DATE

3/18/2021

PURPOSE

To evaluate Type HP™ cleaner under the guidelines proposed in IEEE 1493, "Guide for the Evaluation of Solvents Used for Cleaning Electrical Cables and Accessories."

PROCEDURE & RESULTS

A. SAFETY

Type HP cleaner is available as a pre-saturated towelette. This eliminates any spill hazard and limits usage and vapor exposure. Type HP cleaner has a high flashpoint and does not contain any listed carcinogens.

B. REGULATORY

Type HP cleaner is not listed on the EPA Phase I or Phase II list of banned or phased out chlorofluorocarbons. It is not considered hazardous waste under RCRA. It is not regulated under CERCLA/SARA Sec. 302 as a hazardous substance RQ or extremely hazardous substance TPQ, nor is it regulated under SARA Sec. 313.

C. PHYSICAL PROPERTIES

1. FLASH POINT

Type HP cleaner has a flashpoint of 63 - 67°C. Acceptance criteria is a flashpoint greater than or equal to 60.5°C (141°F).

2. DIELECTRIC

Type HP cleaner produces a dielectric breakdown of >40 kV when tested by ASTM D 877, 100 mil plate gap. Acceptance criteria is a dielectric breakdown greater than or equal to 10 kV.

D. PERFORMANCE

1. EVAPORATION RATE

The evaporation rate of Type HP cleaner is 60.0 as (n-butyl acetate = 1.0) per ASTM D 1901. Since Type HP™ cleaner is used as a wipe (components being cleaned are not soaked or immersed in the cleaner), evaporation takes place relatively quickly.

2. %NON-VOLATILE RESIDUE

Type HP cleaner does not leave a residue. The cleaner was tested per ASTM D 2369. Three samples of approximately 3 grams were weighed accurate to 0.1 mg. The solvent was evaporated at 100°C and residue was determined. The nonvolatile residue was determined to be 0 ppm (not detectable). Acceptance criteria is a non-volatile residue less than 100 ppm.

3. CLEANING EFFECTIVENESS

Type HP cleaner was evaluated in the laboratory for cleaning effectiveness by wiping a semi-conducting cable component with a piece of towel saturated with the cleaner. Type HP cleaner was found to clean the component quickly and effectively.

E. COMPATIBILITY

1. PHYSICAL

a. Plastic Materials – XLPE

XLPE jacket material was stripped from a cable and cut into a dumbbell shape (ASTM D 412 Die D). Samples were immersed in the Type HP cleaner for 1 minute +/- 5 seconds. Tensile and Elongation values were measured at 15 minutes after immersion. Initial jaw separation was 2 inches and pulling speed was set at 2 inches/minute. These values were compared to the control.

DESCRIPTION	TENSILE	ELONGATION
Type HP Solvent Soak	2142 lb/in^2	363%
Control Material Property	2010 lb/in^2	327%
Comparison	107%	111%
Status	**PASS**	**PASS**

Percent weight change of XLPE Cable Jacket 15 minutes after immersion is +0.33%.

b. Rubber Materials – EPDM and Silicone Rubber

Platen samples of the EPDM and Silicone Rubber were obtained and cut into dumbbell shapes (ASTM D 412 Die D). Samples were immersed in the Type HP for 1 minute +/- 5 seconds. Tensile and Elongation values were measured at 15 minutes after immersion. Initial jaw separation was 2 inches and pulling speed was set at 500 mm/min. Acceptance criteria is retaining 80% of the original tensile or elongation after the soak.

SILICONE RUBBER RESULT:

DESCRIPTION	TENSILE	ELONGATION
Type HP Solvent Soak	978 lb/in^2	188%
Control Material Property	1022 lb/in^2	199%
Comparison	96%	94%
Status	**PASS**	**PASS**

Percent weight change of Silicone Rubber 15 minutes after immersion is +3.48%.

EPDM RUBBER RESULT:

DESCRIPTION	TENSILE	ELONGATION
Type HP Solvent Soak	1215 lb/in^2	301%
Control Material Property	1181 lb/in^2	290%
Comparison	103%	104%
Status	**PASS**	**PASS**

Percent weight change of EPDM Rubber 15 minutes after immersion is +3.61%.

c. INSULATION MATERIALS

Insulation materials from Okonite and General Cable cables underwent a solvent soak test as described in IEEE 1493, Section 8.2.1. During this test samples of the insulation materials were soaked in Type HP for 1 minute ± 5 seconds and volume swell was determined by this formula:

$$\% \text{ Volume Swell} = (SG_s * Wt_g) / (Wt_i * SG_l) * 100$$

$$Wt_g = Wt_F - Wt_{tare} - Wt_i$$

Where:
- Wt_i = Initial specimen weight
- Wt_g = Net weight gain of specimen
- Wt_F = Final weight of swollen specimen and bottle
- Wt_{tare} = Tare weight of bottle and lid
- SG_s = Density (or specific gravity) of the specimen
- SG_l = Density (or specific gravity) of the liquid

Acceptance criteria for volume swell after immersion to be less than ±10%.
Average results of three trials are shown in the tables below:

OKONITE EPR INSULATION:

%VOLUME SWELL	STATUS
3.62	**PASS**

GENERAL CABLE EPR INSULATION:

%VOLUME SWELL	STATUS
1.47	**PASS**

2. ELECTRICAL

a. VOLUME RESISTIVITY OF CABLE INSULATION SHIELD

Volume resistivity was tested as a slightly modified version as described in IEEE 1493, Section 8.3.2. Cables were stripped to the insulation shield. Silver paint was applied at a separation of about 20 cm to create potential electrodes. The cables were wrapped in Type HP soaked paper towels for 1 minute ± 5 seconds. A control sample was also tested. Resistance measurements were converted using the following formula:

$$R = V/I$$

Where V is the voltage across the electrodes, and I is the current between the electrodes.
The volume resistivity, ρ, is calculated from:

$$\rho = (\pi/4) \cdot R\,(D^2 - d^2)/L$$

Where D = the diameter over the insulation shield in cm, d = the diameter over the insulation in cm and L = the length between the electrodes in cm. The resulting value for ρ is in ohm cm.

Acceptance criteria for this test is for the samples to not change from the average value measured for the control specimens by more than ± 20% at 96 hours.

Volume resistivity results are as follows:

XLPE INSULATION SHIELD VOLUME RESISTIVITY

EXPOSURE TIME	CONTROL	TYPE HP	% CONTROL
Initial	40 ohm-cm	40 ohm-cm	100
3 minutes	40 ohm-cm	45 ohm-cm	113
15 minutes	40 ohm-cm	45 ohm-cm	113
1 hours	40 ohm-cm	41 ohm-cm	103
24 hours	40 ohm-cm	40 ohm-cm	100
		STATUS:	**PASS**

OKONITE EPR INSULATION SHIELD VOLUME RESISTIVITY

EXPOSURE TIME	CONTROL	TYPE HP	% CONTROL
Initial	24.7 ohm-cm	22.9 ohm-cm	92
30 minutes	24.5 ohm-cm	28.2 ohm-cm	115
24 hours	24.1 ohm-cm	24.1 ohm-cm	100
48 hours	23.1 ohm-cm	23.5 ohm-cm	102
96 hours	22.3 ohm-cm	23.1 ohm-cm	104
		STATUS:	**PASS**

GENERAL CABLE THERMOSET INSULATION SHIELD VOLUME RESISTIVITY

EXPOSURE TIME	CONTROL	TYPE HP	% CONTROL
Initial	516 kohm-cm	534 kohm-cm	103
30 minutes	499 kohm-cm	601 kohm-cm	121
24 hours	430 kohm-cm	536 kohm-cm	124
48 hours	400 kohm-cm	470 kohm-cm	117
96 hours	363 kohm-cm	412 kohm-cm	113
		STATUS:	**PASS**

The cables soaked in Type HP had acceptable volume resistivity.

b. INSULATION ELECTRICAL TEST

The cables were stripped down to their insulation layers and conditioned at room temperature for at least 24 hours. Then two spring electrodes were placed 30 cm apart on the cable. A dc voltage was applied across the electrodes and the leakage was measured at 5, 10, and 15 kV. Then a sample is exposed to the solvent for 1 minute. The leakage was tested again 5 to 7 minutes after that exposure. To pass the leakage for each immersed specimen should be less than or equal to 1.2 times the average of the leakage current of the control specimens. The leakage results are below:

OKONITE EPR INSULATION

VOLTAGE APPLIED	CONTROL	TYPE HP	% CONTROL
5 kV	0 μA	0 μA	100
10 kV	0 μA	0 μA	100
15 kV	0 μA	0 μA	100
		STATUS:	**PASS**

GENERAL CABLE EPR INSULATION

VOLTAGE APPLIED	CONTROL	TYPE HP	% CONTROL
5 kV	0 μA	0 μA	100
10 kV	0 μA	0 μA	100
15 kV	0 μA	0 μA	100
		STATUS:	**PASS**

CONCLUSION

Type HP cleaner has a high flashpoint, good dielectric strength, and excellent cleaning ability. Type HP cleaner has a negligible effect on the physical properties of XLPE plastic and silicone rubber. It has a short-term effect on EPDM and EPR rubber, which becomes negligible within 96 hours after exposure. It also has a negligible effect on the electrical properties of XLPE semi-conducting compound.

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