Designation: D7969 – 16

# Standard Specification for Gravity Convection and Forced Ventilation Ovens[1]

This standard is issued under the fixed designation D7969; 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.

## 1. Scope

1.1 This specification covers the performance requirements for general purpose air ovens ordinarily used in testing operations, which have a testing chamber up to 0.6 $m^3$ (25 $ft^3$) in volume.

1.2 It is applicable to gravity convection ovens designed to operate over all or part of the temperature range from 20°C above ambient room temperature to 200°C.

1.3 It is applicable to forced ventilation ovens designed to operate over all or part of the temperature range from 20°C above ambient room temperature to 500°C.

1.4 This specification does not include safety requirements that are essential for ovens used in the presence of combustible materials.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for reference only and may be approximate.

1.5.1 The SI base unit of the expression of temperature is Kelvin (K), the unit of measure used in this specification is Celsius (°C) and has been derived mathematically.

1.6 Calibration ovens to this standard are necessary to assure their operative performance under typical conditions of use and shall be performed periodically, either according to the manufacturer's recommendations, the quality requirements of the end user, their customers, or suppliers.

1.7 *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.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

## 3. Terminology

3.1 *Definitions:*

3.1.1 *ambient room temperature*—a temperature as recorded, typically but not necessarily, close to room temperature.

3.1.2 *room temperature*—a temperature in the range from 20 to 30°C (68 to 86°F).

3.1.3 *standard laboratory atmosphere*—an atmosphere having a temperature of 23 ± 2°C (73.4 ± 3.6°F) and a relative humidity of 50 ± 10 % RH (40 to 60 % RH) shall be the standard laboratory atmosphere.

3.1.4 *standard laboratory temperature*—a temperature of 23 ± 2°C (73.4 ± 3.6°F) shall be the standard laboratory temperature.

## 4. Oven Types

4.1 This specification covers the following four types of air ovens:

4.1.1 *Type IAGC*—An oven ventilated by gravity convection having a uniformity of temperature within ±2 % of the differential between oven and ambient temperatures.

4.1.2 *Type IBGC*—An oven ventilated by gravity convection having a uniformity of temperature within ±5 % of the differential between oven and ambient temperatures.

4.1.3 *Type IIAFV*—An oven having forced ventilation and a uniformity of temperature within ±1 % of the differential between oven and ambient temperatures.

4.1.4 *Type IIBFV*—An oven having forced ventilation and a uniformity of temperature within ±2.5 % of the differential between oven and ambient temperatures.

## 5. Performance Requirements

5.1 The temperature within the testing chamber shall be controllable by an automatic device, and shall be uniform within the tolerances given in Table 1 for the particular type of oven when tested in accordance with Section 6.

5.1.1 Conformance to temperature uniformity (Section 6) is a requirement.

5.2 The time constant measurement is nonmandatory and is found in Appendix X1 of this specification.

[1] This specification is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.15 on Degradation Tests.

Current edition approved Jan. 1, 2016. Published January 2016. Originally approved in 2015. Last previous edition approved in 2015 as D7969 – 15. DOI: 10.1520/D7969-16.

[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.

**TABLE 1 Performance Requirements for Ovens**

| Characteristic | Type IAGC | Type IBGC | Type IIAFV | Type IIBFV |
|---|---|---|---|---|
| Deviation from specified temperature of test throughout testing chamber during 3 h period for the following differentials between ambient and test temperatures: | | | | |
| ≤50°C ǀ maximum percent of differential | 1.0 | 2.5 | 0.5 | 1.25 |
| >50°C ǀ maximum percent of differential | 2.0 | 5.0 | 1.0 | 2.5 |
| Rate of ventilation testing chamber, air changes per hour: | | | | |
| Minimum | 10 | 10 | 50 | 50 |
| Maximum | — | — | 200 | 200 |

5.3 The rate of ventilation of the testing chamber shall conform to the requirements specified in Table 1 for the particular type of oven when measured in accordance with the procedure given in Section 7.

5.3.1 Conformance to the rate of ventilation (Section 7) is a requirement.

## TEST PROCEDURES

### 6. Temperature Uniformity

6.1 Place nine calibrated thermocouples approximately 0.5 mm in diameter (No. 24 gauge) and having a junction size of not more than 2 mm (0.08 in.), in a clean, properly maintained, empty testing chamber with any shelves or commonly used appurtenances in place and all vents fully open.

6.1.1 Locate one thermocouple in each of the eight corners of the oven approximately 50 mm (2 in.) from each wall.

6.1.2 Place the ninth thermocouple within 25 mm (1 in.) of the geometric center of the chamber.

6.1.3 A minimum length of 300 mm (12 in.) of lead wire for each thermocouple shall be inside the oven to minimize the conduction of heat from the thermocouple.

6.2 The ambient room temperature shall not vary during the duration of the test by more than a total of 10°C as measured by a tenth thermocouple placed externally no less than 2 m (78 in.) from the oven and not in contact with materials known to radiate heat or be thermally conductive, preferably suspended at the approximate midpoint height of the oven.

6.3 Bring the oven to the specified temperature and allow it to reach a steady state.

6.3.1 It may require as much as 24 hours to reach a steady state, that is no more than the deviation from the specified temperature differential as indicated in Table 1 for a period of no less than three hours prior to assessment.

6.3.2 If a steady state is not achieved, a drift in the temperature toward the steady-state condition should exist and be within 3°C of the desired testing temperature (set point) at the time of assessment.

6.4 Record the temperatures of the ten thermocouples for a period of no less than three hours at intervals of no greater than 15 minutes, and determine, from the record, the maximum deviation of each point from the desired temperatures.

6.5 Report the results of the recorded observations from each of the ten thermocouples including the time period for which they were obtained.

### 7. Rate of Ventilation

7.1 Position a calibrated, digital, vane anemometer, capable of accounting for the diameter of the vane opening diameter and calculating the volume of air flow, securely to the oven's air exhaust port so that all air exhausted from the oven passes through the vane area and does not circumvent it.

7.1.1 In instances where positioning the anemometer is not possible due to encumbrances of exhaust hoods, permanently mounted vents, etc., the procedure in E145, Part 5, should be followed and reported accordingly.

7.2 Heat the oven to a temperature of 20 ± 2°C above the ambient room temperature and, while at this temperature, record the airflow through the vane anemometer for a period of at least 30 min.

7.2.1 Calculate the number of changes per hour considering the volume of the chamber, the air flow recorded by the vane anemometer, and the time during which the air flow was recorded and report the result as demonstrated in Eq 1.

7.2.2 It may be desirable to determine the rate of ventilation at temperatures above the range of a vane anemometer, in which case a high temperature (also known as a hot-wire or thermal anemometer) may be used following the procedure for a vane anemometer.

7.3 The ambient room temperature shall be measured as described in 6.2 for the duration of the test.

7.4 Calculate the number of changes per hour of the air in the test chamber from the following equation:

$$N = \left(\frac{e}{v}\right) \times 60 \quad (1)$$

*where:*

$N$ = number of air changes per hours,
$v$ = volume of the testing chamber ($ft^3$ or $m^3$), and
$e$ = exhaust air flow measured by a vane anemometer per minute (cfm or cmm).

NOTE 1—It is important, when performing the above calculation, that the units of measure are in agreement, for example, $ft^3$ and cubic foot per minute (cfm); $m^3$ and cubic metres per minute (cmm).

### 8. Keywords

8.1 forced-ventilation; gravity-convection; ovens

# APPENDIXES

**(Nonmandatory Information)**

## X1. TIME CONSTANT

X1.1 The "time constant" is an arbitrary measure of the rate at which a standard specimen is heated following the procedure prescribed below. The value of the time constant should not exceed the maximum value given in Table X1.1 for the particular type of oven.

X1.1.1 Conformance to the time constant is not a requirement, but may be valuable in assessing the oven's performance in routine service. It should be studied when other parameters are questioned.

**TABLE X1.1 Time Constant Performance Requirements for Ovens**

NOTE 1—Time constant only, other values for reference only, refer to Table 1 in this specification.

| Characteristic | Type IAGC | Type IBGC | Type IIAFV | Type IIBFV |
|---|---|---|---|---|
| Deviation from specified temperature of test throughout testing chamber during 3 h period for the following differentials between ambient and test temperatures: | | | | |
| ≤50°C ǀ maximum percent of differential | 1.0 | 2.5 | 0.5 | 1.25 |
| >50°C ǀ maximum percent of differential | 2.0 | 5.0 | 1.0 | 2.5 |
| **Time constant, maximum seconds** | 600 | 720 | 480 | 660 |
| Rate of ventilation of testing chamber, air changes per hour: | | | | |
| Minimum | 10 | 10 | 50 | 50 |
| Maximum | — | — | 200 | 200 |

## X2. PROCEDURE

X2.1 Heat the oven to within 10°C of the maximum operating temperature for which it is designed and allow it to stabilize for at least 1 h.

X2.2 Alternatively, heat the oven to within 10°C of the operating temperature for which it is typically used and allow it to stabilize for at least 1 h.

X2.3 Prepare a standard specimen consisting of a smooth brass cylinder 9.5 ± 0.1 mm (0.375 ± 0.005 in.) in diameter and 57 ± 1 mm (2.25 ± 0.05 in.) in length, and solder one junction of a differential thermocouple to it.

X2.4 Open the door of the oven for 1 min while the standard specimen and differential thermocouple are being suspended in the testing chamber. Suspend the specimen vertically within 25 mm (1 in.) of the geometric center of the chamber by means of a cord of fine wire (0.3 mm maximum diameter, No. 30 gauge).

X2.5 Place the free junction of the differential thermocouple in the air space of the chamber at least 75 mm (3 in.) removed from the specimen.

X2.6 Close the door and either record or measure the temperature differential every 10 s.

X2.7 Determine the time in seconds required for the temeprature difference to decrease to one tenth of the original or maximum value (for example, from 120 to 12°C) and consider this to be the time constant of the oven and report accordingly.