Government of India
Ministry of Railways
Research Designs & Standards Organisation
Manak Nagar , Lucknow - 226011

NO. EL/2.2.8.4 Dated 20.04.1998

SPECIAL MAINTENANCE INSTRUCTIONS NO. ELRS/SMI/153 (REVISED)

1. TITLE :

Characteristic properties of enamel used on enamelled winding wires.

2. APPLICATION :

Enamelled winding wires used in auxiliary motors and coils of electro-magnetic contactors for electric LOCOS and EMUs.

3. OBJECT :

Railways have reported a large number of failures of auxiliary motors and coils due to inter-turn shorts. These failures can be attributed to inappropriate application of enamelled winding wire obtained from the trade. To arrest these failures in service special instruction is being issued to follow the right enamel for specific enamelled winding wire required for rewinding of auxiliary motors and coils of EM contactors.

4. 0 DRAWING/CATALOGUE NO. :

4.1 Following catalogues on enamel are given below for guidance and adoption for winding wires :

Sl. No.	Reference No.	Name of enamel of Dr. Beck & Co.	Governing IS/ Temp. Index	Application
1.	Tech. Data Sheet 1-50, Revision March 3, 96	TEREBEC TR 543-38	IS : 13730-PT.8/ Temp 180 Class	-
2.	1-29-8903	DUAL COAT WIRES with Base Coat of TEREBEC TR 543-38 and over Coat of Allotherm 602L-35A.	IS : 13730 – Part 13/ Temp 200 class.	Startor winding of 3 phase Aux. Motors.

NOTE : Application as per RDSO existing SMI's and as well as motor manufacturer's recommendations.

5. MAINTENANCE INSTRUCTIONS :

5.1 All auxiliary motors shall be rewound with a specific class of enamelled winding wire. The enamel used on winding wires shall be as per para 4.0 above.

5.2 Procurement of winding wire with enamel shall be as per Para 4.0 above depending on its application.

5.3 Before use of the winding wires, railways shall conduct test as per IS Specification given in Para 4.0

5.4 In the case of varnished (with H69 of Dr. Beck & Co.) double glass covered enamelled (TR 543-38) winding wire, Railway shall use compatible of H69 varnish used on top of glass with the impregnating varnish like Dobeckon FT1052/2005
(500 EK).

5.5 Procurement of the enamel winding wires shall be from the RDSO's approved suppliers only.

6. 0 AGENCY OF IMPLEMENTATION :

Electric Loco sheds and shops of Electrified Railways.

7. 0 PERIODICITY OF IMPLEMENTATION :

i) During rewinding of auxiliary motor in sheds or shops.

ii) During the procurement stage of motor for various applications.

8. DISTRIBUTION :

As per enclosed list.

Encl : As above.

Rajiv Kumar

(R.K. Kulshrestha)

for Director General (Elec)

Chemical Base, Salient Properties and Applications

Terebec TR 543-38 is a THEIC polyesterimide wire enamel having Temperature index > 200.
Terebec TR 543-38 is characterised by :

- UL approved as a base coat with top coat of Allotherm 602C/L-35
- Improved flexibility and adherence to copper

- Excellent resistance to hot transformer oil and refrigerants
- Good burn out resistance
- High cut through temperature at high processing speed
- High tan delta

Terebec TR 543-38 is a medium viscosity wire enamel which is specially suitable for 0.05 to 2.0 wire sizes. For felt wiping application, the enamel may be thinned down to 35% solids (approx. viscosity 450 mPa.s) using Thinner 115.

Terebec TR 543-38 is an ideal choice as base coat enamel for production of dual coated wires using top coat of polyamid-imide such as Allotherm 602 L -35A. Such dual coated wires have high tan delta bending point, and excellent resistance to refrigerants. They satisfy requirements of IS 13730-13/IEC 317-13 (specification for class 200, dual coated enamelled wires). Terebec TR 543-38 as a base coat with overcoat of Allotherm 602L-35 is recognized by Underwriters Laboratories under file No. E73276 providing temperature index 220.

Enamelled wires coated with Terebec TR 543-38 find applications in hermetically sealed motors, ballasts, thermal class H electrical machines etc. Wires coated with Terebec 543-38 meet specification requirements of IS 13730-8/IEC 317-8.

Terebec TR 543-38 properties :

Table 1 : Terebec TR 543-38 properties (as supplied)

Appearance (*)	DBI 1001 (**)		Brown coloured clear liquid
Solids Content (*)	DBI 1022(**) 1g/180 °C/1h	%	37-39
Viscosity at 23 °C (*)	DBI 3005(**) Brookfield Viscometer	m Pa.s	750-850
Flash point	DBI 1005(*) (closed cup)	°C	40 (typical)
Storage stability	In original sealed container at room temperature	months	12

(*) These properties form our sales specification

(**) DBI are internal test methods and are available on request

Properties of Terebec TR 543-38 Enamelled Wires

Table 2 : Typical Properties of 1.0 mm dia. Gr. 2, enamelled copper wire coated with Terebec TR 543-38 processed on vertical machine, 420^{0}C/450^{0}C, 19 m/min.

Test methods according to IS 13778-1 to 6/ICE 851-1 to 6 or unless otherwise specified.

Increase in dia		**mm**	**0.070**
Elongation to break		%	36
Springiness		degree	40
Flexibility and Adherence			
Mandrel winding			OK
Jerk test	20%+1xd		OK
Peel test		n x d	182
Resistance to abrasion	av./min	N	13.8 / 12.4
Solvent resistance	Initial		4H-5H
(Pencil hardness)	Std. Solvent		3H-4H

Break-down voltage Dielectric dissipation factor (Tan delta)	at R.T. at 180°C Beck Test 5003 - At 194° C - bending point	kV kV °C	10.0 9.2 0.01-0.02 180-200
Heat shock Cut-through Temperature Index (Thermal endurance)	2.24 mm d/220°C 350°C/2 min IS 5825/IEC 172		OK OK 209

Packing and storage

Terebec TR 543-38 : 205 kg in MS drums
Thinner 115 : 180 kg and 20 kg in MS drums

The drums with original seal, should be preferably kept in a covered godown, away from direct sunlight and rain water.

Safe Handling :

Terebec TR 543-38 is a flammable liquid. PVC handgloves, safety goggles, face sheild etc. should be used while handling the product. Use foam, CO2 or dry chemical for fire fighting. Inhalation and direct contact with the skin to be avoided. In case of contact, the affected area should be washed with soap and plenty of water. For further details ask for product safety data sheet 1-50.

Notice :

This information is intended only for general guidance in the application of our product. It has been obtained by careful investigation and represents the present state of our knowledge and experience. Because of the large number of possible methods of application and processing, we are not able to assume responsibility in any one particular case for either the technical results or the patent rights situation applicable to the country under consideration.

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Chemical Base, Salient Properties and Application :

Allotherm 602… is a polyamide imide based wire enamel having a Temperature Index 230.

The enamelled wire processed with Allotherm 602… has excellent thermal properties, particularly the heat shock

The enamelled wire coated with Allotherm 602… has excellent abrasion resistance and resistance to refrigerants R-12\R-22.

The enamel film retains dielectric properties after exposure to humid conditions and higher temperatures.

Allotherm 602… has very low stack loss resulting in lower enamel consumption

Allotherm 602… is suitable for the wire range of 0.2 mm to 1.6 mm dia copper conductors

In view of its excellent windability, Allotherm 602… is often used as a top coat enamel, while manufacturing dual coated wires. Due to high abrasion and low coefficient of friction, Allotherm 602… coated wires are ideal for high speed winding machines.

Allotherm 602… enamelled wires have low extractable matter in R-12 and R-22 refrigerants and hence make best choice for hermetically sealed motors.

The excellent thermal properties of Allotherm 602… enamelled wires make it suitable for thermal class 180 and above (class H & C) electrical machines for continuous operation.

Properties of Allotherm 602…

Table 1 : Allotherm 602.35 properties (as supplied)

Chemical base			Polyamide-imide
Appearance			High viscosity dark brown clear liquid
Solids content	1g\200C\2h	%	34 -36
Viscosity at 20° C	Brook field viscometer	mPa.s	2500-3500
Density at 20°C	DIN 51757	g\ml	1.17 (Typical)
Flash point	DIN 53213 (closed up)	°C	42
Compatibility with Thinner 129			1:1

Application Data for Allotherm 602…

Allotherm 602… wire enamel can either be used as a single coat or as a top coat in the dual coat system. While applying it as a top coat, Allotherm 602… is compatible with polyester, polyesterimide and polyesteramide-imide as base coat enamels. While used as top coat, Allotherm 602… wire enamel should not get mixed with conventional base coat enamels containing solvents such as cresylic acid, solvent naptha etc.

Allotrherm 602… is available in two viscosity versions

- Allotherm 602.35 : with higher solids and higher viscosity for die application on vertical enamelling machines.
- Allotherm 602.25 : with lower solids and medium viscosity for felt application on horizontal and vertical enamelling machines.

Table 2 gives typical processing conditions obtained on our pilot plant. The actual processing conditions on the production plants may vary depending upon the oven design and processing parameters.

Table 2 : Application Data

Wire size ¼ mm	Covering	Oven				Number of Passes **	Proce-ssing speed m/min
		Type	Heating length m	Temperature			
				Zone 1 °C	Zone 2 °C		
1.6	Medium	Vertical Catalytic	5.0	420	450	8	9
1.0	Medium	Vertical Catalytic	5.0	420	450	8	15
*.05	Medium	Vertical Conventional	3.0	275	450	7	11
*.03	Medium	Horizontal convential	2.5	275	425	6	20

* Using low viscosity grade Allotherm 602.25

** After annealing in inert atmosphere.

Properties of Allotherm 602 … Enamelled wire

Table 3 : Properties of 1.0 mm enamelled copper wires processed with Allotherm 602.35

Test methods according to IS 4800 (Part III) unless otherwise specified

Diameters : Conductor Increase in dia Covering Elongation to break Springiness		 mm mm % degree	 1.000 0.070 medium 36 43
Flexibility and adherence : Mandrel winding Jerk test Peel test	15 % 1 d	 R * d	 OK OK 72
Abrasion Unidirectional scrape		 N	 16.5
Heat Shock Cut through Burn out resistance High temperature failure test	1d/280° C/30 min 350° C/2 min NEMA-MW-1000 IEC : 251 – 1 at 475° C at 450° C at 425° C	 OFM min min min	 OK OK 12 143 241 399
Solvent resistance Trichloroethylene extraction Blister test	Pencil hardness initial Std. Solvent	 %	 6H 5H <0.05 No blistering
Break-down voltage Dielectric dissipation factor (tang) Break-down voltage 16h/R-22 immersion	at R.T. at 220°C Break Test E 102 at R.T. at 220°C	kV kV kV	10.8 10.0 0.007 0.015 10.0

Available Grades

Table 4 : Available grades of Allotherm 602 …

Trade Designation	Viscosity at 20° C		Solids
	DIN 53211/ cup 4 (s)	(mPa.s)	1g/2h/200°C (%)
Allotherm 602.25	100-120		24-26
Allotherm 602.35		2500-3500	34-36

Packing and Storage

Allotherm 602 : 205 kg in MS drums
Thinner 129 : 180 kg and 21 kg MS drums

Allotherm 602 wire enamel can be stored for 6 to 9 months and Thinner 129 for 1 year at room temperature.

The drums with original seal should be kept in a covered godown away from direct sun light and rain water.

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