Viton® fluoroelastomer

A Product of DuPont Dow Elastomers

The Viton® A-Type Fluoroelastomers

The Viton A-type fluoroelastomers include three different viscosity ranges of vinylidene fluoride/ hexafluoropropylene copolymers:

Polymer	Mooney Viscosity, ML 1+10	Measured at
Viton A-35	32–42	100°C (212°F)
Viton A	59–71	100°C (212°F)
Viton A-HV	90–110	149°C (300°F)

Viton A-types are general-purpose fluoroelastomers, well-suited for solution coatings, roll covers, gaskets, and general molded goods. They may be cured with Viton Curative Masterbatches or systems based on Diak™ curing agents.

Because of the differences in polymer molecular weight between the three A-types, the resulting differences in bulk polymer viscosity afford a range of processing and physical property characteristics. For instance, Viton A-35 is a low-viscosity analog of Viton A, is the easiest processing (i.e., extrusion, calendering) of the three, and is particularly good for use in highly extended stocks. Viton A-HV is a high-viscosity analog of Viton A and gives vulcanizates having the highest tensile strength and best resistance to compression set.

Handling Precautions

Using recommended handling procedures, Viton fluoroelastomer polymers and products based on them present no health hazards of which DuPont Dow Elastomers is aware. Toxic vapors, which may include hydrogen fluoride*, may be liberated from products based on Viton during cure, post-cure, or service at temperatures above 200°C (393°F). Adequate ventilation should be provided in work areas where compounds or parts of Viton are being processed or are likely to be exposed to temperatures in this range.

Avoid breathing vapors or dusts from such operations. If vapors or dusts are inhaled, remove to fresh air following these precautions. Stay within the limits set by OSHA. Before handling or processing Viton, be sure to read and be guided by suggestions in DuPont Dow Elastomers technical bulletin H-71129-02, "Handling Precautions for Viton® and Related Chemicals."

Compounding ingredients that are used with Viton to prepare finished products may present hazards in handling and use. Before proceeding with any compounding or processing work, consult and follow label directions and handling precautions from suppliers of all ingredients.

Product Description

	Viton A-35	Viton A	Viton A-HV
Specific gravity	1.82	1.82	1.82
Mooney viscosity, ML 1 +10 Measured at	36 100°C (212°F)	65 100°C (212°F)	100 149°C (300°F)
Color, sheet	Off white	Off White	Off white
Odor	None	None	None
Solubility	Soluble in low molecular weight ketones, esters	Soluble in low molecular weight ketones, esters	Soluble in low molecular weight ketones, esters
Storage Stability	Excellent	Excellent	Excellent

Note: These data are presented to describe Viton A-35, A, and A-HV and are not intended to serve as specifications.

Polymer Selection and Applications

The polymer viscosities of Viton A-35, A, and A-HV are designed to provide the processing characteristics and physical properties required for a broad range of fluoroelastomer usage. Following are examples of applications that are particularly suited to each A-type of Viton.

* Hydrogen fluoride is regulated as an air contaminant in the United States under the Occupational Safety and Health Act (refer to CFR Title 29 1910.1000). This sets the 8-hr time-weighted average in any 8-hr work shift of a 40-hr work week at 3 ppm.

Type	Applications
Viton® A-35	Solvent-based coatings Extrusions High durometer (highly filled) stocks Viscosity modification of Viton A and A-HV
Viton A	Calendered goods Roll covers General molded parts
Viton A-HV	High-strength molded parts Gaskets & seals O-rings (particularly good with Viton Curative Masterbatches Nos. 20 and 30).

Curing Systems for Viton A-Types

The A-types of Viton can be cured with Viton Curative Masterbatches (Nos. 20 and 30 or Nos. 20 and 40) or with the diamines—Diak™ Nos. 1 or 3. Typical formulations and physical properties for compounds using these two types of curing systems in each of the three A-types of Viton are shown in *Table 1*. In general, the following points can be made about their use.

Curative Masterbatches

The Curative Masterbatches (Nos. 20, 30, and 40) are concentrated mixtures of individual curative chemicals in a Viton fluoroelastomer base. Each is available in a free-flowing form for easy handling, weighing, and premixing with Viton polymers. An important advantage of the Curative Masterbatches is the ability to design and tailor the desired cure characteristics and vulcanizate properties by varying the proportions of Nos. 20 and 30 and Nos. 20 and 40. For a complete review of the use of Curative Masterbatches, see DuPont Dow Elastomers technical bulletin VT-310.1, "Compounding with Viton® Curative Masterbatches."

Summarized below are the main characteristics of Viton Curative Masterbatches.

Curative	Properties of Compounds Produced
Masterbatch No. 20 and Masterbatch No. 30	Produces compounds with excellent resistance to compression set and that have excellent processing safety. In both respects, properties are better than those produced with Diak curatives.
Masterbatch No. 20 and Masterbatch No. 40 (no compounds shown)	Produces compounds with good resistance to compression set. Permits faster cure cycles at lower temperatures than are possible with Masterbatch Nos. 20 and 30. Benefits of this combination are achieved with some sacrifice in scorch safety.

Diak Curing Agents

The Diak curing agents (Nos. 1 and 3) differ in their activity in the A types of Viton. In general, they produce compounds with better tear and tensile strengths at elevated temperatures than compounds formulated with Curative Masterbatches. Some of their other characteristics are as follows:

Curative	Properties of Compounds Produced
Diak No. 1	Produces compounds with higher tensile strength than those produced with Curative Masterbatches. Produces compounds with better resistance to compression set than compounds produced with Diak No. 3. Produces fast-curing compounds with the lowest scorch safety of all curatives used with the A-types of Viton.
Diak No. 3	Produces compounds with better processing safety but slightly poorer resistance to compression set than are produced with Diak No. 1. Has a plasticizing effect resulting in lower compound viscosity.

Table 1
Effect of Curing-Systems in the A Types of Viton®

Compound	Diak™ No. 1			Diak No. 3			Curative Masterbatches		
	1A	1B	1C	1D	1E	1F	1G	1H	1I
Viton A-35	100	—	—	100	—	—	100	—	—
Viton A	—	100	—	—	100	—	—	100	—
Viton A-HV	—	—	100	—	—	100	—	—	100
MT Black	30	30	30	30	30	30	30	30	30
Low-activity MgO	15	15	15	15	15	15	—	—	—
High-activity MgO	—	—	—	—	—	—	3.0	3.0	3.0
Calcium Hydroxide	—	—	—	—	—	—	6.0	6.0	6.0
Diak No. 1	1.5	1.5	1.5	—	—	—	—	—	—
Diak No. 3	—	—	—	3.0	3.0	3.0	—	—	—
Viton Curative Masterbatch No. 20	—	—	—	—	—	—	2.0	2.0	2.0
Viton Curative Masterbatch No. 30	—	—	—	—	—	—	4.0	4.0	4.0
Stock Properties									
Mooney Scorch, MS at 121°C (250°F)									
Minimum Viscosity, units	31	47	90	22	32	85	31	44	88
Time to 10-unit rise, min	10	7	6	32	28	20	0 units in 45 min	0 units in 45 min	35
ODR, 30 min at 177°C (350°F), Microdie, 0.017 rad, 1° Arc, 100 cpm									
M_L (min. torque), N·m (in·lb)	0.6 (5)	1.3 (12)	2.9 (26)	0.4 (4)	0.8 (7)	2.0 (18)	0.4 (4)	0.7 (6)	2.1 (19)
M_c90, N·m (in·lb)	2.9 (26)	3.9 (39)	5.4 (48)	3.6 (32)	4.3 (39)	5.7 (51)	4.3 (39)	4.8 (43)	5.6 (50)
t_c90, min	8.5	7.5	7.0	17.5	17.3	15.5	10.3	8.5	4.6
$t_s0.2$ (t_s2), min	1.8	1.5	1.3	3.5	3.3	2.8	4.8	4.2	2.5
Vulcanizate Properties									
Press Cure: 10 min at 177°C (350°F) No post-cure (1.9 mm [0.075 in] slabs)									
Stress/Strain at 177°C (350°F)									
Tensile Strength, MPa (psi)	2.8 (400)	3.2 (475)	4.8 (700)	2.2 (325)	3.0 (425)	4.6 (675)	3.0 (425)	3.0 (425)	4.0 (575)
Elongation at Break, %	110	110	100	100	100	150	90	90	100
Press Cure: 10 min at 177°C (350°F) Oven Cure: 24 hr at 232°C (450°F) (1.9 mm [0.075 in] slabs)									
Stress/Strain and Hardness at 24°C (75°F)									
Original									
100% Modulus, MPa (psi)	4.6 (675)	6.8 (975)	6.6 (950)	5.0 (725)	6.6 (950)	6.4 (925)	5.8 (850)	5.8 (850)	5.8 (850)
Tensile Strength, MPa (psi)	14.6 (2,125)	16.4 (2,375)	18.0 (2,600)	11.0 (2,375)	12.4 (1,800)	15.6 (2,250)	11.4 (1,650)	12.6 (1,825)	14.4 (2,100)
Elongation at Break, %	200	210	220	190	210	250	170	180	200
Hardness, durometer A	76	76	75	78	78	77	79	78	76
After Aging 3 days at 275°C (528°F)									
100% Modulus, MPa (psi)	4.8 (700)	7.4 (1,075)	6.4 (925)	5.6 (800)	8.0 (1,150)	6.8 (975)	5.6 (800)	6.8 (975)	5.2 (750)
Tensile Strength, MPa (psi)	12.0 (1,750)	13.4 (1,950)	14.4 (2,100)	9.4 (1,375)	10.4 (1,500)	12.6 (1,825)	10.6 (1,550)	10.8 (1,575)	11.6 (1,675)
Elongation at Break, %	190	190	200	170	180	210	160	170	200
Hardness, durometer A	83	82	80	87	86	85	81	80	76
Tear Strength, Die B, kN/M (lb·in)									
At 24°C (75°F)	32.7 (187)	38.0 (217)	39.2 (224)	40.3 (230)	43.1 (246)	43.9 (251)	33.3 (190)	35.0 (200)	36.8 (210)
At 150°C (300°F)	7.4 (42)	7.5 (43)	10.2 (58)	10.9 (62)	11.9 (68)	15.6 (89)	9.5 (54)	9.8 (56)	11.0 (63)
Compression Set, Method B, %, O-Rings, 25.4 mm x 3.5 mm (1.0 in x 0.139 in)									
After 70 hr at 200°C (392°F)	64	53	44	68	56	55	26	26	14
After 70 hr at 232°C (450°F)	88	79	76	91	84	80	75	53	32

Compounding Viton® A-Types

The first step in compounding Viton is to select the polymer type and cure system best suited to the needs. Then, only acid acceptors, fillers, and a process aid, if needed, must be added to complete the formulation.

Acid Acceptors

For use with the Diak™ curatives, the general-purpose acid acceptor system is 15 phr of low-activity magnesium oxide. When using Viton Curative Masterbatches, the recommended acid acceptor system is a combination of a high-activity magnesium oxide and a fine particle size (325 mesh) calcium hydroxide. The use of 3 phr MgO and 6 phr $Ca(OH)_2$ affords a good balance of processing characteristics and physical properties. To obtain improved acid and steam resistance for both the Diak and Curative Masterbatch systems, 15 phr of litharge should be used *in place* of the magnesia/calcium hydroxide.

Fillers

MT carbon black (N908) provides the best balance of processing characteristics and physical properties of all fillers suitable for use in Viton. Several non-black fillers also perform very well in Viton. These make it possible to produce a wide range of colored vulcanizates. A more detailed discussion of fillers in Viton can be found in DuPont Dow Elastomers technical bulletin VT-000.1, “A Capsule View of the A, B, and E Types of Viton®.”

Processing

Mixing

Perhaps the most important aspect of mixing Viton is to use equipment free of contamination from other polymer mixes. Residual oils and sulfur or sulfur-containing chemicals can have ruinous effects on mixing and curing characteristics of Viton compounds.

Viton compounds should be mixed on a mill or in an internal mixer that has adequate cooling capacity, not only to prevent stock scorch, but also to prevent sticking of the mix to rolls or rotors.

All powdered ingredients should be premixed—this ensures good dispersion and also prevents sticking, which occurs if magnesia is added by itself, early in the mix. The use of Diak No. 1 results in fairly scorchy compounds. For this reason, Diak No. 1 should be added last when mill mixing and should be added on the drop mill when using an internal mixer.

Depending on the acid acceptor and filler systems used, remilling compounded stock after a minimum of 24 hr often improves physical properties of the vulcanizates.

Extruding

The higher viscosity A-types (Viton A and A-HV) generally give a better extrudate surface when run through a hot die—100–140°C (212–284°F). The use of 1–1.5 phr of a process aid such as VPA No. 2, carnauba wax,[1] or pentaerythritol tetrastearate[2] markedly improves the surface and definition of extrudates. When using a process aid, it is best to keep the feed zone cool relative to the die and head areas of the extruder to avoid stock slippage and loss of feed.

Curing

Stocks compounded with Diak curatives may be cured at temperatures as low as 160°C (320°F), but when using Curative Masterbatches, 170°C (338°F) is a minimum temperature to use if practical cure times are desired. These are guidelines for a simple, compression-molded part; in transfer molding or compression molding, where the stock flows significantly, enough shear heat may result to shorten “expected” cure times significantly.

To attain maximum physical properties, cured parts of Viton must also be oven post-cured for 24 hr at a temperature between 200–260°C (392–500°F). For more information, see DuPont Dow Elastomers technical bulletin, VT-440.1 “Effect of Oven Post Cure Cycles on Vulcanizate Properties.” In general, property values will reach 80–90% of maximum in 12 hr at 232°C (450°F). Parts thicker than 6 mm (1/4 in) should be step-post-cured to avoid internal fissuring. Starting at 125°C (257°F), the heat can then be increased hourly to the final desired post- cure temperature.

Additional details on processing compounds of Viton may be found in DuPont Dow Elastomers technical bulletin VT-000.1, “A Capsule View of the A, B, and E Types of Viton®.”

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1 Carnauba wax flake or powder requires no grinding before use. It has a melting point of 82°C (180°F) and liquifies in contact with warm, banded polymer.

2 PET must be ground before use. It is not necessary to grind to very small particle size—50 to 60 mesh is sufficient because PET has a softening point of 62–71°C (144–160°F) (Hercules drop method) and melts in contact with warm, prebanded polymer.

Proprietary Materials

Sources of compounding ingredients used in developing the information in this bulletin are listed below. This is not to infer that ingredients from other sources might not be equally satisfactory.

Material	Composition	Supplier
Diak™ No. 1 Curing Agent	Hexamethylenediamine carbamate	DuPont Dow Elastomers Wilmington, DE 19809
Diak No. 3 Curing Agent	N,N'-dicinnamylidene-1.6 hexanediamine	
Viton® Fluoroelastomer	Fluorinated synthetic rubber	
Viton Curative No. 20	33% organophosphonium salt + 67% fluoroelastomer	
Viton Curative No. 30	50% dihydroxy aromatic compound + 50% fluoroelastomer	
Viton Curative No. 40	33% benzophenone compound + 67% fluoroelastomer	
VPA No. 2 Processing Aid	Natural vegetable wax	
Carnauba Wax No. 3 North Country	Carnauba wax—flake or powder form	Merck and Company, Inc. Merck Chemical Division Rahway, NJ 07065
PE Tetrastearate	Pentaerythritol tetrastearate—lump form	Morton Chemical Company Chicago, Illinois 60606

[1]Registered trademark of Morton Chemical Company.

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((04/00) Printed in U.S.A.
[Replaces: H-71131-01]
Reorder No.: H-71131-02

DuPont Dow elastomers