

Technical Information

Introduction

VPA No. 1 is a general-purpose processing aid useful in all types of molded goods made from Viton™. It provides smooth preforms, slightly faster cure rates, and excellent mill and mold release characteristics. It has little or no effect on vulcanizate properties.

VPA No. 2 is a particularly effective extrusion aid allowing compounds of Viton™ to extrude faster, cooler, and smoother. It has some adverse effect on high temperature compression set.

VPA No. 3 provides the best mold release. It has little or no effect on standard physical properties, including compression set resistance, and increases the cure rate of bisphenol-cured systems. VPA No. 3 is best suited for molding operations with automatic part removal and tight compression set resistance requirements.

Applications

The VPA processing aids are recommended for use in Viton™ for the following applications: O-rings, seals, molded shapes, diaphragms, and tubing. The comparative advantages of this family of processing aids in different operations are shown in **Table 1**.

Handling Precautions

VPA No. 1 and VPA No. 3 can cause eye and skin irritation. Avoid contact with eyes, skin, and clothing and avoid breathing dust. Use with adequate ventilation and wash thoroughly after handling. In case of eye contact, immediately flush eyes with plenty of water for at least 15 min and call a physician.

VPA No. 2 has no known toxicological hazards. Keep all containers closed to avoid contamination. Store in a cool, dry place.

Before compounding or processing Viton™ fluoroelastomers, read Chemours technical bulletin "Handling Precautions for Viton™ and Related Chemicals."

Product Descriptions

	VPA No. 1	VPA No. 2	VPA No. 3
Physical Form	Powder	Flake	Pellet
Color	Light tan to white	Yellow	Tan to light brown
Composition	Wax/ aromatic sulfur compound	Vegetable wax	75% sulfur compound on inert carrier
Specific Gravity	1.26	0.99	1.43
Melting Point, °C (°F)	150 (302)	80 (176)	—
Recommended Level, phr	0.5–2	0.5–2	0.5–1.5

Table 1. Comparison of Process Aids in Viton™

	Mold Release	Mill Calender Release	Extrusion Smoothness	Compression Set Resistance
VPA No. 1	o/+	+	o/+	o/-
VPA No. 2	+	++	++	-
VPA No. 3	++	0	0	0

++ Very positive effect + Positive effect o No effect - Negative effect

Product Descriptions

VPA No. 1

VPA No. 1 is recommended for all types of molded goods made from Viton™. It is an effective mill release agent and is particularly useful on mills with inadequate cooling facilities. It can be premixed with other compounding ingredients and added to the batch. It has little or no effect on processing safety, but has a slight activating effect on cure rates at 177 °C (351 °F). Rod-type preforms from compounds containing VPA No. 1 are smooth and uniform.

Note: Complicated extrusion profiles from compounds containing VPA No. 1 are not quite as smooth as those obtained with VPA No. 2.

A slight bloom will be noted on preforms and press-cured articles containing VPA No. 1, which disappears during the oven post-cure.

VPA No. 1 has no effect on original or heat-aged stress/strain properties and only a minor effect on high temperature compression set. Two parts of VPA No. 1 in a standard formulation with Viton™ E-60C will increase shrinkage approximately 0.4% after an oven post-cure of 24 hr at 232 °C (450 °F).

VPA No. 2

VPA No. 2 is recommended as an extrusion aid for a variety of extruded goods, such as tubing and complex profiles. It can be premixed with other compounding

ingredients and added to the batch. As with all wax-type processing aids, proper extruder temperatures are very important. A cool screw and barrel in the feed section of the extruder are particularly important to prevent stock slippage on the screw (see Table 3 for suggested conditions). Extrudates containing VPA No. 2 are generally smooth and glossy.

VPA No. 2 has little or no effect on processing safety, cure rate, or stress/strain properties. It does have an adverse effect on high-temperature compression set. Also, 2 phr of VPA No. 2 in a standard formulation with Viton™ E-60C will increase shrinkage approximately 0.4% after an oven post-cure of 24 hr at 232 °C (450 °F).

VPA No. 3

VPA No. 3 is recommended for all types of molded goods of Viton™. It can be premixed with other compounding ingredients and added as usual. It increases cure rate and can affect scorch safety with bisphenol-cured compounds. VPA No. 3 is hygroscopic—a loss of compound scorch safety can occur if exposed to water, including high-humidity conditions. VPA No. 3 does not affect peroxide-cured compound cure rate.

VPA No. 3 has no effect on original or heat-aged stress/strain properties, including compression set resistance. Addition of 1.6 phr to Viton™ E-60 increases shrinkage by 0.3%.

Table 2. VPA No. 1 Processing Aid in Viton™ E-60C and Viton™ E-430

Compound	2A	2B	2C	2D	2E
Viton™ E-60C	100	100	100	—	—
Viton™ E-430	—	—	—	100	100
MT Carbon Black	30	30	30	10	10
High-Activity MgO	3	3	3	3	3
Calcium Hydroxide	6	6	6	6	6
VPA No. 1	—	1	2	—	2
Stock Properties					
Mooney Scorch, MS at 121 °C (250 °F)					
Units, minimum	33	33	30	22	18
Time to 5-pt rise, min	1 pt in 45 min	2 pt in 45 min	3 pt in 45 min	0 pt in 45 min	0 pt in 45 min
ODR at 177 °C (351 °F), Microdie, 1° Arc, 12 min					
M _L , in-lb	0.8	0.7	0.7	0.5	0.4
t ₅ 0.23 [t ₅ 2], min	2.7	2.5	2.2	3.7	3.2
t _c 90, min	4.9	4.7	4.1	6.1	5.3
M _H , in-lb	5.5	5.6	5.4	3.4	3.2
Garvey Die Extrusion (Cold feed, cold screw, barrel extension—24 °C [75 °F], barrel—66 °C [151 °F], head—104 °C [219 °F], die—135 °C [275 °F], screw speed—35 rpm)					
Rate, cm/min	386	391	406	—	—
Die Swell, g/cm	1.7	1.7	1.8	—	—
Stock Temperature, °C (°F)	124 (255)	124 (255)	121 (250)	113 (235)	110 (230)
Appearance (Ratings range from 1 = very smooth to 4 = very rough)					
Back Edge	4	3	2	2	1
Surface	3	3	2	1	1
Feather Edge	4	4	2	2	1
Vulcanizate Properties					
Press Cure: 10 min at 177 °C (351 °F); Post-Cured: 24 hr at 232 °C (450 °F)					
Mold Shrinkage, % (linear)—25 mm x 200 mm x 6 mm bar					
After Press Cure	2.7	2.7	2.8	—	—
After Oven Cure	3.2	3.4	3.6	—	—
Stress/Strain at 23 °C (73 °F)—Original					
100% Modulus, MPa	5.9	6.4	5.7	1.6	1.6
Tensile Strength, MPa	13.1	13.3	12.9	11.7	12.2
Elongation at Break, %	200	190	190	370	330
Hardness, Durometer A	76	77	75	59	58
Stress/Strain at 23 °C (73 °F)—After Aging 70 hr at 275 °C (527 °F)					
100% Modulus, MPa	5.0	5.0	4.5	1.7	1.7
Tensile Strength, MPa	11.4	11.5	11.0	9.8	10.9
Elongation at Break, %	200	220	200	320	320
Hardness, Durometer A	75	76	75	59	60
Compression Set Resistance, Method B, O-Rings, %, 25.4 mm x 4.0 mm					
70 hr at 24 °C (75 °F)	10	9	8	1.1	9
70 hr at 200 °C (392 °F)	14	15	16	12	15
336 hr at 200 °C (392 °F)	34	34	37	36	39
70 hr at 232 °C (450 °F)	39	41	42	41	46

Table 3. VPA No. 2 Processing Aid in Viton™ E-60C

Compound	3A	3B	3C
Viton™ E-60C	100	100	100
MT Carbon Black	30	30	30
High-Activity MgO	3	3	3
Calcium Hydroxide	6	6	6
VPA No. 2	—	1	2
Stock Properties			
Mooney Scorch, MS at 121 °C (250 °F)			
Units, minimum	33	34	34
Time to 5-pt rise, min	1 pt in 45 min	2 pt in 45 min	3 pt in 45 min
Time to 10-pt rise, min	—	—	—
ODR at 177 °C (351 °F), Microdie, 1° Arc			
M _L , N·m	0.8	0.8	0.8
t ₅ 0.232 [t ₅ 2], min	2.7	2.9	2.9
t _c 90, min	4.9	5.1	5.2
M _H , N·m	5.5	5.4	5.3
Garvey Die Extrusion (Cold feed, cold screw, barrel extension—24 °C [75 °F], barrel—66 °C [151 °F], head—104 °C [219 °F], die—135 °C [275 °F], screw speed—35 rpm)			
Rate, cm/min	386	419	427
Die Swell, g/cm	1.7	1.7	1.7
Stock Temperature, °C	124	113	110
Appearance (Ratings range from 1 = very smooth to 4 = very rough)			
Back Edge	4	3	1
Surface	3	3	2
Feather Edge	4	3	1
Vulcanizate Properties			
Press Cure: 10 min at 177 °C (351 °F); Post-Cured: 24 hr at 232 °C (450 °F)			
Mold Shrinkage, % (linear)—25 mm x 200 mm x 6 mm bar			
After Press Cure	2.7	2.7	2.7
After Oven Cure	3.2	3.4	3.6
Stress/Strain at 23 °C (73 °F)—Original			
100% Modulus, MPa	5.9	6.9	7.1
Tensile Strength, MPa	13.1	12.4	12.4
Elongation at Break, %	200	200	190
Hardness, Durometer A	76	75	75
Stress/Strain at 23 °C (73 °F)—After Aging 70 hr at 275 °C (527 °F)			
100% Modulus, MPa	5.0	5.7	6.9
Tensile Strength, MPa	11.4	11.0	11.7
Elongation at Break, %	200	190	180
Hardness, Durometer A	75	76	78
Compression Set Resistance, Method B, O-Rings, %, 25.4 mm x 4.0 mm			
70 hr at 24 °C (75 °F)	10	10	9
70 hr at 200 °C (392 °F)	14	20	24
336 hr at 200 °C (392 °F)	34	42	44
70 hr at 232 °C (450 °F)	39	50	53

Table 4A. VPA No. 3 Processing Aid in Viton™ E-45 and Viton™ E-60

Compound	4A	4B	4C	4D	4E	4F
Viton™ E-45	97.8	97.8	97.8	—	—	—
Viton™ E-60	—	—	—	96.9	96.9	96.9
MT Black (N908)	30	30	30	30	30	30
High-Activity MgO	3	3	3	3	3	3
Calcium Hydroxide	6	6	6	6	6	6
Viton™ Curative No. 20	1.26	1.26	1.26	1.65	1.65	1.65
Viton™ Curative No. 30	2.8	2.8	2.8	4	4	4
VPA No. 3	—	0.8	1.6	—	0.8	1.6
Stock Properties						
Mooney Scorch, MS at 121 °C (250 °F)—Original						
Units, minimum	32	33	34	40	42	42
Time to 10-pt rise, min	>30	>30	>30	>30	>30	>30
Mooney Scorch, MS at 121 °C (250 °F)—After Aging 7 days at 38 °C (100 °F) and 100% Relative Humidity						
Units, minimum	40	40	42	48	47	48
Time to 10-pt rise, min	12	12	11	12	12	9
ODR at 177 °C (351 °F), Microdie, 3° Arc, 12 min						
M _L , N·m	1.2	1.2	1.2	1.4	1.5	1.6
t _{90.232} [t ₉₂], min	3.4	2.8	2.3	3.1	2.4	2.3
t _{c90} , min	7.8	7.2	6.7	6.4	5.6	5.0
M _H , N·m	8.8	8.6	8.4	13.8	13.9	13.6
Vulcanizate Properties						
Press Cure: 10 min at 177 °C (351 °F); Post-Cured: 24 hr at 232 °C (450 °F)						
Mold Shrinkage, % (linear)—25 mm x 200 mm x 6 mm bar						
After Press Cure	2.6	2.7	2.6	2.6	2.6	2.6
After Oven Cure	2.9	3.2	3.3	3.0	3.2	3.3
Stress/Strain at 23 °C (73 °F)—Original						
100% Modulus, MPa	4.3	4.6	4.5	5.9	6.3	6.2
Tensile Strength, MPa	12.2	11.5	11.8	12.1	12.6	12.5
Elongation at Break, %	265	245	250	205	200	200
Hardness, Durometer A	72	71	70	75	73	73
Stress/Strain at 23 °C (73 °F)—After Aging 70 hr at 275 °C (527 °F)						
100% Modulus, MPa	3.0	3.3	3.3	4.7	4.7	4.9
Tensile Strength, MPa	6.4	6.4	6.5	7.9	7.4	8.0
Elongation at Break, %	315	305	315	200	190	200
Hardness, Durometer A	80	80	80	84	83	84
Compression Set Resistance, Method B, O-Rings, %, 25.4 mm x 4.0 mm						
70 hr at 23 °C (73 °F)	18	18	18	9	9	9
70 hr at 200 °C (392 °F)	24	24	24	18	18	18
70 hr at 232 °C (450 °F)	44	44	44	35	35	35

Table 4B. VPA No. 3 Processing Aid in Viton™ B-50

Compound	4G	4H	4I
Viton™ B-50	96	96	96
MT Black (N908)	30	30	30
High-Activity MgO	3	3	3
Calcium Hydroxide	6	6	6
Viton™ Curative No. 20	3	3	3
Viton™ Curative No. 30	4	4	4
VPA No. 3	—	0.8	1.6
Stock Properties			
Mooney Scorch, MS at 121 °C (250 °F)—Original			
Units, minimum	52	51	53
Time to 10-pt rise, min	>30	>30	>30
Mooney Scorch, MS at 121 °C (250 °F)—After Aging 7 days at 38 °C (100 °F) and 100% Relative Humidity			
Units, minimum	57	55	55
Time to 10-pt rise, min	14	12	10
ODR at 177 °C (351 °F), Microdie, 3° Arc, 12 min			
M _i , N·m	1.4	1.6	1.6
t ₃ 0.232 [t ₂], min	3.3	2.7	2.3
t _c 90, min	7.1	6.5	5.8
M _H , N·m	9.8	9.3	9.2
Vulcanizate Properties			
Press Cure: 10 min at 177 °C (351 °F); Post-Cured: 24 hr at 232 °C (450 °F)			
Mold Shrinkage, % (linear)—25 mm x 200 mm x 6 mm bar			
After Press Cure	2.6	2.6	2.5
After Oven Cure	3.1	3.3	3.4
Stress/Strain at 23 °C (73 °F)—Original			
100% Modulus, MPa	6.2	6.2	6.3
Tensile Strength, MPa	11.8	12.1	12.9
Elongation at Break, %	205	205	220
Hardness, Durometer A	76	77	76
Stress/Strain at 23 °C (73 °F)—After Aging 70 hr at 275 °C (527 °F)			
100% Modulus, MPa	3.4	3.4	3.4
Tensile Strength, MPa	5.9	6.0	5.9
Elongation at Break, %	280	290	315
Hardness, Durometer A	84	82	81
Compression Set Resistance, Method B, O-Rings, %, 25.4 mm x 4.0 mm			
70 hr at 23 °C (73 °F)	15	15	15
70 hr at 200 °C (392 °F)	41	44	41

*Atochem, Buffalo, NY

Test Procedures

Property Measured	Test Procedure
Compression Set	ASTM D3955, Method B (25% deflection)
Compression Set—Low Temperature	ASTM D1299, Method B (25% deflection)
Compression Set, O-Rings	ASTM D1414
Hardness	ASTM D2240, durometer A
Mooney Scorch	ASTM D1646, using the small rotor. Minimum viscosity and time to a 1-, 5-, or 10-unit rise are reported.
Mooney Viscosity	ASTM D1646, ten pass 100 °C (212 °F) and 121 °C (250 °F)
ODR (vulcanization characteristics measured with an oscillating disk cure meter)	ASTM D2084
Property Change After Oven Heat-Aging	ASTM D573
Stress/Strain Properties 100% Modulus Tensile Strength Elongation at Break	ASTM D412, pulled at 8.5 mm/s (20 in/min)
Stiffness, Torsional, Clash-Berg	ASTM D1043
Temperature Retraction	ASTM D1329
Volume Change in Fluids	ASTM D471

Note: Test temperature is 24 °C (75 °F), except where specified otherwise

For more information, visit Viton.com

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