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Document Name: ASTM E145: Standard Specification for Gravity-Convection and Forced- Ventilation Ovens

CFR Section(s): 40 CFR 63.14

Standards Body: American Society for Testing and Materials

APPROVED

Official Incorporator:
THE EXECUTIVE DIRECTOR
OFFICE OF THE FEDERAL REGISTER
WASHINGTON, D.C.

Designation: E 145 – 94ε1

Standard Specification for Gravity-Convection And Forced-Ventilation Ovens[1]

This standard is issued under the fixed designation E 145; 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—Section 7 on Keywords was added editorially March 1995.

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. It is applicable to gravity-convection ovens designed to operate over all or part of the temperature range from 20°C above ambient temperature to 200°C and to forced-ventilation ovens designed to operate over all or part of the temperature range from 20°C above ambient temperature to 500°C.

NOTE 1—Ovens are designed for maximum operating temperatures of about 200°C, 300°C, and 500°C, the thermal insulation and cost of the oven being dependent on the maximum temperature required.

1.2 This specification does not include safety requirements that are essential for ovens used in the presence of combustible vapors or gases.

1.3 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

2. Types

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

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

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

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

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

3. Performance Requirements

3.1 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 4.

3.2 The "time constant" is an arbitrary measure of the rate at which a standard specimen is heated following the procedure prescribed in Section 5. The value of the time constant shall not exceed the maximum value given in Table 1 for the particular type of oven.

3.3 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 6.

TEST METHODS

4. Temperature Uniformity

4.1 Place nine calibrated thermocouples (Note 2) made from iron or copper-constantan wire, approximately 0.5 mm in diameter (No. 24 gage) and having a junction size of not more than 2 mm (0.08 in.), in the empty testing chamber with shelves in place and vents open. Locate one thermocouple in each of the eight corners of the oven approximately 5 cm (2 in.) from each wall and place the ninth thermocouple within 2.5 cm (1 in.) of the geometric center of the chamber. A minimum length of 30 cm (12 in.) of lead wire for each thermocouple shall be inside the oven to minimize the conduction of heat from the thermocouple.

NOTE 2—If calibrated thermocouples are not available, nine thermocouples made from the same spool of wire may be used provided they give the same value for temperature when placed adjacent to one another in the testing chamber at the temperature of test.

4.2 Bring the oven to the specified temperature and allow it to reach a steady state (Note 3). Record the temperatures of the nine thermocouples for a period of at least 24 h, and determine from the record the maximum deviation of each point from the desired temperatures. The ambient room temperature shall vary by not more than a total of 10°C, and the line voltage for electrically heated ovens shall vary by not more than a total of 5 % during the test.

NOTE 3—Some ovens may require as much as 24 h to reach a steady state. If a steady state does not exist, there is a drift in the temperature toward the steady-state condition.

5. Time Constant

5.1 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. 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.

5.2 Open the door of the oven for 1 min while the standard specimen and differential thermocouple are being

[1] This specification is under the jurisdiction of ASTM Committee E-41 on Laboratory Apparatus and is the direct responsibility of Subcommittee E 41.02 on Metalware.

Current edition approved Aug. 15, 1994. Published October 1994. Originally published as E 145 – 59 T. Last previous edition E 145 – 68 (1992).

TABLE 1 Performance Requirements for Ovens

Characteristic	Type IA	Type IB	Type IIA	Type IIB
Deviation from specified temperature of test throughout testing chamber during 24-h period for the following differentials between ambient and test temperatures:				
50°C or less, max, °C	1	2.5	0.5	1.25
More than 50°C, max, percent of differential	2	5	1	2.5
Time constant, max, s	600	720	480	660
Rate of ventilation of testing chamber, air changes per hour:				
min	10	10	50	50
max	...	...	200	200

suspended in the testing chamber. Suspend the specimen vertically within 25 mm (1 in.) of the geometric center of the chamber by means of an asbestos cord of fine wire (0.3 mm maximum diameter, No. 30 gage). 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. Then close the door and either record or measure the temperature differential every 10 s. Determine the time in seconds required for the temperature difference to decrease to one tenth of the original or maximum value (for example, from 120°C to 12°C) and consider this to be the time constant of the oven.

6. Rate of Ventilation (Note 4)

6.1 Seal the ventilation ports, door, and all apertures of electrically heated ovens with adhesive tape or by other means to prevent any air from passing through the oven (Note 5). Connect a watt-hour meter, with the smallest division reading in 0.01 Wh in the electrical supply line to the oven.

NOTE 4—This method is only applicable to electrically heated ovens. Methods are being developed by the committee for determining the rate of ventilation of ovens that are not electrically heated and for determining the uniformity of air-flow within the testing chamber.

NOTE 5—In forced-ventilation ovens, the space around the motor shaft where it enters the oven must be closed, but the fan speed must not be affected by the closure.

6.2 Heat the oven to a temperature of 80 ± 2°C above the ambient room temperature, and while at this temperature measure the consumption of electrical energy for a period of at least ½ h. Start and stop the test at corresponding points of the "on-off" heating cycle, that is, at the moment when the heaters are switched on by the thermostat.

6.3 Then remove the seals, open the ventilation ports, and measure the consumption of electrical energy in the same manner. The ambient room temperature measured at a point approximately 2 m (6 ft) from the oven, approximately level with its base and at least 0.6 m (2 ft) from any solid object, shall be the same within 0.2°C during the two tests.

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

$$N = 3590\,(X - Y)/VD\Delta T$$

where:

N = number of air changes per hour,
X = average power consumption during ventilation, W, obtained by dividing the energy consumption determined from the watt-hour meter readings by the duration of the test in hours,
Y = average power consumption with no ventilation, computed in the same manner, W,
V = volume of the testing chamber, cm^3,
D = density of the ambient room air during the test, g/cm^3, and
ΔT = difference in temperature between the testing chamber and the ambient room air, °C.

7. Keywords

7.1 forced-ventilation; gravity-convection; ovens