Test Method for Electrical Resistance of Yarns

Developed in 1955 by AATCC Committee RA32; reaffirmed 1960, 1969, 1973, 1977, 1989, 2005, 2011, 2018; editorially revised 1974, 1984, 1985, 1997, 2008, 2019; revised 1982, 2000 (with title change); editorially revised and reaffirmed 1987, 1995.

1. Purpose and Scope

1.1 The purpose of this method is to determine the electrical resistance of any textile yarns containing natural or man-made fibers. The tendency of a textile yarn to accumulate electrical charges may depend upon the electrical resistance of the yarn. Due to the mechanism of conductance, this method is not applicable to yarns containing randomly situated stainless steel or other highly conductive fibers (refer to AATCC TM76, Test Method for Electrical Surface Resistivity of Fabrics).

2. Principle

2.1 Specimens of yarn are conditioned at specified relative humidity and temperature. The electrical resistance of the yarn held between two electrodes is measured by the use of an electrical resistance meter.

3. Terminology

3.1 **electrical resistance,** n.—the physical property of a material which is a measure of the ability of electrons to flow through it when a voltage is applied across two points on the material (resistance [in ohms] equal voltage [in volts] divided by current flow [in amperes]).

NOTE: This test method measures the electrical resistance of a material between two electrodes, and the results are expressed as resistance per unit of length per yarn strand, ohms per 10 mm.

4. Safety Precautions

NOTE: These safety precautions are for information purposes only. The precautions are ancillary to the testing procedures and are not intended to be all inclusive. It is the user's responsibility to use safe and proper techniques in handling materials in this test method. Manufacturers MUST be consulted for specific details such as material safety data sheets and other manufacturer's recommendations. All OSHA standard and rules must also be consulted and followed.

4.1 Good laboratory practices should be followed. Wear safety glasses in all laboratory areas.

4.2 The safety recommendations provided by the manufacturer of the radioactive bar should be followed.

4.3 The radioactive bar emits alpha radiation which is externally harmless to the human body. The radioactive isotope polonium 210 is toxic and precaution should be exercised to prevent ingestion or inhalation of the solid material. Do not take the radioactive bar apart or touch the radioactive strip under the grid. If the strip is touched or handled, wash hands thoroughly at once. Return the device to the manufacturer when it loses its effectiveness as a static eliminator or for disposal if use is to be discontinued. ***Do not discard as scrap***.

5. Apparatus and Materials

5.1 Electrical resistance meter equipped with either fixed position parallel plate electrodes or with separate variable position parallel plate electrodes (see 11.1). The concentric ring electrode system recommended for fabrics in AATCC TM76 is not suitable for use in testing yarns.

5.2 Conditioning and test chamber (see 11.2).

5.3 Standard resistors.

5.4 Radioactive bar.

6. Test Specimens

6.1 The length of the test specimens depends on whether or not the electrodes used are in fixed or variable position. If the electrode system used provides for variable distances between the parallel plates, run a preliminary test to determine what distance between the plates provides the greatest sensitivity for resistance measurements for the meter being used.

6.2 To determine the uniformity of resistance along a single end of yarn, make measurements on at least 10 specimens of single strands.

6.3 For predicting the properties of woven or knitted fabrics to be made from yarn tested by this method, measurements should be made on multiple strands.

6.4 Prepare a minimum of three test specimens for each test, with parallel strands having the same tension, evenly spaced, with no overlap or touching along their length. When a limited supply of yarn is available, each specimen should contain 10 strands. If an adequate supply of yarn is available, prepare larger specimens by winding 50-100 turns on a skein winder, then fastening the strands with adhesive tape to prepare lengths suitable for the electrode system used. The number of strands in the specimen must be the same for each test specimen for reproducible results. The resistance may also be dependent on the cross-section of the yarn bundle; thus, similarly manufactured fibers may yield yarns with different resistance, due to different numbers of filaments in the yarn bundle or different numbers of plies.

7. Procedure

7.1 Calibrate the electrical resistance meter according to the manufacturer's recommendations.

7.2 Condition the test specimens in a suitable testing chamber or conditioning room at the pre-selected relative humidity and temperature at which the electrical resistance of the yarn is to be measured.

7.2.1 For yarns which require antistatic treatments or whose electrostatic propensity is critical, measurements at 20% RH will be most meaningful. For special requirements other relative humidities may be used. For example, preconditioning at 21 ± 2°C (70 ± 5°F) is required for antistatic sheeting, film and textiles for use in hospital operating rooms (see 11.2.1). If it is necessary to measure electrical resistance under a broad range of conditions, additional tests may be run at 65% RH and at 24°C (75°F) or other relevant conditions (see 11.3).

7.2.2 Condition the specimens at 24°C and at the predetermined relative humidity for a minimum of 4 h or until equilibrium is attained. A sufficient indication of equilibrium is no significant change of resistance on further conditioning. A significant change may be considered ± 5% of the logarithm of the resistance (Log R).

7.3 Remove static charges from the surface of the yarn by passing a radioactive bar over both sides of the specimen.

7.4 Place the yarn test specimen in firm contact with the electrodes with the direction of the yarn perpendicular to the adjacent edges of the electrodes. Apply sufficient tension to hold the strands straight.

7.5 Measure the electrical resistance of the specimen according to the operating instructions and procedures for the particular resistance meter being used.

7.6 Allow the current to pass through the sample for a minimum period of 1 min and until a constant reading is obtained. The time to reach a constant read-

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ing may vary with the applied voltage and with the resistance of the test specimen. High voltages for prolonged periods of time may damage the yarn.

7.7 For referee purposes, use 30-40 volts for a minimum period of 1 min or until a constant reading is obtained at an electrode separation of 10 mm (see 11.4).

7.8 Avoid the use of any electrically conductive liquids on either the yarn specimens or the apparatus.

8. Evaluation

8.1 Compute the resistance in ohms per 10 mm per strand of yarn.

$$R = \frac{S}{D} \times \frac{r_1 + r_2 + r_3 + \ldots + r_n}{n} \times 10$$

where:

R = resistance in ohms per mm per strand

S = number of strands per specimen

D = distance between electrodes in mm

r = resistance of individual specimens containing S strands per specimen

n = total number of specimens tested (multiplication times 10 converts to the same scale as previously used for this test method)

9. Report

9.1 Report the result as the logarithm of the resistance (Log R) in ohms per 10 mm per strand of yarn and the temperature and relative humidity used (see 10.1).

10. Precision and Bias

10.1 *Precision*. Experience has shown that the reproducibility is within ± 10% of the logarithm of the average resistance.

10.2 *Bias*. Electrical resistivity can be defined only in terms of a test method. There is no independent method for determining the true value. As a means of estimating this property, the method has no known bias.

11. Notes

11.1 The resistance meter in conjunction with the electrode system should be capable of measuring values in the range of 10^8-10^{15} ohms for any critical uses. Equipment that is capable of measuring values in the range of 10^8-10^{13} ohms is suitable for work where performance is known to be acceptable when the resistance is < 10^{13} ohms.

11.1.1 External fixed-position parallel plate electrodes may be used with this instrument and may be built according to specifications described by Hayek & Chromey in *American Dyestuff Reporter*, Vol. 40, 1951, pp164-168. For more versatility these electrodes may be designed so that the distance between them may be adjusted from 5-50 mm.

11.1.2 Other resistance testers may be satisfactory for this test.

11.2 A conditioning and testing chamber is required capable of providing relative humidity control of ± 2% (preferably effective over a range of 20-65% RH) and temperature control of ± 1°C with circulating air. Since equilibration of a test specimen from the dry versus the wet condition relative to the humidity of the test chamber may show hysteresis, it is recommended that specimens approach equilibrium from the dry side relative to the humidity in the test chamber whenever possible.

11.2.1 National Fire Protection Association, Standard NFPA Code #56 A-1973 Section 4663.

11.3 Accumulation of static electricity generally is greater the lower the relative humidity (and vice versa). Yarns which show a low degree of static accumulation at 40% RH may exhibit severe static accumulation at 20-25% RH, while yarns which exhibit static problems at 40% RH may exhibit a low degree of static accumulation at 65% RH. The relationship between the tendency for static accumulation and relative humidity varies with the specific antistatic agent, fiber, yarn construction, surface character, etc. Therefore, 40% RH may not provide significant performance properties of a yarn unless the tests are also run at 20 or 25% RH, an atmospheric condition not unusual in modern heated and air-conditioned buildings. Complete information may also require information on resistance at the upper level of 65% RH.

11.4 For more detailed information regarding the measurement of resistances, see ASTM D257, Tests for D-C Resistance or Conductance of Insulating Materials.

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