Designation: D 5642 – 99

An American National Standard

Standard Test Method for Sealed Tube Chemical Compatibility Test[1]

This standard is issued under the fixed designation D 5642; 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 test method covers procedures for evaluating the interaction of electrical insulation components used, or intended to be used, in electrical insulation systems.

1.2 This test method is useful for determining compatibility but additional testing may be required depending upon application.

1.3 This test method may also provide useful information about the behavior of selected insulating materials when compared to a reference value as opposed to a reference system.

1.4 This test method does not cover systems which operate in liquids or gases other than air.

1.5 The values stated in SI units are the standard in this test method.

1.6 *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.* See also Note 3, Note 4 and 8.3.2.1

2. Referenced Documents

2.1 *ASTM Standards:*

D 149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Frequencies[2]

D 1676 Test Methods for Film-Insulated Magnet Wire[2]

D 1711 Terminology Relating to Electrical Insulation[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *magnet wire*—See Terminology D 1711 for the definition of this term.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aging test, n*—a process of exposure, to a specified set of conditions for a defined period of time, which results in an irreversible change in one or more physical, chemical, electrical, or thermal characteristics of a material.

3.2.2 *candidate system, n*—the proposed electrical insulation system to be evaluated.

3.2.3 *electrical insulation system, n*—an intimate combination of insulating materials with conductors, as used in electrical equipment.

3.2.4 *insulation system class, n*—a standardized designation of the temperature capability of the electrical insulation system. It is expressed by both numbers and letters as follows:

System	Class
105	(A)
120	(E)
130	(B)
155	(F)
180	(H)
200	(N)
220	(R)
240	(S)

3.2.5 *reference system, n*—an electrical insulation system which has been previously evaluated and found acceptable.

3.2.6 *twisted pair, n*—film-insulated round magnet wire that has been prepared in accordance with Test Methods D 1676.

4. Summary of Test Method

4.1 A combination of specific materials is sealed in a limited space and subjected to a specific elevated temperature for a specified time. Following this exposure the dielectric breakdown voltage of the insulated conductors is used as a basis for judging the compatibility of the candidate system.

5. Significance and Use

5.1 This test method is useful for evaluating a combination of materials for potential use in an electrical insulation system.

6. Apparatus

6.1 *Oven*, capable of maintaining the required exposure temperature within ±3°C.

6.2 *Glass Tubes* with inside volume not exceeding 900 mL that can be sealed. Two general types are described as follows:

[1] This test method is under the jurisdiction of ASTM Committee D-9 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.17 on Thermal Characteristics.

Current edition approved March 10, 1999. Published May 1999. Originally published as D 5642 – 94. Last previous edition D 5642 – 97.

[2] *Annual Book of ASTM Standards*, Vol 10.01.

6.2.1 *Flanged High Temperature Glass Tubes* which are designed to be sealed with metal rings and gaskets are preferred.

6.2.2 *Glass Tubes*, which can be fusion sealed after the addition of all materials are acceptable alternatives.

6.3 *Gasket Materials* for use with tubes described in 6.2.1.

6.3.1 Type TFE (Tetrafluoroethylene) or FEP (Perfluoroethylene Propylene) Fluorocarbon.

6.3.2 *Hexafluoropropylene*—vinylidene fluoride elastomer can be used for exposure temperatures not exceeding 155°C.

6.4 Apparatus in conformance with Test Method D 149 to measure dielectric breakdown voltage.

7. Material Specimens

7.1 The specific list of materials to be tested is to be established by agreement between interested parties.

7.2 Represent each of the non-metallic components of the electrical insulation system, with the exception of an impregnating varnish and insulated conductors, with a specimen having a minimum mass of 250 mg.

7.3 *Insulated Conductor Specimens*:

7.3.1 Use film insulated magnet wire twisted pairs constructed in accordance with Test Method D 1676; 18 AWG heavy build is preferred.

7.3.2 For conductors not suitable for constructing twisted pairs, use specimens having a minimum length of 200 mm.

NOTE 1—An example of conductors not suitable for constructing twisted pairs is fibrous wrapped conductors. They shall be represented as described in 7.3.2.

7.4 Apply impregnating varnish to the insulated conductors and cure per manufacturer's recommendations.

8. Procedures

8.1 *Tube Loading and Sealing*:

8.1.1 Clean and dry tubes as needed prior to use.

8.1.2 Prepare one tube with the materials that represent the reference system. Insert all materials as specified in Section 7 into the tube. For each magnet wire type insert a minimum of five twisted pairs or three straight lengths prepared in accordance with Section 7.

NOTE 2—It is acceptable to place a stainless steel screen as a barrier to restrict physical contact of the insulated conductors from the other materials in the tube, to avoid damage to the insulated conductor specimens.

8.1.3 Prepare one tube for each candidate system in the same manner in which the reference system tube was prepared.

8.1.4 Condition each unsealed tube and its contents for 1 h at 105°C. The purpose of this procedure is to minimize the moisture content of all materials in the tube. It is an acceptable procedure to condition materials outside the tube to allow sufficient drying prior to 8.1.2 and 8.1.3. Concurrently condition tubes and gaskets.

8.1.5 Certain materials, including but not limited to hygroscopic papers, may require additional conditioning to remove moisture. If agreed upon by interested parties, higher temperatures and times for drying may be used. Select a time and temperature that do not cause loss of other volatile materials or cause thermal decomposition.

8.1.6 Seal tubes within 1 min after conditioning, and leak test immediately thereafter in accordance with 8.1.6.2.

8.1.6.1 Seal flanged glass tubes by applying a sufficient torque to ensure a seal that is leak free. A torque of 3.4 N·m (30 inch-pounds) in increments of 0.56 N·m (5 inch-pounds), alternating between bolts to tighten evenly and securely has been found acceptable for this purpose.

8.1.6.2 Check glass tubes for leaks using the following procedure: Submerge the still warm tubes into room temperature tap water for a minimum of 2 min. Observe the tubes after they have reached room temperature for condensation on the inner walls. Condensation is a result of leakage.

8.1.6.3 Do not use tubes that exhibit leakage.

8.2 *Aging*:

8.2.1 Place the tubes into an oven that is at room temperature.

8.2.2 Apply power to the oven and allow it to attain the aging temperature.

8.2.2.1 Sealed tubes may be placed into a heated oven, but it should be recognized that the thermal shock will cause stresses that may result in cracking of the glass tubes. Do not use any tubes that crack as a result of such treatment.

8.2.3 The aging temperature shall be 25°C greater than the numerical insulation system class of the reference system.

8.2.4 After a minimum of 336 h exposure to the aging temperature, remove the tubes from the oven. As an alternative, to reduce the extent of thermal shock, turn off the power to the oven and allow the oven and tubes to cool to room temperature.

NOTE 3—**Warning:** Use protective equipment including safety glasses or face shield and high temperature gloves when handling heated glass tubes. Glass tubes may shatter upon being subjected to thermal shock.

8.3 *Procedures for Testing:*

8.3.1 Open the tubes within 72 h of the completion of aging. Remove the insulated conductor specimens.

NOTE 4—**Warning:** Use adequate ventilation when opening the tubes. Fumes emitted from the tube may be toxic.

8.3.2 Determine the dielectric breakdown voltage of twisted pair conductors in accordance with Test Method D 1676.

8.3.2.1 **Caution:** *Lethal voltages may be present during this test. It is essential that the test apparatus, and all associated equipment that may be electrically connected to it, be properly designed and installed for safe operation. Solidly ground all electrically conductive parts that any person might come in contact with during the test. Provide means for use at the completion of any test to ground any parts which: were at high voltage during the test; may have acquired an induced charge during the test; may retain a charge even after disconnection of the voltage source. Thoroughly instruct all operators in the proper way to conduct tests safely. When making high voltage tests, particularly in compressed gas or in oil, the energy released at breakdown may be sufficient to result in fire, explosion, or rupture of the test chamber. Design test equipment, test chambers, and test specimens so as to minimize the possibility of such occurrences and to eliminate the possibility of personal injury.*

8.3.3 For straight conductor specimens prepare electrodes by applying 6 mm wide thin metal foil to the center of a 13 mm

wide, 75 mm long strip of pressure sensitive tape. Apply two electrodes at right angles to each specimen at intervals approximately ⅓ the length of the specimen and wrap smoothly and firmly around the specimen a minimum of 1 and ½complete turns, with the metal surface of the foil in contact with the insulation.

8.3.4 Modification of electrode configuration may be necessary for specific applications: Such modification shall be as agreed between interested parties.

8.3.5 Record the results.

9. Interpretation of Results

9.1 For each type of conductor taken from each tube, calculate the average of at least five dielectric breakdown voltage values using all of the dielectric breakdown voltages obtained. The criteria to be used for eliminating any one dielectric breakdown voltage value from the calculation of the average is to be determined by agreement between interested parties prior to testing.

9.2 A comparison of the average dielectric breakdown voltage values obtained for the conductor specimens taken from the candidate and reference tubes is the basis for determining the compatibility of the materials in a candidate system. The maximum acceptable difference between the average values shall be established by agreement between interested parties.

10. Report

10.1 Report the following information:

10.1.1 Designation and description of the reference and candidate system including all components,

10.1.2 Pre-conditioning or drying conditions,

10.1.3 Aging temperature, and

10.1.4 Length of exposure time.

10.1.5 For each type of conductor taken from each tube,

10.1.5.1 Individual dielectric breakdown voltage values, and

10.1.5.2 Average dielectric breakdown voltage value.

11. Precision and Bias

11.1 No statement is made about either the precision or bias of this test method since the result merely states whether there is conformance to the criteria for acceptability defined in terms of this test method.

12. Keywords

12.1 chemical compatibility; electrical insulation system; sealed tube