



# Standard Test Methods for Compatibility of Construction Material with Silicone Fluid Used for Electrical Insulation<sup>1</sup>

This standard is issued under the fixed designation D5282; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 These test methods cover screening for the compatibility of construction materials with silicone fluid for use in electrical equipment.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety problems, 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:*<sup>2</sup>

- D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester
- D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
- D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration
- D828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus (Withdrawn 2009)<sup>3</sup>
- D877 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- D924 Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids

- D974 Test Method for Acid and Base Number by Color-Indicator Titration
- D1169 Test Method for Specific Resistance (Resistivity) of Electrical Insulating Liquids
- D1933 Specification for Nitrogen Gas as an Electrical Insulating Material
- D2129 Test Method for Color of Clear Electrical Insulating Liquids (Platinum-Cobalt Scale)
- D2225 Test Methods for Silicone Fluids Used for Electrical Insulation
- D2413 Practice for Preparation of Insulating Paper and Board Impregnated with a Liquid Dielectric
- D3612 Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography
- D4243 Test Method for Measurement of Average Viscometric Degree of Polymerization of New and Aged Electrical Papers and Boards
- D4559 Test Method for Volatile Matter in Silicone Fluid
- D4652 Specification for Silicone Fluid Used for Electrical Insulation
- D5837 Test Method for Furanic Compounds in Electrical Insulating Liquids by High-Performance Liquid Chromatography (HPLC)

## 3. Significance and Use

3.1 The magnitude of the changes in the electrical properties of the silicone fluid is of importance in determining the contamination of the fluid by the test specimen.

3.2 Physical and chemical changes in the fluid, such as color and acidity, also indicate solubility or other adverse effects of the test specimen on the fluid.

3.3 Physical changes of the test specimen, such as hardness, swelling, and discoloration, show the effect of the fluid on the test specimen and are used to determine the suitability of the material for use in silicone fluid.

3.4 A material meeting the criteria recommended does not necessarily indicate suitability for use in electrical equipment. Other properties must also be considered. Additionally, certain materials containing additives may meet the requirements of these test methods yet be unsatisfactory when subjected to longer-term evaluations.

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D27 on Electrical Insulating Liquids and Gases and are the direct responsibility of Subcommittee D27.06 on Chemical Test.

Current edition approved Feb. 1, 2012. Published February 2012. Originally approved in 1992. Last previous edition approved in 2005 as D5282 – 05. DOI: 10.1520/D5282-05R12.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

3.5 These test methods may be used as a guide for testing the compatibility of materials for silicone fluids other than 50 cSt poly-dimethyl siloxane fluid, but different criteria for judgment may be necessary.

## 4. Apparatus

### 4.1 *Sample-Handling Apparatus:*

4.1.1 *Oven*, forced draft, adjustable to  $120 \pm 1^\circ\text{C}$ , and a drying oven, adjustable to  $105 \pm 5^\circ\text{C}$ .

4.1.2 *Glass Containers*, 1-L, fitted with glass or aluminum foil covers (**Note 1**).

NOTE 1—Other materials have been found to be suitable as covers.

4.1.3 *Fritted Glass Dispersion Tube* (coarse).

### 4.2 *Sample-Testing Apparatus:*

4.2.1 *Tensile Strength*—As specified in appropriate test method.

4.2.2 *Hardness*—As specified in appropriate test method.

4.2.3 *Dimensional Change*—Micrometer and caliper.

4.2.4 *Weight Change*—Analytical balance.

## 5. Reagents

5.1 *Dry Nitrogen Gas*, Meeting the requirements of Specification **D1933**, Type III with the following exception: the total hydrocarbon content must be  $<0.5$  ppm. Sometimes referred to as Ultra-High Purity (UHP).

5.2 *Dimethyl Silicone Fluid* (50 cSt), conforming to Specification **D4652**.

## 6. Preparation of Test Specimen

6.1 Test specimen size shall be such that the ratio of surface area to liquid volume is four times as large as the ratio encountered in normal use in electrical equipment unless there is some special reason for using a different ratio (**Note 2**). Some suggested ratios are as follows:

6.1.1 If the test specimen can be measured, no less than  $52\text{ cm}^2$  is used with each 800 mL of silicone.

6.1.2 If the test specimen is insoluble in silicone fluid and the surface area cannot be measured, use a test specimen in the amount of 1 % by weight of the silicone.

6.1.3 If the material is soluble in the silicone fluid, use a test specimen in the amount of 0.5 % by weight of the silicone fluid.

6.1.4 When surface areas are employed for solid material testing, all sides of the solid material are to be used in the calculation of surface area as long as that surface is in contact with the silicone fluid.

6.1.5 Varnishes and materials used as dip coatings, and paints shall be cured on aluminum foil or paper known to be compatible with the silicone fluid. They should be tested at a ratio of 14 g or approximately  $1300\text{ cm}^2$  of surface area per 800 mL of silicone fluid.

6.1.6 Core steel and core-steel coatings shall be tested at a ratio of  $3100\text{ cm}^2$  for each 400 mL of silicone fluid for transformer applications. A realistic core steel ratio for regulators is  $5000\text{ cm}^2$  of surface area per each 400 mL of silicone fluid.

6.1.7 Gasket materials shall be tested at a ratio of  $13\text{ cm}^2$  of surface area per 800 mL of silicone fluid.

6.1.8 Wire enamels shall be tested at a ratio of  $1300\text{ cm}^2$  of surface area per 800 mL of silicone fluid.

6.1.9 Cellulosic insulation shall be tested at a ratio  $2000\text{ cm}^2$  of surface area per 800 mL of silicone fluid. These test specimens shall be prepared according to the instructions provided in Practice **D2413**.

6.2 Caution must be taken in obtaining and preparing the sample to ensure that it is a representative sample of the material as supplied by the manufacturer. Use forceps to handle the test specimens or adequately protect them from contamination such as skin oils during handling.

6.3 Pre-dry all solid materials for 16 h in an oven at  $105 \pm 5^\circ\text{C}$ . Gasket materials shall not be pre-dried and cellulosic insulation does not require any further drying as long as it is prepared according to **6.1.9**.

6.4 Remove the test specimen from the oven and place in a 1-L jar with 800 mL of silicone fluid. Bubble the silicone fluid with dry nitrogen for approximately 10 min through a fritted glass tube. To minimize contamination, slide the cover on quickly while removing the aluminum foil and the bubble tube. Fasten the cover tightly.

NOTE 2—There are certain materials in electrical apparatus for which the suggested ratios of material to liquid are impractical; when this condition exists, report the ratio.

6.5 Prepare a reference silicone fluid specimen (control) for each group of specimens tested, as directed in **6.4**. A reference specimen consists of the silicone fluid only.

## 7. Conditioning

7.1 Place the covered glass jars in an oven at  $120 \pm 1^\circ\text{C}$  for 168 h.

7.2 Remove the jars from the oven and cool to room temperature.

## 8. Procedure

8.1 With a pair of clean tongs or forceps, remove the test specimen from the fluid, observe the condition, and conduct any desired test on the material.

8.1.1 Typical tests on materials can include swelling or dimensional changes, weight changes, hardness, discoloration, brittleness, tensile strength (Test Method **D828**), degree of polymerization (Test Method **D4243**), etc.

8.1.2 For comparative tests, use the appropriate method.

8.2 The following tests, as modified in Test Method **D2225**, are suggested for the properties listed below:

8.2.1 *Fire Point*—Test Method **D92**.

8.2.2 *Viscosity*—Test Method **D445**.

8.2.3 *Neutralization Number*—Test Methods **D664** or **D974**.

8.2.4 *Dielectric Strength*—Test Method **D877**.

8.2.5 *Dissipation Factor (Power Factor at 25 and 100°C)*—Test Method **D924**.

8.2.6 *Color*—Test Method **D2129**.

8.2.7 *Resistivity*—Test Method **D1169**.

8.2.8 *Percent Volatiles*—Test Method **D4559**.

8.2.9 *Furanic Compounds (perform when testing cellulosic materials)*—Test Method **D5837**.

8.2.10 *Dissolved Gases-in-Silicone (optional)*—Test Method **D3612**.

## 9. Evaluation of Results

9.1 *Evaluation of Physical Changes of the Material at Room Temperature*—The changes in physical properties of the material being tested must be considered on the basis of the specific needs of the application. For example, paper insulation tested may be submitted for degree of polymerization analysis (Test Method **D4243**) or tensile strength (Test Method **D828**).

### 9.2 *Evaluation of Test Results on Silicone Fluid:*

9.2.1 The test results obtained on the liquids containing the test specimens of construction material must be compared with those of the reference liquid sample to determine any variation.

9.2.2 The absence of any differences between the test specimen fluid and the reference fluid indicates that the test specimen fluid was not affected by the material and that the material is worthy of further consideration or testing, or both.

9.2.3 A significant difference in any of the results, as defined in **9.2.5**, may indicate some compatibility problem, and the material should be either further reviewed or rejected.

9.2.3.1 The amount of change between the reference fluid and the test specimen fluid that is considered to be significant should be established prior to testing by agreement between the purchaser and the seller.

9.2.4 If the aged control fluid reference fails to meet the criteria in **9.2.5**, the liquid itself is suspect for one or more of the following reasons:

9.2.4.1 The fluid does not meet the requirements for approved silicone.

9.2.4.2 The fluid has become contaminated.

9.2.4.3 The test aging temperature exceeded the prescribed limit (see **7.1**).

9.2.5 The aged properties for the control 50 cSt dimethyl silicone fluid specimen should be as follows:

Fire point	340°C, min
Viscosity	47.5 to 52.5 cSt
Neutralization number	0.04, max
Dielectric strength	38 kV, min
Dissipation factor (Power factor), 100°C	0.35 %, max
Color	100, max
Resistivity, 100°C	$10 \times 10^{12}$ , min
Percent volatiles	0.5 %, max
Condition of silicone	clear
Condition of material	unchanged

## 10. Report

10.1 Report the following information:

10.1.1 The results of the tests specified in **9.2.5**, on both the reference silicone specimen and the test specimen silicone,

10.1.2 Any changes in appearance, dimensions, hardness or other relevant properties of the construction material test specimens, and

10.1.3 Whether the construction material evaluated by this test method appears to be compatible (or incompatible) with silicone fluid.

## 11. Precision and Bias

11.1 No practical means exists to specify precision and bias, as this method is used to test materials which may age differently in the presence of silicone fluid.

11.2 Refer to the precision and bias statements for each of the individual test methods used for comparative tests in **8.1.2** and the suggested tests in **8.2**.

## 12. Keywords

12.1 compatibility; construction material; electrical equipment; electrical insulating liquid; poly-dimethyl siloxane; silicone fluid

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