Vamac® DP

Ethylene Acrylic Elastomer - Technical Data

Description

DuPont™ Vamac® DP is an ethylene acrylic dipolymer elastomer. Its general performance characteristics are similar to those of the Vamac® terpolymers, including:

- Good oil and chemical resistance
- High-temperature resistance
- Good compression set resistance
- Good low-temperature flexibility

Vamac® DP dipolymer can be processed without using a post cure, unlike amine cured Vamac® terpolymers. Typical density for Vamac® DP is 1.04 g/cc.

Product Properties

Property	Target Value	Method
Mooney Viscosity, ML (1+4 at 100 °C)	22	ASTM D1646
Volatiles	≤0.4 wt %	Internal DuPont Test
Form (25kg nominal bale size)	51.6 x 34.4 x 13.6 cm	Visual Inspection
Color	Slight orange tint	Visual Inspection

Handling Precautions

Because Vamac® ethylene-acrylic elastomers contain small amounts of residual methyl acrylate monomer, adequate ventilation should be provided during storage and processing to prevent worker exposure to methyl acrylate vapor. Additional information may be found in the Vamac® product Safety Data Sheet (SDS), and DuPont™ bulletin, *Safe Handling and Processing of Vamac®*.

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Compound Properties and Performance

Table 1 — Properties Test Compound made with DuPont™ Vamac® DP

Formulation: 100 phr of Vamac® DP, 55 phr of N550 black, 1 phr of Naugard® 445 antioxidant, 0.5 phr of Armeen® 18D, 0.5 phr of stearic acid, 5.5 phr of Vulcup® 40KE peroxide, 2 phr of HVA #2 coagent, and 1.25 phr Vanfre® VAM

Mooney Viscosity, ML (1+4) at 100 °C, MU	43.6
Mooney Scorch at 135 °C	
Minimum Viscosity, mu	11.6
t3, min	8.2
t10, min	11.3
MDR at 180 °C, 1° arc	
ML, in-lb	0.9
MH, in-lb	23.1
ts2, min.	0.54
t50, min.	1.10
t90, min.	3.55
Slope	6.0
Original Properties (10 min. at 180 °C)	
Hardness, Shore A, pts.	64
100% Modulus, MPa	7.2
Tensile Strength, MPa	18.2
Elongation at Break, %	208
Compression Set, %	
72 hrs at 150 °C	21.5
168 hrs at 150 °C	23.0
1008 hrs at 150 °C	43.4
Low Temperature Properties	
Tg by DSC, °C	–29
TR10, °C	–24

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Table 1 (continued) — Ageing Properties of Test Compound made with DuPont™ Vamac® DP

Heat Ageing, 1 week at 150°C	
Hardness, Shore A, pts.	71
100% Modulus, MPa	7.8
Tensile Strength, MPa	18.3
Elongation at Break, %	206
Delta Hardness, pts.	7
Delta 100% Modulus, %	8
Delta Tensile Strength %	1
Delta Elongation at Break, %	–1
Heat Ageing, 6 weeks at 150 °C	
Hardness, Shore A, pts.	73
100% Modulus, MPa	8.7
Tensile Strength, MPa	17.2
Elongation at Break, %	200
Delta Hardness, pts.	9
Delta 100% Modulus, %	20
Delta Tensile Strength, %	–5
Delta Elongation at Break, %	–4
SF105 Oil Ageing, 1 week at 150 °C	
Hardness, Shore A, pts.	56
100% Modulus, MPa	6.2
Tensile Strength, MPa	15.2
Elongation at Break, %	188
Delta Hardness, pts.	–8
Delta 100% Modulus, %	–14
Delta Tensile Strength, %	–16
Delta Elongation at Break, %	–10
Volume Change, %	19

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Table 1 (continued) — Ageing Properties of Test Compound made with DuPont™ Vamac® DP

SF105 Oil Ageing, 6 weeks at 150 °C	
Hardness, Shore A, pts.	56
100% Modulus, MPa	6.4
Tensile Strength, MPa	13.8
Elongation at Break, %	166
Delta Hardness, pts.	–8
Delta 100% Modulus, %	–11
Delta Tensile Strength, %	–24
Delta Elongation at Break, %	–20
Volume Change, %	21
IRM 903 Ageing, 6 weeks at 150 °C	
Hardness, Shore A, pts.	48
100% Modulus, MPa	6.4
Tensile Strength, MPa	10.8
Elongation at Break, %	144
Delta Hardness, pts.	–16
Delta 100% Modulus, %	–12
Delta Tensile Strength, %	–41
Delta Elongation at Break, %	–31
Volume Change, %	44
Dexron® III ATF Ageing, 6 weeks at 150 °C	
Hardness, Shore A, pts.	64
100% Modulus, MPa	8.1
Tensile Strength, MPa	16.4
Elongation at Break, %	171
Delta Hardness, pts.	0
Delta 100% Modulus, %	12
Delta Tensile Strength, %	–10
Delta Elongation at Break, %	–18
Volume Change, %	16

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Properties Changes as Peroxide Decreases

Peroxide levels influence the properties and performance of Vamac® DP compounds. Table 2 compares Vamac® DP compound properties as the peroxide level is reduced from 5.5 to 3.5 phr.

Table 2 —Compounds with Various Levels of Peroxide made with DuPont™ Vamac® DP

Formulation: 100 phr of Vamac® DP, 55 phr of N550 black, 1 phr of Naugard® 445 antioxidant, 0.5 phr of Armeen® 18D, 0.5 phr of stearic acid, 2 phr of HVA® #2 coagent, and 1.25 phr Vanfre® VAM

	Peroxide Level:		
Vulcup® 40KE, phr	5.5	4.5	3.5
Mooney Viscosity ML (1+4) at 100 °C, MU	49	50	51
Mooney Scorch at 135 °C			
Minimum Viscosity, MU	12.5	12.9	12.8
t3, min.	9.2	9.5	11.5
t10, min.	13.3	13.8	19.0
MDR at 180 °C, 1° arc			
ML, in-lb	1.03	1.04	1.02
MH, in-lb	23.4	20.5	17.7
ts2, min.	0.56	0.62	0.71
t(50), min.	1.12	1.2	1.34
tc(90), min.	3.5	3.6	3.8
Cured Properties (10 minutes at 180 °C)			
Hardness, Shore A, pts.	68	67	64
100% Modulus, MPa	7.0	6.7	5.8
Tensile Strength, MPa	15.4	16.9	16.1
Elongation at Break, %	198	232	254
Compression Set, % 168 hrs at 150 °C	37.9	47.5	52.0

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Properties Changes with Different Coagents

Compounds can be modified according to requirements for different applications using alternatives to HVA-2 as coagent for peroxide cure. Table 3 compares Vamac® DP compound properties using different coagents.

Table 3 — Property Changes of Compounds made with Vamac® DP using Various Coagents

Formulation: 100 phr of Vamac® DP, 65 phr of Sterling® SO-N550 black, 1 phr of Naugard® 445 anti-oxidant, 0.5 phr of Armeen® 18D, 1.5 phr of stearic acid, 5phr Bisoflex® T810T, 5 phr Perkadox® 14/40

Coagent:				
HVA-2, phr	2			
Activator OC (TAC), phr		2		
Sartomer® 350 (TRIM), phr			2	
Diak™ No. 7 (TAIC), phr				2
Mooney Viscosity ML(1+4) at 100 °C, MU	45.7	41.7	43.2	43
Mooney Scorch at 121°C				
T5, m.m	10.9	31.9	9.2	14.6
MDR at 190 °C, 0.5° arc, 12 min.				
ML, dNm	0.63	0.6	0.62	0.6
MH, dNm	14.2	14.4	9.8	13.7
ts2, min.	0.43	0.7	0.9	0.77
T(10), min.	0.39	0.6	0.65	0.65
t(50), min.	0.66	1.38	1.43	1.57
tc(90), min.	1.64	3.21	2.98	3.64
Press-Cure 5 min at 190 °C				
Hardness, Shore A, pts.	73	72	71	71
100% Modulus, MPa	6.8	7.4	4.7	7
Tensile Strength, MPa	14.5	14.9	13.5	14.7
Elongation at Break, %	208	195	299	214
Tear Strength (ISO-34), N/mm	23	19.8	29	21.4
Trouser Tear (DIN 53507), N/mm	6.3	7	nd	5.3

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Table 3 (continued) — Property Changes of Compounds made with Vamac® DP using Various Coagents

Formulation: 100 phr of Vamac® DP, 65 phr of Sterling® SO-N550 black, 1 phr of Naugard® 445 anti-oxidant, 0.5 phr of Armeen® 18D, 1.5 phr of stearic acid, 5phr Bisoflex® T810T, 5 phr Perkadox® 14/40

Compression Set, %				
70 hrs at 150 °C	25	36	35	32
22 hrs at 150 °C, VW PV 3307	77	73	90	75
Low Temperature Properties				
Tg by DSC, °C	–31.7	–31.2	–32	–31.2
Heat Ageing, 2 weeks at 175 °C				
Hardness, Shore A, pts.	82	82	82	81
100% Modulus, MPa	8.8	7.7	6.2	7.9
Tensile Strength, MPa	13	12.5	11.7	13
Elongation at Break, %	182	187	273	183
Delta Hardness, pts.	9	10	11	10
Delta 100% Modulus, %	29.4	4.1	29.2	12.9
Delta Tensile Strength, %	–10	–16	–13	–12
Delta Elongation at Break , %	–13	–4	–9	–14
Cecilia 20, Ageing, 168 h at 175 °C				
Hardness, Shore A, pts.	65	58	58	61
100% Modulus, MPa	6.2	4	3.3	5.5
Tensile Strength, MPa	12.2	11.7	10.9	12.7
Elongation at Break, %	194	252	318	191
Delta Hardness, pts.	–8	–12	–13	–10
Delta 100% Modulus, %	–8.8	–45.9	–31.3	–21.4
Delta Tensile Strength, %	–16	–21	–19	–14
Delta Elongation at Break, %	–7	29	6	–11
Volume Change, %	13	14	15	13
Weight Change, %	9	9	10	9

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ASTM Test Methods used for this work:

Rheology	
Mooney Viscosity	D 1646
Mooney Scorch	D 1646
MDR	D 5289
Physicals	
Hardness	D 2240
Tensile, Elongation, Modulus	D 412
Ageing in Air	D 573
Fluid Ageing	D 471
Compression Set	D 395
Tg by DSC	D 3418
Temperature of Retraction	D 1329

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