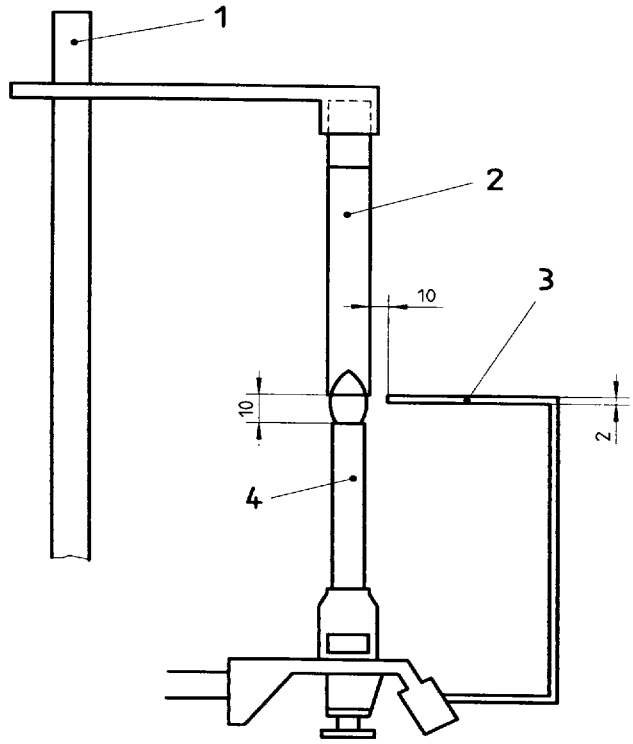
Dimensions in millimetres



1 Specimen
2 Burner
3 Cotton wool

Figure 2 — Application of flame

Dimensions in millimetres



1 Fixed stand
2 Specimen
3 Indicator rod
4 Burner

Figure 3 — Burner with optional flame distance indicator

ICS 13.220.40; 83.080.01

Descriptors: plastics, flexible plastics, tests, fire tests, flammability testing.

Price based on 11 pages