SLOVENSKI STANDARD
SIST HD 438 S1:1998

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Method of test for electrical resistance and resistivity of insulating materials at elevated temperatures (IEC 60345:1971)

Method of test for electrical resistance and resistivity of insulating materials at elevated temperatures

Prüfverfahren für den elektrischen Durchgangswiderstand und den spezifischen Widerstand von Isolierstoffen, bei erhöhten Temperaturen

Méthode d'essai pour la résistance d'isolement et la résistivité transversale des matériaux isolants à des températures élevées

Ta slovenski standard je istoveten z: **HD 438 S1:1984**

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METHOD OF TEST FOR ELECTRICAL RESISTANCE AND RESISTIVITY OF INSULATING MATERIALS AT ELEVATED TEMPERATURES

Méthode d'essai pour la résistance d'isolement et la résistivité transversale des matériaux isolants à des températures élevées

Verfahren zur Prüfung des elektrischen Widerstandes und des spezifischen elektrischen Widerstandes von Isolierstoffen bei erhöhten Temperaturen

BODY OF THE HD

The Harmonization Document consists of:

- IEC 345 (1971) ed 1; IEC/SC 15A, not appended

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The English and French versions of this Harmonization Document are provided by the text of the IEC publication and the German version is the official translation of the IEC text.

According to the CENELEC Internal Regulations the CENELEC member National Committees are bound:

to announce the existence of this Harmonization Document at national level by or before 1984-07-01

to publish their new harmonized national standard by or before 1985-07-01

to withdraw all conflicting national standards by or before 1985-07-01.

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Method of test for electrical resistance and resistivity of insulating materials at elevated temperatures

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

METHOD OF TEST FOR ELECTRICAL RESISTANCE AND RESISTIVITY OF INSULATING MATERIALS AT ELEVATED TEMPERATURES

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote this international unification, the IEC expresses the wish that all National Committees having as yet no national rules, when preparing such rules, should use the IEC recommendations as the fundamental basis for these rules in so far as national conditions will permit.

4) The desirability is recognized of extending international agreement on these matters through an endeavour to harmonize national standardization rules with these recommendations in so far as national conditions will permit. The National Committees pledge their influence towards that end.

PREFACE

This Recommendation has been prepared by Sub-Committee 15A, Short-Time Tests, of IEC Technical Committee No. 15, Insulating Materials.

A first draft was discussed at the meeting held in Venice in 1963. A new draft was discussed at the meeting held in Tel-Aviv in 1966. As a result of this latter meeting, a final draft was submitted to the National Committees for approval under the Six Months' Rule in September 1968.

The following countries voted explicitly in favour of publication:

Australia
Belgium
Canada
Czechoslovakia
Denmark
Finland
France
Germany
Israel
Italy
Korea (Democratic People's Republic of)
Netherlands
Romania
South Africa
Sweden
Switzerland
Turkey
Union of Soviet Socialist Republics
United Kingdom
Yugoslavia

METHOD OF TEST FOR ELECTRICAL RESISTANCE AND RESISTIVITY OF INSULATING MATERIALS AT ELEVATED TEMPERATURES

1. Scope

This test method covers procedures for the determination of insulation resistance and volume resistivity of insulating materials at temperatures up to at least 800 °C.

The measurements shall be made in accordance with IEC Publication 93, Recommended Methods of Test for Volume and Surface Resistivities of Electrical Insulating Materials, and with IEC Publication 167, Methods of Test for the Determination of the Insulation Resistance of Solid Insulating Materials, utilizing the following special procedures.

2. Preparation of specimens and electrodes

For *insulation resistance* measurements, the specimens may be of any suitable size and shape and may have electrodes already attached (see IEC Publication 167). When *volume resistivity* is measured, the specimens shall preferably be in the form of disks, a three electrode system shall be used, one of which is a guarded electrode. The thickness variation between any two places on the disk shall be no greater than 5% of the mean thickness. The specimen electrodes shall preferably be circular and consist of fired-on conducting paint or a conducting coating evaporated or sprayed onto the specimen faces. Gold or platinum are suitable electrode metals. Silver should not be used since it migrates at elevated temperatures. Thin layers of gold may lose their conductivity since the gold may agglomerate at the higher temperatures. It is difficult to apply evaporated or sprayed-on electrodes to porous test specimens and the results obtained with them are of doubtful value. To minimize surface effects at the edges of the specimen (due sometimes to handling in specimen preparation), it is recommended that if no guarded electrode is used, the minimum distance from the electrodes to the specimen edge shall be 0.5 cm.

3. Test equipment

3.1 *Resistance measurement (see Figure 1, page 12)*

The resistance between electrodes shall be measured with a suitable device having the required sensitivity and accuracy (see IEC Publication 93).

3.2 *Heating chamber*

For heating the specimen, a suitable electric oven or furnace shall be used. The construction shall be such that the specimen is subjected to a uniform temperature throughout its total volume with temperature fluctuations as small as possible. An adequate muffle should be provided to shield the specimen from direct radiation by the heating elements. This muffle may be made of a ceramic such as aluminum oxide or equivalent. A grounded metallic shield of silver, stainless steel or equivalent metal shall also be provided within the oven. The shield shall act as a guard to prevent leakage currents between the heating circuit and the measuring circuit. In the case of very high resistance specimens, it may be necessary to disconnect the heating element to prevent interference during the measurement.

3.3 *Specimen holder*

The specimens shall be mounted securely between two electrode backing plates within the heating chamber. These backing plates and their respective leads should be made of a metal which is mechanically stable and resistive to oxidation. High-heat-resistant alloys such as stainless steel may also be utilized. Alternatively, the tests may be performed in an inert atmosphere. The backing plates shall be of sufficient thickness to prevent warping and to provide heat equalization between the specimen and the electrode backing plates. The contact faces of the plates should be equal in size to the specimen electrodes, and one electrode backing plate should be movable so as to allow insertion and removal of the test specimen.

3.4 *Measuring leads*

Insulated measuring leads should be brought into the furnace through high-resistance ceramic insulators located in a cool zone and adequately guarded so as to prevent leakage current from affecting the test results.

Note. — Alternatively, the leads may be passed through holes in the top or in a wall of the furnace (which should be earthed). If stiff leads are used, they can be supported externally so as not to touch anything but their supports. The supports will be relatively cool and thus can be made of any rigid insulating material.

3.5 *Temperature control*

A means of temperature control shall be provided which can maintain temperature tolerances according to IEC Publication 212, Standard Conditions for Use prior to and during the Testing of Solid Electrical Insulating Materials. The use of two thermocouples is recommended, one in the chamber for control and a second for the direct measurement of the specimen temperature.

The temperature of the specimen shall be measured using a thermocouple mounted as close as possible to the specimen without causing electrical interaction with the measurement of resistance. For example, the thermocouple may be inserted directly into a hole extending almost to the surface of the backing plate adjacent to the specimen (see Figure 1, page 12). The hole may be drilled from the opposite face of the plate perpendicular to the surface of the specimen or from the side of the plate parallel to the specimen surface. If the thermocouple is mounted within the electrode backing plate, the leads and the temperature-indicating instrument must be adequately insulated or the thermocouple must be disconnected or removed when measurements are made.

3.6 *Special precautions during measurements*

If the material insulating the leads into the oven is subjected to heat, the insulation resistance of the lead insulation may become low enough to affect the measurements. Since the circuit is earthed between the current-measuring instrument and the voltage source (both sides of the specimen being insulated from earth), the conductance between the high potential lead and earth can be ignored if it does not constitute too large a current drain on the voltage source. A conductance between the low potential lead and earth constitutes a shunt across the current-measuring instrument. The resistance to earth of the measuring electrode must be high (10 to 100 times) as compared to the input resistance of the current-measuring instrument (which may be as much as 10^{11} Ω for the most sensitive instruments). The leakage resistance must be determined by a separate measurement at each temperature. Thermocouple potentials between dissimilar metals, when they are used in leads and electrode holders, can cause measurement errors. A measurement of current, with the supply voltage replaced by a short circuit, will indicate the magnitude of this thermocouple effect.

4. Conditioning

The conditioning which a specimen should receive depends upon the material being tested; it should be specified in the material specification and should be selected from among those listed in Table I of IEC Publication 212.

5. Procedure

5.1 *Continuously increasing temperature (Method A)*

This method is suitable for obtaining quickly an approximate relationship between resistance and temperature of a single specimen over a wide temperature range. The method is suitable only with materials for which the effects of dielectric absorption* can be neglected, or for obtaining comparative results for similar materials.

The specimen shall be mounted tightly between the electrode backing plates, but not so tightly that the specimen is distorted while being heated. The specified voltage shall be applied to the test specimen and the temperature shall be increased at a rate depending on the thickness of the material and not higher than 5 deg C per minute.

A sufficient number of resistance measurements shall be made, as the temperature is increased, so as to define adequately the relationship between resistance and temperature.

5.2 *Increasing the temperature by steps (Method B)*

This method is suitable for obtaining the relationship between resistance and temperature of a single specimen more accurately than is possible with continuously increasing temperature. It is useful also with specimens for which dielectric absorption is a problem. The method is also convenient when more than one specimen is to be tested. The need to wait for thermal equilibrium of each specimen, when several specimens are to be measured, is avoided if a specimen holder is provided for each specimen or if a means is provided for transferring the specimens from the heating chamber to the specimen holder without opening the chamber.

The test specimen shall be mounted tightly between the electrode backing plates but not so tightly that the specimen is distorted while being heated. The temperature of the test specimen shall be increased as rapidly as possible from room temperature to the desired test temperature** and subsequently from each test temperature step to the next.

When the temperature of the electrode backing plate is within 2 deg C or 1% (whichever is larger) of the desired test temperature, the voltage specified in the material specification shall be applied to the specimen for 1 min (or for other times as specified) and the resistance shall then be measured. When the measurement is completed, the voltage shall be removed and the high voltage, measuring and guarded (if used) electrodes shall be connected to each other (short-circuited).

A sufficient number, but no less than five, test temperatures shall be selected to define adequately the relationship between temperature and resistance over the desired range of temperatures. At the lower temperatures, the temperature increments should be relatively small, e.g. 10 deg C. As the test temperature is increased, the temperature increments should also be increased.

Note. — The logarithm of resistance (or resistivity) is often plotted as a function of the reciprocal absolute temperature.

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* Dielectric absorption in some cases may reduce the short-time value of resistance compared to the long-time value by a factor of as much as 100.

** The test chamber should be controlled in such a manner that the temperature of the electrode backing plate does not exceed the desired test temperature.