Designation: ~~D5374 – 93 (Reapproved 2005)~~ D5374 – 13

An American National Standard

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

This standard is issued under the fixed designation D5374; 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 These test methods cover procedures for evaluating the characteristics of 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 These test methods are based on IEC Publication 216-4-1, and are technically identical to it. This compilation of test methods and an associated specification, D5423, have replaced Specification D2436.

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D2436 Specification for Forced-Convection Laboratory Ovens for Electrical Insulation (Withdrawn 1994)[3]

D5423 Specification 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 Refer to the terminology section of Specification D5423.

4. Significance and Use

4.1 ~~It is essential that ovens~~ Ovens used for thermal evaluation of insulating materials are to be capable of maintaining uniform conditions of temperature and air circulation over the extended periods of time that are required for conducting these tests. Specification D5423 specifies the permissible deviations from absolute uniformity that have been generally accepted internationally for these ovens. These test methods include procedures for measuring these deviations and other specified characteristics of the ovens.

5. Apparatus

5.1 *Multi-Point Recording Potentiometer,* having provisions for at least nine iron-constantan or chromel-alumel thermocouples, with scale readings to 0.1°C or less. Use of a data processor or a data logger ~~may be~~ is helpful in reducing the number of calculations required.

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[1] These test methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D09.17 on Thermal Characteristics.

Current edition approved ~~Sept. 1, 2005~~Sept. 1, 2013. Published ~~October 2005~~September 2013. Originally approved in 1993. Last previous edition approved in ~~1999~~2005 as D5374 – 93 (2005). ~~(1999).~~ DOI: ~~10.1520/D5374-93R05.~~10.1520/D5374-13.

[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.

5.2 *Calibrated Iron-Constantan or Chromel-Alumel Thermocouples,* using 0.5-mm diameter or smaller wire and having a junction size not over 2.5 mm long. ~~If calibrated thermocouples are not available, thermocouples made from a single spool of thermocouple wire may be used provided that, when placed within 10 mm of each other without touching in an oven chamber at 200°C, they give values for temperature that do not differ from each other by more than 0.2°C.~~

5.2.1 If calibrated thermocouples are not available, use thermocouples made from a single spool of thermocouple wire that gives values for temperature that do not differ from each other by more than 0.2°C when placed within 10 mm of each other without touching inside an oven chamber at 200°C.

5.3 ~~A~~ It is acceptable to use a temperature measuring system other than thermocouples and a ~~potentiometer may be used,~~ potentiometer, provided that the sensitivity, accuracy, and response time are ~~at least~~ equivalent to that of the equipment described above, and that the objectives of 6.2.3 relative to minimization of heat conduction effects ~~can be~~ are met.

5.4 *Thermal Lag Time Specimen,* consisting of a solid brass cylinder, 10 mm in diameter and 55 mm long, with one junction of a differential thermocouple soldered to the surface midway between the ends. The other junction of the thermocouple must be capable of being moved at least 80 mm away from the brass cylinder. An appropriate temperature indicator (as in 5.1, or other) must be provided for indication of temperature differences to the nearest 0.1°C as measured by the differential thermocouple.

5.5 *Watt-Hour Meter,* of the appropriate voltage and phase, capable of reading to the nearest 1.0 Wh or less.

6. Procedures

6.1 *Rate of Ventilation:*

6.1.1 *Summary of Test Method*—The rate of ventilation is calculated using determinations of (*1*) the average power required to maintain the oven at a given temperature with its ports open and (*2*) the average power required to maintain the oven at the same temperature with its ports closed. The test is conducted at 100°C and at the maximum temperature at which the oven ~~may be~~ is used.

6.1.2 Seal all openings into the oven, including, but not necessarily limited to, the vent ports, door, thermometer ports, and the space around the blower shaft (if the blower motor is mounted externally).

6.1.3 Install a watt-hour meter, as described in 5.5, in the oven electrical supply line.

6.1.4 Install a temperature sensor, such as a thermometer, 2 m to 3 m away from the oven, at least 1 m away from any solid object, and approximately level with the oven air intake. Use the oven temperature indicator to measure the internal temperature of the oven.

6.1.5 Raise the oven temperature to 100 ± 2°C. When the temperature of the oven has stabilized, measure the consumption of power over a measured period of 30 to 40 min. Begin and end the measuring period at corresponding points of the cyclic temperature fluctuation; for example, the moment when the heaters are switched on by the thermostat in the case of an "on/off" control. Measure and record the room temperature, which must not vary by more than 2°C during the test.

6.1.6 Remove the seals to restore the oven to its normal operating condition. If necessary, adjust the vents and dampers to positions estimated to provide the specified rate of ventilation.

6.1.7 Repeat 6.1.5. The average ambient air temperature must be within 2°C of the average ambient temperature measured in 6.1.5.

6.1.8 Calculate the rate of ventilation in the oven using the following equation:

$$N = 3.59\,(P_2 - P_1)/(V \cdot \rho \cdot \Delta T) \quad (1)$$

where:

N = number of air changes per hour,
P_1 = average power consumption, with no ventilation, obtained by dividing the energy consumption determined from the watt-hour meter readings by the duration of the test in hours, W,
P_2 = average power consumption during ventilation, calculated in the same manner, W,
V = total volume of air circulated within the oven, m^3 (see Note 1),
ρ = density of the ambient room air during the test, kg/m^3 (see Note 2), and
ΔT = difference in temperature between the oven and the ambient room temperature, °C.

NOTE 1—This volume includes space outside the testing chamber. The amount of this additional space depends on the physical design of the oven.
NOTE 2—The density of air is dependent on ambient temperature and pressure; at one atmosphere and 20°C it is 1.205 kg/m^3.

6.1.9 If the rate of ventilation is not within the specified limits for the oven, adjust the vents and dampers and repeat 6.1.7 through 6.1.8.

6.1.10 Repeat 6.1.2 through 6.1.9, except heat the oven to the maximum temperature at which the oven ~~may be~~ is used.

6.1.11 Report the following information:

6.1.11.1 Identification of the oven,

6.1.11.2 Date and location of test,

6.1.11.3 Test temperatures, and

6.1.11.4 Rate of ventilation at each temperature.