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

Caoutchouc vulcanisé — Produits antiélectrostatiques 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 2878 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products.*

This second edition cancels and replaces the first edition (ISO 2878 : 1978), of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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

0 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 an article 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 conductiviy can be produced. The conductive network is sensitive to strain, and the electrical resistance of the material varies according to the degree of strain and the time and temperature history after strain. Antistatic properties may 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.

1 Scope and field of application

This International Standard specifies a method of test to determine the electrical resistance of antistatic and conductive articles and products manufactured wholly or in part from rubber whose electrical resistance measured between defined points, when new, does not exceed $1 \times 10^8\ \Omega$ 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.

It does not apply to:

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

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

The tests are carried out on the finished product, using a defined system of electrodes, by a system suited to factory inspection or service testing.

This International Standard is intended to be used in conjunction with ISO 2882 and ISO 2883, which specify resistance limits for specific products.

NOTE — Only if their suitablility has been established experimentally should these methods of test be used for products not covered by this International Standard (for example, products in which the electrical conductivity is not obtained by the addition of carbon black and/or other appropriate substances to the bulk material or which have a substantial area of insulating material).

2 References

ISO 471, *Rubber — Standard temperatures, humidities and times for the conditioning and testing of test pieces.*

ISO 1853, *Conducting and antistatic rubbers — Measurement of resistivity.*

ISO 2882, *Rubber, vulcanized — Antistatic and conductive products for hospital use — Electrical resistance limits.*

ISO 2883, *Rubber, vulcanized — Antistatic and conductive products for industrial use — Electrical resistance limits.*

3 Apparatus

3.1 Testing instruments

The test shall be made with an instrument having a nominal open circuit voltage of 500 V d.c., preferably an insulation tester (ohm meter), 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 may occur when low test voltages are involved. In case 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 test piece.

3.2 Electrodes and contacts

Except for the method specified in 6.9, electrodes shall be formed on the surface by means of a conductive silver lacquer, colloidal graphite or a conductive liquid.

The conductive liquid shall consist of:

— 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, except where otherwise stated.

With electrodes other than the liquid type and where specified below for liquid electrodes, the product specification shall state the mass of the metal contacts.

The surface of the product shall not be deformed either during the application of the contacts or during the test, except as necessary to comply with 6.5.1 and 6.5.2. The product shall be supported on an insulating surface except when otherwise specified. The insulating surface shall be such that its surface resistivity is greater than 10^{10} Ω·m or sufficiently great that, when using two electrodes as described in 6.1 on the insulating surface, the resistance is too great to be indicated using the instrument used to test the product.

4 Test conditions

4.1 Test atmospheres

All tests shall be carried out under one of the following laboratory conditions in accordance with ISO 471:

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

or

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

However, where very large articles 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.

4.2 Time-interval between vulcanization and testing

The minimum time-interval between vulcanization and testing shall be 16 h.

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

4.3 Temperature and humidity conditioning

The articles shall be conditioned for at least 16 h in one of the following standard laboratory conditions in accordance with ISO 471:

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

or

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

However, where very large articles 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 %.

4.4 Mechanical conditioning

During the time-interval between manufacture and testing, or between receipt of the product and testing, the article shall be subjected to either 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 should therefore be stated in the relevant product standard.

5 Procedure

5.1 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.

In the case of hoses, dry fuller's earth shall be used.

5.2 Application of electrodes

Apply the electrodes and metal contacts (3.2) as appropriate to the article to be tested as described in clause 6.

5.3 Reconditioning

Recondition the article for not less than 15 min and not more than 2 h under the conditions specified in 4.3.

5.4 Determination

Support the product on an insulating surface and apply the voltage in the manner appropriate to the article as described in

clause 6, taking the resistance reading 5 ± 1 s after the application of the voltage.

NOTE — As some materials are sensitive to moisture, care should be taken to avoid breathing on the samples prior to and during the test.

5.5 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 reference to the appropriate part of clause 6, if given there;

c) by applying the following principles:

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

2) for other articles 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.

All the test results shall be within the specified limits unless otherwise stated.

6 Procedural details applicable to different articles

NOTE — The procedural details in this clause apply to various products, 6.1 and 6.2 being suitable for a number of different products as indicated in ISO 2882 and ISO 2883. Unless otherwise specified in this clause, the procedures of clauses 3 to 5 should also be followed.

6.1 Tests on one surface

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

Apply the metal contacts to the electrodes and measure the resistance.

6.2 Tests between two surfaces

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

Apply the metal contacts to the electrodes and measure the resistance.

6.3 Tests on products bonded or clamped to metal parts

6.3.1 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.

NOTE — For tyres for hospital furniture, the test may be carried out by placing the tyre on an insulated wet metal plate wetted with tap water containing a small quantity of wetting agent and measuring the resistance between the plate and the hub of the wheel.

6.3.2 Products bonded or clamped to two metal parts

Measure the resistance between the metal parts.

6.4 Tests on tubing

6.4.1 Tests between inside surface and outside surface

Two tests shall be carried out in accordance with 6.4.1.1 and 6.4.1.2.

6.4.1.1 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 round the complete circumference.

Apply the metal contacts to the electrodes and measure the resistance.

6.4.1.2 Proceed as specified in 6.4.1.1, with the electrode situated on the inside surface at B and outside surface at A.

NOTE — 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.

6.4.2 Tests on tubing over 6 m in length, on ends only

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 and extend around the complete circumference.

Apply the 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.

NOTE — 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.

6.4.3 Tests on tubing with permanently attached metal end fittings

Measure the resistance between the fittings.

6.5 Tests on anaesthetic breathing bags

6.5.1 Bag with loop and neck

Apply electrodes on the loop of the bag (not to extend to the body of the bag) and inside the neck of the bag. The latter electrode shall be a 25 mm wide band around the circumference.

Suspend the bag by the loop on a 6 mm diameter metal rod and insert in the neck of the bag a metal tube 5 to 10 % larger in diameter than the neck.

Measure the resistance between the rod and the tube.

6.5.2 Bag with two necks

Two tests shall be carried out:

6.5.2.1 Apply electrodes inside the necks of the bag and to an area approximately square with 25 mm sides in the centre of the outside surface of the bag. The electrodes inside the necks shall be 25 mm wide bands around the circumference. Insert in each neck of the bag a metal tube 5 to 10 % larger in diameter than the neck.

6.5.2.2 Apply the metal contact to the central electrode and to one of the tubes. Measure the resistance. Then measure the resistance from the central electrode to the other tube.

6.5.3 Bag with one neck and no loop

Apply electrodes inside the neck of the bag and to an area approximately square with 25 mm sides in the centre of the outside surface of the bag. The electrode inside the neck shall be a 25 mm wide band around the circumference. Insert in the neck a metal tube 5 to 10 % larger in diameter than the neck.

Apply the metal contact to the central electrode. Measure the resistance between the tube and the central contact.

6.6 Tests on furniture feet

Apply electrodes to the whole of the bottom surface of the cavity into which the leg of the furniture fits and to the whole of the surface normally in contact with the floor.

Apply the metal contacts to the electrodes and measure the resistance.

6.7 Tests on furniture buffers, textile cots and aprons

Apply electrodes to the surfaces which would normally make the contacts to provide the electrical path so that the resistance through the article is measured. The dimensions of the electrodes shall be as large as practicable but should not extend beyond the contacting areas, and should not exceed 25 mm square.

Apply the metal contacts to the electrodes and measure the resistance.

6.8 Test on detachable tyres having tread-to-rim conduction

Apply electrodes to three areas each approximately 25 mm square. One test area shall be located on the external portion of each bead of the tyre which will be in contact with the flange of the rim, and the third on the centre line of the tread.

Apply metal contacts to the electrode on the centre line and to each of the others in turn and measure the two resistances.

6.9 Tests on footwear

Antistatic footwear shall be tested according to 6.9.1 and 6.9.2. Conductive footwear shall be tested according to 6.9.1 only.

6.9.1 Wet/wet electrode system

With the footwear resting with the heel and sole in contact with a metal plate, wetted with tap water containing a small quantity of a wetting agent, apply a metal contact to a liquid electrode 25 mm × 25 mm inside the footwear in the sole area of the insole and measure the resistance. Repeat this procedure with the liquid electrode in the heel area and measure the resistance. It is permissible to place a thoroughly wetted fabric pad between the metal plate and the footwear.

For the antistatic footwear, take the lower reading as the minimum resistance value.

For conductive footwear, take the lower reading as the maximum resistance value.

In the case of dispute, the resistance shall be measured with a force of 45 N applied to the 25 mm square electrode and a similar force applied in the sole area when the electrode is in the heel area and vice versa and for antistatic footwear only, the test voltage shall be not less than 200 V d.c.

NOTE — Combined electrodes consisting of a metal electrode enclosed in a moistened pad may be used in place of the internal liquid electrode/metal plate system.

6.9.2 Wet/dry electrode system

With the footwear resting with heel and sole in contact with a dry metal plate, apply a metal contact to a 25 mm × 25 mm liquid electrode inside the footwear in the sole area of the insole and measure the resistance. Repeat the procedure with the electrode in the heel area and measure the resistance.

Take the lower reading as the maximum resistance value.

In the case of dispute, the resistance shall be measured with a force of 45 N applied to the 25 mm square electrode and a similar force applied in the sole area when the electrode is in the heel area and vice versa.

NOTE — Combined electrodes consisting of a metal electrode enclosed in a moistened pad may be used in place of the internal liquid electrode/metal plate system.

6.10 Tests on flat transmission belting

Apply electrodes on two areas each 25 mm wide and extending across the full width of the belt and separated by a dry distance of 600 ± 12 mm on the face of the belt which will make contact with the pulley.

Apply the contacts to the electrodes and measure the resistance.

For endless belting less than 3 m long, the dry distance shall be reduced to 100 ± 5 mm.

6.11 Tests on synchronous belts (toothed transmission belts)

Without cutting the belt, and using insulating clamps, lightly clamp flat a length of belt comprising at least seventeen teeth (with the teeth uppermost) on to an insulating surface. Apply liquid electrodes to two areas on the toothed side of the belt and extending across the full width of the belt. The electrodes shall each cover the top surface of three adjacent teeth and the sides and bottoms of the two grooves between them and shall extend across the width of the belt. The dry distance between the electrodes shall span seven grooves and six teeth.

Apply to each electrode a flat metal contact which covers the top surfaces of the three teeth. Apply to these surfaces a pressure of between 10 and 40 kPa.

Measure the resistance between the contacts.

7 Test report

The test report shall include the following particulars:

a) full identification of the article tested;

b) reference to the method of test used (for example, ISO 2878, 6.8);

c) temperature and humidity of conditioning;

d) temperature and humidity of testing;

e) electrode material and size;

f) distance between the nearest edges of the electrodes;

g) each individual test result;

h) the average test result;

i) whether or not mechanically strained (see 4.4) and, if strained, details of straining.

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