Designation: D5423 – 14

Standard Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation[1]

This standard is issued under the fixed designation D5423; 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 forced-convection ventilated electrically-heated ovens, operating over all or part of the temperature range from 20°C above the ambient temperature to 500°C, and used for thermal endurance evaluation of electrical insulating materials.

1.2 The specification requirements for Type I ovens are based on IEC Publication 216-4-1, and are technically identical to it. The requirements for Type II ovens are essentially identical to the requirements of Specification D2436. This specification and an associated test method, D5374, have replaced Specification D2436.

1.3 While the ovens covered by this specification are intended primarily for thermal endurance evaluation, they can also be used wherever their characteristics make them suitable for other applications.

1.4 *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]

D2436 Specification for Forced-Convection Laboratory Ovens for Electrical Insulation (Withdrawn 1994)[3]

D5374 Test Methods for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation

2.2 *Other Document:*

IEC Publication 216-4-1 Guide for the Determination of Thermal Endurance Properties of Electrical Insulating Materials, Part 4—Aging Ovens, Section 1—Single-Chamber Ovens[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *rate of ventilation, n*—the number of air changes per hour in the oven chamber.

3.1.2 *set temperature, n*—the average of all of the measured temperatures within the oven, averaged over the period of any cyclic temperature variation that may occur.

3.1.2.1 *Discussion*—This is the actual operating temperature of the oven.

3.1.3 *temperature fluctuation, n*—temperature differences at one point in the oven over a period of time.

3.1.3.1 *Discussion*—This property depends upon the sensitivity and type (on/off or proportional) of control used and the heater mass in relation to surface area.

3.1.4 *temperature gradient, n*—the maximum temperature difference at one time between different points in the oven chamber.

3.1.4.1 *Discussion*—This property depends on such factors as uniformity of heater temperature, heater distribution about the oven, and air flow patterns within the oven.

3.1.5 *temperature variation, n*—temperature differences with time and location due to the combination of temperature gradient and temperature fluctuation.

3.1.6 *thermal lag time, n*—the time required for a defined specimen to reach a specified temperature (or range of temperature).

3.1.6.1 *Discussion*—This property is largely dependent upon the rate of air circulation within the oven. In IEC 216-4-1, this term is called" time constant."

3.1.7 *time constant, n*—See thermal lag time.

[1] This specification is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.17 on Thermal Characteristics.

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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] The last approved version of this historical standard is referenced on www.astm.org.

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

4. Classification

4.1 *Type I*—Ovens with rate of ventilation of 5 to 20 air changes per hour.

4.2 *Type II*—Ovens with rate of ventilation of 100 to 200 air changes per hour.

5. Test Methods

5.1 Determine the properties specified in Section 6 using Test Methods D5374.

6. Performance Requirements

6.1 *Rate of Ventilation*—The rate of ventilation at 100°C and at the maximum temperature at which the oven is used shall be:

6.1.1 For Type I ovens, 5 to 20 air changes per hour,

6.1.2 For Type II ovens, 100 to 200 air changes per hour.

NOTE 1—Past experience in the United States has been to specify 100 to 200 air changes per hour, as required for Type II ovens. However, international practice, as defined in IEC Publication 216-4-1, has been to use the lower rate of ventilation, which is specified for Type I ovens.

6.2 *Set Temperature*—The set temperature, measured over a five-day test period, shall not vary by more than the values given in Table 1.

6.3 *Temperature Variation*—The temperature shall not exceed that given in Table 1 for any test temperature.

NOTE 2—Some test standards may require closer control of temperature variation or of set temperature. In such cases, reduction of the variations specified in Table 1 is subject to agreement between purchaser and manufacturer.

6.4 *Thermal Lag Time*—The thermal lag time, measured with the oven operating at a temperature of 200 ± 5°C, shall not exceed 660 s.

7. Construction Requirements

7.1 The oven shall be soundly constructed of suitable materials and all electrical and mechanical fittings shall be readily accessible for inspection, maintenance, and replacement purposes.

TABLE 1 Temperature Requirements

Set Temperature Range °C	Temperature Variation °C, max	Variation in Set Temperature, ±°C, max
≤80	4	2
>80 to ≤180	5	2.5
>180 to ≤ 300	6	3
>300 to ≤ 400	8	4
>400 to ≤ 500	10	5

7.2 The interior of the oven shall be constructed of suitable corrosion-resistant, non-absorbent material, and fabricated so any joints are leak-proof and not subject to corrosion, and having interior surfaces that are easy to clean.

7.3 The door(s) shall be fitted with hinges and latches to provide sufficient pressure for an effective seal between the interior of the oven and the external atmosphere.

7.4 The oven shall have provisions for automatically switching off the heaters when the actual oven temperature substantially exceeds the set temperature.

7.5 Ports for admitting and exhausting air shall be provided, with fittings for attaching conduits for exhaust air. When specified, provisions shall be made for supplying inlet air or other gases from a controlled source.

7.6 Dampers for adjusting the rate of ventilation and the air circulation shall be provided to enable compliance with other requirements of this specification.

8. Certification

8.1 For each oven furnished under this specification, the purchaser shall be furnished certification that ovens of exactly the same design have been tested in accordance with this specification and Test Methods D5374, and that the requirements have been met.

8.2 Where specified, the purchaser shall be furnished with results of tests on the ovens furnished. In such cases, the positions of the dampers during the tests shall be clearly marked.

9. Product Marking

9.1 The following information shall be attached to each oven furnished under this specification:

9.1.1 Name of manufacturer and model number of the oven,

9.1.2 Purchase order or contract number,

9.1.3 Supply voltage, current, and power consumption,

9.1.4 Maximum continuous operating temperature,

9.1.5 Internal dimensions,

9.1.6 External dimensions, and

9.1.7 Weight.

10. Keywords

10.1 forced-convection; ovens; set temperature; temperature fluctuation; temperature gradient; thermal endurance evaluation; thermal lag time; ventilated; ventilation rate

APPENDIXES

(Nonmandatory Information)

X1. IN-SERVICE MONITORING BY THE USER

X1.1 Regular periodic tests of the oven are necessary in order to ensure that the oven retains its original characteristics in service. For ovens in continuous use, these tests should be conducted twice a year. It is good practice to make these tests before beginning aging tests at a different temperature.

X1.2 These tests are aimed at measuring the set temperature and temperature variations at the planned aging temperature. If possible, tests should be repeated with the oven loaded with specimens.

X1.3 The values to be determined according to Test Methods D5374 should include at least the following:

X1.3.1 The set temperature,

X1.3.2 The temperature variation at the set temperature, and

X1.3.3 The temperature fluctuation at the center of the oven chamber over a 24 h period.

X1.4 The set temperature measured and reported in X1.3 should be recorded as the aging temperature. The temperature variation should be within the limits given in Table 1.

X2. OVEN LOADING

X2.1 The air circulation within a forced-convection oven should be considered when loading specimens into the oven chamber. Forced-convection ovens are designed to provide uniform air temperature throughout the test chamber. This uniformity of air temperature is achieved by using baffles, or different sizes of holes, or both at the air inlet and outlet to and from the chamber.

X2.2 The air flow within an oven is almost laminar at the air inlet and outlet and near the walls of the test chamber. The air is turbulent within the center of the chamber.

X2.3 It has been noted that specimens positioned in the laminar air flow regions age faster than those in the turbulent region. The reason for this phenomenon is not understood, but it has been observed that the leading edges of flat specimens are a degree or two hotter than the trailing edge. There also may be a tendency for plasticizers to be stripped more rapidly from specimens in the laminar flow regions because of higher air velocity across the surface of the specimens.

X2.4 For maximum reproducibility of test results, specimens should be placed in the turbulent air flow region. In an empty oven chamber, the turbulent flow region occupies the inner half of the chamber volume. This region decreases with loading, depending on specimen geometry and positioning. Placement of specimens near the inlet or outlet ports should be avoided, because of the laminar air flow.