DuPont™ Vamac® DP

Technical Information — Rev. 2, July 2010

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; and
- Good low-temperature flexibility

Unlike Vamac® terpolymers, Vamac® DP dipolymer can be processed without using a post cure. 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, wt %	≤0.4	Internal DuPont Test
Form, mm (in)	Bale size is nominally: 560 x 370 x 165 (22 x 15 x 7)	Visual
Color	Slight orange tint	Visual

Safety and Handling Precautions

Because Vamac® DP contains small amounts of residual methyl acrylate monomer, adequate ventilation should be provided during mixing and processing to prevent worker exposure to methyl acrylate vapor. Additional information may be obtained in the Material Safety Data Sheet (MSDS) and the "Safe Handling and Processing of Vamac® and Vamac® Compounds Guide" available from **vamac.dupont.com**.

Compound Properties and Performance

Table 1 shows the properties and aging performance of a test compound made with Vamac® DP.

Table 1 — Properties and Aging Performance of 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, μ	43.6
Mooney Scorch at 135 °C	
Min. Visc., mu	11.6
t3, Mins	8.2
t10, Mins	11.3
MDR at 180 °C, 1° arc	
ML, in-lb	0.91
MH, in-lb	23.14
ts2, minutes	0.54
t50, minutes	1.10
t90, minutes	3.55
Slope	6.0
Cured Properties (10 min. at 180 °C)	
Hardness, pts	64
M(100), MPa	7.2
Tb, MPa	18.2
Eb, %	208
Compression Set, %	
72 hrs at 150 °C	21.5
168 hrs at 150 °C	23.0
1008 hrs at 150 °C	43.4
Heat Aging, 1 week at 150°C	
Hardness, pts	71
M(100), MPa	7.8
Tb, MPa	18.3
Eb, %	206
Change in Hardness, pts.	7
Change in Modulus, %	8
Change in Tensile, %	1
Change in Elongation, %	–1
Heat Aging, 6 weeks at 150 °C	
Hardness, pts	73
M(100), MPa	8.7
Tb, MPa	17.2
Eb, %	200
Change in Hardness, pts.	9
Change in Modulus, %	20
Change in Tensile, %	–5
Change in Elongation, %	–4
SF105 Oil Aging, 1 week at 150 °C	
Hardness, pts	56
M(100), MPa	6.2
Tb, MPa	15.2
Eb, %	188
Change in Hardness, pts.	–8
Change in Modulus, %	–14
Change in Tensile, %	–16
Change in Elongation, %	–10
Change in Volume, %	19

(continued)

Table 1 — Properties and Aging Performance of Test Compound made with DuPont™ Vamac® DP *(continued)*

SF105 Oil Aging, 6 weeks at 150 °C	
Hardness, pts	56
M(100), MPa	6.4
Tb, MPa	13.8
Eb, %	166
Change in Hardness, pts	–8
Change in Modulus, %	–11
Change in Tensile, %	–24
Change in Elongation, %	–20
Change in Volume, %	21
ASTM No. 1 Aging, 1 week at 150 °C	
Hardness, pts	66
M(100), MPa	7.6
Tb, MPa	18.1
Eb, %	188
Change in Hardness, pts.	2
Change in Modulus, %	6
Change in Tensile, %	–1
Change in Elongation, %	–10
Change in Volume, %	4
IRM 903 Aging, 6 week at 150 °C	
Hardness, pts	48
M(100), MPa	6.4
Tb, MPa	10.8
Eb, %	144
Change in Hardness, pts	–16
Change in Modulus, %	–12
Change in Tensile, %	–41
Change in Elongation, %	–31
Change in Volume, %	44
Dexron® III ATF Aging, 6 weeks at 150 °C	
Hardness, pts	64
M(100), MPa	8.1
Tb, MPa	16.4
Eb, %	171
Change in Hardness, %	0
Change in Modulus, %	12
Change in Tensile, %	–10
Change in Elongation, %	–18
Change in Volume, %	16
Low Temperature Properties	
Tg by DSC, °C	–29
TR10, °C	–24

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 — Property Changes of Compounds made with DuPont™ Vamac® DP at Various Levels of Peroxide

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, µ	49	50	51
Mooney Scorch at 135 °C			
Minimum Viscosity, µ	12.5	12.9	12.8
t3, m.m	9.2	9.5	11.5
t10, m.m	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, m.m	0.56	0.62	0.71
t(50), m.m	1.12	1.2	1.34
tc(90), m.m	3.5	3.6	3.8
Cured Properties (10 minutes at 180 °C)			
Hardness, pts, Shore A	68	67	64
M(100), MPa	7.0	6.7	5.8
Tb, MPa	15.4	16.9	16.1
Eb, %	198	232	254
Compression Set, % 168 hrs at 150 °C	37.9	47.5	52.0

Properties Changes with Different Coagents

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

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, µ	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, m.m	0.43	0.7	0.9	0.77
T(10), m.m	0.39	0.6	0.65	0.65
t(50), m.m	0.66	1.38	1.43	1.57
tc(90), m.m	1.64	3.21	2.98	3.64
Press-Cure 5 min at 190 °C				
Hardness, pts, Shore A	73	72	71	71
M(100), MPa	6.8	7.4	4.7	7
Tb, MPa	14.5	14.9	13.5	14.7
Eb, %	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
Compression Set, %				
70 hrs at 150 °C	25	36	35	32
22 hrs at 150 °C, VW PV 3307	77	73	90	75

(continued)

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

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

Low Temperature Properties				
Tg by DSC, °C	–31.7	–31.2	–32	–31.2
Heat Aging, 2 weeks at 175 °C				
Hardness, pts	82	82	82	81
M(100), MPa	8.8	7.7	6.2	7.9
Tb, MPa	13	12.5	11.7	13
Eb, %	182	187	273	183
Change in Hardness, pts.	9	10	11	10
Change in Modulus, %	29.4	4.1	29.2	12.9
Change in Tensile, %	–10	–16	–13	–12
Change in Elongation, %	–13	–4	–9	–14
Cecilia 20, Aging, 168 h at 175 °C				
Hardness, pts	65	58	58	61
M(100), MPa	6.2	4	3.3	5.5
Tb, MPa	12.2	11.7	10.9	12.7
Eb, %	194	252	318	191
Change in Hardness, pts.	–8	–12	–13	–10
Change in Modulus, %	–8.8	–45.9	–31.3	–21.4
Change in Tensile, %	–16	–21	–19	–14
Change in Elongation, %	–7	29	6	–11
Change in Volume, %	13	14	15	13
Change in Weight, %	9	9	10	9

Materials Used in Formulations — General Composition and Supplier

Material	Composition	Supplier
Polymer		
Vamac® DP	Ethylene Acrylic Elastomer	DuPont
Release Aids		
Armeen® 18D	Octadecyl Amine	Akzo Nobel
Vanfre® VAM	Complex Organic phosphate ester	R.T. Vanderbilt
Stearic Acid		
Antioxidants		
Naugard® 445	Diphenyl Amine	Uniroyal Chemical
Fillers		
N550	Carbon Black	
Plasticizers		
Bisoflex T810T	Trimellitate	Laporte Speciality
Curatives		
Vulcup® 40KE	a-a-bist (t-butyl peroxy) diisopropylbenzene	Hercules, Inc./GEO Specialty Chemicals, Inc.
HVA-2	N,N-m-phenylene dimaleimide	DuPont
Activator® OC	Triallylcyanurate (100%)	AKZO
Sartomer® 350	Trimethylol-propane-trimethacrylate	Sartomer
Diak™ No. 7	Triallylisocyanurate	DuPont
Test Fluids		
Name	**Fluid Type**	**Supplier**
ASTM #1 Oil	Mineral Oil Test Fluid	ASTM Test Monitoring Center
Service Fluid 105	Service Fluid 105	ASTM Test Monitoring Center
IRM903	Mineral Oil Test Fluid	ASTM Test Monitoring Center
Cecilia® 20	SAE 5W40 Reference Oil	BP

The test methods used in the work are shown below:

Rheology	
Mooney Viscosity	D 1646
Mooney Scorch	D 1646
MDR	D 5289
Physicals	
Hardness	D 2240
Tensile, Elongation, Mod	D 412
Tear, Die C	D 624
Fluid Aging	D 471
Compression Set	D 395
Tg by DSC	D 3418
Aging in Air	D 573
Temperature of Retraction	D 1329

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(11/06) Reference No. VME-A10637-00-C0710

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