



Designation: D2115 – 17

Standard Practice for Oven Heat Stability of Poly(Vinyl Chloride) Compositions¹

This standard is issued under the fixed designation D2115; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This practice lists procedures for determining the relative thermal stability of sheet or molded poly(vinyl chloride) compounds as indicated by discoloration due to exposure to an elevated temperature at controlled oven conditions.

1.2 A specimen preparation technique using a two-roll mill is provided for compositions that are not in molded or sheeted form.

1.3 This practice is not intended for use in purchasing specifications because the conditions of processing plastic compounds vary widely, and the degree of correlation of data obtained by this practice to process exposure has not been determined. However, despite this limitation, this practice does yield data of value in judging the comparative service quality of poly(vinyl chloride) compositions.

1.4 The values stated in SI units are to be regarded as the standard. The values in parentheses are given for information only.

1.5 *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, health and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This standard is similar in content, but not technically equivalent to ISO 305–1990.

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

D883 Terminology Relating to Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

2.2 *ISO Standard:*

ISO305–1990 Plastics—Determination of Thermal Stability of Poly(Vinyl Chloride), Related Chlorine-Containing Polymers and Copolymers and Their Compounds—Discoloration Method³

3. Terminology

3.1 *General*—Definitions are in accordance with Terminology **D883** and abbreviations with Terminology **D1600**, unless otherwise indicated.

4. Significance and Use

4.1 Poly(vinyl chloride) compositions degrade by discoloration on prolonged exposure to heat. The degree of discoloration is related to the condition of exposure, such as length of period and temperature. When the conditions of exposure are fixed and controlled, then the relative resistance to discoloration due to heat of two or more compositions is able to be determined. The precision of heat stability testing is also dependent on the thickness of the specimens and the history of heat exposure prior to testing. This practice allows for control or the reporting of these variables.

4.2 This practice is particularly applicable for determining gross differences in the heat stabilities of poly(vinyl chloride) compositions that are detectable as a color change. It is not intended to measure absolute thermal stability. Although the observed color changes may be evidence of degradation,

¹ This practice is under the jurisdiction of ASTM Committee **D20** on Plastics and is the direct responsibility of Subcommittee **D20.15** on Thermoplastic Materials.

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² 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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.

molecular degradation phenomena such as chain-scission or cross-linking may not be identifiable.

NOTE 2—While discoloration caused by exposure to elevated temperature is commonly regarded as evidence of degradation in poly (vinyl chloride) compositions, it must be borne in mind that some vinyl compositions may undergo substantial change in color without appreciable loss of mechanical strength, chemical resistance, etc., whereas others may resist change in color yet undergo substantial change in other properties. Therefore, resistance to discoloration should not be taken as sole evidence of thermal stability. It is recommended that this test be supplemented by others such as tensile strength and elongation, impact strength, and deflection temperature under load (for rigid compositions), durometer hardness (for nonrigid compositions), and dilute solution viscosity. The test results before and after oven exposure are compared to determine the degree of degradation that has been produced in each of the properties measured.

4.3 This practice is able to predict the relative discoloration in processing, provided that the compositions in question are tested at the relative maximum temperatures developed in processing.

4.4 This practice is not applicable to materials that will cross-contaminate during oven exposure.

5. Apparatus

5.1 *Mill*—A two-roll laboratory mill used for preparing plastic or rubber specimens from the basic ingredients or from molding or other compounds. Provision shall be made for heating the rolls to the desired temperature and for maintaining this temperature constant over the surfaces of both rolls within $\pm 3^{\circ}\text{C}$.

5.2 *Oven*—The oven shall be of the forced-air type and shall have the following additional requirements:

5.2.1 The oven temperature shall be controlled by an accurate, reliable thermoregulator maintaining the set point within $\pm 0.5^{\circ}\text{C}$ or better.

5.2.2 The oven shall be equipped with a calibrated ASTM thermometer, and the proper stem correction shall be applied to the temperature measurement.

5.2.3 The oven shall be maintained at the temperature of test for at least 1 h prior to insertion of the specimens.

5.2.4 The air distribution in the oven shall be adjusted to provide a temperature uniform throughout the test area of the oven to an extent sufficient to produce specimens of uniform color when checked in accordance with 5.2.5. This will usually require an air flow of not less than $0.283\text{ m}^3/\text{min}$ ($10\text{ ft}^3/\text{min}$).

5.2.5 Prior to test operation, verify the temperature uniformity within the oven. Lack of uniform temperature distribution shall be corrected before proceeding with the tests.

NOTE 3—One method to verify the oven temperature distribution is to insert 8 to 10 specimens of the same stock, distributed uniformly over the area used in the test, and exposed until an early stage of discoloration is reached. Use a formulation that causes a sharp change in color within 45 to 60 minutes under test conditions.

5.2.6 The inside of the oven shall be free of contamination or surface deposits. Use stainless steel oven liners to reduce corrosion due to continued exposure to decomposition gases.

5.3 *Specimen Supports*—The specimens shall be supported by new, clean aluminum foil placed on removable oven racks. If an oven equipped with a rotating specimen holding device is

employed, the specimen must be supported so that there is no appreciable elongating or necking down during the test period that alters specimen dimensions, especially the thickness. The uniformity of oven temperature shall be checked in a manner similar to 5.2.5 using the specimen mounting facility provided by the oven rotating device.

6. Test Specimens

6.1 Test specimens shall be prepared by compounding on a laboratory two-roll mill as follows:

6.1.1 If the sample has been precompounded, omit 6.1.3 and 6.1.4.

6.1.2 The batch size shall be such that a rolling bank 6.4 to 12.7 mm ($\frac{1}{4}$ to $\frac{1}{2}$ in.) in diameter is obtained across the face of the mill with the rolls set to give a sheet $1.02 \pm 0.10\text{ mm}$ ($0.040 \pm 0.004\text{ in.}$) thick. If other sample thicknesses are evaluated, all comparative tests shall be made on specimens of the same nominal thickness.

6.1.3 Weigh all components to an accuracy of $\pm 1\%$ of their nominal weight.

6.1.4 Premix the solid and liquid components until homogeneous in appearance. Use mixing techniques similar to those employed in compound production.

6.1.5 Charge the batch or composition to the mill rolls which have been preheated to a temperature suitable for complete fluxing of the compositions. A minimum temperature of $149 \pm 3^{\circ}\text{C}$ ($300 \pm 6^{\circ}\text{F}$) is suitable for most poly(vinyl chloride) compounds.

6.1.6 Adjust the rolls to give a $1.02 \pm 0.10\text{-mm}$ ($0.040 \pm 0.004\text{-in.}$) thick sheet after banding. Cut and mix the compound continuously for 5 min after banding; then cut from the rolls.

NOTE 4—When this practice is used to discern differences in stability effects of compounding ingredients, that is, resin, stabilizers, etc., it is important to maintain consistent conditions of temperature and time in the preparation of the specimens.

6.1.7 Cut the sheet into specimens not less than 25.4 by 25.4 mm (1 by 1 in.).

7. Procedure

7.1 Prepare a specimen support of sufficient size to hold one specimen of each of the different compositions under test, for each time interval of test.

NOTE 5—As an example, suitable exposure times at $177.5 \pm 0.5^{\circ}\text{C}$ ($350 \pm 1^{\circ}\text{F}$) for the test formulation that causes a sharp change in color, (see **Note 3**) might be 30, 45, 60, 90, 120 min, in which case five pieces of aluminum foil would be cut such that each is large enough to hold one specimen of this and each other composition to be tested but not too large to prevent placing all the foils on the oven rack at one time.

7.2 Place one specimen of each composition on each of the foil supports.

7.3 Place all of the foils on a removable oven rack.

7.4 Place the rack in the oven at the test temperature, keeping the oven door open for the minimum time and extent necessary. The oven air-circulating fan shall be off while the door is open. Use an oven temperature of $177.5 \pm 1.0^{\circ}\text{C}$ ($350 \pm 2^{\circ}\text{F}$) if the temperature of test is not specified.

NOTE 6—The temperature of the oven should be carefully monitored.