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Raychem
Tubing

Specification
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Raychem HRHF, HRNF, and HRSR High Shrink Ratio Heat Shrinkable Tubing

1. SCOPE

This specification covers the requirements for three types of electrically insulating, extruded tubing whose diameter will reduce to a predetermined size upon the application of heat in excess of 120°C. They are suitable for use with Hot Melt Adhesive /97 or Sealant /226.

1.1 HRSR.

HRSR tubing is a semi rigid, flame retardant, cross-linked modified polyolefin. The standard color is black and can be supplied with a Sealant or Hot Melt Adhesive.

1.2 HRHF

HRHF tubing is a highly flexible, flame retardant cross-linked modified polyolefin. The standard color is black (and clear for non-flame retardant material) and can be supplied with a Sealant or Hot Melt Adhesive.

1.3 HRNF

HRNF tubing is a semi rigid, non-flame retarded, cross-linked modified polyolefin. The standard color is black and can be supplied with a Sealant or Hot Melt Adhesive.

2. REQUIREMENTS

2.1 Composition and Appearance

The tubing shall be fabricated from thermally stabilized, modified polyolefin and shall be irradiation cross-linked. It shall be homogeneous and essentially free from flaws, defects, pinholes, bubbles, seams, cracks and inclusions.

3. PROPERTIES

The tubing shall meet the requirements of Tables 1 and 2.

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS

4.1.1 Qualification Tests

Qualification tests are those performed on the tubing submitted for qualification as a satisfactory product and shall consist of all the tests listed in this specification.

4.1.2 Production Routine Tests

Production routine tests shall be carried out on every batch, unless otherwise specified and shall consist of the following: dimensions, longitudinal change, tensile strength, ultimate elongation, heat shock, low temperature flexibility and flammability. Flammability is not applicable for HRNF and clear tubings.

5. SAMPLING INSTRUCTIONS

5.1 Qualification Test Sample

Qualification test samples shall consist of 50 feet (15m) of tubing. Qualification of any size qualifies all sizes. The color shall be black.

5.2 Production Routine Test Samples

Production routine test samples shall consist of a sufficient length to perform all the tests in 4.1.2 selected at random from each batch. A batch shall consist of all tubing of the same size, from the same production run and offered for inspection at the same time. Physical property tests performed at this time qualify subsequent tubing lots produced from the same compound batch.

6. TEST PROCEDURES

Unless otherwise specified the tubing shall be recovered in a forced air circulating oven for 10 minutes at $150 \pm 2^\circ\text{C}$. All tests shall be performed without the adhesive. Uncoated samples are available upon request.

6.1 Dimensions and Longitudinal Change

The test method shall be as specified in ASTM D 2671.

The length and inside diameter of three 250 mm long specimens of expanded tubing shall be measured. The specimens shall be recovered and the length and inside diameter of each shall be measured. The longitudinal change shall be expressed as a percentage of the original length. The minimum and maximum recovered wall thicknesses shall be determined.

6.2 Tensile Strength and Ultimate Elongation

The test method shall be as specified in ASTM D 638.

For tubing of recovered inside diameter greater than 6 mm, five Type IV dumbbell specimens shall be tested. For tubing of recovered inside diameter less than or equal to 6 mm, five tubular specimens 150 mm long shall be tested. Rate of jaw separation shall be 500 ± 10 mm per minute.

The test shall be carried out at a temperature of $23 \pm 2^\circ\text{C}$.

7. PREPARATION FOR DELIVERY**7.1 Form**

The tubing shall be supplied in cut lengths unless otherwise specified.

7.2 Packaging

Packaging shall be in accordance with good commercial practice.

7.3 Marking

Each container of tubing shall be permanently and legibly marked with the size, quantity, manufacturer's identification and batch number.

8. RELATED DOCUMENTS

A-A-694	5% NaCl
ASTM D 570	Standard Test Method for Water Absorption
ASTM D 638	Standard Test Methods for Tensile Properties of Plastics
ASTM D 792	Standard Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 876	Standard Test Methods for Non Rigid Vinyl Chloride Polymer Tubing Used for Electrical Insulation
ASTM D 882	Standard Test Methods for Tensile Properties of Thin Plastic Sheet
ASTM D 2671	Standard Test Methods for Heat-Shrinkable Tubing for Electrical Use
ISO 846 Method B	Plastics – Evaluation of the Action of Microorganisms
MIL-H-5606	Hydraulic Fluid Petroleum Base, Aircraft, Missile and Ordnance
MIL-PRF-7808	Lubricating Oil
MIL-A-8243	De-icing Fluids
MIL-L-23699	Lubricating Oil
MIL-DTL-83133	Turbine Fuel, Aviation, Grade JP-8
SAE-AMS-DTL-23053	Insulating Tubing, Electrical, Heat Shrinkable, General Specification

Table 1
Tubing Dimensions

Part Number	Internal Diameter, mm		Wall Thickness, mm
	(Min.) Expanded as Supplied	(Max.) Recovered After Heating	(Nom.) Recovered After Heating
HR**060	15.24 (0.600)	3.81 (0.150)	1.52 (0.060)
HR**125	31.75 (1.250)	6.10 (0.240)	1.52 (0.060)
HR**175	44.45 (1.750)	8.00 (0.315)	2.41 (0.095)
HR**200	50.80 (2.000)	9.53 (0.375)	2.67 (0.105)
HR**250	63.50 (2.500)	12.70 (0.500)	3.05 (0.120)
HR**300	76.20 (3.000)	19.05 (0.750)	3.05 (0.120)
HR**400	101.60 (4.000)	22.86 (0.900)	3.56 (0.140)

**NF, HF or SR () Inches

TABLE 2
REQUIREMENTS

PROPERTY	UNIT	HRNF	HRHF	HRSR	TEST METHOD
PHYSICAL					
Dimensions	mm (in.)	In accordance with Table 1	In accordance with Table 1	In accordance with Table 1	Section 6.1 ASTM D 2671
Longitudinal Change	Percent	+1, -10	+1, -10	+1, -10	Section 6.1 ASTM D 2671
Tensile Strength	MPa	8.4 Min.	8.4 Min.	8.4 Min.	Section 6.2 ASTM D 638
Ultimate Elongation	Percent	200 Min.	200 Min.	200 Min.	Section 6.2 ASTM D 638
Secant Modulus (Expanded)	MPa	150 Max.	120 Max.	220 Max.	ASTM D 882
Specific Gravity		1.5 Max.	1.4 Max.	1.5 Max.	ASTM D 792
Low Temperature Flexibility 4 hours at $-55 \pm 2^{\circ}\text{C}$		No cracking	No cracking	No cracking	SAE-AMS-DTL-23053
Heat Shock 4 hours at $225 \pm 3^{\circ}\text{C}$		No dripping, flowing or cracking	No dripping, flowing or cracking	No dripping, flowing or cracking	SAE-AMS-DTL-23053
Heat Resistance 168 hrs at $175 \pm 2^{\circ}\text{C}$ for HRHF-BK/HRSR 168 hrs at $150 \pm 2^{\circ}\text{C}$ for HRNF/HRHF-CL Followed by tests for Tensile Strength Ultimate Elongation	MPa Percent	7.0 Min. 300 Min.	7.0 Min. 100 Min.	7.0 Min. 100 Min.	ASTM D 638 ASTM D 638
ELECTRICAL					
Dielectric Strength	KV/mm	7.9 Min.	7.9 Min.	7.9 Min.	ASTM D 2671 *Note 1
Volume Resistivity	Ohm-cm	10^{13} Min.	10^{13} Min.	10^{13} Min.	ASTM D 876
CHEMICAL					
Copper Mirror Corrosion 16 hours at $120 \pm 2^{\circ}\text{C}$		No removal of copper	No removal of copper	No removal of copper	SAE-AMS-DTL-23053
Copper Contact Corrosion 16 hours at $120 \pm 2^{\circ}\text{C}$		No pitting or blackening of copper	No pitting or blackening of copper	No pitting or blackening of copper	SAE-AMS-DTL-23053
Flammability	Seconds	N/A	Procedure B 15 Max. *Note 3	Procedure C 60 Max.	SAE-AMS-DTL-23053 ASTM D2671
Fungus Resistance Followed by tests for Tensile Strength Ultimate Elongation Dielectric Strength	MPa Percent KV/mm	8.4 Min. 200 Min. 7.9 Min.	8.4 Min. 200 Min. 7.9 Min.	8.4 Min. 200 Min. 7.9 Min.	ISO 846 Method B ASTM D 638 ASTM D 638 ASTM D 2671
Water Absorption 24 hours at $23 \pm 2^{\circ}\text{C}$	Percent	0.5 Max.	0.5 Max.	0.5 Max.	ASTM D 570
Fluid Resistance 24 hours at $23 \pm 2^{\circ}\text{C}$ JP-8 Fuel (MIL-DTL-83133) Hydraulic Fluid (MIL-H-5606) De-icing Fluid (MIL-A-8243) Lube Oil (MIL-PRF-7808) Lube Oil (MIL-L-23699) 5% NaCl (A-A-694) Followed by tests for Tensile Strength Ultimate Elongation Dielectric Strength	MPa Percent KV/mm	5.2 Min. 100 Min. 7.9 Min.	5.2 Min. 100 Min. 7.9 Min.	5.2 Min. 100 Min. 7.9 Min.	SAE-AMS-DTL-23053 ASTM D 638 ASTM D 638 ASTM D 2671 *Note 2
<p>*Note 1 Recover specimens on the metal mandrels for 10 minutes, minimum, at $200 \pm 3^{\circ}\text{C}$ or until the tubing is completely recovered on the mandrels.</p> <p>*Note 2 For dielectric strength, immerse the recovered specimens in the fluids for 24 hours at $50 \pm 2^{\circ}\text{C}$. After drying, place the specimens over closest fitting metal mandrels.</p> <p>*Note 3 N/A for HRHF-CL, which is non-flame retardant.</p>					