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भारत सरकार

रेल मंत्रालय

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

डीजल ईलेक्ट्रिक लोकोमोटिव के कर्षण मोटरों में प्रयोग हेतु

स्लॉट लाइनर इन्सुलेटिंग टेप

के लिए

तकनीकी विशिष्टि

TECHNICAL SPECIFICATION
FOR
SLOT LINER INSULATING TAPE
USED ON TRACTION MOTORS OF DIESEL ELECTRIC LOCOMOTIVES

विशिष्टि संख्या चा0 श0.0.२४.00.३४ (संशोधन-0२)

अक्टूबर, २०२३

SPECIFICATION No. MP. 0. 24.00.34 (REV.-02)
OCTOBER, 2023

अनुसंधान, अभिकल्प एवं मानक संगठन

मानक नगर, लखनऊ - २२६ ०११

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LIST OF AMENDMENTS:

SN.	Amendment date	Revision	Reasons for amendment
1.	April-2005	00	First issue
2.	August-2005	01	Second issue
3.	October - 2023	02	Title of the specification changes as "*Technical Specification for SLOT LINER INSULATING TAPE used on Traction Motors of Diesel Electric Locomotives*" from "*Technical Specification for SLOT LINER NOMEX TAPE used on Traction Motors of Diesel Electric Locomotives*"
			Addition of LIST OF AMENDMENTS
			Addition of INDEX
			"RDSO" is replaced by 'Vendor Approving Authority' at Para 5.0, 9.1, 9.2.
			At Para 9.1, type tests in every three years & at the time of upgradation has been deleted.
			New Para 9.1.1 "Field trial" has been added
			New Para 13. "PREFERENCE TO MAKE IN INDIA" has been added.

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Technical Specification for SLOT LINER INSULATING TAPE used on Traction Motors of Diesel Electric Locomotives

1.0 SCOPE:

This specification covers the technical requirements of Slot liner nomex tape which is coated with high temperature resistant release coating. It should consist of good releasing property. Moisture absorption during application is minimized due to presence of preventing coating. This material facilitates easy insertion into the slot & removal of coils during subsequent repair and also no wrinkles are formed at the time of inserting the armature coils into the slot. It should not stick on the surface of armature slot and have thermal index of at least 200.

2.0 APPLICATION:

This material shall be used as slot liner for armature coil insulation in class 200 insulated Traction Machines of Diesel Electric Locomotives/DEMUs.

3.0 DIMENSIONS AND TOLERANCES:

Dimensions and tolerances are given in table – 1.

Table – 1

Standard Thickness (mm)	Standard Width (mm)	Length/Roll (m)	Tolerance		
			Thickness (mm)	Width (mm)	Length (m)
0.13	450	50	±0.02	± 2.0	+1

Thickness, width and length shall be as stated as per individual requirements. However, for special applications, any other size may be ordered.

4.0 BASIC MATERIALS:

4.1 Nomex Paper:

Nomex type 410 calendered having thermal Index of at least class 200 shall be used. It must possess high temp., durability, excellent mechanical

strength and good electrical properties. It shall have good resistance to acid, alkalies, refrigerants, ketones, alcohols and oils. It must be compatible with silicone based insulating varnish. Moisture content shall be less than 5%.

4.2 Release coating Resin:

The resin of at least 200 thermal index used for release coating should be Silicone as determined by Infra-Red Spectrograph or any other suitable standard method.

5.0 MATERIAL COMPOSITION:

Materials shall have the following ingredients:

Total Substance	Resin content
(g/m^2)	(%)
120 ± 4	4 (min.)

Note:-

If manufacturer proposes any deviation regarding dimensions & tolerances (clause No. 3) and material composition, prior approval for acceptance of the deviation shall be required from Vendor Approving Authority. In addition, it will be the firm's responsibility that this deviation shall not adversely affect the performance of the motor against electrical properties, magnetic loading and air gap between armature & poles and other design parameters.

6.0 PROPERTIES:

6.1 Surface condition & unreeling characteristics:

The material should be tack-free, smooth and free from wrinkles & cuts. The material shall not be blocking within the roll after storing at 27deg.C for 24 hrs. and it should also not show any sign of deterioration like swelling, becoming hard, porous for a period of at least Shelf life. The material shall not stick to the adjacent layers in the absence of the inter-leaving.

6.2 Flexibility:

The Slot liner shall be flexible. When wound on a 18 mm dia. mandrel at room temperature, there shall be no sign of cracks in the sheet.

7.0 JOINTS:

The material shall be supplied in continuous lengths as stated on the order. Rolls having joint shall be packed separately and appropriately marked. 90% of the consignment shall be without joints. Per roll, maximum only one joint is permitted. Material used for jointing shall not adversely affect the properties of the cured insulation. If the material used for jointing is not compatible with the insulation, the supplier shall notify accordingly.

8.0 SHELF LIFE AND STORAGE:

At 25 ± 3 deg. C, 12 months, minimum.

The storage life depends upon storage temperature. For prolonged life, the tapes are stored in original carton without tampering polyethylene bags in cool dry cold storage preferably refrigerated cold storage. Optimisation of chemical composition of resin and process must ensure that the material shall retain the properties prescribed in the standard during storage at 25 ± 3 deg. C for 12 months (min.) after the date of manufacturing.

The Slot liner should be taken out from refrigerator/cold storage 24 hrs. in advance before application so that the tape can be brought fully to ambient temperature (room temperature). On account of this, the condensed water on the polyethylene bag will not come in contact with the tape and tape will be saved. If it comes in contact with water, the water will damage the sensitive chemicals of the resin inside the rolls.

9.0 TESTS & INSPECTION AT SUPPLIER'S WORKS:

9.1 Type Test:

Type tests shall be conducted on the prototype samples as per tests mentioned in **Table – 2.** Successful completion of the type tests is mandatory for product / firm approval.

Type tests shall be witnessed by Vendor Approving Authority's representatives. The supplier shall provide all facilities without any charge to satisfy the latter that the material is being furnished in accordance with this specification. The supplier shall prepare and provide necessary test specimens for testing to be carried outat his premises. If testing facilities for any test are not available at his premises, the supplier shall make necessary arrangements for carrying out that test at outside laboratories, either reputed or Govt. approved. The supplier shall notify in advance about readiness of the materials for inspection and testing.

In case of any changein the material or design, the complete type tests shall be repeated.

If the product is proved to be successful during type testing, at least two motors shall be manufactured with the insulating materials offered for type test and temperature rise test shall be conducted to see suitability of the materials for making the coils and also performance of the motors will be examined in practical condition.

9.1.1 Field Trial:

After successful completion of type tests and temperature rise test, required quantity of the insulating materials shall be subjected to field trials for specified time period. The required Quantity and Period for field trials shall be governed by Vendor Directory on UVAM.

Performance feedback of the motors manufactured with the insulating materials shall be furnished by User Railways in the following format:

S. No.	Name of Insulating Tape	Armature No.	Magnet Frame No.	Fitted on Loco No.	Qty. Used	Dispatched Date	Shed	Date of fitment in loco	Date of Failure, if any	Remarks regarding performance

9.2 Routine Tests:

Routine tests shall be carried out by the manufacturer on all finished products on lot basis to ensure consistency of the product. The supplier shall maintain records of Routine test results. These results shall be handed over to the purchaser before dispatch the materials to Rlys. Vendor Approving Authority may however, carry out these tests on samples sealed at random as per the relevant specification to verify the results observed by the manufacturer.

The Routine test schedule shall be constituted of all those tests marked as Routine Tests in **Table - 2.**

9.3 Acceptance Tests:

Acceptance tests shall be carried out on samples selected randomly from a lot ready for dispatch to Railways for the purpose of acceptance of the lot by the purchaser or any other inspecting agency nominated by the purchaser as per the tests marked as acceptance tests in **Table – 2**. The supplies offered for inspection shall be considered to be satisfactory and acceptable, if all the test results are within acceptable limits and statistically satisfactory.

If any of the test results does not meet the requirements, the whole tests shall be repeated on other samples selected again.

If the results of the repeated tests are not found within acceptable limit, the entire supplies shall be rejected. The purchaser shall have however the right to reject the supplies in full or in part.

If the results of the repeated tests are found within acceptable limit, the supplies shall be considered to be acceptable.

10.0 TEST CERTIFICATES:

Unless otherwise stated, three copies of certificates shall be supplied along with each consignment bearing the following information:

- RDSO Specification no. ---------
- Railway's purchase order no. -------
- Manufacturer's / supplier's name ------
- Trade mark/Grade, if any -------
- Batch/Lot no. --------
- No. of rolls supplied and length per roll -------
- Date (Month & Year) of manufacture and expiry ---------
- Test results ------

In addition, the supplier shall ensure to enclose one copy of test certificates along with their dispatch documents to facilitate quick clearance of the materials.

11.0 PACKING:

Slot liner nomex tape shall be supplied in rolls wound on spools with both sides well protected so as to prevent from distortion and damage of the rolls during transportation, handling & storage and from deterioration due to climatic condition. Rolls shall be wrapped in such manner that they will not adhere to each other and also to the container.

The individual roll of the same thickness, width and length shall be individually packed in polyethylene to ensure that these can be easily separated and are protected from moisture, dust, direct sunlight and damage during transit.

The Slot liner in the form of rolls packed in polyethylene bags should be packed in suitable carton so that it may not get damaged during transportation. After the roll is received, it should immediately be transferred to the consignee's cold storage (not cooled by air-conditioners) which should run and maintain specified temperature continuously 24 hrs. without stopping after office hours & holidays and a log book should be maintained to monitor the temperature of the cold storage.

12.0 MARKING:

12.1 Each roll of the tape shall be clearly and legibly marked with the following information: -

a) Manufacturer's / Supplier's name ---------
b) Type of tape /Designation/trade-mark, if any -------
c) Length of roll, in meters -------
d) Thickness and width of tapes, in mm -------
e) Date (Month & Year) of manufacture --------
f) Date (Month & Year) of expiry -------
g) Batch No/lot No.----------

12.2 Each transit pack containing number of rolls shall have following information, clearly and indelibly marked on it :

- RDSO specification no. ---------
- Railway's purchaser order no. --------
- Manufacturer's / Supplier's name ---------
- Type of tape/Designation/trade-mark, if any -------
- Batch/Lot No. ---------
- Length of roll, in meters -------
- Thickness and width of tapes, in mm -------
- No. of Rolls & meters supplied -------
- Date (Month & Year) of manufacture -------
- Date (Month & Year) of Expiry-------
- Condition of Storage & preservation ---------

13.0 PREFERENCE TO MAKE IN INDIA

The Government of India policy on 'Make in India' shall apply.

TEST METHODS & ACCEPTABLE CRITARIA

Table - 2

S.No.	Tests	Type Test	Routine Test Per Lot	Acceptance Test Per Lot	Instruments	Test Methods	Acceptable Criteria
1.0	Thickness (mm)	√	√	√	Micrometer	IEC 60371-2, Cl. 3	0.13±0.02
2.0	Width (mm)	√	√	√	Vernier Caliper / Scale	----------	450 ± 2
3.0	Total Substance (gm/m²)	√	√	√	Electronic Balance	IEC 60371-2, Cl. 6	128 ± 5
4.0	Release strength (after curing)	√	√	---------	Tensile Tester	As per Annexure - 1	200g/25mm (max)
5 .0	Binder Content (g/m²)	√	√	-----	• Electronic Balance • Muffle Furnace	IEC 60371-2, Cl. 6	10±2
6.0	Tensile Strength	√	√	√	Tensile Tester	IEC 60626-2, Cl. 4	25 Kg / 2.5 cm
7.0	Electrical Strength (BDV),	√	√	√	BDV Testing m/c	IEC 60371-2, Cl. 15	4.5 Kv / layer
8.0	Temp. Index	√	-------	--------	TGA Analyser	IEC 60216 / TGA Method (As per Annexure-A)	Min. 200
9.0	Type of Binder	√	--------	--------	FTIR	Infra-red Spectrograph Or Any Standard method	Silicone
10.0	Stiffness	√	-----	-----	--------	IEC 60371-2, Cl. 10	40 N/m(Max)
11.0	Elongation at break (%)	√	√	√	Tensile Tester	IEC 60371-2, Cl. 7	Min. 10

Annexure – 1

Procedure for testing Release Strength of Slot Liner Nomex tape

1. Test Apparatus -

I) Tensile testing machine
II) Steel roller for pressing
III) Polyimide film tape with Silicone Adhesive on one side 25 mm width (pressure sensitive tape)

2. Procedure -

I) Cut the sample specimen 25 mm width x 200 mm length.

II) Apply adhesive side of the pressure sensitive tape on the specimen upto 150 mm length from one end, so that 50 mm length remain free.

III) Apply roller on the bonded specimen up to 150 mm length by giving 3 rounds of rolling by hand.

IV) Prepare the specimen in the form of 'T' so that 50 mm each of specimen and self – adhesive tape can be fixed in the jaws of Tensile Tester.

V) Switch on the machine ensuring that jaws of the Tensile Tester move apart at a speed of 300 mm/min.

3. Report -

Report the release strength of Slot liner nomex tape in gm/25mm width.

Annexure – A

PROCEDURE TO DETERMINE RELATIVE TEMPERATURE INDEX BY TGA (THERMOGRAVIMETRIC ANALYSIS) METHOD

1.0 PROCEDURES

Heating rate – 1ºC per minute
Sample configuration – Cubical
Atmosphere – Air
Degree of cure – As per recommendation of the supplier
Sample size – 10-20 milligrams
Interpretation – By tangential technique and 50% loss criterion

2.0 INTERPRETATION OF TEST RESULT

2.1 Determination of factor X using standard Polyimide film of temperature index (Ti = 240) or Known value as reference.

2.1.1 Draw a thermogram in the TG equipment available in the laboratory as per procedure described in **Clause 1.0**

2.1.2 Using 100% loss point as reference point, a tangent is drawn along the steep portion of the curve. Another tangent is drawn from point at which curve deviates from its initial straight line. The point of intersection 'A' is the temperature at which decomposition starts.

2.1.3 The intercept of the curve at 50% weight loss 'B' arbitrarily picked up. A rectangle is now formed, ½ the difference between A and B is added to A, to correct for the slope of the steep portion. (See curve).

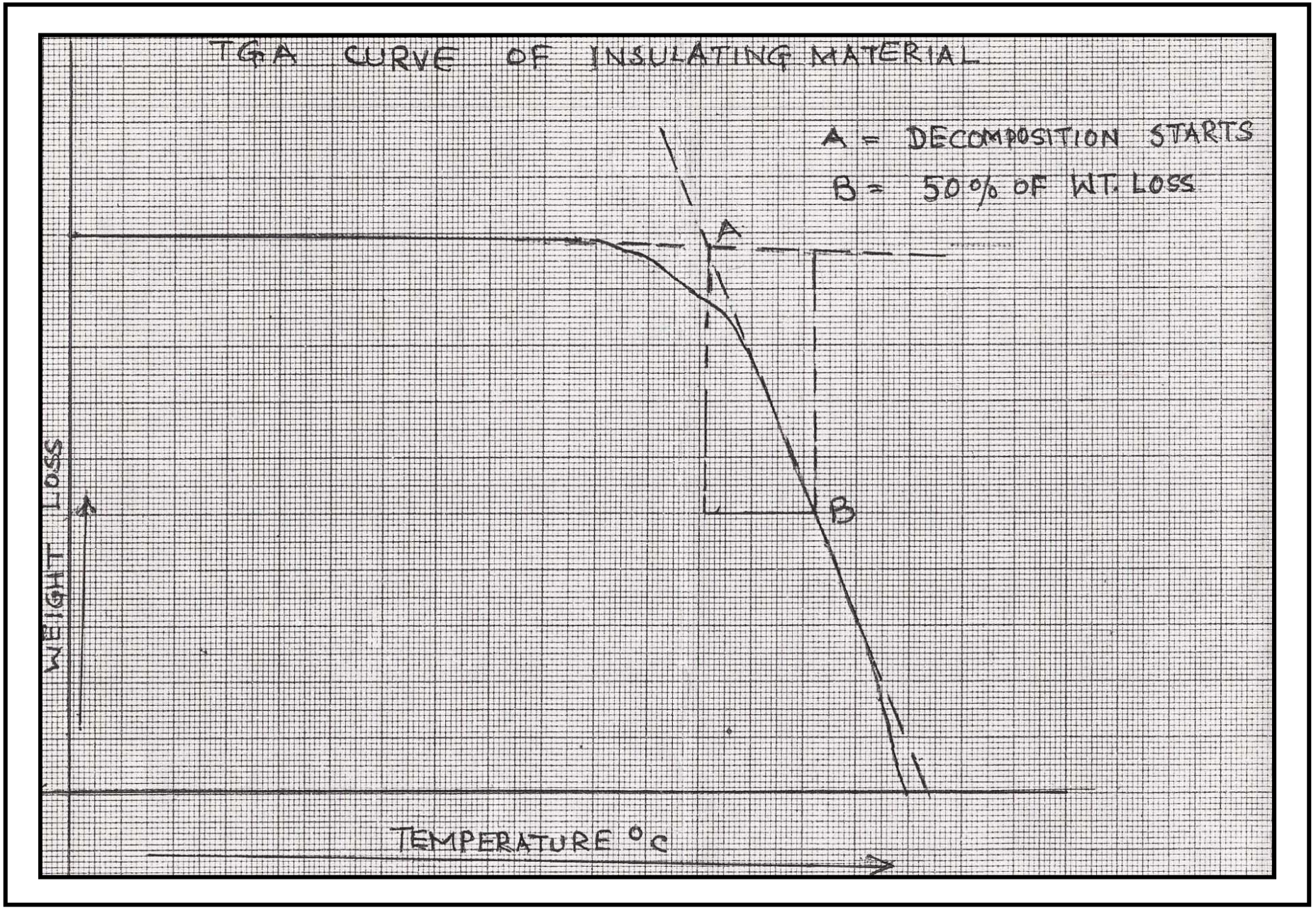
2.1.4 With the above, calculate Factor X as under:

$$\frac{A + \frac{1}{2}(B - A)}{X} = 240, \qquad \text{Or,} \quad X = \frac{A + \frac{1}{2}(B - A)}{240}$$

Note: The factor X shall be applicable for use to determine relative temperature index of any other materials e.g. Silicone varnishes, epoxy varnishes etc., in the equipment available in the particular laboratory.

3.0 CALCULATION OF RELATIVE THERMAL INDEX OF AN INSULATING MATERIAL

$$\text{Rating Index} = \frac{A + \frac{1}{2}(B - A)}{\text{Factor X}}$$


TGA CURVE OF INSULATING MATERIAL
A = DECOMPOSITION STARTS
B = 50% OF WT. LOSS
A
B
WEIGHT LOSS
TEMPERATURE °C