Standard Test Methods for Electrical Resistivity of Liquid Paint and Related Materials[1]

This standard is issued under the fixed designation D 5682; 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 the determination of specific resistance (resistivity) of liquid paints, solvents, and other fluids in the range of 0.6 to 2640 MΩ-cm.

1.2 Test Method A describes a procedure for making resistance tests with a commonly used paint application[2] test assembly (Fig. 1).

1.3 Test Method B describes a procedure for making resistance tests with a conductivity meter[3] (Fig. 2).

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. Terminology

2.1 *Definitions:*

2.1.1 *specific resistance (resistivity)*—The ratio of the d-c potential gradient in volts per centimeter paralleling the current flow within the specimen to the current density in amperes per square centimeter at a given instant of time and under prescribed conditions.

2.1.1.1 *Discussion*—This is numerically equal to the resistance between opposite faces of a centimeter cube of the liquid. The units are ohm centimeters (or megohm centimeters).

2.2 *Definitions of Terms Specific to This Standard:*

2.2.1 *kilohms (KΩ)*—resistance value equal to 1000 Ω (10^3).

2.2.2 *megohms (MΩ)*—resistance value equal to 1 000 000 Ω (10^6).

2.2.3 *ohm-centimeters (or megohm-centimeters)*—unit of specific resistance (resistivity).

FIG. 1 Paint Application Test Assembly

3. Summary of Test Methods

3.1 Test Methods A and B measure direct current through concentric cylinder electrodes immersed in a liquid paint specimen.

4. Significance and Use

4.1 These tests are suitable for testing paints adjusted for compatibility with various electrostatic spray coating applications, and by their use, spray performance can be optimized.

5. Interferences

5.1 Contamination of the specimen is the most likely cause of error. Very small amounts of water, acids, or polar solvents will lower the resistance of high resistivity solvents and paints.

5.2 High humidity is not known to interfere with the test itself but can lead to water pickup by the specimen. For repeatable results, tests should be made under the same atmospheric conditions and specimens should be stored and handled so as to keep water pickup to a minimum.

5.3 Resistivity varies with temperature. A standard test temperature of 25°C is recommended. Other temperatures are possible on agreement between the producer and the user.

5.4 Electrification time must be the same for every test due to ion migrations that cause current flow to decrease with time. Variations with time of electrification can result in appreciable variation in the test results.

5.5 Equipment outlined in Test Methods A and B apply different test voltages (45 V and 15 V, respectively). Because of

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[2] Paint application test assembly such as the Ransburg 70408-00 Tester or equivalent may be obtained from ITW Ransburg Electrostatic Systems, P.O. Box 913, Toledo, OH 43697-0913.

[3] Conductivity meter such as the Byk-Gardner LC2 conductivity meter, Model 1722/1710 or equivalent may be obtained from Byk-Gardner, Inc., 2435 Linden Lane, Silver Spring, MD 20910.

FIG. 2 Conductivity Meter

this, some variation in results may be expected.

6. Apparatus

6.1 *Paint Application Test Assembly*[2]—designed to provide measurement of the electrical resistance of paint formulations for all electrostatic applications. To provide greater accuracy in measuring low resistance paints, the meter is equipped with dual range selection. Range "A" is .005 to 1 MΩ, Range "B" is .05 to 20 MΩ.

7. Reagents and Materials

7.1 *Low Resistivity Cell Constant Standards* (see Appendix X1 for cell constant determination method).

7.2 *Potassium chloride*, 1000 μΩ/cm.[4]

7.3 *Cleaning Solvents and Solutions*—It is essential to thoroughly clean the probe before and after tests. The cleaning solvent should be chosen on the basis of the paint tested. Due care must be exercised in cleaning to ensure all cleaning solvents are removed from the probe before reusing. The probe must be dry and free from contaminates or results will vary.

TEST METHOD A

8. Standardization

8.1 For maximum accuracy, the probe should be standardized to determine the exact cell constant. For routine measurements a cell constant (*K*) of 132 may be used (see Appendix X1).

8.2 The electronic-resistance measuring assembly may be checked by use of a standard-resistance decade box (½ % accuracy or better).

9. Procedure

9.1 Prior to tests, make sure that the probe is thoroughly cleaned (see Section 9.2).

9.2 Insert the paint test probe into the jack in the lower right side of the meter case.

9.3 Set the scale select switch (top center) to the Scale B position.

9.4 Move the mode select switch (top right) to the Zero Adjust position and rotate the zero adjust knob (top left) until the dial indicator needle centers on the adjust position (far right). Maximum accuracy will be realized with the meter lying flat, meter face up.

NOTE 1—If the needle will not adjust to zero, replace the battery.

9.5 Move the mode select switch to the Paint Test position.

9.6 Immerse the probe vertically into a well-mixed, visually uniform specimen of the subject material until the holes at the bottom of the slots in the probe sleeve are submerged.

Caution—Do **NOT** immerse the probe past the top of sleeve.

9.7 Read the paint resistance from Scale B. If the reading is less than 0.5 on the B scale, move the scale select switch to the Scale A position, repeat 9.4, then read the paint resistance from Scale A.

9.8 Read the scale value at 10 s after immersion in the test sample. Ignore any slow drift that may occur after this time.

9.9 To convert the megohms reading on the tester to resistivity in megohm-centimeters, multiply by constant "K" found in 8.1 or 132.

9.10 Clean the probe thoroughly. Allow the apparatus and specimen to stand for 1 h (keep lids on specimens tightly closed to prevent loss of volatiles). Repeat the measurement, making certain to remix the specimen.

9.11 Report the result as the mean value of the two measurements.

TEST METHOD B

10. Apparatus

10.1 *Conductivity Meter*,[3] provides measurement of electrical resistivity of solvents and pain formulations for electrostatic spray applications. This meter permits evaluation of solvents and liquid paints in the resistance range of 0.05–20 MΩ.

11. Standardization

11.1 For maximum accuracy, the probe should be standardized to determine the cell constant. For routine measurement, a cell constant (K) of 132 may be used (see Appendix X1).

11.2 The electronic resistance measuring assembly may be checked by use of a standard resistance decade box (½ % accuracy or better).

[4] One thousand μΩ/cm test solutions are available from scientific supply companies (see[5]).

12. Procedure

12.1 Prior to tests, thoroughly clean the probe. See Section 12.

12.2 Connect the measuring cable of the probe to the socket in the back of the instrument.

12.3 Immerse the measuring cell into a well mixed, visually uniform specimen. The specimen should reach the two holes in the probe.

12.4 Press the measuring button. After 10 s the measured value is displayed in megohms.

12.5 To convert the megohms readings to specific resistivity in megohm-centimeters, multiply by 132.5 cm.

12.6 Clean the probe thoroughly. Allow the apparatus and specimen to stand for 1 h (keep lids of specimen tightly closed to prevent loss of volatiles). Repeat the measurement, making certain to remix the specimen.

12.7 Report the result as the mean value of the two measurements.

13. Report

13.1 Report the following information:

13.1.1 Identification of the material under test,

13.1.2 Identification of the tester used,

13.1.3 The test temperature, and

13.1.4 The resistivity in megohm-centimeters (the mean value of two measurements).

14. Precision and Bias

14.1 *Precision*—The precision estimates are based on an interlaboratory study in which one operator in each of seven different laboratories (five using the first tester[2], two the second tester)[3] measured the resistivity in duplicate on two different days for three solvent specimens ranging in resistivity from 40 to 818 MΩ-cm (0.3–6.2 MΩ resistance). The within-laboratory coefficient of variation was found to be 4.0 % with 16 df and the between-laboratory coefficient of variation 23.0 % with 13 df. Based on these coefficients, the following criteria should be used for judging the acceptability of results at the 95 % confidence level.

14.1.1 *Repeatability*—Two results, each the mean of duplicate determinations, obtained by the same operator on different days should be considered suspect if they differ by more than 12 % relative.

14.1.2 *Reproducibility*—Two results, each the mean of duplicate determinations, obtained by operators in different laboratories should be considered suspect if they differ by more than 70 % relative.

14.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for the procedures in these test methods, bias has not been determined.

15. Keywords

15.1 conductivity meter; electrical resistance; electrical resistivity; electrostatic spray application—compatibility; paint application test assembly; specific resistance

APPENDIX

(Nonmandatory Information)

X1. TESTING THE PROBE (CELL CONSTANT DETERMINATION)

X1.1 These cells depend on concentricity of the inner and outer section for accuracy and repeatability. The cell constant may be tested by the following method. Both cells have identical cell constants by design, so may be tested in same manner. The main reason for doing this is to determine whether the cell is in good condition, clean, and operating properly. If the cell is dirty or damaged, it will not give the correct cell constant.

X1.2 Obtain a standard solution of approximately 1000 μΩ/cm.[5]

X1.3 Measure the resistance of the standard solution (in ohms) using the probe and an ohmmeter with full scale reading of about 25 Ω, *since the test meters normally used in these methods are not suitable for measuring this low value of resistance.*

X1.4 The cell constant may be found by substituting in the following equation:

$$K = P/R \tag{X1.1}$$

where:

K = the cell constant in cm,
P = the resistance in MΩ-cm, and
R = the resistance in MΩ.

X1.5 This value is typically 132, but may vary slightly because of manufacturing tolerances, or slight damage while in use. If the cell constant is <128 or >133, reclean the cell and recheck the constant. If it is still outside the range 128 to 133, then the outer sleeve probably has been damaged and must be replaced.

[5] Test solutions may be obtained from chemical supply companies such as American Scientific Products, 1210 Waukegan Road, McGraw Park, Illinois 60085, or Ricca Chemical Company, 448 W. Fork Drive, Arlington, Texas 76013.