

	AMENDMENT - NOTIFICATION		AA 0851710 REV.No. 01		
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<u>AA 085 17 10 : TEST METHODS FOR INSULATING VARNISHES AND ENAMELS</u> 1. <u>Page 16 of 30: Clause 25.1.2. Weight:</u> <u>Repalce the first sentence with the following:</u> A cylinder weight of 0.9+ 0.01 kg and of diameter 60 + 1 mm and having impact ball (tip) diameter 18.7 mm at the striking end, made to fit inside the tube, shall be used. 2. <u>Page 17 of 30: Clause 25.2: Line 7:</u> Reword the sentence as '<u>Raise the weight up the tube to aheight of 30 cm unless otherwise specified in the relevant CPS.</u>'					
Please see instructions on the reverse.					
Ref: Cl. 27.8.2 of MOM of MRC (E)	Amd. No. 01	Approved MRC (E)	Issued Corp R&D	Date Oct 93	Cum. Sr. No. A 1355



CORPORATE STANDARD

AA 085 17 10

PAGE 1 OF 30

TEST METHODS FOR INSULATING VARNISHES & ENAMELS

1. SCOPE:

This standard describes the methods of sampling and various test methods for insulating varnishes and enamels.

TESTS FOR INSULATION VARNISHES/ENAMELS

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3.	Viscosity	6	
4.	Non volatile matter	7	
5.	Gel time	8	
6.	Polymerisation time	9	
7.	Fineness of grind	10	Applicable to pigmented varishes only
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9.	Compatibility	12	
10.	Skinning	13	
11.	Flash point	14	
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14.	Acid value	17	
15.	Free phenol content	18	Applicable to phenolic varnishes only.
16.	Epoxy value	19	Applicable to epoxy based varnishes only
17.	Pigment content	20	Applicable to paints only

TEST FOR VARNISHES/ENAMEL FILM

18.	Drying time	21	
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32.	Specific surface resistivity	35	Applicable to conducting/semi-conducting paints only
33.	Comparative tracking index	36	
34.	Interlaminar resistivity	37	Applicable to core plate varnishes only.

Revisions : Brought upto date
Ref.Cl.25.6.1 of MOM of MRC(E)

Approved :
**INTERPLANT
STANDARDIZATION COMMITTEE** MRC(E)

Rev. No.	Rev. Date	Revised:	Prepared	Issued	Date
01	June '92	BHOPAL	HARDWAR	CORP. R&D	March '80

2. SAMPLING:

The following precautions and directions shall be observed, while drawing samples.

1. Samples shall not be taken in an exposed place.
2. The sampling apparatus shall be clean and dry.
3. Precautions shall be taken to protect the samples, the material being sampled, the sampling apparatus and the containers for samples from adventitious contaminations.
4. Before drawing a representative sample from the selected containers, surface skin, if any, shall be carefully removed. In case of paints and enamels, the contents of each container selected for sampling shall be mixed thoroughly by shaking or stirring or both by suitable means or by rolling.
5. The samples shall be placed in clean, dry and air tight metal or opaque glass container on which the material has no action.
6. The sample containers shall be of such a size that they are almost completely filled by the sample.
7. Each sample container shall be sealed airtight after filling and marked with full details of sampling, the date of sampling and the month and year of manufacture of the material.
8. Sample shall be stored in such a manner that the temperature of the material does not vary unduly from the normal temperature.

2.1 Sampling Apparatus:

The apparatus shall be capable of drawing a composite sample representative of all the different cross-sections of the contents of each selected container. For this purpose, a tube made of metal or thick glass, 20 to 40 mm in diameter and 400 to 800 mm in length with two ends conical and reaching 5 to 10 mm in diameter, is recommended. If required, handling may be facilitated by two rings at the upper end. For taking sample representative of all cross sections of the container, the tube is slowly inserted to the full depth with the upper end open. The upper end is then closed and the tube is withdrawn. If a tube is closed at the top with the thumb or a stopper and lowered till the desired depth is reached. It is opened for a short time to admit the material and then closed and withdrawn.

2.2 Lot:

In a single consignment, all containers of the same size and drawn from the same batch of manufacture shall constitute a lot. If a consignment is known to consist of different matches of manufacture or of different sizes of containers, the containers belonging to the same batch and size shall be grouped together and each such group shall constitute a separate lot.

A sample shall be drawn at random from a container of each batch of manufacture and tested.

In case of nonconformity of the properties of this sample to our relevant Corporate Purchasing Specification (CPS), two more samples shall be drawn from two different containers chosen at random and different from the original container from which the first sample has been drawn and tested separately for their properties. The batch will be accepted if both the sample conform to the relevant Corporate Purchasing Specifications.



From each of the containers selected, draw a representative portion of the material not less than 1 litre in volume.

Each sample shall be divided into three equal parts and transferred to the separate containers giving full identification, particulars of the sample on containers. The material in each container constitute an individual test sample. One of the three sets shall be marked for testing, the second for the supplier and the third for storage which shall be tested in case of dispute.

Unless otherwise stated, the tests shall be carried out at a temperature of $27 \pm 2^\circ\text{C}$ and a relative humidity of 65 ± 5 percent.

3. PREPARATION OF FILM:

The varnish/enamel film shall be prepared as described below:

3.1 Preparation of Panels:

Metal or glass panels shall be used as required for different tests.

3.1.1 Metal Panels:

These shall be mild steel fully finished (conforming to deep drawing quality of IS:513) 150mm x 100mm x 1.25mm in size and/or shall be of ETP copper (conforming to IS:191), 150 x 150 x 0.25mm, free from surface imperfections such as rolling marks, scores and scale. For Flexibility and Scratch Hardness Test, the panels shall be of tinned mild steel of size.

100 x 50 x 0.315 mm. However, for Impact Resistance Test, the panels shall be of mild steel of size: 150 x 150 x 0.6 mm.

3.1.2 Preparation:

The mild steel panel shall be cleaned thoroughly to remove all dust, oil, roughly degrease with petroleum hydro-carbon solvents (conforming to IS:1745) or Xylene (conforming to IS:359) and then burnish uniformly with IS Grit No.180 emery cloth (conforming to IS:715). The burnishing operation shall be as follows:

- Straight across the panel, in a direction parallel to any one side.
- Perpendicular to first direction and until all signs of original burnishing have been obliterated and
- With circular motion of diameter approximately 75 mm, until a pattern consisting of circular burnishing marks super-imposed one upon another is produced. Remove the trace of emery dust by wiping with a linen rag. Degrease the panel by swabbing two or three times with a linen rag soaked in suitable hydro-carbon solvent.

- 3.1.3 The copper panel shall be cleaned thoroughly to remove dust and oxide film and then washed with petroleum hydrocarbon solvent or xylene as stated in clause 3.1.2.

3.2 Glass Panel:

The glass panels shall be 150 x 150 x 2 mm in size, plane and free



from surface irregularities. They shall be cleaned as per Cl.3.2.1.

- 3.2.1 All oil or grease shall be removed from the panel by dipping it in benzene and rubbing with a soft and clean rag. The panel shall be rinsed thoroughly with water and well washed with soap and water, until the wetted panel shows no water breaks when held in vertical position. The panel shall then be rinsed thoroughly with alcohol and allowed to dry in air in dust free chambers.

3.3 Application:

The varnish/enamel shall be applied by dipping to obtain a thickness of 0.05 mm on each side after two dippings.

- 3.3.1 The varnish/enamel sample shall be filtered through a 150 micron sieve (conforming to IS 460) and thinned down with its solvent to obtain uniform smooth film of the thickness as specified in Cl.3.3.
- 3.3.2 Immerse vertically and completely the panels appropriately prepared as per Cl.3.1.2, 3.1.3 or 3.2.1 in the varnish/enamel at 27°C for one minute. Withdraw the immersed panels from the varnish/enamel at a rate at which the excess of varnish/enamel slips down the surface of the panel, care being taken to avoid air bubbles sticking to the surface of the panel. The specimen shall be dried in a well ventilated dust free chamber at 27°C for 30 minutes. The specimen shall then be cured at a temperature and for a period as specified in the relevant corporate purchasing specification. The specimen shall then be turned up side down and the second coat applied dried and cured as earlier.
- 3.3.3 In certain tests where the panel is to be coated on one side only, the panel of glass/metal shall be kept horizontally and single coat of paint applied either by a flat brush conforming to IS:384 or by spraying carefully; so as to obtain an even and uniform coat. Then the panel shall be dried in horizontal position at a temperature and time as specified in relevant CPS.

3.4 Conditioning:

Unless otherwise specified in the relevant CPS, condition all test panels at $27 \pm 2^\circ\text{C}$ and $65 \pm 2\%$ RH for atleast 16 hours before testing.

3.5 Thickness of Film:

Unless otherwise specified in the relevant CPS, the thickness of the film shall be measured with a bench type micrometer having an anvil of 10 mm diameter and exerting a pressure of one kilogram on the specimen.

4. GENERAL CONDITION:

- 4.1 The material shall be visually examined for the condition of skin (if any), foreign matter, visible impurities, degree and nature of precipitation, turbidity and separation (if any). The material thereafter shall be filtered through a 150 micron sieve (conforming to IS:460).

75 ml of the filtered varnish is poured into a 100 ml measuring flask with a glass stopper and kept for 48 hours. Observe for turbidity, precipitation and separation and record if present.



Pour varnish over a 90 x 120 mm glass plate and keep it at 45° inclination in a dust free chamber for 30 minutes at 27°C and inspect under reflected light. Record impurities if present.

5. DENSITY (WEIGHT PER TEN LITRES):

The density of the varnish shall be determined by weighing a sample of varnish to the nearest 5 mg in a wide mouthed pycnometer of 25 cm³ capacity (minimum), at 27 ± 2°C, and dividing the mass at the varnish by its volume.

The density can also be determined with a hydrometer. However, in case of dispute, a pycnometer shall be used. Report the result in g/cm³ or kg/10 litres.

6. VISCOSITY:

Unless otherwise specified the viscosity shall be determined at 27°C using various flow cups conforming to IS:3944. However, absolute viscosity as and when required shall be determined as per the method prescribed in IS 197 using ostwald 'U' tube viscometer or by any other viscometer as specified in the relevant CPS.

6.1 Procedure:

Place the flow cup on the stand in a place free from draughts. Level the rim of the viscometer using a spirit level.

With the orifice closed by the finger, fill the cup with sample until it just begins to overflow into the gallery, pouring slowly to minimise the formation of air bubbles. If any bubbles are present, allow them to rise to the surface and then remove them with a spatula.

Check the temperature of the material in the cup to be within 0.5°C of the specified value. The cup may be at a temperature different from that of the sample and it is recommended to allow one or two minutes before checking the temperature.

Place the scraper on the rim of the cup and draw it firmly across until excess sample flows into the gallery. Place the receiver beneath the cup. Remove the finger and simultaneously start the stop watch. Watch the stream of liquid flowing from the orifice. At the first evidence of a break of the stream into droplets, stop the stop watch. Record the time taken in seconds as time of flow in flow cup and shall be taken as viscosity of the material in seconds.

7. NONVOLATILE MATTER:

Weigh accurately about 1.5 - 2.0 g of the well mixed sample in a flat bottomed, circular, aluminium dish, about 75 mm in diameter and spread the material uniformly in the dish. Heat the dish and the contents initially at a lower temperature to drive off the volatile solvents and then at the temperature and time specified in the relevant CPS. Allow the dish and contents to cool in a desiccator to room temperature and weigh again. Repeat the process of heating, cooling and weighing until the difference between the successive weighings is not more than 0.001 g.

Calculate from the weight of residue, the non-volatile content as percentage of the weight of the material taken.

8. GEL TIME:

Take a test tube of 19 mm internal diameter provided with a polished plunger consisting of 3.2 mm diameter brass rod screwed to a brass disc diameter 15.9 mm. Fill the test tube to a depth of 100 ± 6 mm with the sample. Keep the clean polished plunger in the material with the disc as far down in the test tube as possible and maintain the rod at the centre during heating. Heat the test tube and the plunger with the varnish to a temperature specified in the relevant CPS.

The sample shall be deemed to have passed the test, if it has solidified or if voids are left in the material when the plunger is moved through it, after a time specified in the relevant CPS.

9. POLYMERISATION TIME:

Take a clean metallic plate of 150 x 150 x 10 mm having an aperture in the side for holding a thermometer. Heat it to the temperature as specified in the relevant CPS and maintain it at that temperature. Pour about, one gramme of the sample at the centre of the plate and start the stop watch simultaneously. Spread out the sample uniformly to a circular area of 60 mm diameter with a glass rod and stir continuously, strings shall be drawn after the specified intervals of time. Record the Polymerisation time as the time elapsed when it becomes difficult to draw strings with the glass rod from the heated material.

10. FINENESS OF GRIND (FOR PIGMENTED VARNISHES ONLY):

This test is intended to measure the degree of dispersion commonly referred to as fineness of grind of pigment in vehicle system. It is to be used as a rapid test for routine testing. In the test, the material is spread in a calibrated tapered groove. At some point in this groove particles or agglomerates, or both, will become visible. A direct reading from the calibrated scale is then made at the point where visible particles appear.

10.1 Apparatus:

- a) Gauge: A hardened steel block approx. 180 mm long 63.5 mm wide and 12.5 mm thick, shall be ground to a smooth flat surface at the top and a 12.5 mm wide groove shall be cut to a length of 133.4 mm in the centre. The groove shall be tapered uniformly in depth lengthwise from 0.102 mm at one end to Zero depth at the other, calibrated with a scale number in accordance with its depth as given in Table below. For comparing two samples, a double groove gauge may also be used.

**Relationship Between Depth of Tapered Groove and Scale for Fineness of Grind**
(Clause 10.1)

Distance from zero end mm	Depth mm	Hegman Scale
133.350	0.102 +	Well for sample
127.0	0.102	0
111.125	0.089	1
95.250	0.076	2
79.375	0.064	3
63.500	0.051	4
47.625	0.038	5
31.750	0.025	6
15.875	0.013	7
0.000	0.000	8

- b) Scraper: A double edged steel blade 87.5 mm long, 37.5 mm wide and 6.8 mm thick. The two edges along the length shall be rounded to a radius approx. 0.25 mm.

10.2 Procedure:

- i) Place the gauge on a flat, non-slippery surface, and wipe it clean immediately before the test.
- ii) Place the material to be tested in the deep end of the groove so that it over flows the groove slightly. Care must be taken to see that the sample is free of air bubbles.
- iii) Using both hand, hold the blade perpendicular to the block surface and at right angles to the length of the groove, draw the material down the length of the groove with a uniform, deliberate motion. Use sufficient pressure to clean the level face of the gauge.
- iv) Immediately read the fineness as follows:
 - a) View the gauge from the side so that the line of vision is at right angles to the longer dimension of the groove.
 - b) Hold the gauge in the light so as to make the pattern readily visible.
 - c) For actual reading, make the angle between the face of the gauge and the line of vision not more than 30° and not less than 20°.
 - d) Interpret the pattern and designate dispersion in millimetres or scale number, ignoring the few isolated and irregularly spaced particles towards the deep end of the groove.

Using a fresh sample of the material each time, obtain three readings in like manner. The first draw-down and reading is preliminary in order to establish proper conditions and to locate the fineness pattern. With this known, the second and third readings can be made with a minimum time lapse between completion of draw-down and actual reading. No reading shall be considered for reporting fineness when time lapse exceeds 10 seconds. Reading shall be reproducible within 0.13 mm.

**10.3 Care Of Gauge:**

After each reading the gauge shall be immediately cleaned with solvent and soft cloth. Keep the gauge covered at all times when not in use. Gauges that are not in use for a long time shall be protected from rust.

Do not allow any hard materials to come in contact with the gauge surface or scraper in any other manner that might result in scarring or nicking. Topping or scratching with other metallic surfaces shall be avoided.

The scraper edge may be rendered unsatisfactory for use by wear of the contact edge or by warpage. Wear or warpage of the scraper may be noted by facing the edge of the scraper down on the smooth level face of the gauge and then inspecting the contact edge by means of strong light, placed behind the gauge. Rocking the scraper forward or backward will reveal poor contact due to wear or warpage. If any face shows that the scraper has been damaged, it shall not be used.

11. 'B' STAGE CURE:**11.1 Preparation Of Test Specimens:**

The varnish shall be thinned with its specified thinner so as to obtain a dry film thickness of 0.05 mm on a glass tape. A woven glass tape of 0.13 mm thick, 25 mm wide x 250 mm long shall be dipped in the varnish and after a sufficient dipping time and ensuring a complete wetting of the glass tape, it shall be withdrawn from the varnish at rate at which the excess of the varnish slips down the surface. The specimen shall then be given a flash off time of about 10 minutes to drain off the excess varnish.

It shall then be suspended in an oven maintained at 100°C for 10-15 minutes. The specimen shall then be removed from the oven and allowed to cool down to 27°C. The specimen shall be tested for tack free stage by pressing it with the thumb, counter poising with an equivalent load of 2.5 kilograms for one minute. The thumb shall be released slowly. The specimen shall then be examined for tackiness and/or thumb impression. If the sample remains tacky it shall be force dried in the oven to attain B-stage. Force drying time shall be noted.

A copper rod of 25 mm diameter and 300 mm long shall be kept in an oven at 100°C for sufficient time to attain the oven temperature.

11.2 Procedure:

Remove the copper rod from the oven and apply the specimen tape with one half-over lap layer along the length of the rod. The varnish shall deemed to have passed the test, if it melts while wrapping and provide interlayer adhesion between successive layers of the glass tape.

12. COMPATIBILITY:

Take about 50 ml of the filtered varnish/enamel in a 250 ml glass beaker. Add about 50 ml of recommended thinner and stir well during



addition of thinner. If the solution is clear and homogenous, the varnish enamel shall be deemed to be compatible with the thinner.

13. **SKINNING:**

Keep the sample in ambient atmosphere in an open glass dish of 70 mm diameter for 72 hours. Observe for any superficial skinning. However, uniform thickening throughout the depth shall not be considered as skinning.

14. **FLASH POINT:**

It is taken as the lowest temperature at which application of the test flame causes the vapor above the sample to ignite with a distinct flash inside the cup.

14.1 **Apparatus:**

The apparatus to be employed shall be as per Cl. 3 of IS:101 Part 1/Sec. 6.

14.2 **Procedure:**

As per Cl. 5 of IS:101 (Part 1/Sec.6).

14.3 **Calculations:**

As per Cl. 6 of IS:101 (Part 1/Sec.6).

14.4 **Precision:**

As per Cl. 7 of IS:101 (Part 1/Sec.6).

15. **AIR OXIDATION:**

This test is intended to observe skinning on gel formation due to oxidation by air through its thinner at an elevated temperature.

The apparatus consists of:

A 500 ml conical flask for sample varnish, a 500 ml woulf's bottle for its thinner, an electric oven and a regulated air circulation system.

Take about 250 ml of the sample in a conical flask and mark the level. Take the recommended thinner in the Woulf's bottle upto two thirds of its capacity. Connect one end of the Woulf's bottle to the conical flask through a 6 mm dia. glass tube and other to the regulated air supply. Place the apparatus in a oven maintained at 60°C. Regulate the rate of bubbling of air in the Woulf's bottle to 5 bubbles per second. Continue the test for 7 days, making up the loss of thinner, if any, every 24 hours. Observe for skinning or gel formation at the end. The material shall be deemed to have passed the test if skinning or gel formation is absent.

16. **ASH CONTENT:**

It is determined by finding out the loss in weight of the material after igniting in a muffle furnace until all the carbonaceous matter is oxidised.



Take 10 to 25 ml of the material in a weighed porcelain/silica crucible or dish and weigh again. Incinerate the material by playing the flame of a burner on its surface and allow it to burn quickly until most of the material is burnt. Transfer the crucible or dish to a muffle furnace or heat it over a burner at or below dull red heat until all carbonaceous matter has been oxidised. Cool the crucible or dish in a desiccator and weigh.

Calculate the percentage of ash content on the weight of the material taken for the test.

17. **ACID VALUE:**

Acid value is the number of milligrams of potassium hydroxide required to neutralize the free acid contained in one gram of the material.

17.1 **Procedure:**

Weight 5 to 10g of the well mixed sample accurately into the long necked 250 ml flask and add to it 125 ml of neutralized mixture of solvents, consisting of equal parts of 95% ethanol and benzene (conforming to IS:534). Dissolve the sample in the above solvent mixture completely by shaking and warming if necessary. Titrate the dissolved sample against 0.1 N potassium hydroxide solution, using 0.5 ml of 1% alcoholic solution of phenolphthalein as indicator to a light permanent pink colour end point of same intensity as that of the neutralized solvent before it was added to the sample. The colour shall persist for 30 seconds.

$$\text{Acid value} = 56.1 \times \frac{VN}{W}$$

V = Volume in ml of standard potassium hydroxide solution used.

N = Normality of the standard potassium hydroxide solution*

and W = Weight in grammes of the sample taken for the test.

* The strength of the standard potassium hydroxide solution shall be checked at intervals to determine the possible deterioration/change in strength.

18. **FREE PHENOL CONTENT:**

It is the quantity of unreacted phenolic groups present in 100 grams of the material. The method is applicable only to those varnishes whose resins are soluble in ethyl alcohol.

18.1 **Reagents:**

Ethyl alcohol (conforming to IS:321).

Hydrochloric acid (conforming to IS:265).

10% Potassium Iodide Analar/A.R. grade.

Potassium Bromide (conforming to IS:2797).

Potassium Bromate Analar/A.R. grade.



0.1N aqueous solution of sodium-thio-sulphate (conforming to IS:246).

0.5% starch solution of soluble A.R. Grade starch.

Distilled water (conforming to IS:1070).

Prepare bromide bromate solution by dissolving 10 g of potassium bromide and 27.84 g of potassium bromate in 1 litre of distilled water.

18.2 Procedure:

Weigh about one gram of resin to the nearest 0.002 mg in a litre round bottom flask and dissolve it in 20 ml of ethyl alcohol and add 100-150 ml of distilled water to obtain an emulsion. Place the flask in a bath connected with a liebig condenser and drive off the free phenol or cresol with steam, the distillate being collected in a 1 litre measuring flask. During the distillation the flask is placed on the sand bath so as to avoid any condensation of vapour back into the flask. Distillation shall be performed at a rate whereby about 200 ml are distilled in 40-50 minutes and shall be discontinued when drop of distillate with bromine water does not show any turbidity. When distillation is over, add water to make up the volume.

Place 100 ml of distillate obtained as above in 250 ml of iodine flask and add to it 50 ml of bromide solution + 5 ml of hydrochloric acid, insert the ground glass stopper, shake the flask and place it in a dark place with a few ml of potassium iodide solution around the stopper.

After fifteen minutes, open the flask, add 15 ml of potassium iodide solution, shake the flask and put again in a dark place for 15-30 minutes with a few ml of potassium iodide solution around the stopper. Titrate it against sodium thiosulphate solution, using starch solution as indicator, from dark blue to colourless end point. Repeat the same procedure from blank titration without the sample.

18.3 Calculation:

Free phenol cresol content is calculated as follow:

$$M = \frac{(V_o - V) N \times K \times 10 \times 100}{G}$$

Where

M = Free phenol present in the material, percentage.

V_o = Volume of sodium thiosulphate solution required for blank, ml.

V = Volume of sodium thiosulphate solution required for sample, ml.

N = Normality of sodium thiosulphate solution.

G = Weight of resin taken in grams.

K = 0.001802 for cresol
0.001568 for phenol

19. EPOXY VALUE:

It is the value indicating, the fractional number of epoxy groups present in 100 grams of resin.

Epoxy Equivalent:

It is the weight of resin in grammes which contains one gram equivalent of epoxide.

19.1 Reagents:

Acetone conforming to IS:170.

0.1 N solution of sodium hydroxide conforming to IS:376.

0.01% alcoholic solution of Methyl red.

Hydrochloric acid conforming to IS:265.

A solution of hydrochloric acid in acetone by adding 1 ml of hydrochloric acid to 40 ml of acetone.

19.2 Procedure:

Weigh accurately 0.2 to 0.3 g of resin to the nearest 0.002 mg. Place it in a 10 ml conical flask. Add 10 ml of acetone solution of hydrochloric acid. Hold the mixture for 2 hours at room temperature. Titrate with 0.1 N Sodium hydroxide solution using methyl red as indicator, to yellow end point. Repeat the same procedure for blank titration without the sample.

19.3 Calculation:

Calculate the epoxy content (E) as follows:

$$E = \frac{(V - V_1) \times 0.0043 \times 100}{G}$$

Where

V = Volume of 0.1 N solution of sodium hydroxide required for blank in ml.

V₁ = Volume of 0.1 N solution of sodium hydroxide required for sample in ml.

and

G = Weight of resin in grams.

0.0043 is the quantity of epoxy group which corresponds to 1 ml of 0.1 N solution of sodium hydroxide in grammes.

Some epoxy resins do not dissolve easily in the acetone solution of hydrochloric acid as specified in this method. In such cases the mixture shall be refluxed for 30 minutes before titration and same treatment shall also be given to blank sample.



20. PIGMENT CONTENT:

20.1 Reagents:

Benzene conforming to IS:534.

Methyl alcohol conforming to IS:517.

Acetone conforming to IS:170.

145/205 low aromatic petroleum hydrocarbon conforming to IS:1745.

20.2 Procedure:

Prepare an extraction mixture (A) with 5 parts by volume of benzene, 4 parts by volume of methyl alcohol and 1 part by volume of acetone and dehydrate over sodium sulphate.

If this mixture does not fully extract resins and bodied oils from the sample; prepare a mixture (B) of, equal parts of benzene and petroleum hydrocarbon.

If the extra fine pigments of the sample do not settle well in (B), use a mixture of A & B in suitable proportions.

Weigh accurately 15 to 20 g of the well mixed sample into a weighed centrifuge tube. Add 20 to 30 ml of appropriate extraction mixture mentioned above and mix thoroughly using a glass rod. After mixing, rinse the glass rod thoroughly with the extraction mixture in the centrifuge, counter balancing the opposite arm of the container and whirl at a minimum speed of 3000 r.p.m. until maximum separation is effected. Decant the liquid and repeat the process twice or more if required. Place the tube containing the pigment on the top of the air oven for half an hour for the solvents to escape and then inside an oven maintained at $100 \pm 2^\circ\text{C}$ and weigh after drying to constant weight. The ratio of this weight of pigment to the weight of sample shall be the pigment content, percentage.

21. DRYING TIME:

Take a glass panel specified in Cl.3.2 and prepare as per Cl.3.2.1. Apply a varnish/enamel film as per Cl.3.3.2. Place a 20 mm dia piece of tissue paper on the film and load it with the appropriate weight specified below, for one minute. The paper shall not stick to the film, when lifted after removal of the load. Drying is graded as follows:

<u>Weight in g</u>	<u>Grade</u>
100	B1
200	B2
300	B3

22. FINISH:

The film when prepared on the panels of mild steel/copper/glass as described in Cl.3 shall dry to a hard, firmly adherant, flexible, smooth film, free from sagging and wrinkling.

23. FLEXIBILITY AND ADHESION:

- 23.1 Take tinned mild steel panels specified in Cl.3.1 and prepare as per 3.1.2. Apply varnish enamel film on one side as per 3.3.3. Bend the panel double, 75 mm from the upper edge over 6.25 mm diameter rod in an apparatus illustrated in figure 1, with varnish/enamel film outside. The time of bending shall not exceed one second. The material shall be deemed to have passed the test if there is no visible damage or detachment of the film.

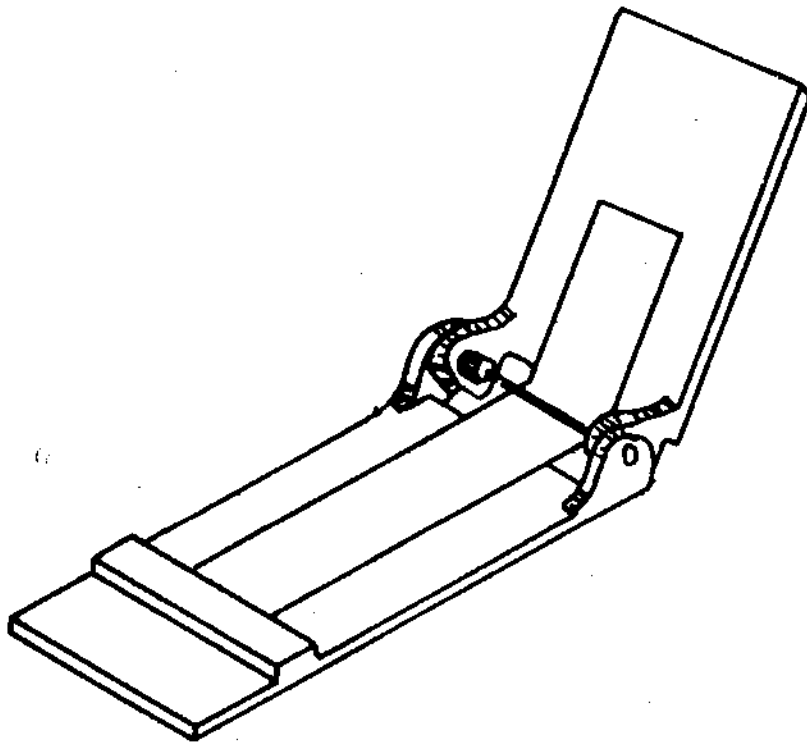


FIG.1 FLEXIBILITY-ADHESION TEST APPARATUS

23.2 Effect Of Heat Ageing On Flexibility:

Take copper panels size 150 x 50 x 0.25 mm, and prepare as per Cl.3.1.3. Apply varnish/enamel film on the side as per Cl.3.3.3. to a thickness of 0.125 mm. Heat the varnished panel for 100 hours at a temperature specified in the relevant CPS in a ventilated oven. At the end of this period, cool the varnished panel to room temperature for one hour.

Bend the panel double 75 mm from the upper edge with the varnished film over a 3 mm diameter rod in the apparatus illustrated in Fig. 1, with the varnish enamel film outside. The rate of bending should be such that the complete bend of 180° is performed in approximately one second. The material shall be deemed to have passed the test if there is no visible damage or detachment of the film.

23.3 CUPPING TEST (Erichsen Test):

To be performed according to ISO Standard 1520, Paints and Varnishes - Cupping test.

The following particulars are stipulated:

The measuring device shall allow an accuracy of 1 mm.

Five test specimens prepared on mild steel panels (preferably mild steel according to ISO Recommendation R 1514.) shall be used.

The procedure for the determination of minimum depth of indentation to cause failure shall be used.

The indentation speed shall be 4 mm per minute. The surface of the film shall be inspected continuously, using a lamp to illuminate the film surface.

Discontinue the indentation when visible cracks appear and read the indentation depth on the scale to an accuracy of 1 mm.

Higher values than 6 mm shall not be determined, except for special purposes. Check that the steel plate has not cracked; if it has, the test is discarded and further specimens prepared and examined.

Report the indentation depth readings of the measurements.

24. SCRATCH HARDNESS:

In this method, resistance to scratching under a specified load, of a film of varnish/enamel is determined.

A suitable apparatus for carrying out the test shown in Fig.2. The apparatus essentially consists of a horizontal sliding panel driven by a constant speed motor at a rate of 3 to 4 cm/sec. beneath the point of 1 mm diameter hemispherical hardened steel scratching needle shown in fig.3 held perpendicular to the film. The needle is fixed in a chuck, directly above which is a holder for weight which should be able to take weights of atleast 1000 g. The apparatus is adjusted so that the needle comes smoothly into contact with the film, namely before the stop reaches the bottom of the sloping ramp. The scratch should be straight and not less than 6 cm. in length. A ramp with an angle of 10° to 15° to the horizontal has been found to be satisfactory. An electrical indicating device based on conductivity shall be used as a guide to penetration of the film. Examine the needle under a x 30 magnification to ensure that the hardened steel point is smooth, hemispherical and free from contamination. Fix the needle in the chuck so that the position of operation is perpendicular to the coating.

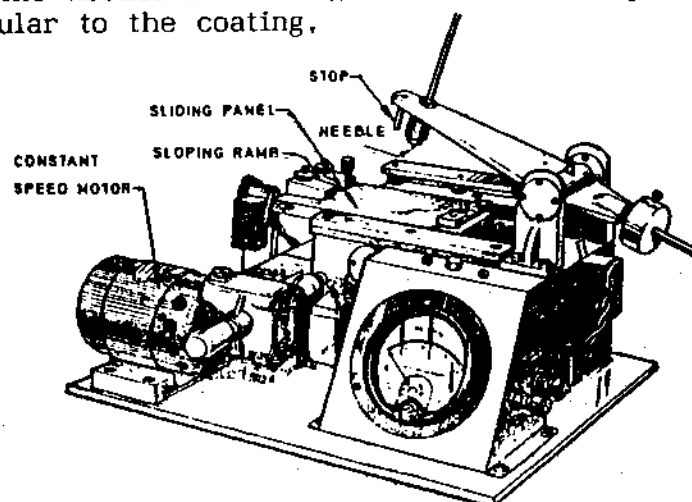


FIG.2 MECHANIZED SCRATCH HARDNESS TEST APPARATUS

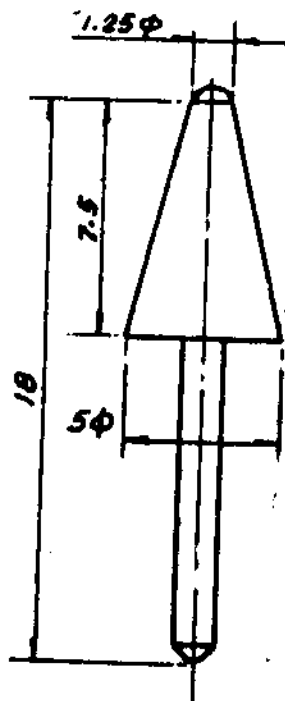


FIG.3 SHANK OF SCRATCH TEST NEEDLE

Take a tinned mild steel panel specified in Cl.3.1.1 and prepare as per Cl.3.1.2. Apply varnish/enamel film on one side as per Cl.3.3.3. Clamp the panel on the sliding base with coated side upwards and apply a load of 1 kilogram or as specified in the relevant CPS on the holder above the needle.

Start the motor of the apparatus and allow the scratch to be made on the coating. Remove the panel and examine the scratch to see if the coating has been penetrated to the substrate. The material shall be deemed to have passed the test if the bare metal is not visible.

25. IMPACT RESISTANCE:

This method covers the procedure for rapidly deforming a coated film by impact and evaluation of such deformation.

25.1 Apparatus:

25.1.1 Guide And Calibration Tube:

A steel tube 0.6 to 1.2 metre long mounted vertically in a base plate. A slot is cut lengthwise on one side of the tube to act as a guide for a weight which fits inside the tube. A scale shall be inscribed along this slot from bottom to top. The base shall be so constructed that a thin flat panel can be inserted at least 50 mm under the tube. This panel shall be firmly supported underneath on a steel plate but with a 25.4 mm diameter cylindrical hole directly under the tube.

25.1.2 Weight:

A cylindrical weight made to fit inside the tube. A pin is fitted into one side of the weight to act as a guide by riding in the slot in the tube and to serve as a handle by which the weight can be



raised and released.

25.1.3 Indenter:

A semispherical steel fixture which usually is affixed to the lower surface of a steel block that rests on the top surface of the test-panel. This block also holds the panel in place. The panel rests on another block with a female die (hollow) centered under the area of impact.

25.2 Procedure:

Take mild steel panel specified in 3.1.1 and prepare as per Cl.3.1.2. Apply varnish/enamel film on one side as per Cl.3.3.3 to a dry film thickness specified in the relevant CPS. Place the panel in the apparatus shown in Fig.4 with coated side either up or down as specified in the relevant CPS. The panel should be flat against the base support and the indenter should be in contact with the top surface of the panel. Raise the weight up the tube to a height as specified in the relevant CPS. Release the weight so that it drops on the indenter. Remove the test panel from the apparatus and observe the impact area for cracks in the coating. The material shall be deemed to have passed the test in the absence of any visible crack.



FIG.4 IMPACT - TEST APPARATUS

26. THERMOSETTING PROPERTY:

Take two mild steel panels specified in Cl.3.1.1 and prepare as per Cl.3.1.2. Apply varnish/enamel film on one side as per Cl.3.3.3. Press the panels at nip pressure, keeping coated sides in contact and heat at 130°C for 30 minutes. Separate the panels after cooling them to 27°C. The material shall be deemed to have passed the test if no visible damage occurs to the films when separated.

27. ABILITY TO CURE IN CONSIDERABLE THICKNESS:27.1 Apparatus:

- Flat pieces of aluminium foil 0.1 mm thick of about 95 x 95 mm;
- Steel former with a base area of 45 x 45 mm and a height of 25 mm;
- Cylindrical weight with a mass of 500 g and a contact surface with a diameter of 20 mm;
- Filter paper cellulosic based of 0.20 ± 0.20 mm thickness, ash content 0.06 percent max, weight 92 ± 2 g/m², filtration time 12 seconds per 100 ml maximum, similar to Whatman No.4.
- Constant temperature oven with forced air circulation. The air content of the oven shall be replaced not less than three times per hour. Temperature inside the oven shall not vary by more than 20°C from the specified temperature.

27.2 Procedure:

Fold three small troughs of aluminium foil having a base area of 45 x 45 mm and a height of 25 mm by bending the foil round the former. Clean the aluminium foil with a mixture of xylene and anhydrous ethanol before using. Weigh the varnish to be tested to the nearest 0.1 g in troughs so prepared, the quantity being dependent on the content of non-volatile matter as table given below:

QUANTITY OF VARNISH REQUIRED FOR ABILITY TO CURE TEST

CONTENTS OF NON-VOLATILE MATTER IN VARNISH UNDER TEST IN PERCENT	MASS IN g
40	25.0
50	20.0
60	16.7
70	14.3
80	12.5
90	11.1

After drying, the thickness of the resulting gel layer shall be about 4 mm. Place the troughs in the drying oven. The drying condition, temperature and time shall be according to relevant purchase



specification for the insulating varnishes, or as recommended by the supplier of the varnishes.

Take out the sample from the drying oven, and allow it to cool at a temperature of $27 \pm 2^{\circ}\text{C}$. Remove walls and the underside of the aluminium troughs by bending them back. Afterwards, remove the sample from the foil and keep the sample for 16 hours at a temperature $27 \pm 2^{\circ}\text{C}$ and a relative humidity of 45 to 75 percent.

Evaluation:

The varnish residue (gel), formed in the troughs shall be assessed visually and by touch.

The condition of top and bottom side of the specimen can be evaluated as per the table given below:

Side	Identity Letter	Condition of the specimen	Identity figure
(Upper) Top	S	Smooth	1
		Wrinkled	2
(Under) Bottom	U	Non-tacky	1
		Tacky	2

In order to find out the tackiness of the specimens, the following test shall be made.

Place a filter paper on a sample whose underside is turned up, load the paper for one minute with the cylindrical weight as described in Cl.21. Remove the weight after one minute and examine the sample.

The condition of the inside of the specimen can be evaluated as per table given below:

CONDITION OF THE INTERIOR OF THE SPECIMEN	Identity Letter	SYMBOLS	
		First	Second
Interior	I		
Brittle-hard	-	1	-
Horny machinable	-	2	-
Leather-like rigid	-	3	-
Soft rubber-like	-	4	-
Gel-like	-	5	-
Liquid	-	6	-
Free of bubbles	-	-	1
Few bubbles	-	-	2
Bubbly	-	-	3



A statement whether the interior is almost "uniform" or "not uniform" may be made by adding the relevant term to the symbol or to the next for example, "I3.1 uniform" or "interior leather-like rigid, free of bubbles".

Bending the specimen with the fingers sometimes helps judging the mechanical properties (brittleness, softness, etc); it may be necessary to cut the specimen to examine the interior.

Test Report:

In the test report, the results of the visual examination of the two specimens and the results of the tackiness examination of the underside shall be indicated by means of the following symbols:

Condition of the upperside for smooth condition of	-- S.1
Condition of the underside for tacky condition of underside	-- U.2
Condition of the interior for soft rubber-lik, free of bubbles uniform con- dition of the interior.	-- I4.1 Uniform.

28. **BOND STRENGTH:**

The primary function of varnish is to bond the components of an insulation system. The strength of the varnish film being the measure of its performance. By measuring the changes in the bond strength of varnish film as affected by cure, temperature, ageing at high temperature, immersion in solvent, water and other chemical contaminants, the quality of the varnish is compared.

28.1 **Method A:**

This method is intended for evaluating the bond strength of thermo-setting nonflexible varnishes. Take 4 clean copper strips of 100 x 25 x 5 mm and coat them upto 25 mm length, with the sample under test and prepare a double lap joint as shown in fig.5. Place the specimen in a suitably heated press and apply a contact pressure so as to ensure that the strips forming the joint are in position. Cure the specimen at a temperature and time as specified in the relevant CPS. While cooling the specimen, release the pressure at about 40°C and allow the specimen to cool down to 27°C. Determine the bond strength using a standard tensometer at a speed of 50 mm/min.

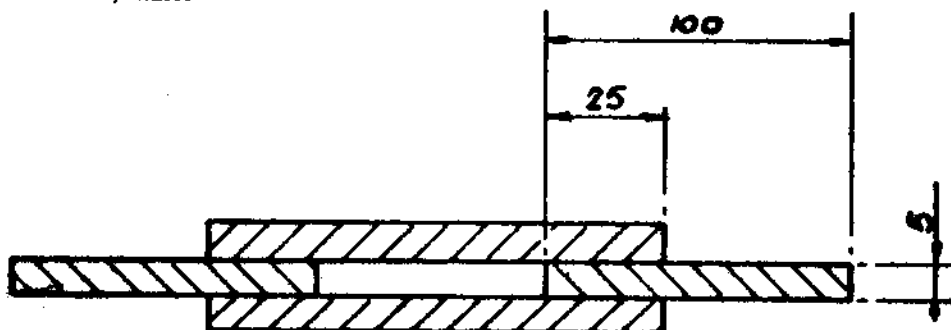


FIG.5 SPECIMEN FOR BOND STRENGTH TEST



28.2

Method B:

This method is intended for evaluating the bond strength of flexible impregnating vanishes using a helical coil. In this test, 1 mm diameter aluminium wire in the form of a helical coil is coated with varnish and cured. The force necessary to break this coil as a sample beam is a measure of the bond strength of the varnish film.

The behaviour of the varnish on enamelled wire may differ from that exhibited on aluminium wire and to study compatibility and adhesion between the material and enamelled wire, it is essential to repeat the test with the particular enamelled wire to be employed in practice.

From the helical coils by winding without gap between adjacent turns on a 6.3 mm diameter mandrel, a 1 mm diameter uncoated/enamelled, clean, smooth and annealed aluminium wire using a suitable mechanical system. Apply to the wire a suitable load in order that the turns fit exactly to the mandrel. The coil may be wound in a long continuous length and then cut off to a length of 75 mm. The wire ends of each coil shall be twisted to form a loop. Clean the coils by immersing then in a suitable solvent and rinse once or twice with water and finally dry.

Immerse the coil for 5 minutes in vertical position in the sample under test, care being taken that no air bubbles adhere to the surface and two coats give a dry film thickness of 0.1 mm. Remove the coil mechanically at the rate of 10 cm per minute, drain for 30 minutes and place in the oven in the same vertical position. Bake the specimen at temperatures and times as stipulated in the material specifications. Remove the coil and cool down to 27°C.

Place the coil in the universal tensile tester, accurate to 2 percent of lowest load. Apply the increasing force by operating the machine and note the force necessary to break the coil. Since most of the flexible varnishes have low elongation, provision shall be made to allow time to register the value of tensile strength. The rate of elongation is adjusted to be 5 cm per minute. Test five such coils and calculate the average tensile strength.

Determine the bending of the specimen prior to breaking using strain in measuring equipment associated with tensile tester. When measurements are made at higher temperature, the varnish may become thermoplastic and the coil may bend excessively instead of breaking. In such cases, the force necessary to cause an arbitrarily selected amount of bending is taken as failure value (usually one mm bending is recommended).

For evaluating curing characteristics prepare three sets of specimens to test at three curing temperatures which may vary from 25 to 50°C among themselves and in time by 4 hours.

Conduct the tensile tests prescribed above on all specimens and take the average. To evaluate the compatibility, prepare coils of pre-enamelled wire and subject them to tensile strength test as prescribed above. Conduct the test simultaneously on bare aluminium coils also. Draw the graph of tensile strength against time and compare it with that of test sample specimen wires



of enamelled and aluminium coils.

29. RESISTANCE TO TRANSFORMER OIL:

29.1 General:

Effect of transformer oil on the material can be determined by dipping the test specimen in the oil at the specified temperature for the specified time and visually observing whether the varnish is dissolved, blistered, wrinkled and loosened and the change in colour at the transformer oil.

29.2 Apparatus:

- A container, filled with transformer oil conforming to IS:335 - 1972, and
- Metal panels as per Cl.3.1.1 of this this specification.

29.3 Test Specimens:

Five test specimens prepared by coating the metal panels with a layer of varnish as per Cl.3.3.2 of this specification.

29.4 Procedure:

Coat the edges of the specimens with wax and immerse in the insulating oil at the temperature prescribed in relevant part of the individual varnish specification for 48 hours. Wipe the specimens with cotton batting. Note the effect of insulating oil on the specimen whether the varnish dissolved, blistered, wrinkled, loosened or was not physically affected in a visible manner.

29.5 Results:

The following shall be interpreted and reported as evidence of attack.

- Soiling of cotton batting, which appears due to softened or disintegrated varnish;
- Blistering, wrinkling, disintegration or separation of the varnish film; and
- Change of colour of the insulating oil.
- There shall be no appreciable change in acidity or sludge of transformer oil.

30 RESISTANCE TO SOLVENTS:

Take mild steel panels specified in Cl.3.1.1 and prepare as per Cl.3.1.2. Apply the varnish/enamel film as per Cl.3.3.2. Immerse the panel in the solvent specified in the relevant CPS for one minute. Remove the panel, allow it to stand in a vertical position for five minutes at 27°C and then swab it vigorously for five seconds with a cotton wool soaked in the same solvent. Examine the film for softening, blistering or peeling. The material shall be deemed to have passed the test if the film does not exhibit any defect.



31. EFFECT OF MOISTURE:

Take copper panel specified in Cl.3.1.1 and prepare as per Cl.3.1.3 Apply the varnish/enamel film as per Cl.3.3.2 and weigh (W₁). Condition the panel in a desiccator over calcium chloride for 24 hours and weigh (W₂). Immerse the panel in distilled water for 24 hours. Remove & dry between sheets of filter paper and weigh immediately (W₃). The water absorption is given by the formula.

$$\frac{W_3 - W_2}{W_2 - W_1} \times 100$$

Mean of three readings shall be recorded as percentage of water absorption.

Dielectric strength and volume resistivity shall be determined before and after water absorption as per methods described in clause 32, 33 of this Corporate Standard.

32. DIELECTRIC STRENGTH:

The electric strength at specific temperature is determined by inserting the test specimen between two electrodes of specified dimensions and noting down the voltage at which the specimen is punctured when the voltage is raised gradually. The thickness of the film shall be between 125 to 175 microns.

32.1 Condition Of The Test:

The test shall be carried out in air at 27°C and at the thermal class temperature of the sample, immediately after completion of baking of second coat. If this is impracticable, the test shall be carried out within 24 hours and the specimen shall be heated at the thermal class temperature for 30 minutes immediately before the voltage is applied. The time taken to transfer the specimen from the oven to the electrodes for test at 27°C is sufficient to allow the specimen to cool to this temperature.

For tests at thermal class temperature the electrodes shall be raised to this temperature before the specimen is placed in position and the specimen and electrodes shall be maintained at the test temperature for not less than one minute and not more than ten minutes, before the voltage is applied. The temperatures shall be measured by a thermometer inserted in a hole in the top electrode and reaching to within 12.5 mm of the bottom.

32.2 Electrodes:

The top electrode shall be a solid cylinder of brass 25 mm diameter and 40 mm height. The bottom electrode shall consist of a flat brass disc of 50 mm diameter and 25 mm thick. The sharp edges shall be rounded to 0.8 mm radius. These electrodes shall be arranged coaxially.

32.3 Test Voltage:

The test voltage shall be alternating and of a frequency of 50 Hz.



It shall be approximately Sine wave form and peak factor shall lie within the limits of 1.34 to 1.48. The peak value of the test voltage may be measured by a peak voltmeter or by a cathod ray oscilloscope in which case the rms value for the purpose of this specification shall be considered as the peak value so determined divided by 1.414.

32.4 Procedure:

Apply the test voltage between the two electrodes containing the test specimen and raise at a uniform rate of 500 volts per second from zero until breakdown. Make ten such puncture tests. Determine the thickness of the specimen from the means of three measurements taken as close to the point of puncture as practicable. Use the mean value in computing the breakdown voltage in KV per mm. The mean of all the test results shall be obtained after eliminating the suspect results. For the detection of suspect results, an objective method based on statistical reasoning is as given below.

If there are n test results, arrange them in the ascending order of magnitude X1, X2, X(n-1), Xn so that X1 is the smallest and Xn is the largest of the values. If Xn is suspect, calculate the value.

$$K1 = \frac{Xn - Xn-1}{Xn - X2}$$

If X1 is suspect, calculate the value

$$K2 = \frac{X2 - X1}{X(n-1) - X1}$$

If the calculated values of K1 or K2 exceed the corresponding values given in Table IV below the suspect result shall be rejected otherwise not.

The above procedure can also be applied repeatedly to remove the suspect results other than one first removed, after properly rearranging and redesignating the remaining values.

If more than two values are suspected at an extreme, the test shall be rejected and a fresh test shall be conducted.

TABLE IV: VALUES OF CRITERION

<u>No. of Test Results</u> (n)	<u>Value of K1 or K2</u>
8	0.554
9	0.512
10	0.477

The mean of all results shall be obtained. This mean value of the remainder of the breakdown voltage (KV/mm) shall be deemed to be electrical strength of the varnished film.

32.5 Electrical Strength After Immersion In Water:

The specimens shall be prepared and immersed in water as prescribed in Cl.31. Take out one specimen from the water at a time and quickly

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place between the sheets of blotting paper to remove the surface moisture. Immediately insert it in the electrodes and determine the electrical strength as per clause 32.4.

33. SPECIFIC VOLUME RESISTIVITY:

33.1 Electrodes:

The system of electrodes shall be as shown in the fig.6. The material of the electrodes and the surface finish shall be as follows:

The electrodes shall be cylindrical in shape and made of brass with the contact surface finish not exceeding 3 microns.

The upper electrode shall be of 50 mm diameter and 25 mm in length. The lower electrode shall be of 74 mm diameter and 15 mm in length. They shall be placed coaxially so as to provide an annular ring of minimum 2 mm with the help of guard electrode of 30 mm length and of 54 mm internal diameter and 74 mm outer diameter.

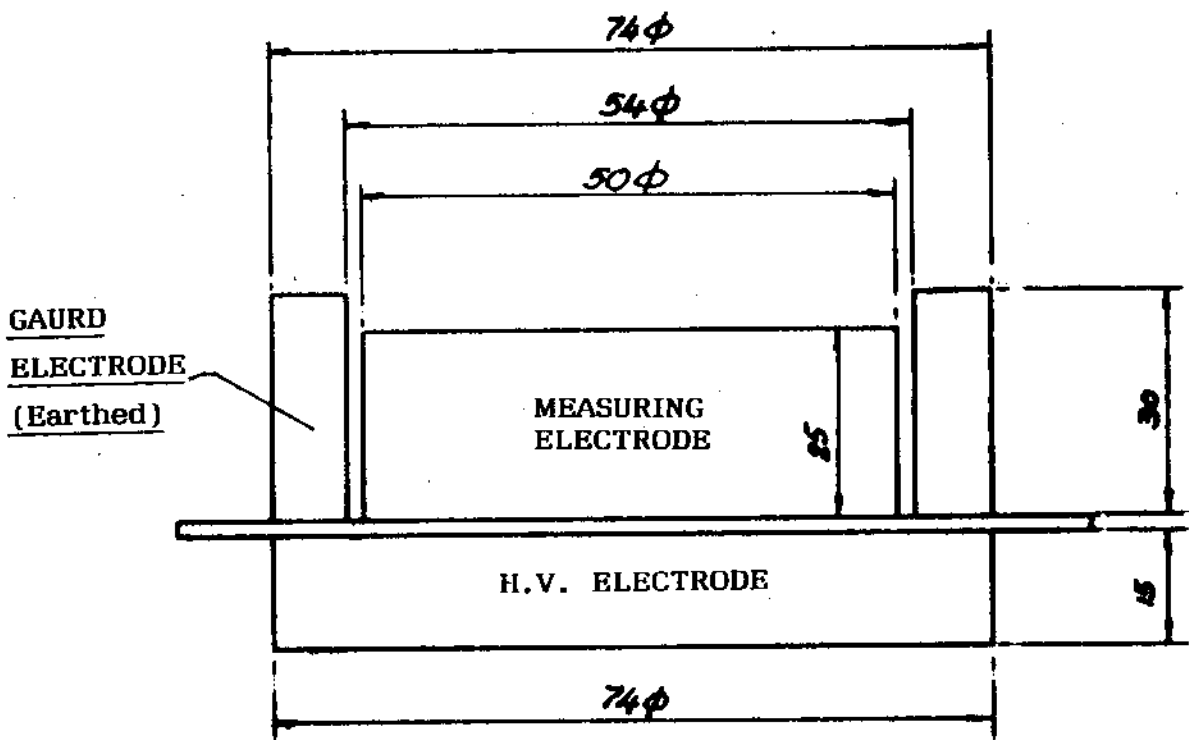


FIG.6 ARRANGEMENT OF ELECTRODE

Aluminium or Tin foil of 0.01 to 0.02 mm thickness and of the same contour as that of the electrodes shall be interposed between the surfaces of electrodes with the help of conducting grease.

33.2 Procedure:

A steady voltage of 500 volts D.C. shall be applied between the upper and lower electrodes, the guard electrodes being earthed. Specific volume resistivity (Qv) in ohm cm shall be calculated from the equation given below:

$$Qv = \frac{D^2 R}{4t}$$



Where R = Volume resistance in ohms
D = Diameter of measuring
t = thickness of varnish film in cm.

34. DISSIPATION FACTOR:

Panels described as in Cl.3.1 shall be used. A direct reading Schering bridge of suitable design to eliminate the effect of stray capacitance shall be used. The system of electrodes is identical to the one used in clause 33.1. The measurements shall be done at 500 Volts AC at 50 Hz.

35. SPECIFIC SURFACE RESISTIVITY:

This test is applicable only for conducting/Semiconducting paints. Coat the sample on a non absorbent press paper to C.P.S. after obtaining the required consistency by using the appropriate thinner so as to get a film thickness of 0.05 mm. Dry the coating as specified in the relevant CPS. Cut the coated paper into strips of 10 mm width, avoiding the edges. Measure the resistance with knife electrodes placed 10 mm apart and at right angles to the length of the strip. Using a "Wheatsone" bridge applying 3 - 6 V. Express the surface resistivity in ohms/square metre.

36. COMPARATIVE TRACKING INDEX:

36.1 General:

Comparative Tracking Index is a numerical value of the voltage, as determined under the conditions specified in this standard, which will cause tracking with the application of 50 drops of the electrolyte.

Tracking - The progressive formation of a conducting path on the surface of the material between two points at different potential owing to the localized electric sparks which occur when the leakage path in surface contaminant is broken.

36.2 Test Specimen:

Any smooth flat surfaced insulating moulded disc laminate coated with the sample varnish as per Cl.3.3.3 may be used provided that its area is sufficient to ensure that no liquid over flows the edges of the specimen during the test. Convenient minimum dimensions for the test specimen are 15 x 15 x 2 mm. Regions containing surface scratches should be avoided since these will increase the dispersion in the results. No conditioning of the test specimen is necessary. The test specimen should only be cleaned with a dry cloth; water or other solvents shall not be used.

36.3 Apparatus:

The brass electrodes of rectangular cross section $5 \pm 0.1 \times 2.0 \pm 0.1$ mm and approximately 20 mm long shall be used. The ends shall be bevelled to an angle of 30° and the sharp edge so formed shall be slightly rounded as shown in fig.7.

When specially required, the electrodes may be of a different material and this fact shall then be reported. The electrodes should be held on the test piece as shown in fig.8 and in such a way that they bear on the test specimen with a force of 100 ± 10 grams.

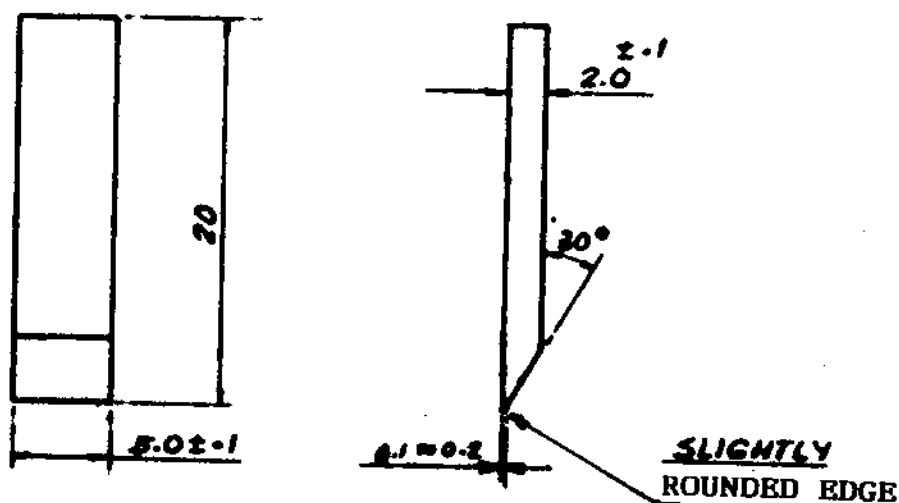


FIG. 7 ELECTRODE

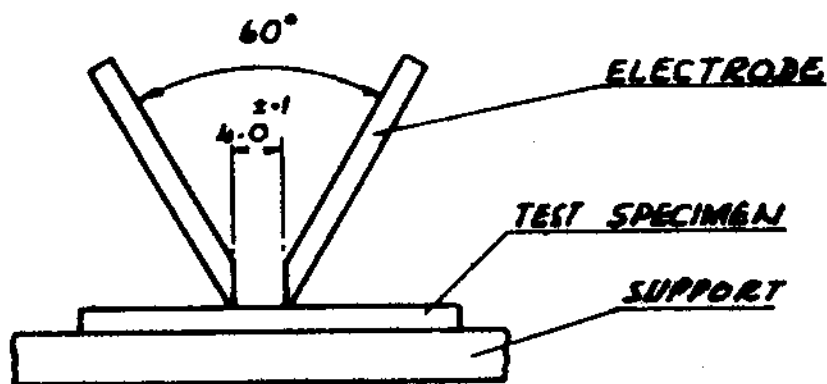
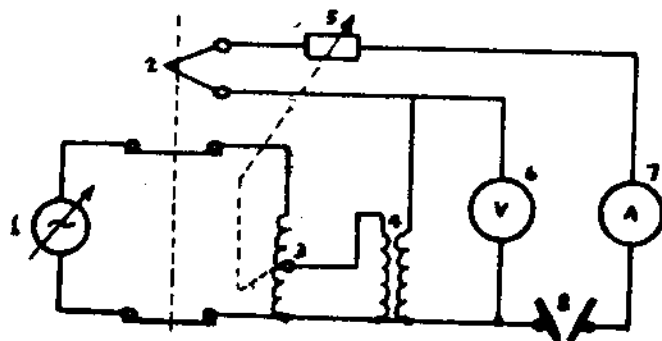


FIG. 8 TEST APPARATUS

Supply to the electrodes: The electrodes shall be supplied from a variable voltage alternating current source of 50 Hz, the current being limited on short circuit to one ampere at a power factor of 0.9 to 1.0. A manual or automatic switch shall be included in the circuit to interrupt the supply when 0.5 A flows between the electrodes for 2 seconds at test voltages upto and including 500 V and for 10 seconds at higher test voltages.

Electrolyte Circuit Arrangement:

A typical circuit arrangement is shown in fig.9. The electrolyte shall be 0.1 ± 0.002 percent solution of ammonium chloride of analytical reagent grade in deionized water conforming to IS:1070.



- | | |
|-------------------------------|-----------------------|
| 1. Variable voltage AC supply | 2. Over Current Relay |
| 3. Auto transformer | 4. Transformer |
| 5. Rheostat | 6. Voltmeter |
| 7. Ammeter | 8. Electrodes |

FIG. 9 DIAGRAM OF CONNECTIONS

Electrolyte dropper - The apparatus shall be capable of depositing electrolyte in drop size $20 \pm 5 \text{ mm}^3$ from a height of $30 \pm 10 \text{ mm}$ above the test piece at intervals of 30 ± 5 seconds. It has been found that an hypodermic needle having an outside diameter of 0.9 to 1.1 mm with the tip cut off square provided drops of the required size. However the apparatus shall generally conform to IS:2824.

36.4

Procedure:

The test shall be carried out at an ambient temperature of 27°C . The test surface shall be horizontal and the electrodes shall rest on it as shown in Fig.8. Contact of the electrodes with the specimen shall be such that when a light source is placed so that the light reaches the observers eye along the surface of the specimen, no light is visible between the specimen and the electrodes. The electrodes shall be re-ground, if necessary, to achieve this.

The test voltage shall be applied to the electrodes and the series resistance adjusted so that a current of $1.0 \pm 0.1 \text{ A}$ flows when the electrodes are short circuited. During this adjustment the over current switching device also should be short circuited.

Drops of electrolyte shall be allowed to fall on the test surface midway between the electrodes at a specified rate until 50 or more drops have been deposited without giving rise to failure by tracking. Test shall be made at several voltages on areas unaffected by previous test. The voltages shall be so chosen as to enable a curve, showing the number of drops required to cause the failure by tracking as a function of voltage be drawn with sufficient accuracy to determine the comparative tracking index within 10%. In tests where tracking does not occur, the maximum depth of erosion in the vicinity of the electrodes shall be measured.

36.5

Test Report:

The following information shall be reported as well as other facts which may be relevant:

The material of the base used.



Quantity of material tested including any surface treatment.

Thickness of test specimens.

The treatment, if any, given to produce a flat test area.

Each test voltage and the associated number of drops.

The comparative tracking Index of the base without the varnish coated.

The comparative tracking Index of the base with the varnish coating.

The maximum depth of erosion.

37. INTER LAMINAR RESISTIVITY:

37.1 General:

The method provides a means of testing varnish coated single steel strip or punching for interlaminar resistance under predetermined conditions of voltage, pressure and temperature. An average resistance from multiple contacts through one insulating coating to the metal core of the lamination is measured at the desired contact pressure.

37.2 Apparatus:

The apparatus shall consist of a contact unit or test head which is attached to the head of the hydraulic press, a hot plate attached to the lower platen of the press, a control unit (apart from the press but connected electrically) having suitable batteries, voltage and current instruments and the necessary switches and rheostat. However, the apparatus may generally conform to ASTM - D - 344.

37.3 Test Specimen:

The specimens shall consist of atleast four strips cut from the same lift in a manner to assure representative sampling. The width and length shall be respectively greater than the width and length of the assembly of contacts. It is not necessary to remove the shearing burrs since they do not affect the measurements. The specimens shall be coated to the required thickness with the sample varnish and cured as specified in the relevant CPS.

37.4 Procedure:

The specimen shall be laid on the hot plate beneath the test head and so post positioned that all the contacts shall be within the test area when the test head is brought in contact with the specimen by applying the specified pressure. After such time as is required to heat the specimen to the temperature as specified in the relevant CPS adjust the voltage to 0.5 volts and obtain the ammeter reading. The insulating quality of the coating is measured by this current which ranges from zero for a perfect insulator to 1 Ampere, for a conductor. A sufficient number of tests shall be made to obtain a representative value of Inter Laminar Resistivity for the quantity of punchings involved. If both sides of the strips or punchings are to be coated, then both sides shall be tested.

To ensure correct test conditions, a short circuit test shall be made



occasionally by testing a bare metal surface. When the short circuit current is less than 0.98 amps, the contacts must be cleaned.

The thinner used with the sample varnish may be used for cleaning the contacts. Reference check specimens may be used if desired. Such check specimens, however, should not be used for long periods as may become inaccurate with repeated use.

The recommended pressures for the test purposes shall be 0.69, 0.138, 3.45 or 6.9 MN/m². If more than one test pressure is to be used, the pressures shall be applied in ascending order.

37.5 Calculations:

The interlaminar resistivity shall be calculated as follows:

$$I = \frac{10 E}{R1 + RS + 2A1}$$

Where

E = Applied voltage (0.5 V)

I = Measured current in Amps.

R1 = Series resistance per contact (5 ohms)

A1 = Area of each contact in m²

RS = Inter laminar resistivity in ohms/m²