

# इंटरनेट

# मानक

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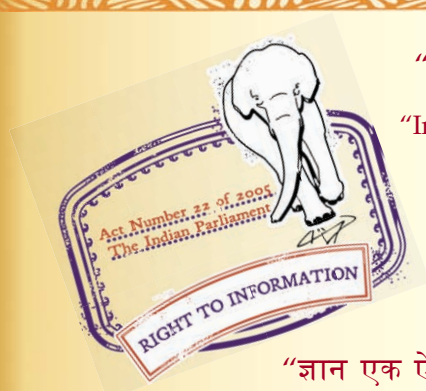
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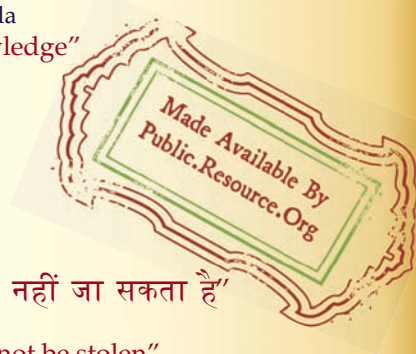
IS 10810-13 (1984): Methods of test for cables, Part 13:  
Ozone resistance test [ETD 9: Power Cables]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



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*Indian Standard*

## METHODS OF TEST FOR CABLES

## PART 13 OZONE RESISTANCE TEST

**1. Scope** — Covers a method for estimating the resistance of elastomeric material of electric cable to ozone attack.

**2. Significance** — Unsaturated polymeric materials when exposed to ozone undergo degradation revealing the same as cracks. Amount of degradation depends on the test temperature, material, ozone concentration and mechanical strain. This test is designed to find out static resistance of polymeric material to ozone.

**3. Terminology** — Ozone resistance of elastomeric materials is defined as their ability to withstand degradation when exposed to ozone.

**4. Apparatus****4.1 Test Chamber**

**4.1.1** The test chamber shall be constructed of a material which has no reaction with ozone and shall be large enough to accommodate largest test sample.

**4.1.2** A means for generating and controlling an air-ozone stream shall be provided. The generating source shall be located outside of the chamber. Adequate filtration of foreign matter from the stream shall be provided. The air-ozone stream shall be introduced into the chamber in such a manner that stratification of ozone is prevented.

**4.1.3** The air-ozone replacement rate or throughput rate shall be 7 to 9 changes per hour.

**4.1.4** A means of controlling the temperature of the chamber from ambient to 70°C shall be provided. The temperature regulation should be capable of maintaining the test temperature within  $\pm 1^\circ\text{C}$ .

**4.2 Ozone Generator** — It consists of concentric electrodes, separated by a thin glass dielectric, between which voltage may be applied. This generator may be supplied by a potential transformer which is equipped with a variable voltage control rated between 20 and 30 kV.

**4.3 Means for Determining the Percentage of Ozone Concentration** — ( See Appendix A ).

**4.4 Mandrel** — To meet the requirements for bending the test specimens, given in 6.3.

**5. Material** — Chemical reagents ( see Appendix A ), if chemical analysis method is used for determining ozone concentration.

**6. Test Specimen**

**6.1** Whether the cable is single or multicore, only one core need be tested. Sufficient length of core shall be cut from a position not less than 1.5 m from the end of the length of cable to provide two test pieces, unless the core has an extruded semi-conductor layer on the outside, when the length sufficient for four test pieces shall be taken.

**6.2 Preparation of Test Specimens** — Any protective coverings present on the core shall be removed, unless they were applied directly to the insulation prior to vulcanization and adherent to it, without damaging the insulation. If the core has a semi-conducting screen in the form of tape on the outside, this shall be removed. If the core has an extruded semi-conducting screen on the outside, this shall be removed from two test pieces and left in position on the other two.

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### 6.3 Bending of Test Specimens

**6.3.1** If the core does not have an extruded core screen, one sample shall be bent in the direction and plane of its existing curvature, without twisting, for one complete turn around a mandrel and bound with twine or tape where the ends cross, and a second test specimen of the same core shall be bent similarly in the plane of its existing curvature but in the opposite direction.

**6.3.2** If the core as manufactured has an extruded core screen, two samples, one with the semi-conducting layer removed and one with the semi-conducting layer left in position, shall be bent, as shown in 6.3.1 in each direction.

**6.3.3** The bending shall be carried out at room temperature or 27°C, whichever is higher, using a brass, aluminium or suitably treated wooden mandrel having the following diameter:

| Measured Diameter of Unbent Core |                           | Ratio of Mandrel Diameter to Core Diameter |
|----------------------------------|---------------------------|--------------------------------------------|
| Above<br>mm                      | Up to and Including<br>mm |                                            |
| —                                | 13                        | 4                                          |
| 13                               | 20                        | 5                                          |
| 20                               | 30                        | 6                                          |
| 30                               | 45                        | 8                                          |
| 45                               | —                         | 10                                         |

**6.3.4** If the test specimen is too rigid to permit the ends to be crossed, it shall be bent and tied so that at least a 180° bend of the specified diameter is obtained.

**7. Conditioning** — The surface of each test specimen shall be wiped with a clean cloth to remove dirt or moisture. The bent test specimens on their mandrels shall be kept in air at ambient temperature without any further treatment for 30 to 45 minutes before being tested.

### 8. Procedure

**8.1** The conditioned test specimens shall be exposed in a chamber fitted with a test cock and maintained at a temperature of  $27 \pm 2^\circ\text{C}$ , to a circulating current of dry air having an ozone concentration as specified for the insulating compound in the standard for the type of cable for the period specified in the cable standard. The air flow shall be between 280 and 560 l/h, and the air pressure shall be maintained slightly above atmospheric pressure.

**8.2** After the specified test duration, the test specimens shall be removed from test chamber and the insulation in 180° section of the bent portion farthest from the tie shall be examined for any cracks.

**8.3** Method for determination of ozone concentration is described in Appendix A.

### 9. Tabulation of Observations

| Test Specimen<br>Number | Ozone<br>Concentration | Test<br>Duration | Visual Examination<br>of Insulation |
|-------------------------|------------------------|------------------|-------------------------------------|
|-------------------------|------------------------|------------------|-------------------------------------|

**10. Calculation** — Appendix A gives details of calculations pertaining to determination of ozone concentration by chemical analysis method. No other calculation is involved.

### 11. Report

#### 11.1 Ozone Resistance Test for Elastomeric Material

Cable Type

Batch No./Lot No.

Cable No./Drum No.

Date of Testing

**11.2 Observations** — Cracks visible/not visible.

**11.3 Conclusion** — The specimen meets/does not meet the requirement of the specification.

## APPENDIX A

( Clauses 4.3, 8.3 and 10 )

### DETERMINATION OF OZONE CONCENTRATION

#### A-1. Chemical Analysis

##### A-1.1 Reagents

**A-1.1.1** The reagents shall be of a recognized analytical reagent quality. Distilled water shall be used throughout.

**A-1.1.2 Starch indicator solution** — 1 g of soluble starch shall be stirred into 40 ml of cold water and heated to boiling point with constant stirring until the starch is completely dissolved. This solution shall be diluted with cold water to about 200 ml and 2 g of crystallized zinc chloride added. The solution shall be allowed to settle and the supernatant liquid poured off for use. In keeping for periodic use, the solution shall be renewed every two or three days.

Alternatively, a fresh solution of 1 g of soluble starch in 100 ml of boiling water may be prepared.

When either of these starch solutions is used as an indicator, a few drops of 10 percent acetic acid shall be added to the solution being titrated.

**A-1.1.3 Standard iodine solution** — 2 g of potassium iodide ( KI ) and 10 ml of water shall be placed in a weighing tube, which shall then be weighed. Iodine shall be added directly to the solution in the tube on the balance pan until the total iodine in solution is about 0.1 g. The solution with the added iodine shall be accurately weighed and the amount of added iodine determined. The solution shall then be poured into a beaker. The weighing tube, held over the beaker, shall be washed with water. The solution shall be poured from the beaker into a flask calibrated at 1 000 ml, the beaker rinsed with water into the flask and the solution in the flask diluted to 1 000 ml.

**Note** — This solution is fairly stable if kept in a cool dark place in a well-stoppered brown bottle.

**A-1.1.4 Sodium thiosulphate solution** — Sodium thiosulphate (  $\text{Na}_2\text{S}_2\text{O}_3$  ) solution of approximately the same strength as the standard iodine solution shall be prepared by placing about 0.24 g of  $\text{Na}_2\text{S}_2\text{O}_3$  in a 1 000 ml flask and diluting to 1 000 ml. Since it gradually loses its strength, the solution shall be standardized against the iodine solution on the day of the ozone test.

The strength of the  $\text{Na}_2\text{S}_2\text{O}_3$  solution, calculated as iodine equivalence and expressed as milligrams of iodine per millilitre of the solution, is:

$$\frac{F \times C}{S}$$

where

$F$  = volume of the iodine solution in millilitres,

$C$  = concentration of iodine in milligrams per millilitre, and

$S$  = volume of the  $\text{Na}_2\text{S}_2\text{O}_3$  solution required for titration in millilitres.

**A-1.1.5 Potassium iodide solution** — About 20 g of pure potassium iodide ( KI ) shall be dissolved in 2 000 ml of water.

**A-1.1.6 Acetic acid** — A 10 percent solution ( by volume ) shall be prepared.

##### A-1.2 Procedure

**A-1.2.1** A measured volume of the air containing ozone shall be bubbled from the test chamber through the KI solution, or, a measured volume of the air containing ozone shall be collected and mixed with the KI solution, by a suitable means.

Two alternative methods which may be employed are given in **A-1.2.2** and **A-1.2.3**.

**A-1.2.2** A sampling bottle containing 100 ml of KI solution is connected to the sampling cock of the test chamber on one side and to a 500 ml gas burette on the other. The glass tube connecting the sampling bottle to the sampling cock of the gas chamber reaches well below the level of the KI solution in the sampling bottle. The two-way stop-cock on the burette is opened to the atmosphere and the burette filled to its full mark with water by lifting the aspirator connected to the bottom of the burette. The stop-cock on the burette is then closed to the atmosphere and opened to the sampling bottle and the sampling cock on the test chamber is opened to the sampling bottle. The aspirator is then lowered until the water is emptied from the burette. When this point is reached, 500 ml of the gas from the test chamber will have bubbled through the KI solution. The stop-cocks are then closed and the bottle withdrawn for titration.

**A-1.2.3** A separating funnel of 400 ml capacity is filled with the KI solution and connected to the test cock of the test chamber. The test cock and the stop-cock on the bottom of the separating funnel are opened simultaneously until about 200 ml of the KI solution have drained into a graduated cylinder placed below it. The test cock and stop-cock are quickly closed and the separating funnel, which then contains a volume of gas equal to the difference between 400 ml and the volume of KI solution in the measuring cylinder is removed and stoppered. The separating funnel shall be shaken to produce complete reaction with the KI solution. The solution in the graduated cylinder shall be tested with a starch indicator for the presence of free iodine and if any free iodine is detected, the gas sample shall be rejected and another collected.

The KI solution which has reacted with a known volume of gas from the test chamber, by whatever method adopted, shall be titrated with the standardized  $\text{Na}_2\text{S}_2\text{O}_3$  solution using the starch indicator.

### **A-1.3 Calculation**

**A-1.3.1** Since 1 mg of iodine is equivalent to 0.1 ml of ozone at room temperature and pressure (within the accuracy of this method of analysis at average room temperature and pressure), the ozone concentration can be calculated as follows:

$$\text{Ozone, percent by volume} = \frac{10 \times S \times E}{V}$$

where

$S$  = volume of  $\text{Na}_2\text{S}_2\text{O}_3$  solution used to titrate the solution in millilitres,

$E$  = iodine equivalent of the  $\text{Na}_2\text{S}_2\text{O}_3$  solution in milligrams of iodine per millilitre of  $\text{Na}_2\text{S}_2\text{O}_3$ , and

$V$  = volume of the gas sample collected in millilitres.

## **A-2. Direct Measurement with an Ozonometer**

**A-2.1** As an alternative to the chemical analysis, the ozone concentration may be measured directly with an ozonometer, which has been calibrated by comparison with results obtained by the chemical method.