Eastman™ 168 plasticizer

Applications for vinyl water stops, lacquer mar-resistant vinyl and wire coating compounds

Contents

Eastman™ 168 is an excellent general-purpose non-orthophthalate plasticizer, with performance equal to or better than most orthophthalate plasticizers. The important properties of Eastman™ 168 plasticizer are listed in Table 1.

Eastman™ 168 is compatible with polyvinyl chloride (PVC) and with polyvinyl chloride/vinyl acetate (PVC/VA) copolymer resins and provides low, stable viscosity in plastisols. It also offers good permanence properties, resistance to extraction by soapy water and excellent low-temperature flexibility.

Eastman™ 168 plasticizer has been evaluated in flexible PVC formulations useful for vinyl water stops, low-marring vinyl compounds and wire coating compounds. These formulas and test results are good starting points to guide the vinyl formulator.

Table 1 Typical properties of Eastman™ 168 plasticizer[a]

General	
Molecular weight (theoretical)	390.57
Empirical formula	$C_{24}H_{38}O_4$
Physical	
Form	Liquid
Color (Pt-Co scale)	15
Refractive index, $n\frac{25°C}{D}$	1.4867
Acidity, as phthalic acid, wt %	0.01 max.
Specific gravity @ 20°C/20°C	0.9835
Wt/Vol @ 20°C (68°F)	
lb/gal (U.S.)	8.18
kg/L	0.980
lb/gal (Imperial)	9.82
Boiling point @ 760 mm, °C (°F)	400 (752)
Freezing point, °C (°F)	−48 (−55)
Solubility in water @ 20°C, µg/L	0.4
Viscosity (ASTM D445), cP	
−17.8°C (0°F)	2,500
0°C (32°F)	410
25°C (77°F)	63
100°C (212°F)	5
Stability	
Boiling water stability (% hydrolyzed after 96h)	0.04
Heat stability (205°C, 2h), % acid	0.06
Electrical	
Volume resistivity, ohm-cm (ASTM D257)	3.9×10^{12}
Dielectric constant @ 1 MHz (ASTM D150)	4.6
Dissipation factor @ 1 MHz (ASTM D150)	0.1×10^{-2}

[a]*Properties are reported for information only. Eastman makes no representation that the material in any particular shipment will conform exactly to the values given.*

Vinyl water stops

Good-quality vinyl water stops can be made using formulations containing Eastman™ 168 as the plasticizer. A more economical blend of Eastman™ 168 and Eastman TXIB™ plasticizers also produces satisfactory results and facilitates dry-blend preparation. Polyvinyl chloride water stops that pass U.S. Army Corps of Engineers Specifications CRD-C 572-74 have been made using the formulations shown in Table 2. These two formulations, one containing Eastman™ 168 and the other a combination of Eastman™ 168 and Eastman TXIB™, are listed showing the properties in comparison with CRD-C 572-74 requirements. Samples taken from the finished water stop must meet requirements for initial properties and must pass Accelerated Extraction and Effect-of-Alkalies tests. The following methods of testing are set forth in CRD-C 572-74, Paragraphs 7.1 and 7.2.

Accelerated extraction tests

Five tensile test specimens cut to the shape and dimension given in CRD-C 573, using die C, will each be weighed to the nearest 0.001 g. The specimens will be placed in a 1 L, tall-form beaker with a spout. The beaker will be filled within 2 in. (5 cm) of the top with a solution made by dissolving 5 g of chemically pure sodium hydroxide and 5 g of chemically pure potassium hydroxide in 1 L of distilled water.[1] The specimens will be completely immersed, and the top of the beaker covered with a watch glass. The beaker will then be placed in a constant temperature bath, and the temperature of the solution maintained at 60°–65.5°C (140°–150°F). A 1⁄4-in. (6.35-mm) diameter glass tube will be inserted into the spout of the beaker to within 1⁄2 in. of the bottom of the beaker. Air will then be gently bubbled through the solution at the rate of approximately one bubble per second. The solution will be changed every 24 hours, the new solution being warmed to 65.5°C (150°F) before replacing the old.

Once daily, each of the five specimens will be removed from the beaker (preferably at the time the solution is renewed) and rinsed slightly with distilled water. Each specimen will then be superficially dried with a clean cloth. Ten minutes after the specimens have been dried, the group of five specimens will be weighed and the weight recorded.

The testing sequence will be carried out continuously for a period of not less than 14 days. After that period, provided the specimens have reached constant weight (see note below), they will be tested for tensile strength and elongation.

Tensile strength will be calculated from the total load at failure, the nominal width, and the thickness as determined prior to exposure to the extraction tests. If the tests for tensile strength and elongation cannot be made within 1 hour after completion of the weighings that demonstrate constant weight has been achieved, the specimens will be immersed in fresh alkali solution and stored at room temperature. Prior to being tested for tensile strength and elongation, the specimens will be removed, rinsed, dried, stored for 10 minutes and weighed. The tensile strength and elongation will be determined not more than 72 hours after the weighings that demonstrated a constant weight had been achieved.

Note: Constant weight is assumed to have been achieved when the weights of the group of specimens on three successive weighings do not differ from each other by more than 0.05% of the original weight. If constant weight has not been achieved after 90 days, the exposure will be terminated, the specimen tested for tensile strength and elongation, and a note added to the report indicating the weight losses between the last three successive weighings and the fact that constant weight, as defined here, was not achieved.

Effect-of-alkalies tests

Three specimens weighing approximately 75 g each will be pressed in accordance with CRD-C 515. The specimens will be washed in tap water, rinsed with distilled water, wiped with a clean cloth and allowed to dry in laboratory air for approximately 1 hour.

The weight of each specimen to the nearest 0.001 g will be recorded. Ten durometer readings, using the Shore A Durometer, will be taken on each specimen in accordance with CRD-C 569. The specimens will be immersed in a freshly made solution containing 5 g of chemically pure sodium hydroxide and 5 g of chemically pure potassium hydroxide in 1 L of distilled water kept at 21°–24°C (70°–75°F).

[1]*Sodium and potassium hydroxides, as solids or solutions, can cause severe burning of the eyes and skin. Dust or mists can cause injury to the eyes and respiratory tract. Do not get on skin or in eyes. Do not breathe dust or mists. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes and get medical attention.*

At the end of 7 days, the specimens will be removed, rinsed with distilled water, wiped with a clean cloth and allowed to dry in laboratory air for approximately 1 hour. The weight and durometer hardness will be measured and recorded. Changes in weight and durometer readings will be recorded as a percentage of the weight and durometer readings of the original samples; the averages of these changes for the three specimens tested will be reported to determine compliance with applicable requirements.

Table 2 Water stop formulations[a]

	Parts per hundred resin	
Ingredient	**Formula 1**	**Formula 2**
PVC resin, medium to high molecular weight	100.0	100.0
Calcium carbonate filler	35.0	35.0
Ba-Cd stabilizer	1.0	1.0
Eastman™ 168 plasticizer	62.0	55.8
Eastman TXIB™ plasticizer	—	6.2

Water stop properties

Property	**Requirement by CRD-C 572-74**	**Test data**	
Initial			
Tensile strength, psi	Not less than 1,750	2,560	2,570
Ultimate elongation, %	Not less than 300	370	385
Low temperature brittleness, °C (°F)	No sign of failure @ −37°C (−35°F)	−39 (−38)	−38 (−36)
Hardness, Shore A Durometer, 5 s		82	83
Accelerated extraction			
Tensile strength, psi	Not less than 1,500	2,530	2,560
Ultimate elongation, %	Not less than 280	375	395
Effect of alkalies after 7 days			
Change in weight, %	Between −0.10 and +0.25	+0.05	+0.002
Change in Shore A Durometer reading	Not more than ±5	+1	+1

[a]*Formulations are reported for illustration only. Eastman makes no warranty as to the accuracy of the formulations or that the formulations will meet your particular needs.*

Reduced lacquer marring

Marring of nitrocellulose lacquer by plasticized PVC is common in various applications. It can be a problem, particularly for lacquered wood furniture that may be in contact with vinyl objects such as upholstery, tablecloths, place mats, handbags and other items.

Such marring can be easily reduced by using Eastman™ 168 plasticizer in place of DOP or other orthophthalates in vinyl products that might come in contact with lacquered surfaces. Work in Eastman laboratories has confirmed the very low lacquer mar properties imparted to fused vinyl with Eastman™ 168.

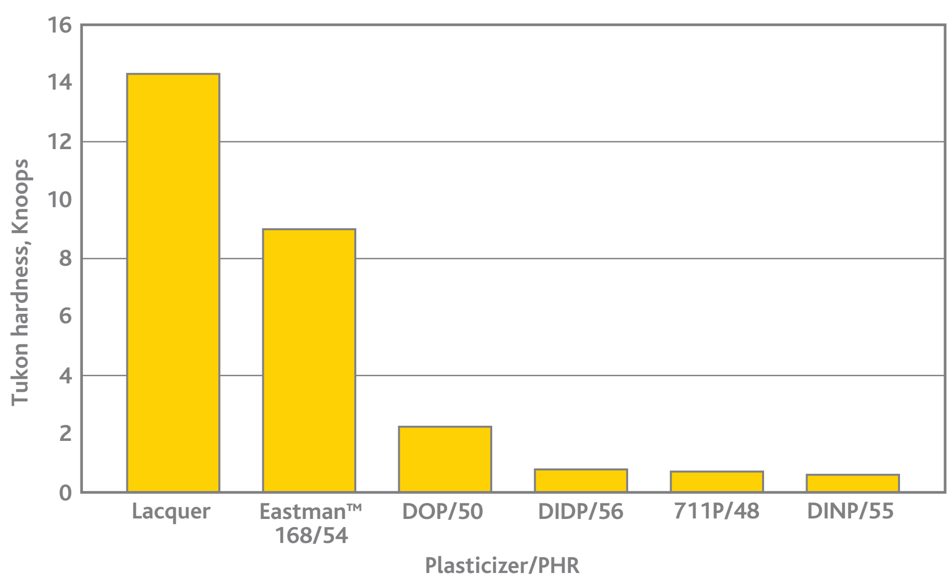
A fused vinyl formulation (Table 3) containing Eastman™ 168 exhibited much less lacquer marring than the same formulation containing orthophthalate plasticizers. The difference in marring is visually obvious, and the greater hardness of the lacquer contacting the Eastman™ 168 containing vinyl can be easily detected with the fingernail. In the laboratory, the actual hardness can be measured accurately using a Tukon hardness tester. The measurement of plasticizer migration from vinyl to nitrocellulose lacquer is based on ASTM D2199.

A small sample of vinyl is placed on a nitrocellulose lacquer film under a pressure of 1⁄2 psi, and the assembly is heated in an oven for 3 days at 50°C (122°F). At the end of the test time, the lacquer is examined for marring or softening, and the hardness is measured with a Tukon tester. Test results comparing the effect of Eastman™ 168 with that of DOP, DINP, DIDP and a C_7-C_9-C_{11} orthophthalate plasticizer are presented in Figure 1.

Table 3 Equal modulus flexible PVC formulations for lacquer mar testing

	PHR
PVC resin	100
Plasticizer	As indicated in Figure 1
Heat stabilizer	3

Figure 1 Nitrocellulose lacquer mar resistance



ASTM D2199; 72h, 50°C, 1/2 psi

Wire coating compounds

Eastman™ 168-CA containing PVC is a useful plasticizer for resins intended for use in wire coatings. Eastman™ 168-CA offers good permanence and good electrical properties for this end use.

Underwriters Laboratories Inc. (UL) conducted testing on a polyvinyl chloride compound containing Eastman™ 168-CA plasticizer. The compound formulation, intended for a 60° wire coating, is given in Table 4. UL tests conclude that this compound complies with their requirements for 60° wire coating. The test procedure and results follow in their entirety.

Table 4 Wire coating compound based on Eastman™ 168-CA plasticizer

	PHR
Borden™ 106 PM PVC resin	100
Eastman™ 168-CA plasticizer	45
Tribase EXL	6
SP33 clay filler	10
Atomite filler	10
Dibasic lead stearate	0.1

Test procedure

Introduction

Eastman is not engaged in the manufacture of insulated wires but is interested in supplying the jacketing compound to wire manufacturers who will use it in producing a finished wire. It is expected that the individual wire manufacturer will submit the finished wire to Underwriters Laboratories Inc. for investigation and recognition. The investigation made on such material will be limited to identification of the material and performance tests designed to establish the ability of the wire to operate safely when used as intended.

Description

Product Covered Eastman™ PVC insulating compound 60-1, Oil resistance I 60°C (140°F), suitable for use with type TW wire.

Construction Details General — The wire employing Eastman™ PVC insulating compound 60-1 complies with the requirements of the Underwriters Laboratories Inc., Standard for Thermoplastic-Insulated Wires.

Marking — The wires covered by this report will be marked as specified in the Underwriters Laboratories Inc., Standard for Thermoplastic-Insulated Wires.

Test record no. 1

Samples

The compound manufacturer submitted coils of Type TW Thermoplastic-Insulated Wire in Size No. 14 AWG, solid-copper conductors employing Eastman™ 168-CA PVC insulation compound 60-1 in red and black colors.

The following tests were conducted on the samples submitted, and all results complied with requirements.

Detailed Examination

	Red	Black
Conductor diameter, mil	64.6	64.7
Average insulation thickness, mil	32	32
Minimum insulation thickness, mil	29	28

Physical properties

	Red	Black
Unaged		
Average tensile strength, psi	2,519	2,550
Average elongation, %	110	130
After 7-day air oven @ 100°C (212°F)		
Average tensile strength, psi	2,860	2,766
Percent of original	114	108
Average elongation, %	100	100
Percent of original	91	77
After 96h @ 100°C (212°F) oil immersion		
Average tensile strength, psi	3,124	3,204
Percent of original	124	126
Average elongation, %	80	80
Percent of original	73	62
Conductor corrosion		
After the above aging	none	none
Flexibility tests		
After 1 h @ −25°C (−13°F)	no cracking	no cracking
After 1 h @ 121°C (250°F)	no cracking	no cracking
After 7-day air oven @ 100°C (212°F)	no cracking	no cracking

Physical properties *(continued)*

		Red	Black
Deformation test @ 121°C (250°F)			
Loads, g		500	500
T-2/T-1		0.76	0.82
Mechanical water absorption @ 70°C (158°F), g/in.^{2}			
Specimen	1	0.005	0.005
	2	0.005	0.005
	3	0.005	0.005
Capacitance test @ 30°C (86°F)			
After 1 day		5.18, 5.36	5.22, 5.40
Percent of change	14 days	6.1, 6.6	6.2, 6.1
	7–14 days	3.5, 3.7	3.2, 3.2
Vertical flame test		complies	complies
Dielectric withstand test			
1,500 volts for 1 min		no breakdown	no breakdown

Insulation resistance test	**Average insulation resistance (Megohms — 1,000 ft. of conductor)**	
Immersion time	**Red**	**Black**
1 day[a]	7,300	4,433
1 week[b]	19.7	22.5
2 weeks	20.7	24.9
3 weeks	—[c]	—[c]
4 weeks	26.9	34.5
5 weeks	29.9	38.0
6 weeks	30.9	43.5
7 weeks	52.3	75.0
8 weeks	54.3	84.2
9 weeks	60.2	88.3
10 weeks	59.5	88.0
11 weeks	66.3	97.2
12 weeks	68.0	100.3

[a]*23h in water at room temperature and 1 additional hour in water @ 15.6°C (60°F).*
[b]*Water @ 50°C (122°F) for this and subsequent periods.*
[c]*Reading not taken.*

Temperature correction factor test method

Method

Two 250-ft coils in each of the insulated wires (white, blue, red and black) were placed in water at room temperature for at least 12 hours (overnight). The insulation resistance was then measured to each coil at each of the following temperatures: 25°C (77°F), 20°C (68°F), 15.6°C (60°F) and 11°C (52°F).

The water was at the desired temperature for a period of 1½ hours before reading the insulation resistance. Care was taken that no air bubbles were clinging to the samples when readings were taken.

Results

The temperature correction factor is Column IV of Table 43.1 of the Underwriters Laboratories Inc., Standard for Thermoplastic-Insulated Wires.

Conclusion

The product covered by this report has been found to comply with the requirements covering the class.

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