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IS 10810-4 (1984): Methods of test for cables, Part 4: Persulphate test of conductor [ETD 9: Power Cables]

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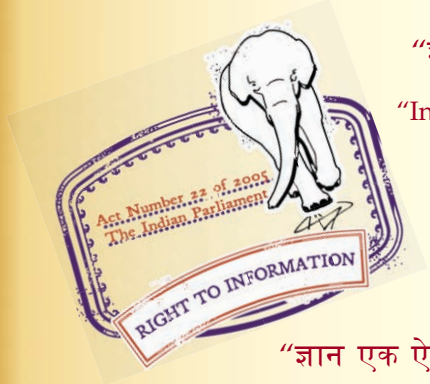

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"Knowledge is such a treasure which cannot be stolen"

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Indian Standard (Reaffirmed 2001)

METHODS OF TEST FOR CABLES

PART 4 PERSULPHATE TEST OF CONDUCTOR

[Ref : Doc : ETDC 59 (2240)] Power Cables Sectional Committee, ETDC 59; Panel for Methods of Tests for Cables, ETDC 59/P1

1. Scope — Covers two methods for determination of exposed copper in case of tinned copper wire for conductors used in electrical cables.

2. Significance — Copper wires are tinned for the following reasons:

a) To act as a barrier between bare copper conductor and elastomeric insulations to avoid degradation of the latter due to catalytic effect of copper on elastomers.

b) To avoid formation of oxide on the copper conductor which reduces the solderability of the material.

During tinning there is possibility of formation of pinholes on the conductor, thereby defeating the purpose of application of tin. The persulphate test ascertains the continuity of tin coating on the conductors.

3. Terminology

3.1 a) *Method A* — The continuity of tin coating is examined by comparing the persulphate solution in which the sample has been immersed with an equal volume of reference standard colour reagent for depth of colours.

b) *Method B* — The mass of copper dissolved is expressed as grams of copper per square metre of wire immersed in the persulphate solution.

4. Apparatus

4.1 *Porcelain or Glass Beaker* — Capacity 250 ml.

4.2 *Nesslers' Tube* — Capacity 100 ml.

4.3 *Pipette Graduated* — Capacity 100 ml.

4.4 *Balance* — Accuracy 0·1 mg.

4.5 *Volumetric Flask* — Capacity 1 000 ml.

5. Material

5.1 *Persulphate Solution* — Dissolve 10 g of fresh analytical grade crystalline ammonium persulphate [$(NH_4)_2S_2O_8$] in distilled water, add 20 ml of ammonia solution (specific gravity 0·88 at 27°C) and make up to one litre with distilled water.

The ammonium persulphate solution should be freshly prepared each day and should not be subjected to temperature above 35°C.

5.2 *Standard Colour Reagent*

a) *For Method A* — Dissolve 0·200 g of pure copper sulphate ($CuSO_4\,5H_2O$) in distilled water, add 50 ml of chemically pure solution of ammonia (specific gravity 0·88 at 27°C) and dilute to one litre.

b) *For Method B* — Dissolve 3·927 g of pure copper sulphate ($CuSO_4\,5H_2O$) in distilled water with 50 ml of ammonia solution (specific gravity 0·88 at 27°C) and make up to one litre with distilled water. One millilitre of this solution is equivalent to 0·001 g of copper.

6. Test Specimen

6.1 A test sample of length (L) equal to $\frac{300}{d} + 80$ mm (where d is the nominal wire diameter in mm) in case of Method A and a test sample of the length given in col 4 of Table 1 in case of Method B is cut from the insulated core or from each core of finished cable and the insulation is removed by any method which does not cause any injury to the tin coating, for example, the insulation may be loosened from the conductor by drawing a solvent and/or oil in the interstitial spaces of the conductor.

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6.2 Two groups of specimens of continuous length (*L*) as mentioned in **6.1** in case of Method A and two groups of specimens of continuous length, each group comprising the number of single wires given in col 5 of Table 1 in case of Method B, are taken from the test samples and marked 40 mm from each end by means of a grease pencil or in some other manner which does not cause damage to the tin coating. The groups are composed of wires selected at random from the various cores of the cables.

6.3 Each group of test specimens is wound into one helix upon a smooth mandrel, in such a manner as to ensure that no twisting moment is imparted to the wires. Those portions of the test specimens which are necessary to lead up to the 40 mm ends and provide for their projections above the surface of the testing solution in which the specimens are to be immersed are not formed to the mandrel but suitably bent for the purpose in such a way that the radius of the bends is not less than half the diameter of the mandrel used to produce the helix. The diameter of the mandrel is given below.

Diameter of Wire		*Diameter of Mandrel*
Over	Up to and Including	
mm	mm	mm
—	0·20	15
0·20	0·30	18
0·30	0·50	22
0·50	0·70	29
0·70	0·90	33
0·90	1·10	38
1·10	1·40	51
1·40	1·80	56
1·80	2·00	64
2·00	2·30	70
2·30	—	76

6.4 The helix is removed from the mandrel by slipping it off end-wise without further distortion of the wire.

6.5 A cleaning operation is carried out after the helix has been removed from the mandrel and immediately prior to its immersion in the test solution and the part to be immersed is not handled.

The method of cleaning is by the immersion of the test helix for a period of 10 s in a suitable solvent, for example, chloroform or methylated ether, contained in one vessel, followed by a similar period of immersion in solvent contained in a second vessel, the helix being agitated during each immersion and allowed to dry before immersion in the test solution. Should the colouration of the solvent due to dissolved material become discernible, the solvent is renewed, care being taken to ensure that the vessel containing the cleaner liquid is used for the second (and final) wash.

6.6 An alternative method is to clean the wire before or after the test helix is wound, by rubbing with a pad of clean cotton wool soaked in the solvent. If the insulating material is very hard to remove, it may be removed by preliminary treatment with hot solvent. In no case, however, should the test helix be straightened and rewound, or subjected to any other serious mechanical deformation for the purpose of cleaning, and in all cases the double immersion described above constitutes the final cleaning operation.

TABLE 1 TEST SPECIMENS FOR TINNING TEST (FOR METHOD B)

(*Clauses* 6.1, 6.2 and 8.1)

Diameter and Number of Wires Comprising the Conductor			Length of Test Specimens	Number of Test Specimens	Length of Test Specimen Between Marks	
Diameter		Number			For Each Specimens	Total for Each Group
Over	Up to and Including					
(1)	(2)	(3)	(4)	(5)	(6)	(7)
mm	mm		mm		mm	mm
—	0·20	10 or more	580	10	500	5 000
0·20	0·30	6 or more	1 080	5	1 000	5 000
0·30	0·75	3 or more	750	3	670	2 010
0·75	3·20	3 or more	410	3	330	990
0·75	3·20	1	1 080	1	1 000	1 000

7. Conditioning — The test is carried out under normal room temperature but immediately before the immersion of the helix the test solution is brought to a temperature of 27 ± 2°C.

8. Procedure

8.1 a) *For Method A* — After cleaning, the helix is immersed for 10 min in a vessel containing 100 ml of the persulphate solution described in **5.1** in such a manner that the surface of the wire between the marks is exposed to the testing solution and the 40 mm ends project above the surface. The helix is then removed, and the test solution compared with an equal volume of the reference standard colour reagent for depth of colours, both being taken in similar Nesslers' tube. The colour comparison should be made by viewing the solutions lengthwise through the Nesslers' tubes.

b) *For Method B* — After cleaning, the helix is immersed for 10 min in a vessel containing the persulphate solution described in **5.1** in such a manner that the surface of the wire between the marks (*see* col 6 of Table 1) is exposed to the testing solution and the 40 mm ends project above the surface.

The volume of the solution is as follows:

For wires up to and including 1·80 mm dia	75 ml
For wires above 1·80 mm dia	200 ml

The mass of copper dissolved from the wire by the persulphate solution is determined colorimetrically by comparison with the standard colour reagent described in **5.2**(b).

9. Tabulation of Observations

9.1 *For Method A*

Groups of Specimen	*Colour of the Test Solution After Immersion is Darker/Lighter than the Reference Standard Colour Reagent*

9.2 *For Method B*

Groups of Specimen	*Standard Colour Reagent Required to Match the Colour, ml*
1.	
2.	

10. Calculation

10.1 a) *For Method A* — Nil

b) *For Method B* — Surface area of immersed length, $m^2 = \pi DI$

where

D = diameter of wire in m, and

L = length of wire in m.

Mass of copper dissolved $= \frac{W}{\pi DL}$ g/m²

where

W = copper dissolved in g.

11. Report

11.1 *Persulphate Test of Conductor*

Cable Type

Batch No./Lot No.

Cable No./Drum No.

Date of Testing

11.2 *Results*

Reference Specification _____

11.2.1 *For Method A*

Specimen No.	*Colour to Reference Standard Colour Reagent*	
	Observed	Specified

11.2.2 *For Method B*

Specimen No.	*Diameter of Wire* mm	*Mass of Copper Dissolved, g/m²*	
		Observed	Specified

11.3 *Conclusion* — The sample meets/does not meet the requirements of the specification.

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