Designation: D2303 – 13

Standard Test Methods for Liquid-Contaminant, Inclined-Plane Tracking and Erosion of Insulating Materials[1]

This standard is issued under the fixed designation D2303; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods cover the evaluation of the relative tracking and erosion resistance of insulating solids using the liquid-contaminant, inclined-plane test.[2] The following test methods also can be used to evaluate the tracking resistance of materials: D2132 (contaminants: dust and fog) and D3638 (contaminant: conductive liquid drops).

1.2 Two tracking and one erosion test procedure are described:

1.2.1 A "variable voltage method" to evaluate resistance to tracking.

1.2.2 A "time-to-track method" to evaluate resistance to tracking.

1.2.3 A method for quantitative determination of erosion (Annex A1).

1.3 While a particular contaminant solution is specified, other concentrations of the same contaminant, or different contaminants are used to simulate different environmental or service conditions.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 *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.* Specific precautionary statements are given in Section 8.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D374 Test Methods for Thickness of Solid Electrical Insulation (Withdrawn 2013)[4]

D1711 Terminology Relating to Electrical Insulation

D2132 Test Method for Dust-and-Fog Tracking and Erosion Resistance of Electrical Insulating Materials

D3638 Test Method for Comparative Tracking Index of Electrical Insulating Materials

2.2 *IEC Standards:*

IEC 60587 Test Methods for Evaluating Resistance to Tracking and Erosion for Electrical Insulating Materials Used Under Severe Ambient Conditions

3. Terminology

3.1 *Definitions:*

3.1.1 *erosion, electrical, n*—the progressive wearing away of electrical insulation by the action of electrical discharges.

3.1.2 *erosion resistance, electrical, n*—the quantitative expression of the amount of electrical erosion under specific conditions.

3.1.3 *track, n*—a partially conducting path of localized deterioration on the surface of an insulating material.

3.1.4 *tracking, n*—the process that produces tracks as a result of the action of electric discharges on or close to the insulation surface.

3.1.5 *tracking, contamination, n*—tracking caused by scintillations that result from the increased surface conduction due to contamination.

3.1.6 *tracking resistance, n*—the quantitative expression of the voltage and the time required to develop a track under specified conditions.

3.2 *Definitions of Terms Specific to This Standard:*

[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 D09.12 on Electrical Tests.

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[2] K. N. Mathes, Chapter 4, "Surface Failure Measurements," *Engineering Dielectrics, Vol IIB, Electrical Properties of Solid Insulating Materials, Measurement Techniques*, R. Bartnikas, Editor, ASTM STP 926, ASTM, Philadelphia, 1987.

[3] 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.

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

3.2.1 *initial tracking voltage, n*—the applied voltage at which continuous tracking can be initiated in a specified time.

3.2.2 *time-to-track, n*—the time in which tracking proceeds a specified distance between the test electrodes at a specified voltage.

3.3 Other definitions pertinent to these test methods are given in Terminology D1711.

4. Significance and Use

4.1 These test methods differentiate among solid electrical insulating materials on the basis of their resistance to the action of voltage stresses along the surface of the solid when wet with an ionizable, electrically conductive liquid contaminant.

4.2 These test methods quantitatively evaluate, in a relative manner, the effects upon an insulating material resulting from the action of electrical discharges upon a material surface. The effects are similar to those that may occur in service under the influence of dirt combined with moisture condensed from the atmosphere.

4.2.1 In the field, the conditions resulting in electrical discharges occur sporadically. Degradation, often in the form of a conducting "track," develops very slowly until it ultimately bridges the space between conductors thus causing complete electrical breakdown.

4.2.2 In these test methods, the conducting liquid contaminant is continuously supplied at an optimum rate to the surface of a test specimen in such a fashion that essentially continuous electrical discharge can be maintained.

4.2.3 By producing continuous surface discharge with controlled energy it is possible, within a few hours, to cause specimen failure which is similar to failure occurring under long-time exposure to the erratic conditions of service in the field.

4.2.4 The test conditions, which are standardized and accelerated, do not reproduce all of the conditions encountered in service. Use caution when making either direct or comparative service behavior inferences derived from the results of tracking tests.

4.3 The time-to-track a 1-in. (25-mm) distance at a specified voltage between electrodes separated 2 in. (50 mm) has also been found useful in categorizing insulating materials for indoor and protected outdoor applications, such as metal-clad switchgear.

4.4 The initial tracking voltage has been found useful for evaluating insulating materials to be used at high voltages or outdoors and unprotected, as well as for establishing (see 10.1) the test voltage for the time-to-track test.

4.5 In service many types of contamination cause tracking and erosion of different materials to different degrees. This method recognizes the importance of such variability and suggests the use of special test solutions to meet specific service needs. For example, an ionic contaminant containing, in addition, a carbonaceous component such as sugar is substituted to cause tracking on very resistant materials like polymethylmethacrylate. Such contamination is considered representative of some severe industrial environments. In this case, the time-to-track technique is used, since time is required to decompose the contaminant solution and build up conducting residues on the sample surface.

4.6 Very track-resistant materials, such as polymethylmethacrylate, typically erodes rather than track under more usual contaminant conditions in service. The use of this method for measuring erosion is consequently important. For erosion studies, only tests as a function of time at constant voltage are useful.

5. Apparatus

5.1 A simple schematic diagram of the apparatus is given in Fig. 1 and consists of the following. Details are given in Annex A2.

5.1.1 A 60-Hz power supply with an output voltage stabilized to ±1 % which can be varied from 1 to at least 7.5 kV with a rated current of no less than 0.1 A for every test station to be used (that is, 0.5 A for five stations).

5.1.2 A means for applying a specified contaminant solution at a controlled rate to the specimen surface. A pneumatically actuated repeating pipet has been found useful for this purpose and is described in Annex A2. Peristaltic pumps have also been used (A2).

5.1.3 Stainless steel top and bottom electrodes as shown in Fig. 2.

NOTE 1—Stainless-steel type 302 is recommended.

5.1.4 A pad of filter paper cut as shown in Fig. 3*a* and *b* to fit under the top electrode and used to smooth out the flow of the contaminant solution.

5.1.5 A set of ballast resistors (50, 10, and 1-kΩ rated at 200 W each) to be connected as specified in series with each test specimen on the high-voltage side of the power supply. Somewhat lower resistances are being considered by the International Electrotechnical Commission (IEC/TC15).

5.1.6 A330-Ω, ½-W, carbon resistor[5] mounted with a simple tension spring and connected in series with the specimen and ground to act as an overload, high-voltage fuse.

5.1.7 Structural parts and a grounded safety enclosure.

5.1.8 Clip to hold the hose and filter paper in place. Fig. 3*a* and *b* shows an example of a paper clip configuration that may be used. Other paper clip configurations may be used as long as they do not pinch the hose affecting the contaminant flow.

6. Sampling

6.1 Refer to applicable materials specifications for sampling instructions.

7. Test Specimens

7.1 Specimens with a flat surface measuring approximately 2 × 5 in. (50 × 130 mm) as shown in Fig. 4. Measure the thickness in accordance with Test Methods D374 if there is no standard for a particular material. Specimens must be thick

[5] International Resistance Co. RC 20-mil type carbon-composition resistors, available from the TRW Electronics Corp., Commerce Terminal Bldg., Philadelphia, PA, have been found satisfactory.

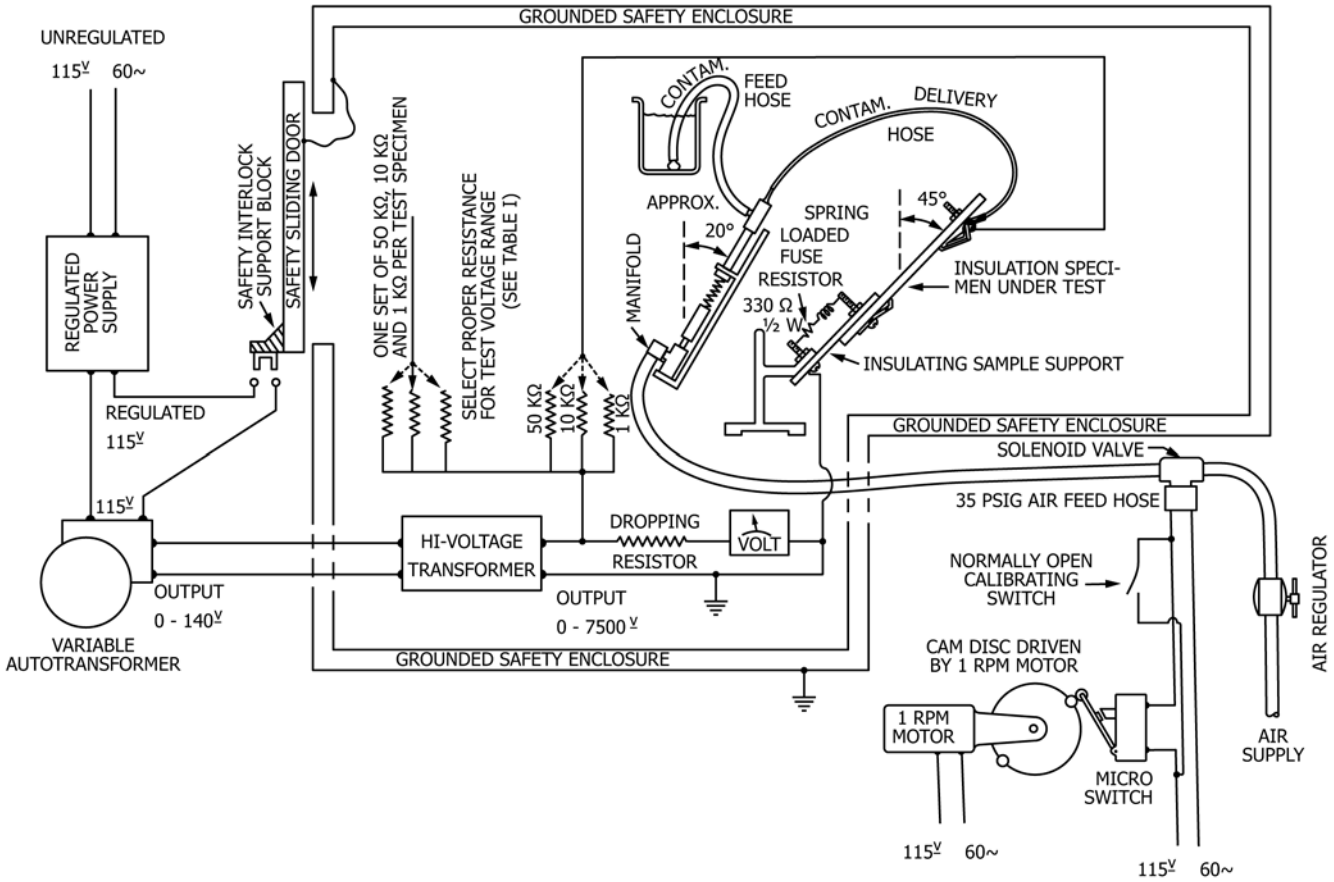

FIG. 1 Schematic Diagram of Apparatus

enough that tracking does not penetrate completely through the specimen during the test.

7.1.1 Thin specimens shall be mounted on the apparatus as individual layers (that is, samples shall not be stacked).

7.1.2 Thin specimens shall be secured by mounting them on a support plaque made from an inert nonconductive material. Fig. 3*a* shows an example of a mounting support plaque made out of PTFE (polytetrafluoroethylene) at an approximate thickness of 6 mm.

7.1.3 Care shall be exercised with thin specimens to ensure contaminant does not flow on the back of the specimen. This can lead to inconclusive results.

7.2 Prepare separate specimens representative of different surfaces affected by anisotropy, morphology, texture, surface treatments, pull direction, fill direction, etc. Identify the different surfaces to be tested, such as mold face, press face, textured side, machine direction, cross-machine direction, warp or fill direction, etc. Prepare two sets of specimens of materials with noticeable directional characteristics, with the predominant directional characteristic in line with the electrodes for one set and at right angles to the other set. Identify the specimen direction such as machine direction, cross-machine direction, warp or fill direction (for woven textile reinforced products). (See Fig. 5.)

7.3 *Preparation of Specimens*—Clean the specimen face with a suitable solvent[6] and rinse with distilled water. For specimens to be used in the time-to-track method, do not mechanically destroy, that is, sand, abrade, and so forth. the natural surface finish of the specimen unless otherwise specified. However, with the variable-voltage method, the surface of the test specimens shall be lightly but completely sanded under flowing tap water with 400A-grit wet silicon carbide paper and rinsed with distilled water. Such sanding removes gloss and contaminants to provide a surface that is wet more easily and rapidly by the contaminant. Loss of gloss and slight erosion of the surface usually occurs in service, particularly outdoors. Generously cover the specimen area under the bottom electrode with conductive silver paint[7] and add the 1-in. (25-mm) tracking reference marks as shown in Fig. 5. For all tests, other than the time-to-track test, soak the test specimens prepared as above for 24 to 48 h in the specified contaminant solution before test.

7.4 Prepare five specimens for each determination.

[6] The solvent should not soften or otherwise damage the test specimen. Isopropyl alcohol has been found suitable for many materials.

[7] DuPont silver paint No. 4817 has been found suitable for this purpose.