



Designation: **D1929—14 D1929 – 16**

Standard Test Method for Determining Ignition Temperature of Plastics¹

This standard is issued under the fixed designation D1929; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This fire test response test method² covers a laboratory determination of the flash ignition temperature and spontaneous ignition temperature of plastics using a hot-air furnace.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *Caution*—During the course of combustion, gases or vapors, or both, are evolved that have the potential to be hazardous to personnel.

1.4 *This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire-hazard or fire-risk assessment of the materials, products, or assemblies under actual fire conditions.*

1.5 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Specific precautionary statements are given in 1.3 and 1.4.*

NOTE 1—This test method and ISO 871-1996 are identical in all technical details.

2. Referenced Documents

2.1 *ASTM Standards*:³

[D618 Practice for Conditioning Plastics for Testing](#)

[E176 Terminology of Fire Standards](#)

2.2 *International Standards*:⁴

[ISO 871-1996 Plastics—Determination of Ignition Temperature Using a Hot-Air Furnace](#)

[ISO 5725 Precision of Test Methods—Determination of Repeatability and Reproducibility for Standard Test Methods by Interlaboratory Tests](#)

[IEC 584-2 Thermocouples—Part 2: Tolerances](#)

3. Terminology

3.1 For definitions of terms relating to fire, see Terminology [E176](#).

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *flash ignition temperature (FIT)*—the minimum temperature at which, under specified test conditions, sufficient flammable gases are emitted to ignite momentarily upon application of a small external pilot flame.

3.2.2 *glowing combustion*—combustion of a material in the solid phase without flame but with emission of light from the combustion zone, caused by slow decomposition and carbonization at various points in the specimen, without general ignition occurring.

¹ This test method is under the jurisdiction of ASTM Committee [D20](#) on Plastics and is the direct responsibility of Subcommittee [D20.30](#) on Thermal Properties.30.03). Current edition approved Dec. 1, 2014 April 1, 2016. Published December 2014 April 2016. Originally approved in 1962. Last previous edition approved in 2013 2014 as [D1929 – 13](#) [D1929 – 14](#). DOI:10.1520/D1929-14 DOI:10.1520/D1929-16.

In 1996, this test method was totally revised to be technically equal to ISO 871-1996, and a specific air velocity is specified, which eliminates the need for approximations.

² The following reference may be of interest in connection with this test method: Stetchkin, N. P., "A Method and Apparatus for Determining the Ignition Characteristics of Plastics," *Journal of Research*, National Institute of Standards and Technology, Vol 43, No. 6, December 1949 (RP 2052), p. 591.

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

*A Summary of Changes section appears at the end of this standard

3.2.3 *spontaneous ignition temperature or self-ignition temperature (SIT)*—the minimum temperature at which the self-heating properties of the specimen lead to ignition or ignition occurs of itself, under specified test conditions, in the absence of any additional flame ignition source.

4. Significance and Use

4.1 Tests made under conditions herein prescribed can be of considerable value in comparing the relative ignition characteristics of different materials. Values obtained represent the lowest ambient air temperature that will 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.

4.2 This test is not intended to be the sole criterion for fire hazard. In addition to ignition temperatures, fire hazards include other factors such as burning rate or flame spread, intensity of burning, fuel contribution, products of combustion, and others.

5. Apparatus

5.1 *Hot-Air Ignition Furnace*—A furnace similar to that shown in Fig. 1, consisting primarily of an electrical heating unit and

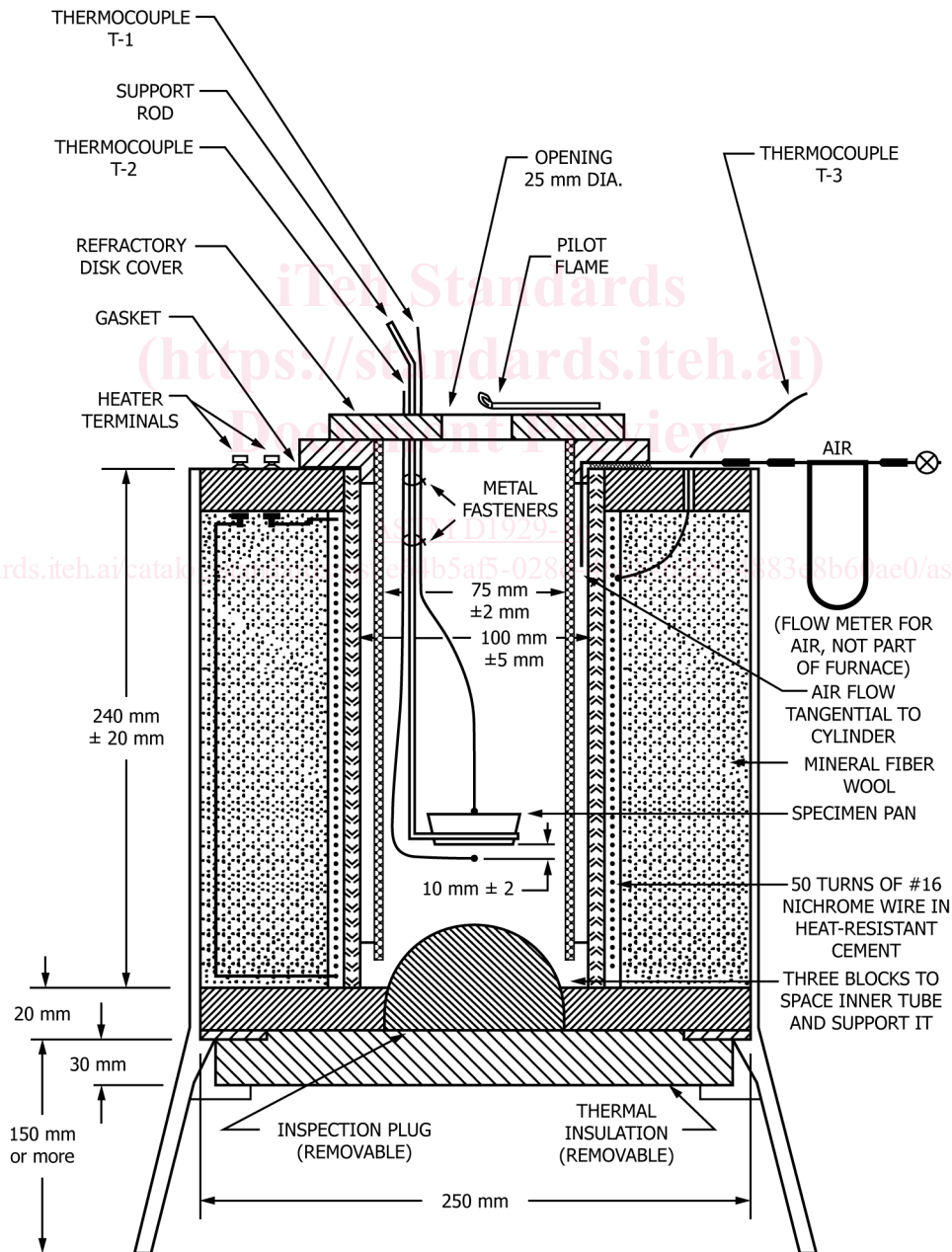


FIG. 1 Cross Section of Hot-Air Ignition Furnace

specimen holder.

5.2 Furnace Tube—A vertical tube with an inside diameter of 100 ± 5 mm and a length of 230 ± 20 mm, made of a ceramic that will withstand at least 750°C . The vertical tube stands on the furnace floor, fitted with a plug for the removal of accumulated residue.

5.3 Inner Ceramic Tube—A ceramic tube that will withstand at least 750°C , with an inside diameter of 75 ± 5 mm, length of 230 ± 20 mm, and thickness of approximately 3 mm, placed inside the furnace tube and positioned 20 ± 2 mm above the furnace floor on three small spacer blocks. The top is covered by a disk of heat-resistant material with a 25 ± 2 -mm diameter opening in the center that is used for observation and passage of smoke and gases. The pilot flame is located immediately above the opening.

NOTE 2—Fire resistant materials such as silica glass and stainless steel have also been found suitable for this application.

5.4 Air Source—An 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. Air shall be heated and circulated in the space between the two tubes and enter the inner furnace tube at the bottom. Air shall be metered by a rotameter or other suitable device.

5.5 Electrical Heating Unit, contained within the mineral fiber sleeve and constructed of 50 turns of 1.3 ± 0.1 mm Nichrome V alloy wire, wound around the furnace tube and embedded in heat-resistant cement.

NOTE 3—Other constructions such as finely coiled wire embedded in molded ceramic fiber have also been found to be acceptable.

5.6 Insulation, consisting of a layer of mineral fiber, approximately 60-mm thick, and covered by a metal jacket.

5.7 Pilot Igniter, consisting of a nominal 1.8 ± 0.3 -mm inside diameter (ID) copper tubing attached to a gas supply of 94 % minimum purity propane and placed horizontally 5 ± 1 mm above the top surface of the disk cover. The pilot flame shall be adjusted to 20 ± 2 mm in length and centered above the opening in the disk cover.

5.8 Specimen Support and Holder—The specimen pan consists of a metal container of approximately 0.5-mm thick steel measuring 40 ± 2 mm in diameter by 15 ± 2 mm in depth. It is held in a ring of approximately 2.0-mm diameter stainless steel welding rod. The ring is welded to a length of the same type of rod extending through the cover of the furnace, as shown in Fig. 1. The bottom of the specimen pan shall be located 185 ± 5 mm down from the top of the inner furnace tube.

5.9 Thermocouples, 0.5-mm diameter, Chromel-Alumel (Type K) or Iron-Constantan (Type J), for temperature measurement connected to a calibrated recording instrument with a tolerance not exceeding $\pm 2^{\circ}\text{C}$. The thermocouple tolerance shall be in accordance with IEC 584-2, Table 1, Class 2 or better.

5.10 Heating Control—A suitable variable transformer or an automatic controller connected in series with the heating coils.

5.11 Timing Device, having an accuracy of at least 1 s.

6. Location of Thermocouples

6.1 Thermocouple TC_1 measures the temperature, T_1 , of the specimen. It is located as close as possible to the center of the upper surface of the specimen when the specimen is in place within the furnace. The thermocouple wire is attached to the specimen support rod.

6.2 Thermocouple TC_2 gives some indication of the temperature, T_2 , of the air traveling past the specimen. It is located 10 ± 2 mm below the center of the specimen pan. The thermocouple wire is attached to the specimen support rod.

NOTE 4—Thermocouple TC_2 may be installed through a hole drilled adjacent to the inspection plug below the specimen pan.

6.2.1 It is acceptable to install thermocouple TC_2 through a hole drilled adjacent to the inspection plug below the specimen pan, instead of introducing it from the top, as shown in Fig. 1.

6.3 Thermocouple TC_3 measures the temperature, T_3 , of the heating coil. It is located adjacent to the furnace heating coil and is used as a reference for temperature adjustment purposes. A metallic sheathed thermocouple with a diameter not greater than 1.7 mm is permitted to be used for thermocouple TC_3 . The limit on thermocouple thickness in 5.9 does not apply to thermocouple TC_3 .

7. Test Specimens

7.1 It is acceptable to use as test specimens materials, or products, supplied in any form, with some examples being pellets, powders and films. It is also acceptable to use composites as test specimens. The test report shall include full details of the form in which the test specimens have been tested.

NOTE 4—Specimens containing high levels of inorganic fillers are difficult to evaluate.

NOTE 5—In some cases the same material will give different results if tested in different forms.

7.2 A specimen mass of 3.0 ± 0.2 g shall be used for materials having a density greater than 100 kg/m^3 .

7.2.1 Instructions for Specific Types of Test Specimens:

7.2.1.1 For sheet materials, cut the sheet into squares of 20 ± 2 by 20 ± 2 mm maximum size, and stack these to a height that gives the required specimen mass.

7.2.1.2 For film materials, roll a strip 20 ± 2 mm wide and of length sufficient to give the required specimen mass.

7.2.1.3 For cellular materials having a density less than 100kg/m^3 , remove any outer skin and cut the specimens in the form of a block measuring 20 ± 2 by 20 ± 2 by 50 ± 5 mm.

7.3 Sufficient material is required for at least two determinations.

7.4 The test specimens shall be conditioned at $23 \pm 2^\circ\text{C}$ and $50 \pm 10\%$ relative humidity for not less than 40 h prior to test, in accordance with Practice **D618**.

8. Procedure

8.1 Flash Ignition Temperature (FIT):

8.1.1 Set the air velocity to 25 mm/s by adjusting the actual air flow rate through the full section of the inner tube at the furnace temperature, using the following formula:

$$Q_v = 6.62 \times \frac{293}{T}$$

where:

Q_v = air flow rate, L/min, and

T = temperature, K, at T_2 .

Ensure that the air flow rate is maintained at $\pm 10\%$ of the calculated value.

8.1.2 Adjust the electric current supplied to the heating coil by means of the variable transformer or automatic controller, by reference to temperature T_3 until the air temperature, T_2 , remains constant at the desired initial test temperature.

8.1.2.1 The default initial test temperature shall be 400°C when no prior knowledge of the probable ignition temperature of the material or product to be tested is available.

8.1.2.2 If the approximate ignition temperature of the material or product to be tested is known, set the initial test temperature to 50°C below the expected ignition temperature.

8.1.3 Proceed as shown in **8.1.3.1** through **8.1.3.4** to assess the flash ignition temperature. Ignition is likely to be followed by continuous burning of the specimen.

8.1.3.1 Raise the specimen pan to the cover opening, and place the specimen on the pan.

8.1.3.2 Lower the pan into the furnace, while ensuring that thermocouples TC_1 and TC_2 are in their correct position, as per **6.1** and **6.2**.

8.1.3.3 Start the timer and ignite the pilot flame.

8.1.3.4 Watch for the occurrence of the following events, any one of which represents evidence of ignition:

(1) flaming combustion of the specimen,

(2) glowing combustion of the specimen,

(3) flash,

(4) explosion,

(5) rapid rise in temperature T_1 above that of T_2 .

NOTE 6— T_2 is essentially the temperature of the air surrounding the test specimen. T_1 is essentially the temperature of the top surface of the test specimen. For a non-combustible test specimen, it would be expected that the temperature of T_1 , the test specimen surface, would not significantly exceed the actual temperature T_2 of the air flowing past it. If T_1 were to significantly rise above T_2 , the only source for this heat energy would be the test specimen itself. Because of this relationship, an instantaneous change in the heating rate of T_1 , where T_1 becomes greater than T_2 , may be taken as an indication of ignition (burning) of the test specimen

8.1.4 At the end of 10 min, depending on whether ignition has or has not occurred, lower or raise the temperature T_2 by 50°C accordingly, and repeat the test with a fresh specimen.

8.1.5 When the range within which the flash ignition temperature lies has been determined, begin the test 10°C below the highest temperature within this range, and continue by dropping the temperature in 10°C steps until the temperature is reached at which there is no ignition during a 10 min period.

8.1.6 Record the lowest air temperature, T_2 , at which a flash is observed, during the 10 min period, as the flash ignition temperature.

8.2 Spontaneous Ignition Temperature (SIT):

8.2.1 Follow the same procedure as described in **8.1** with two exceptions:

(1) do not use pilot flame;

(2) use the evidences of ignition listed in **8.2.2** instead of those listed in **8.1.3.4**.

8.2.2 The occurrence of any one of the following events is considered evidence of spontaneous ignition:

(1) flaming combustion of the specimen;

(2) glowing combustion of the specimen;

(3) rapid rise in temperature of T_1 above that of T_2 .

NOTE 7—With some materials, it is difficult to detect spontaneous ignition visually when burning is by glowing combustion rather than flaming