



Designation: D 4100 – 82 (Reapproved 1989)^{ε1}

AMERICAN SOCIETY FOR TESTING AND MATERIALS
1916 Race St., Philadelphia, Pa. 19103
Reprinted from the Annual Book of ASTM Standards, Copyright ASTM
If not listed in the current combined index, will appear in the next edition.

Standard Test Method for Gravimetric Determination of Smoke Particulates From Combustion of Plastic Materials¹

This standard is issued under the fixed designation D 4100; 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 reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—Editorial changes were made throughout in January 1989.

1. Scope

1.1 This test method covers a laboratory test procedure for gravimetric determination of smoke particulate matter produced from the combustion or pyrolysis of plastic materials. This method applies to standard-size samples of plastic materials in a slab configuration. The test is conducted in the laboratory under dynamic conditions in a flaming mode of combustion.

1.2 Percent char and total amount of plastic burned at a designated time period are recorded in this test. However, there is not necessarily a relationship between these measurements.

1.3 *This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.*

1.4 The values stated in SI units are to be regarded as the standard.

1.5 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems 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 hazard statements are given in Section 7.*

2. Referenced Documents

2.1 ASTM Standards:

C 778 Specification for Standard Sand²

D 618 Methods of Conditioning Plastics and Electrical Insulating Materials for Testing³

D 883 Definitions of Terms Relating to Plastics⁴

D 1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds⁵

D 1898 Practice for Sampling of Plastics⁶

E 176 Terminology Relating to Fire Standards⁷

3. Terminology

3.1 Definitions:

3.1.1 *General*—Definitions are in accordance with Terminology E 176 or Definitions D 883, unless otherwise indicated.

3.2 Description of Term Specific to This Standard:

3.2.1 *smoke particulate, n*—airborne particles of 0.3- μm size or larger, resulting from pyrolysis or incomplete combustions, consisting of free carbon tars or soot; and present in sufficient quantity to be observable under conditions of this test.

4. Summary of Test Method

4.1 A specimen and glass-fiber filter are weighed separately on an analytical balance. The specimen and filter are positioned in a laboratory test chamber with a high-capacity vacuum source and filtration system. Air is drawn through the test chamber at a prescribed rate. A propane fueled micro bunsen burner ignition source is ignited. The ignition source is applied to the specimen and smoke particulates from the flaming combustion of the specimen impinge upon the filter. The sample is allowed to burn for 30 s, unless greater burn times are necessary, to generate the minimum smoke particulates required for accuracy. The ignition flame is then extinguished and the air flow is allowed to continue for 30 additional seconds to collect any particulates in the chimney. On completion of the burn, the specimen and filter are removed from the instrument and weighed upon an analytical balance. Char is mechanically or manually removed from the burned specimen and then the sample is reweighed. Smoke particulate and char mass are calculated by difference and expressed as percentages of the total amount of sample burned.

5. Significance and Use

5.1 This test method provides a means for comparing the smoke particulate generation properties of a plastic material

¹ This method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.30 on Thermal Properties (Section D20.30.03).

Current edition approved April 28, 1982. Published May 1982.

² Annual Book of ASTM Standards, Vol 04.01.

³ Annual Book of ASTM Standards, Vol 08.01.

⁴ Annual Book of ASTM Standards, Vols 08.01 and 08.04.

⁵ Annual Book of ASTM Standards, Vols 08.02 and 08.04.

⁶ Annual Book of ASTM Standards, Vol 08.02.

⁷ Annual Book of ASTM Standards, Vol 04.07.

using a standard set of exposure conditions at the start of the test. Smoke particulate generation properties are comparable only when burn times and sample size are similar.

5.2 The test is intended for research and development programs, and is not intended for regulatory purposes. It may be used for quality control purposes and is applicable to screening programs for a specific plastic where large numbers of trial formulations may be evaluated in a short period of time.

5.3 The test is not intended for comparisons between different plastic materials, since different chemical reactions or burning mechanisms, as well as varying tendency to drip or flow, are involved.

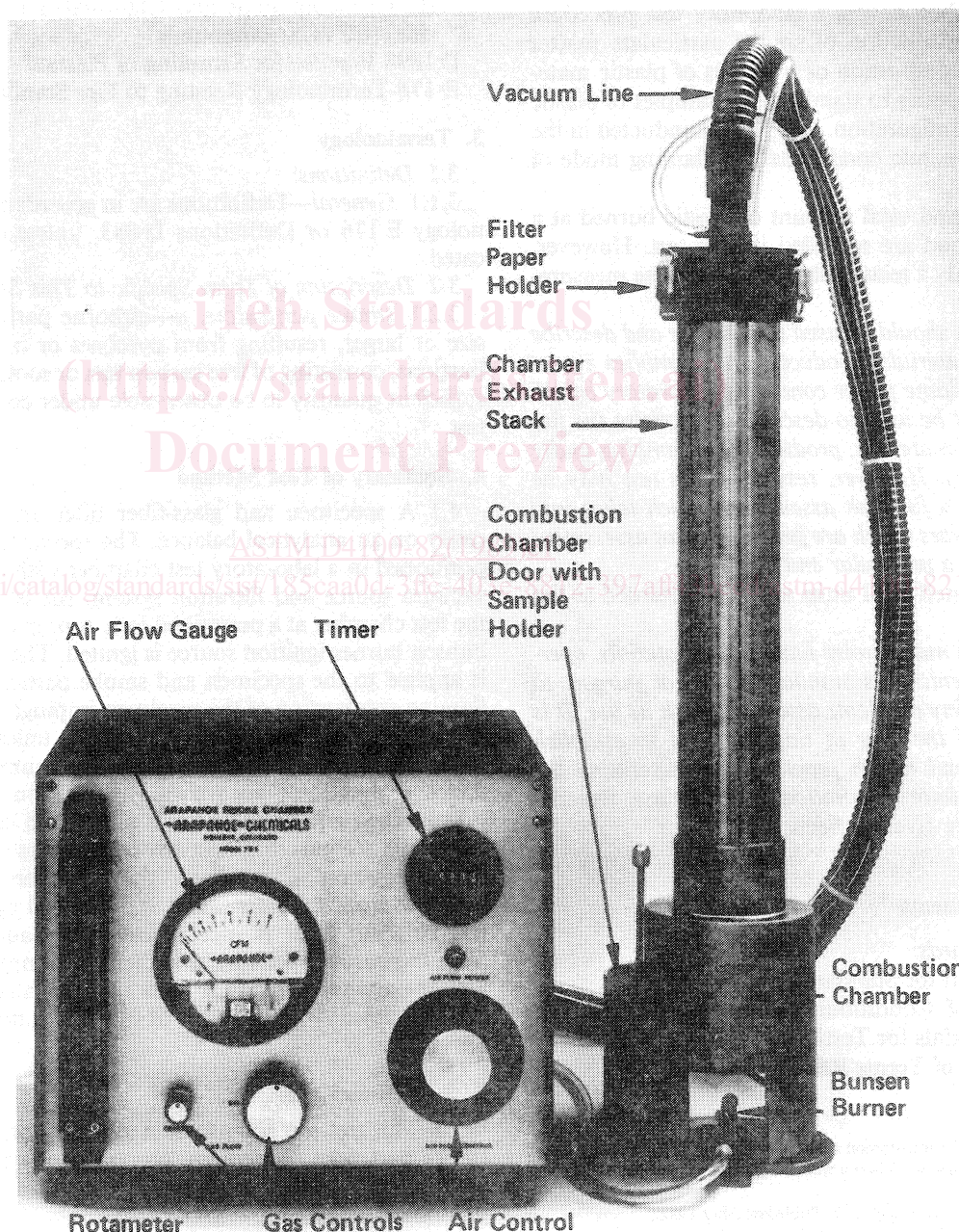
6. Apparatus

6.1 *Laboratory Analytical Balance*, with at least 10-g capacity and 0.2-mg accuracy.

6.2 Complete construction details of the smoke test apparatus are given in Annex A1, *Smoke Test Apparatus* but, in general, the equipment consists of a combustion chamber, ignition source, chimney, a particulate-filtration system, and a decharring roll mill (Figs. 1, 2, 3, and 4).

6.3 *Propane Source*, with adjustable regulator to deliver at least 150 cm³/min of 95 % pure propane gas at no more than 17.3 kPa (2.5 psi) or no less than 3.45 kPa (0.5 psi) outlet pressure.

6.4 *Nitrogen Gas Source* that can be directed at the sample to extinguish the flame or any smoldering that may



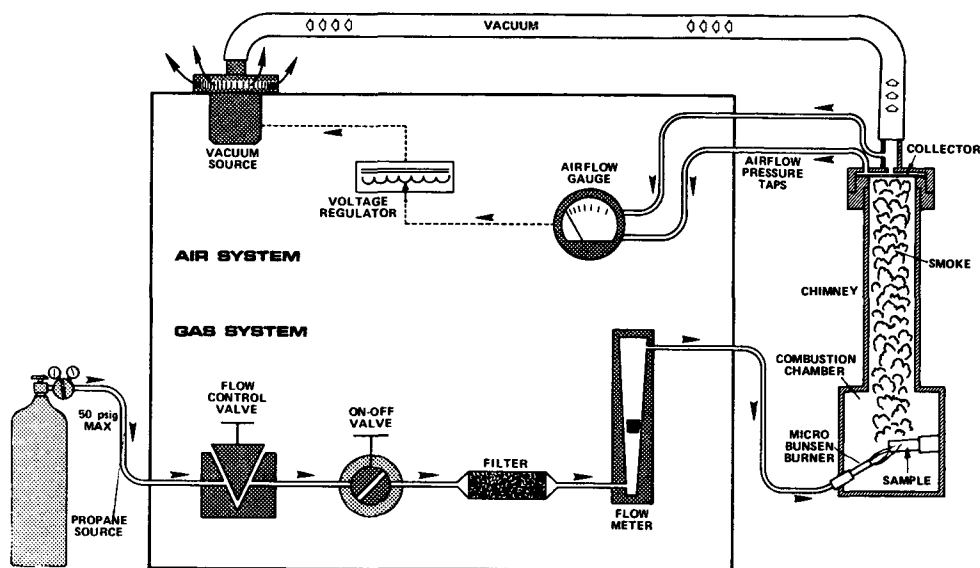


FIG. 2 Conceptual Schematic of Smoke Chamber

occur after the ignition flame is extinguished.

7. Safety Precautions

7.1 All connections in the ignition system shall be checked for leakage of propane gas.

7.2 The flow of propane gas to the micro bunsen burner in the combustion chamber shall not be started unless air is flowing through the filtration system.

7.3 It is recommended that the test be conducted in a laboratory fume hood meeting regulatory requirements, since it is not known whether the combustion and pyrolysis gases may be toxic.

8. Sampling

8.1 The test specimen shall be a slab of standard dimensions. The specimen shall be cut in a manner that produces a surface free of projecting fibers, chips, and ridges.

8.2 The test sample shall consist of a minimum of six specimens.

8.3 Unless specified by purchaser and seller, sampling shall be in accordance with Practice D 1898.

9. Test Specimen

9.1 The standard specimen shall be 38.1 ± 0.64 mm (1.5 ± 0.025 in.) by 12.7 ± 1.3 mm (0.5 ± 0.050 in.) by 3.18 ± 0.25 mm (0.125 ± 0.010 in.) thick. Specimen sizes other than those stated above, with the same tolerances, may be used if the size is reported and all other test specimens in the sample series of the same dimensions. All materials that tend to melt, warp, and distort should be evaluated at thickness equal to or greater than 3.18 mm (0.125 in.).

9.2 Rigid materials may be cut to the required dimensions on a band saw with metal cutting blade having between 14 and 24 teeth per 25.4 mm (1 in.) or equivalent.

9.3 Flexible materials shall be cut to the required dimensions with a sharp, single-edge razor blade or similar cutting device.

9.4 Each test specimen shall be numbered with indelible ink on one end for reference purposes.

10. Preparation of Apparatus

10.1 Clean the combustion chamber and stack with soap and water or suitable solvent and thoroughly dry on a daily basis, or after each series of 60 tests. More frequent cleaning may be desirable, depending upon the materials tested and their combustion products.

10.2 Position the micro bunsen burner so that the end of the burner is pointed up at a 10° angle above the chamber base in direct line with a standard-size sample mounted in the sample holder and 22.2 mm (0.875 in.) from the sample. This can be accurately achieved by mounting a special sample 60.5 mm (2.38 in.) long by 12.7 mm (0.5 in.) wide in the sample holder, closing the door, and then adjusting the burner so that it just touches the sample. The top edge of the burner should touch this special sample at the center of the sample (see Fig. 3). The air ports on the burner should be wide open to allow maximum air-to-gas ratio.

10.3 Replace the sand in the roll mill with clean standard sand after it has been used to dechar a maximum of 36 test specimens.

11. Conditioning

11.1 *Conditioning*—Follow Procedure A of Methods D 618.

11.2 *Test Conditions*—After removal of specimens from the conditioning chamber, test within 15 min. (Usually six to ten specimens can be tested during this time period.)

12. Procedure

12.1 Weigh a test sample and the glass-fiber filter media separately on the analytical balance. Record the data. Handle the specimen and filter with forceps.

12.2 Install the filter in the holder assembly at the top of the combustion chamber stack. The smooth side of the filter should be against the support screen.

12.3 Fasten retainer ring clamps and slide the filter paper holder into place at the top of chimney on the combustion chamber.

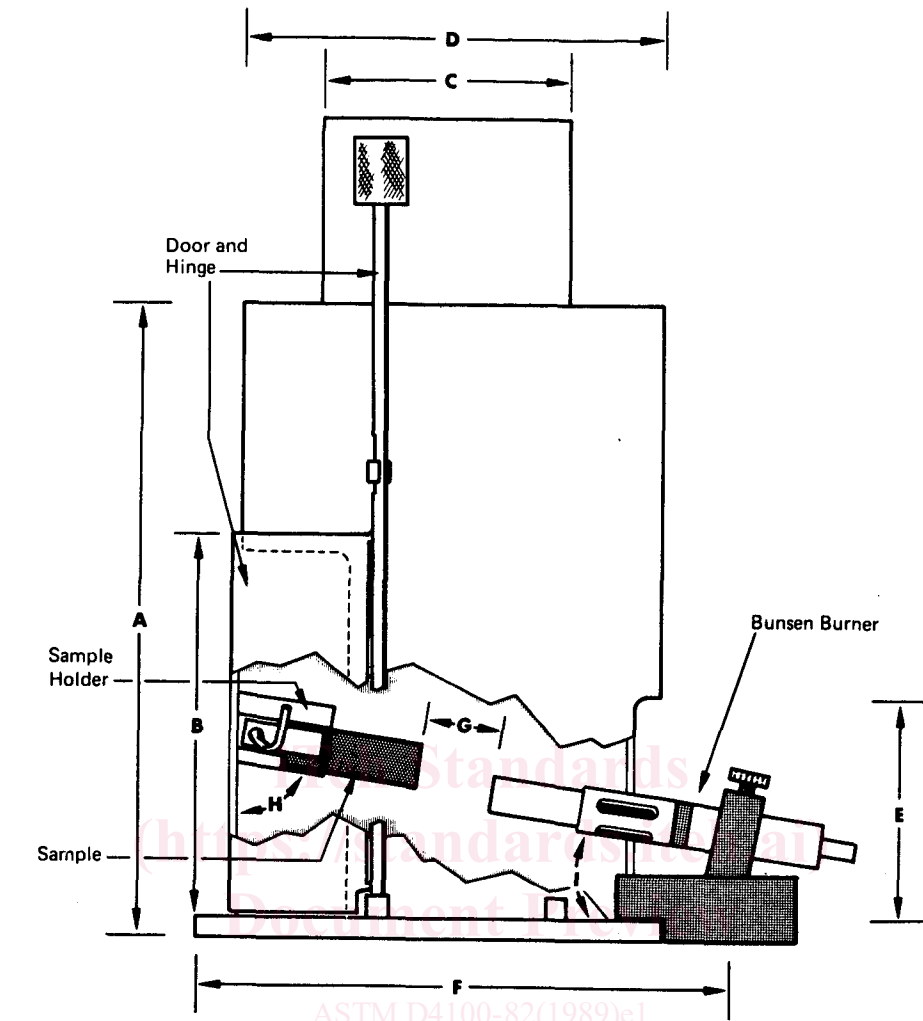


FIG. 3 Combustion Chamber, Sample Holder and Burner

Dimension Table					
	in.	mm		in.	mm
A	7	177.8	F	6	152.4
B	4.25	108.0	G	0.875	22.2
C	3	76.2	H	80°	—
D	5	127.0	I	10°	—
E	2.25	57.2			

12.4 Install the test specimen in the combustion chamber by removing the rear door and sliding the numbered end of the sample into the spring-loaded holder clip. Position the sample securely in the holder clip with the 39.1-mm (1.5-in.) length on the horizontal axis and the 12.7 mm (0.5-in.) height on the vertical axis. The rear and top edges of the specimen should be in contact with the sample holder to assure fixed and repeatable positioning of the specimen relative to the ignition source.

12.5 Replace the combustion chamber door at the rear of the instrument, leaving the door open.

12.6 Set the instrument timer to zero seconds.

12.7 Start air flow through the combustion chamber and filtration system and adjust to a 127.4 L (4.5 ft³)/min reading on the magnahelix gage using the air flow control knob.

12.8 Open the gas valve in the ignition system to allow

propane gas to flow. Adjust the flow with the micro metering valve to 90 ± 2 cm³/min (5.49 ± 0.12 in.³/min) as measured on the rotameter. The air ports on the micro burner should be wide open.

12.9 Ignite the micro bunsen burner through the front opening in the combustion chamber.

12.10 Close the combustion chamber door to ignite the specimen. This will start the timer and begin the test.

12.11 Allow the specimen to burn for 30 s in front of the micro bunsen burner before closing the gas valve and extinguishing the ignition flames, except as otherwise required. If the specimen continues to flame or smolder after ignition flame has been extinguished, a small jet or flow of nitrogen on the test specimen may be necessary to prevent further combustion. A minimum of 10, but no more than 40 mg, of smoke must be collected on the filter. It may be