INTERNATIONAL STANDARD

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Rubber, vulcanized or thermoplastic — Antistatic and conductive products — Determination of electrical resistance

Caoutchouc vulcanisé ou thermoplastique — Produits antistatiques et conducteurs — Détermination de la résistance électrique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2878 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This fourth edition cancels and replaces the third edition (ISO 2878:2005), which has been technically revised to include a calibration schedule for the instruments used in the test (see Annex A).

Introduction

The elimination or reduction of static voltages and charges on rubber products is important in many applications. By providing suitable leakage paths the charge can be dissipated. The antistatic properties of a product are also influenced by its electrostatic charging characteristics. This International Standard deals only with methods involving the use of leakage paths.

The addition of carbon black to a polymer in sufficient quantities causes a conductive network of carbon particles to be formed within the mixture, and materials with a wide range of electrical conductivity can be produced. The conductive network is sensitive to mechanical strain, and the electrical resistance of the material varies according to the degree of strain and the time and temperature history after straining. Antistatic properties can also be conferred on rubber materials by incorporating ionizable materials into the rubber mix.

A method for the measurement of the resistivity of specially prepared test pieces of antistatic and conductive rubber is described in ISO 1853.

Rubber, vulcanized or thermoplastic — Antistatic and conductive products — Determination of electrical resistance

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. 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 to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

IMPORTANT — Certain procedures specified in this International Standard might involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate documentation on safe handling and disposal after use.

1 Scope

This International Standard specifies a method of test to determine the electrical resistance of antistatic and conductive products manufactured wholly or in part from rubber whose electrical resistance measured between defined points, when new, does not exceed $3 \times 10^8\ \Omega$ and whose conductivity is derived from the addition of carbon black and/or other appropriate substances to the bulk of the material.

NOTE Highly conductive mixes cannot be made in this way.

This International Standard specifies the electrode configuration for basic geometries, but reference should be made to relevant product specifications for requirements for specific products.

It does not apply to:

a) products the relevant surfaces of which are composed of mixtures of insulating and conductive areas;

b) products with a substantial surface area of insulating material, except for footwear (which does not normally have a conductive or antistatic upper).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18899:2004, *Rubber — Guide to the calibration of test equipment*

3 Principle

The resistance between two positions on a product is measured, using a defined system of electrodes, by a system suited to factory inspection or service testing.

4 Apparatus and materials

4.1 Test instrument

The test shall be made with an instrument having a nominal open-circuit voltage of 500 V DC, preferably an insulation tester (ohmmeter), or with any suitable instrument known to give comparable results.

The instrument shall be sufficiently accurate to determine the resistance within 10 % and shall not dissipate more than 3 W in the product.

The resistance values obtained will vary with the applied voltage, and errors can occur when low test voltages are involved. In cases of dispute, the voltage applied to the product shall be not less than 40 V, except where this conflicts with the requirement not to dissipate more than 3 W in the product.

4.2 Electrodes and contacts

Unless otherwise specified in the product standard, electrodes shall be formed on the surface by means of a conductive silver lacquer, colloidal graphite or a conductive liquid of the following composition:

— anhydrous polyethylene glycol (of molecular mass 600): 800 parts by mass;

— water: 200 parts by mass;

— any suitable wetting agent: 1 part by mass;

— potassium chloride: 10 parts by mass.

When a conductive liquid is used, the electrode contact area shall be completely wetted and shall remain so until the end of the test.

The conductive silver lacquer or colloidal graphite shall be dried in air at room temperature; the surface resistivity of the dried film shall be below 100 Ω.

Clean metal contacts shall be applied to the electrodes so that the contact area is approximately the same size as, but not greater than, the electrodes, unless otherwise specified.

The surface of the product shall not be deformed either during the application of the contacts or during the test, unless specified in the product standard. The product shall be supported on an insulating surface except when otherwise specified. The insulating surface shall be such that its volume resistivity is greater than 10^{10} Ω·m or sufficiently great that, when using two electrodes as described in 8.1 on the insulating surface, the resistance is too great to be indicated using the instrument used to test the product.

5 Calibration

The test apparatus shall be calibrated in accordance with the schedule given in Annex A.

6 Test conditions

6.1 Test atmospheres

All tests shall be carried out under one of the following sets of standard laboratory conditions:

(23 ± 2) °C and (50 ± 5) % relative humidity

or

(27 ± 2) °C and (65 ± 5) % relative humidity.

However, where very large products are being tested, it is permissible, by agreement between supplier and customer, to use the conditions prevailing in the factory, warehouse or laboratory, provided that the relative humidity is not more than 70 %. The temperature and humidity shall then be reported.

6.2 Time-interval between forming and testing

The minimum time-interval between product manufacture and testing shall be 16 h. Whenever possible, the time-interval between manufacture and testing should not exceed 3 months. In other cases, tests shall be made within 2 months of receipt of the product by the customer.

6.3 Temperature and humidity conditioning

The products shall be conditioned for at least 16 h under one of the following sets of standard laboratory conditions:

(23 ± 2) °C and (50 ± 5) % relative humidity

or

(27 ± 2) °C and (65 ± 5) % relative humidity.

However, where very large products are being tested, it is permissible, by agreement between the supplier and customer, to use the conditions prevailing in the factory, warehouse or laboratory, provided that the relative humidity is not more than 70 %.

6.4 Mechanical conditioning

During the time-interval between manufacture and testing, or between receipt of the product and testing, the product shall be subjected to one of the following conditions:

a) Maintain in the undeformed state at room temperature without straining in any way.

b) Strain once to the maximum limit to which the product is strained in normal use. Thereafter, maintain at standard laboratory temperature.

NOTE The two methods a) and b) will not necessarily give the same results. The choice of method will normally be stated in the relevant product standard.

7 Procedure

7.1 Cleaning

Clean the surfaces of the product by rubbing with a paste of fuller's earth (aluminium magnesium silicate) and water, washing with distilled water and allowing to dry at a standard laboratory temperature. Do not buff or abrade the test surfaces.

7.2 Application of electrodes

Apply the electrodes and metal contacts (4.2) as appropriate to the product to be tested as described in Clause 8.

7.3 Reconditioning

Recondition the product for not less than 15 min and not more than 2 h under the conditions specified in 6.3.

7.4 Determination

Support the product on an insulating surface (see 4.2) and apply the voltage in an appropriate manner as described in Clause 8, taking the resistance reading (5 ± 1) s after the application of the voltage.

As some materials are sensitive to moisture, take care to avoid breathing on the samples prior to and during the test.

7.5 Number of tests

The number of tests shall be decided in accordance with the following criteria, in order of preference:

a) by reference to an International Standard for the particular product, if one exists;

b) by applying the following principles:

1) for small products such as furniture feet and for products used between defined contact points, one test shall be made;

2) for other products such as tyres, sheeting, belting and pads, at least five tests shall be made on different areas chosen so that the tests will be representative of the electrical properties of the whole article.

8 Procedural details applicable to different products

8.1 Tests on one surface

Apply electrodes to two areas, each a square with sides approximately 25 mm long and such that the distance between the facing edges is (50 ± 5) mm, located on the same surface of the product being tested.

Apply metal contacts to the electrodes and measure the resistance.

8.2 Tests between two surfaces

Apply electrodes to two areas, each approximately 25 mm square. The test areas shall be located so that the results represent the electrical resistance of the normal discharge path in the working conditions anticipated. Specifications for particular products will normally state the location of the test areas.

Apply metal contacts to the electrodes and measure the resistance.

8.3 Tests on products bonded or clamped to metal parts

8.3.1 Products bonded or clamped to one metal part

Apply an electrode to an area as nearly as possible 25 mm square on the working surface of the product; the area shall not extend to other surfaces.

Apply a metal contact to the electrode and measure the resistance from this contact to the bonded or clamped metal.

8.3.2 Products bonded or clamped to two metal parts

Measure the resistance between the metal parts.

8.4 Tests on tubing

8.4.1 Tests between inside surface and outside surface

Two tests shall be carried out in accordance with a) and b):

a) Apply electrodes on the inside surface at one end (A) of the tubing and on the outside surface at the other end (B). The electrodes shall be 25-mm-wide bands extending around the complete circumference.

Apply metal contacts to the electrodes and measure the resistance.

b) Proceed as specified in 8.4.1 a), but with the electrodes situated on the inside surface at B and on the outside surface at A.

Ensure that there are no stray leakage paths in parallel with the product resistance and that no electrically conductive contact takes place between coils of the tubing.

8.4.2 Tests on tubing over 6 m in length

Apply electrodes on the inside surface at one end of the tubing and on the outside surface at distances of 3 m and 6 m from the same end. The electrodes shall be 25-mm-wide bands extending around the complete circumference.

Apply metal contacts to the electrodes. Measure the resistance R_a between the inside contact and that at 3 m and the resistance R_b between the inside contact and that at 6 m. The difference between the values R_a and R_b shall be regarded as the resistance for 3 m of the tubing, provided that no reading exceeds $10^7\ \Omega$. If any reading exceeds $10^7\ \Omega$, thoroughly check all electrodes and repeat the test.

Ensure that there are no stray leakage paths in parallel with the product resistance and that no electrically conductive contact takes place between coils of the tubing.

8.4.3 Tests on tubing with permanently attached end fittings

Measure the resistance between the fittings.

9 Test report

The test report shall include the following information:

a) a full description of the product tested and its origin;

b) test method:

   1) a reference to the test method used, i.e. the number of this International Standard,

   2) details of the particular procedure used (see Clause 8);

c) test details:

   1) the standard laboratory temperature and relative humidity used,

   2) the time, temperature and relative humidity of conditioning prior to the test,

   3) the temperature of test, if other than a standard laboratory temperature, and the relative humidity,

   4) the electrode material and electrode size,

   5) the distance between the nearest edges of the electrodes,

   6) whether or not mechanical conditioning was carried out (see 6.4) and, if so, details of the straining,

   7) details of any procedures not specified in this International Standard;

d) test results:

   1) the number of products tested,

   2) the individual test results,

   3) the mean of the results;

e) the date of the test.

Annex A
(normative)

Calibration schedule

A.1 Inspection

Before any calibration is undertaken, the condition of the items to be calibrated shall be ascertained by inspection and recorded in any calibration report or certificate. It shall be reported whether calibration is carried out in the “as-received” condition or after rectification of any abnormality or fault.

It shall be ascertained that the apparatus is generally fit for the intended purpose, including any parameters specified as approximate and for which the apparatus does not therefore need to be formally calibrated. If such parameters are liable to change, then the need for periodic checks shall be written into the detailed calibration procedures.

A.2 Schedule

Verification/calibration of the test apparatus is a mandatory part of this International Standard. However, the frequency of calibration and the procedures used are, unless otherwise stated, at the discretion of the individual laboratory, using ISO 18899 for guidance.

The calibration schedule given in Table A.1 has been compiled by listing all of the parameters specified in the test method, together with the specified requirement. A parameter and requirement can relate to the main test apparatus, to part of that apparatus or to an ancillary apparatus necessary for the test.

For each parameter, a calibration procedure is indicated by reference to ISO 18899, to another publication or to a procedure particular to the test method which is detailed (whenever a calibration procedure which is more specific or detailed than that in ISO 18899 is available, it shall be used in preference).

The verification frequency for each parameter is given by a code-letter. The code-letters used in the calibration schedule are:

C requirement to be confirmed, but no measurement;

N initial verification only;

S standard interval as given in ISO 18899;

U in use.

Table A.1 — Calibration frequency schedule

Parameter	Requirement	Subclause in ISO 18899:2004	Verification frequency guide	Notes
Insulation tester	Accurate to 10 %	14.4	S	Any suitable instrument
Voltage (open circuit)	500 V DC	14.2	S	
Power dissipation	≤3 W	C	U	
Lowest voltage (on load)	40 V	14.2	S	Except where this conflicts with ≤3 W power dissipation requirement
Surface resistivity of electrode film	<100 Ω	14.4	U	
Metal contacts	Clean and not larger than electrodes but approximately same size	C	U	
Surface of product	Not deformed	C	U	
Volume resistivity of insulating surface	$>10^{10}$ Ω·m	14.4	N	Or, when using two electrodes, too great to be indicated
Square electrodes	25 mm square, (50 ± 5) mm apart	C, 15.2	U	Approximately 25 mm square for tests between surfaces
Band electrodes	25 mm wide	C	U	Around complete circumference
Stray leakage paths	Check that none present	C	U	
Position of second electrode when testing tubing more than 6 m long	3 m and 6 m from end at which first electrode is fitted	C	U	
Materials	Conductive liquid to formula given in 4.2, silver lacquer or colloidal graphite	C		
	Fuller's earth paste	C		
	Distilled water	C		

In addition to the items listed in Table A.1, use of the following is implied, all of which need calibrating in accordance with ISO 18899:

— a timer;

— a thermometer for monitoring the conditioning and test temperatures;

— a hygrometer for monitoring the conditioning and test humidities;

— instruments for determining the dimensions of the test products.

Bibliography

[1] ISO 1853, *Conducting and dissipative rubbers, vulcanized or thermoplastic — Measurement of resistivity*

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