



Viton™ GBL-600S

Fluoroelastomers

Technical Information

Introduction

Viton™ GBL-600S is a next generation, easy processing, peroxide-cured 68% fluorine fluoroelastomer based on new Advanced Polymer Architecture (APA) technology.

Features

- Cures exceptionally fast to a high state of cure
- Exhibits improved mold release/mold fouling properties compared to Viton™ GBL-200
- Exhibits improved mold flow, less shear sensitivity, and lower extruder die swell for a 65 Mooney FKM
- Exhibits excellent physical properties with high elongation, both original and aged
- Exhibits similar heat, fluids, and low temperature resistance compared to Viton™ GBL-200
- Exhibits excellent compression set resistance with short (2 hr) or no post-cure

Processing

A load factor of >70% for internal mixing of Viton™ GBL-600S is recommended. The recommended process aids for Viton™ GBL-600S are 1 phr of Struktol® HT 290 or combinations of 0.5 phr Armeen® 18D with carnauba wax or Struktol® WS 280. The use of TMAIC (trimethylalyl isocyanurate) is NOT recommended, as it causes poor mold release and high compression set. Viton™ Curative No. 7 (VC-7) is the recommended coagent for all Viton™ GBL-600S compounds and is usually used at a 2.5 phr level or lower, unless high modulus is needed. High levels of VC-7 can bleed out and cause molding flaws.

Safety and Handling

Before handling or processing Viton™ GBL-600S, be sure to read and be guided by the suggestions in the Chemours technical bulletin, "Handling Precautions for Viton™ and Related Chemicals."

Product Description

| | |
|--|---|
| Chemical Composition | Copolymer of hexafluoropropylene, vinylidene fluoride, and tetrafluoroethylene with a cure site monomer |
| Physical Form | Sheet |
| Appearance | Off-white |
| Odor | None |
| Mooney Viscosity, ML 1 + 10 at 121 °C (250 °F) | 65 |
| Specific Gravity | 1.84 |
| Storage Stability | Excellent |
| Fluorine, % | ~68 |



Chemours™

Table 1. Comparison of General Properties of Viton™ GBL-600S

| | Viton™ GBL-600S | |
|--|-------------------------------------|--------------------------------------|
| Viton™ GBL-600S | 100 | |
| Zinc Oxide | 3 | |
| N990 (MT Black) | 30 | |
| Viton™ Curative No. 7 (VC-7) | 3 | |
| Luperox® 101XL 45 | 3 | |
| Total phr | 139 | |
| Mooney Scorch at 121 °C (250 °F) | | |
| Minimum, MU | 31 | |
| 2 pt Rise, min | 23.6 | |
| 5 pt Rise, min | 25.1 | |
| 10 pt Rise, min | 25.8 | |
| ODR at 162 °C (324 °F), 3° Arc, 100 Range, 30 min Clock | | |
| ML, dN.m | 16 | |
| ts2, min | 1.1 | |
| t'50, min | 2.1 | |
| t'90, min | 3.2 | |
| MH, dN.m | 144 | |
| MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 6 min Clock | | |
| ML, dN.m | 1.7 | |
| ts2, min | 0.4 | |
| t'50, min | 0.6 | |
| t'90, min | 0.9 | |
| t'95, min | 1.1 | |
| MH, dN.m | 27.8 | |
| Rosand Capillary Rheometer at 100 °C (212 °F), 1.5 mm Die, L/D = 0/1 and 10/1 | | |
| <i>Piston Speed, mm/min</i> | <i>Shear Rate, sec⁻¹</i> | <i>Pressure, MPa (L/D = 0/1 die)</i> |
| 5 | 44 | 4.4 |
| 12.7 | 113 | 5.3 |
| 50.8 | 452 | 6.8 |
| 127 | 1,129 | 8.1 |
| 250 | 2,222 | 9.9 |
| Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), No Post-Cure | | |
| M10, MPa | 0.6 | |
| M100, MPa | 3.3 | |
| Tb, MPa | 13.5 | |
| Eb, % | 332 | |
| Hardness, A, pts | 67 | |
| Hot Tear Strength at 150 °C (302 °F)—Original, Cured 7 min at 177 °C (351 °F), No Post-Cure | | |
| Tear Die B, N/mm | 10.4 | |
| Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), Post-Cured at 232 °C (450 °F) | | |
| | 2 hr | |
| M10, MPa | 0.7 | |
| M100, MPa | 4.4 | |
| Tb, MPa | 20.4 | |
| Eb, % | 324 | |
| Hardness, A, pts | 69 | |

continued

Table 1. Comparison of General Properties of Viton™ GBL-600S (continued)

| | Viton™ GBL-600S |
|---|-----------------|
| Compression Set, Method B, O-Rings | |
| 22 hr at 200 °C (392 °F) | |
| – No Post-cure | 17 |
| – Post-cured at 232 °C (450 °F) | 14 |
| 336 hr at 200 °C (392 °F) | |
| – No Post-cure | 53 |
| – Post-cured at 232 °C (450 °F) | 56 |
| Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven (Slabs Post-Cured) | |
| M10, MPa | 0.8 |
| M100, MPa | 4.3 |
| Tb, MPa | 20.8 |
| Eb, % | 306 |
| Hardness, A, pts | 71 |
| Pt Change | 2 |
| % Change, M10 | 14 |
| % Change, M100 | -1 |
| % Change, Tb | 2 |
| % Change, Eb | -6 |
| Physical Properties at RT—Heat-Aged 70 hr at 275 °C (527 °F) in Oven (Slabs Post-Cured) | |
| M10, MPa | 0.8 |
| M100, MPa | 3.5 |
| Tb, MPa | 15.7 |
| Eb, % | 405 |
| Hardness, A, pts | 70 |
| Pt Change | 1 |
| % Change, M10 | 7 |
| % Change, M100 | -21 |
| % Change, Tb | -23 |
| % Change, Eb | 25 |
| Physical Properties at RT—Heat-Aged 168 hr at 150 °C (302 °F) in Oven (Slabs Post-Cured) | |
| M10, MPa | 1.1 |
| M100, MPa | 5.1 |
| Tb, MPa | 10.1 |
| Eb, % | 158 |
| Hardness, A, pts | 73 |
| Pt Change | 4 |
| % Change, M10 | 49 |
| % Change, M100 | 18 |
| % Change, Tb | -51 |
| % Change, Eb | -51 |
| Volume Swell, % | 0.9 |
| Volume Swell After Immersion—Time and Temperature as Noted | |
| Fuel C, 168 hr at 23 °C (73 °F) | 3.5 |
| Methanol, 168 hr at 23 °C (73 °F) | 54.5 |
| Water, 168 hr at 100 °C (212 °F) | 4.3 |
| Compound Specific Gravity | 1.860 |

Table 2. Viton™ GBL-600S—Filler Study

Table 2 is a filler study where various levels of MT Black and different mineral fillers are tested in GBL-600S. The compounds all contain the process aid Armeen® 18D.

| | 5-MT Black | 30-MT Black | 60-MT Black | 40-Woolastocoat | 40-BaSO ₄ |
|---|------------|-------------|-------------|-----------------|----------------------|
| Viton™ GBL-600S | 100 | 100 | 100 | 100 | 100 |
| N990 (MT Black) | 5 | 30 | 60 | — | — |
| Wollastocoat | — | — | — | 40 | — |
| Blanc Fixe (BaSO ₄) | — | — | — | — | 40 |
| Armeen® 18D | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Viton™ Curative No. 7 (VC-7) | 3 | 3 | 3 | 3 | 3 |
| Varox® DBPH-50 | 3 | 3 | 3 | 3 | 3 |
| Total phr | 111.5 | 136.5 | 166.5 | 146.5 | 146.5 |
| Mooney Scorch at 121 °C (250 °F) | | | | | |
| Minimum, MU | 24 | 28 | 39 | 32 | 25 |
| 2 pt Rise, min | 19.5 | 10.7 | 6.9 | 17.32 | 20.6 |
| 5 pt Rise, min | >30 | 13.2 | 9.3 | 18.3 | 21.8 |
| 10 pt Rise, min | — | 15.2 | 11.9 | 19.7 | 23.8 |
| ODR at 162 °C (324 °F), 3° Arc, 100 Range, 30 min Clock | | | | | |
| ML, dN.m | 10 | 15 | 17 | 18 | 16 |
| ts2, min | 2.3 | 0.8 | 0.6 | 0.8 | 0.9 |
| t'50, min | 4.2 | 1.3 | 1.2 | 1.3 | 1.5 |
| t'90, min | 5.4 | 2.7 | 2.6 | 2.0 | 2.9 |
| MH, dN.m | 49 | 138 | 173 | 128 | 114 |
| MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 6 min Clock | | | | | |
| ML, dN.m | 0.9 | 1.6 | 2.7 | 1.8 | 1.5 |
| ts2, min | 0.8 | 0.4 | 0.3 | 0.4 | 0.5 |
| t'50, min | 1.1 | 0.6 | 0.6 | 0.6 | 0.6 |
| t'90, min | 2.0 | 1.0 | 1.4 | 0.8 | 0.9 |
| t'95, min | 2.6 | 1.4 | 2.1 | 1.0 | 1.1 |
| MH, dN.m | 16.6 | 26.7 | 45.5 | 25.4 | 20.7 |
| Physical Properties at RT—Original, Cured 5 min at 177 °C (351 °F), No Post-Cure | | | | | |
| M10, MPa | 0.4 | 0.8 | 1.4 | 0.9 | 0.5 |
| M100, MPa | 1.3 | 3.0 | 5.9 | 3.5 | 1.5 |
| Tb, MPa | 11.0 | 10.7 | 10.0 | 11.6 | 12.2 |
| Eb, % | 423 | 379 | 300 | 423 | 441 |
| Hardness, A, pts | 52 | 69 | 82 | 67 | 60 |
| Physical Properties at RT—Original, Cured 5 min at 177 °C (351 °F), Post-Cured 2 hr at 232 °C (450 °F) | | | | | |
| M10, MPa | 0.4 | 0.9 | 2.1 | 0.9 | 0.6 |
| M100, MPa | 1.4 | 3.9 | 8.6 | 5.4 | 1.8 |
| Tb, MPa | 11.7 | 16.3 | 16.4 | 14.5 | 11.6 |
| Eb, % | 379 | 335 | 240 | 406 | 419 |
| Hardness, A, pts | 55 | 74 | 87 | 70 | 64 |

continued

Table 2. Viton™ GBL-600S—Filler Study (continued)

| | 5-MT Black | 30-MT Black | 60-MT Black | 40-Woolastocoat | 40-BaSO ₄ |
|---|-------------|-------------|-------------|-----------------|----------------------|
| Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven | | | | | |
| M10, MPa | 0.3 | 1.1 | 2.9 | 1.0 | 0.6 |
| M100, MPa | 1.2 | 4.8 | 10.2 | 7.7 | 3.0 |
| Tb, MPa | 19.5 | 18.4 | 19.1 | 13.2 | 15.2 |
| Eb, % | 492 | 341 | 200 | 285 | 440 |
| Hardness, A, pts | 56 | 77 | 87 | 71 | 66 |
| Pt Change | 1 | 3 | 0 | 1 | 2 |
| % Change, M10 | -11 | 24 | 39 | 6 | 5 |
| % Change, M100 | -12 | 22 | 18 | 41 | 60 |
| % Change, Tb | 67 | 13 | 17 | -9 | 31 |
| % Change, Eb | 30 | 2 | -17 | -30 | 5 |
| Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven | | | | | |
| M10, MPa | 0.4 | 1.1 | 3.2 | 1.2 | 0.7 |
| M100, MPa | 1.5 | 5.2 | 9.3 | 7.0 | 2.1 |
| Tb, MPa | 4.7 | 10.2 | 11.7 | 8.4 | 3.9 |
| Eb, % | 268 | 179 | 127 | 132 | 253 |
| Hardness, A, pts | 58 | 76 | 89 | 73 | 66 |
| Pt Change | 3 | 2 | 2 | 3 | 2 |
| % Change, M10 | -5 | 22 | 49 | 36 | 18 |
| % Change, M100 | 10 | 33 | 9 | 29 | 14 |
| % Change, Tb | -60 | -37 | -29 | -43 | -66 |
| % Change, Eb | -29 | -46 | -47 | -68 | -40 |
| Volume Change, % | 1.4 | 1.2 | 1.1 | 1.2 | 1.5 |
| Compression Set, Method B, O-Rings | <i>2 hr</i> | <i>2 hr</i> | <i>2 hr</i> | <i>2 hr</i> | <i>2 hr</i> |
| 22 hr at 200 °C (392 °F) | | | | | |
| - No Post-cure | 21 | 34 | 37 | 24 | 43 |
| - Post-cured at 232 °C (450 °F) | 17 | 29 | 31 | 21 | 28 |
| Volume Swell After Immersion | | | | | |
| Fuel C, 168 hr at 23 °C (73 °F) | 6.9 | 6.0 | 5.9 | 4.7 | 4.9 |
| Methanol, 168 hr at 23 °C (73 °F) | 7.7 | 5.1 | 3.7 | 6.1 | 7.8 |
| Water, 168 hr at 100 °C (212 °F) | 6.7 | 3.9 | 4.0 | 8.6 | 9.7 |
| Compound Specific Gravity | 1.84 | 1.84 | 1.84 | 2.05 | 2.19 |

Table 3. Viton™ GBL-600S—Process Aid Study

In Table 3, various process aids are evaluated in Viton™ GBL-600S. While Armeen® 18D is the preferred process aid, due to its excellent mold release, it can be seen that Armeen® accelerates the cure rate and hurts scorch life. Armeen® also seems to retard the completion of cure in the short post-cure cycle. Compounds with Armeen® do better with a 6 hr, rather than 2 hr, post-cure. Struktol® WS280 and carnauba wax did not seem to affect scorch life as much as Armeen®. Compounds with 1–1.5 phr of process aid seems to need the longer 6–8 hr post-cure to optimize properties. Struktol® WS280 seems to aid mold flow best, followed by carnauba wax (see spider mold results). New process aid Struktol® HT290 was developed after this study was run; but, recent results indicate that at a 1 phr level, it tends to be superior to a 0.5 phr Armeen® 18D/Struktol® WS280 system.

| | A26-01 Viton™ GBL-600S No PA | A26-02 8650 0.5 phr 18D | A26-03 8650 0.5 phr WS280 | A26-04 8650 1 phr Carnauba Wax | A26-05 0.5 phr 18D WS280 | A26-06 0.8 phr 18D WS280 | |
|--|---------------------------------------|--|------------------------------------|---|-----------------------------------|-----------------------------------|-----|
| Viton™ GBL-600S | 100 | 100 | 100 | 100 | 100 | 100 | |
| Zinc Oxide | 3 | 3 | 3 | 3 | 3 | 3 | |
| N990 (MT Black) | 30 | 30 | 30 | 30 | 30 | 30 | |
| Armeen® 18D | — | 0.5 | — | — | 0.5 | 0.8 | |
| Struktol® WS280 | — | — | 0.5 | — | 0.5 | 0.8 | |
| Carnauba Wax | — | — | — | 1 | — | — | |
| Viton™ Curative No. 7 (VC-7) | 3 | 3 | 3 | 3 | 3 | 3 | |
| Varox® DBPH-50 | 2 | 2 | 2 | 2 | 2 | 2 | |
| Total phr | 138 | 138.5 | 138.5 | 139 | 139 | 139.6 | |
| Banbury mixed "right side up" (polymer/metal oxide/N990/peroxide in—ram down) with process aids and VC-7 added at a 70 °C (158 °F) sweep | | | | | | | |
| Mooney Scorch at 121 °C (250 °F) | | | | | | | |
| Minimum, MU | 36 | 30 | 35 | 31 | 29 | 28 | |
| 2 pt Rise, min | >30 | 9.6 | >30 | 29.8 | 12.3 | >10.9 | |
| 5 pt Rise, min | — | 12.8 | — | >30 | 15.6 | 14.6 | |
| 10 pt Rise, min | — | 15.9 | — | — | 18.4 | 17.9 | |
| MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 6 min Clock | | | | | | | |
| ML, dN.m | 1.7 | 1.5 | 1.6 | 1.5 | 1.5 | 1.5 | |
| ts2, min | 0.5 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 | |
| t'50, min | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | |
| t'90, min | 1.2 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | |
| t'95, min | 1.5 | 1.5 | 1.4 | 1.6 | 1.6 | 1.6 | |
| MH, dN.m | 27.6 | 25.5 | 28.4 | 26.4 | 25.7 | 23.8 | |
| Rosand Capillary Rheometer at 100 °C (212 °F), 1.5 mm Die, L/D = 0/1 and 10/1 | | | | | | | |
| <i>Piston Speed, mm/min</i> | <i>Shear Rate, sec⁻¹</i> | <i>Pressure, MPa (L/D = 0/1 short die)</i> | | | | | |
| 5 | 44 | 4.0 | 2.9 | 0.9 | 3.2 | 2.8 | 1.0 |
| 12.7 | 113 | 4.9 | 3.9 | 4.6 | 4.1 | 3.8 | 3.5 |
| 50.8 | 452 | 6.3 | 5.6 | 6.2 | 5.6 | 5.4 | 5.0 |
| 127 | 1,129 | 7.4 | 7.3 | 7.8 | 7.1 | 6.9 | 6.5 |
| 250 | 2,221 | 8.9 | 9.1 | 9.4 | 8.8 | 8.6 | 8.3 |
| Spider Mold Flow Test—Sprue 0.0625 in (~1.6 mm), Cured 7 min at 177 °C (351 °F) | | | | | | | |
| Total Shot Weight, g | 31.7 | 31.9 | 31.9 | 32.0 | 31.9 | 31.4 | |
| Weight of Spider, g | 12.5 | 11.7 | 20.6 | 18.7 | 16.1 | 18.5 | |
| Fill Factor, % | 39 | 37 | 64 | 58 | 51 | 59 | |

continued

Table 3. Viton™ GBL-600S—Process Aid Study (continued)

| | A26-01 Viton™ GBL-600S No PA | A26-02 8650 0.5 phr 18D | A26-03 8650 0.5 phr WS280 | A26-04 8650 1 phr Carnauba Wax | A26-05 0.5 phr 18D WS280 | A26-06 0.8 phr 18D WS280 |
|--|---------------------------------------|----------------------------------|------------------------------------|---|-----------------------------------|-----------------------------------|
| Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), No Post-Cure | | | | | | |
| M10, MPa | 0.7 | 0.7 | 0.7 | 0.9 | 0.7 | 0.8 |
| M100, MPa | 2.9 | 2.7 | 2.9 | 2.9 | 2.7 | 2.7 |
| Tb, MPa | 12.0 | 10.9 | 10.2 | 10.5 | 10.8 | 10.8 |
| Eb, % | 370 | 407 | 271 | 380 | 416 | 434 |
| Hardness, A, pts | 67 | 67 | 67 | 70 | 68 | 67 |
| Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), 2 hr Post-Cured at 232 °C (450 °F) | | | | | | |
| M10, MPa | 0.8 | 0.9 | 0.6 | 1.0 | 0.8 | 1.0 |
| M100, MPa | 3.8 | 3.5 | 3.5 | 3.4 | 3.2 | 3.3 |
| Tb, MPa | 16.3 | 14.0 | 16.4 | 12.3 | 12.4 | 11.4 |
| Eb, % | 321 | 362 | 337 | 361 | 364 | 379 |
| Hardness, A, pts | 69 | 71 | 71 | 73 | 72 | 73 |
| Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), 5.5 hr Post-Cured at 232 °C (450 °F) | | | | | | |
| M10, MPa | 0.8 | 1.0 | 0.8 | 1.0 | 1.0 | 1.2 |
| M100, MPa | 3.8 | 3.9 | 3.9 | 3.8 | 3.8 | 4.1 |
| Tb, MPa | 17.8 | 18.5 | 18.7 | 16.7 | 17.5 | 18.2 |
| Eb, % | 295 | 314 | 305 | 336 | 317 | 364 |
| Hardness, A, pts | 71 | 74 | 72 | 74 | 72 | 76 |
| Physical Properties at RT—Original, Cured 7 min at 177 °C (351 °F), 8 hr Post-Cured at 232 °C (450 °F) | | | | | | |
| M10, MPa | 0.8 | 1.0 | 0.8 | 1.1 | 1.0 | 1.2 |
| M100, MPa | 3.8 | 4.2 | 4.0 | 4.0 | 4.0 | 4.2 |
| Tb, MPa | 18.9 | 20.3 | 18.5 | 18.4 | 18.9 | 18.0 |
| Eb, % | 312 | 354 | 293 | 339 | 345 | 325 |
| Hardness, A, pts | 71 | 74 | 72 | 75 | 75 | 76 |
| Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) Oven (After 2 hr at 232 °C [450 °F] Post-Cure) | | | | | | |
| M10, MPa | 0.8 | 1.1 | 0.9 | 1.2 | 1.1 | 1.29 |
| M100, MPa | 3.7 | 4.5 | 4.0 | 4.8 | 4.4 | 4.8 |
| Tb, MPa | 18.1 | 19.2 | 19.9 | 19.6 | 19.6 | 18.6 |
| Eb, % | 296 | 300 | 321 | 313 | 323 | 336 |
| Hardness, A, pts | 71 | 74 | 72 | 76 | 75 | 77 |
| Pt Change | 2 | 3 | 1 | 3 | 3 | 4 |
| % Change, M10 | 7 | 19 | 9 | 21 | 30 | 29 |
| % Change, M100 | 4 | 29 | 14 | 42 | 39 | 46 |
| % Change, Tb | 11 | 38 | 21 | 59 | 58 | 63 |
| % Change, Eb | -8 | -17 | -5 | -13 | -11 | -11 |
| Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) Oven (After 5.5 hr at 232 °C [450 °F] Post-Cure) | | | | | | |
| M10, MPa | 0.8 | 1.1 | 0.9 | 1.2 | 1.1 | 1.32 |
| M100, MPa | 3.8 | 4.5 | 4.0 | 4.8 | 4.6 | 5.0 |
| Tb, MPa | 18.4 | 19.2 | 20.3 | 19.5 | 19.3 | 18.7 |
| Eb, % | 296 | 303 | 335 | 306 | 323 | 327 |
| Hardness, A, pts | 71 | 74 | 72 | 76 | 76 | 77 |
| Pt Change | 0 | 0 | 0 | 2 | 4 | 1 |
| % Change, M10 | 3 | 6 | 10 | 19 | 8 | 9 |
| % Change, M100 | 2 | 15 | 2 | 28 | 21 | 20 |
| % Change, Tb | 3 | 4 | 9 | 17 | 11 | 2 |
| % Change, Eb | 1 | -4 | 10 | -9 | 2 | -10 |

Table 3. Viton™ GBL-600S—Process Aid Study (continued)

| | A26-01 Viton™ GBL-600S No PA | A26-02 8650 0.5 phr 18D | A26-03 8650 0.5 phr WS280 | A26-04 8650 1 phr Carnauba Wax | A26-05 0.5 phr 18D WS280 | A26-06 0.8 phr 18D WS280 |
|--|---------------------------------------|----------------------------------|------------------------------------|---|-----------------------------------|-----------------------------------|
| Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) Oven (After 8 hr at 232 °C [450 °F] Post-Cure) | | | | | | |
| M10, MPa | 0.8 | 1.1 | 0.9 | 1.2 | 1.1 | 1.29 |
| M100, MPa | 3.6 | 4.6 | 4.1 | 4.8 | 4.6 | 5.0 |
| Tb, MPa | 18.7 | 19.0 | 20.4 | 19.6 | 20.1 | 19.1 |
| Eb, % | 317 | 302 | 336 | 309 | 334 | 344 |
| Hardness, A, pts | 72 | 75 | 72 | 76 | 76 | 77 |
| Pt Change | 1 | 1 | 0 | 1 | 1 | 1 |
| % Change, M10 | 7 | 4 | 9 | 11 | 8 | 8 |
| % Change, M100 | -4 | 10 | 2 | 21 | 16 | 18 |
| % Change, Tb | -1 | -6 | 11 | 7 | 7 | 7 |
| % Change, Eb | 2 | -15 | 14 | -9 | -3 | 6 |
| Compression Set, Method B, O-Rings | | | | | | |
| 22 hr at 200 °C (392 °F) | | | | | | |
| - No Post-cure | 20 | 31 | 19 | 27 | 34 | 49 |
| - Post-cured 2 hr at 232 °C (450 °F) | 14 | 20 | 13 | 20 | 20 | 29 |
| - Post-cured 5.5 hr at 232 °C (450 °F) | 16 | 20 | 14 | 19 | 20 | 23 |
| - Post-cured 8 hr at 232 °C (450 °F) | 14 | 19 | 13 | 14 | 16 | 21 |
| 70 hr at 200 °C (392 °F) | | | | | | |
| - No Post-cure | 30 | 47 | 29 | 43 | 49 | 63 |
| - Post-cured 2 hr at 232 °C (450 °F) | 26 | 34 | 23 | 33 | 36 | 46 |
| - Post-cured 5.5 hr at 232 °C (450 °F) | 24 | 29 | 21 | 21 | 31 | 37 |
| - Post-cured 8 hr at 232 °C (450 °F) | 24 | 29 | 23 | 23 | 29 | 39 |
| Compression Set, Method B, Plied Discs | | | | | | |
| 22 hr at 200 °C (392 °F) | | | | | | |
| - Post-cured 2 hr at 232 °C (450 °F) | 10 | 15 | 10 | 14 | 16 | 22 |
| - Post-cured 5.5 hr at 232 °C (450 °F) | 11 | 14 | 11 | 13 | 16 | 21 |
| - Post-cured 8 hr at 232 °C (450 °F) | 12 | 15 | 11 | 14 | 16 | 20 |
| 70 hr at 200 °C (392 °F) | | | | | | |
| - Post-cured 2 hr at 232 °C (450 °F) | 12 | 25 | 13 | 20 | 25 | 34 |
| - Post-cured 5.5 hr at 232 °C (450 °F) | 17 | 20 | 14 | 17 | 21 | 27 |
| - Post-cured 8 hr at 232 °C (450 °F) | 18 | 23 | 16 | 18 | 23 | 30 |
| Volume Swell After Immersion—Time and Temperature as Noted | | | | | | |
| Fuel C, 168 hr at 23 °C (73 °F) | 12 | 25 | 13 | 20 | 25 | 34 |
| CM15 Fuel, 168 hr at 23 °C (73 °F) | 17 | 20 | 14 | 17 | 21 | 27 |
| Water, 168 hr at 100 °C (212 °F) | 18 | 23 | 16 | 18 | 23 | 30 |
| Low Temperature Properties, Tg by DSC, °C | | | | | | |
| - No Post-cure | -22.4 | -22.4 | -21.8 | -21.2 | -21.8 | -21.8 |
| - Post-cured 2 hr | -19.2 | -18.8 | -18.6 | -18.6 | -18.8 | -18.8 |
| - Post-cured 5.5 hr | -18.7 | -18.3 | -18.1 | -18.2 | -18.6 | -18.9 |
| - Post-cured 8 hr | -18.7 | -18.9 | -18.5 | -18.0 | -18.3 | -18.5 |

Table 4. Viton™ GBL-600S—Screening DOE on Viton™ Curative No. 7 (VC-7) Peroxide Levels

A screening design of experiments (DOE) was run on commercial Viton™ GBL600-S, where levels of peroxide and VC-7 coagent were varied from 0.5–5 phr. The data shows that, as expected, the VC-7 is the primary cross-linker controlling the state-of-cure, and the peroxide controls the rate-of-cure that affects the scorch and cure speed of this new Advanced Polymer Architecture (APA) technology Viton™ fluoroelastomer. It should be noted that 0.5 phr of peroxide and coagent is too low for good curing; a level of 1.0 phr and above is better.

| | A03-01 | A03-02 | A03-03 | A03-04 | A03-05 | A03-06 | A03-07 | A03-08 | A03-09 | A03-10 |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Viton™ GBL-600S | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Zinc Oxide | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| N990 (MT Black) | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Viton™ Curative No. 7 (VC-7) | 0.5 | 0.5 | 0.5 | 2.75 | 2.75 | 2.75 | 2.75 | 5 | 5 | 5 |
| Luperox® 101XL45 | 0.5 | 2.75 | 5 | 0.5 | 2.75 | 2.75 | 5 | 0.5 | 2.75 | 5 |
| Total phr | 134 | 136.25 | 138.5 | 136.25 | 138.5 | 138.5 | 140.75 | 138.5 | 140.75 | 143 |
| Mooney Scorch at 121 °C (250 °F) | | | | | | | | | | |
| Minimum, MU | 42 | 39 | 36 | 36 | 34 | 34 | 32 | 31 | 29 | 26 |
| 2 pt Rise, min | >30 | >30 | 27.8 | >30 | 23.9 | 28.1 | 11.6 | >30 | 19.3 | 11.6 |
| 5 pt Rise, min | — | — | >30 | — | 25.5 | >30 | 13.1 | — | 21.4 | 12.9 |
| 10 pt Rise, min | — | — | — | — | 28.8 | — | 14.2 | — | 23.1 | 14.0 |
| ODR at 162 °C (324 °F), 3° Arc, 100 Range, 30 min Clock | | | | | | | | | | |
| ML, dN.m | 18 | 18 | 18 | 15 | 16 | 16 | 17 | 13 | 14 | 15 |
| ts2, min | 4.7 | 2.3 | 1.4 | 2.5 | 1.3 | 1.5 | 1.0 | 2.5 | 1.3 | 1.1 |
| t'50, min | 15.5 | 5.1 | 2.9 | 5.8 | 2.7 | 2.9 | 2.0 | 6.0 | 2.5 | 2.2 |
| t'90, min | 24.8 | 8.5 | 4.5 | 9.9 | 5.5 | 4.6 | 3.9 | 9.9 | 3.8 | 3.7 |
| MH, dN.m | 91 | 113 | 121 | 135 | 140 | 142 | 155 | 108 | 130 | 157 |
| MDR 2000 at 177 °C (351 °F), 0.5° Arc, 100 Range, 6 min Clock | | | | | | | | | | |
| ML, dN.m | 1.9 | 2.1 | 2.2 | 1.6 | 1.9 | 1.8 | 2.1 | 1.3 | 1.7 | 1.8 |
| ts2, min | 1.5 | 0.6 | 0.5 | 0.7 | 0.4 | 0.4 | 0.3 | 0.7 | 0.4 | 0.3 |
| t'50, min | 2.7 | 0.9 | 0.6 | 1.4 | 0.6 | 0.6 | 0.5 | 1.7 | 0.6 | 0.5 |
| t'90, min | 4.9 | 1.6 | 0.9 | 2.8 | 1.0 | 1.1 | 0.7 | 3.6 | 1.0 | 0.8 |
| t'95, min | 5.4 | 2.1 | 1.2 | 3.6 | 1.3 | 1.5 | 0.9 | 4.3 | 1.4 | 1.1 |
| MH, dN.m | 15.4 | 22.2 | 21.6 | 28.2 | 29.4 | 29.5 | 28.8 | 30.2 | 32.4 | 32.6 |
| Spider Mold Flow Test—0.0625 in, 1.6 mm Sprue/1900 psi, ~131 bar Transfer Pressure, Cured 5 min at 177 °C (351 °F) | | | | | | | | | | |
| Spider Weight, g | 24.2 | 17.8 | 15.8 | 17.1 | 12.2 | 14.5 | 13.5 | 18.1 | 16.2 | 20.4 |
| Scrap in Transfer Pot, g | 7.7 | 13.7 | 16.1 | 15.4 | 19.7 | 17.5 | 18.4 | 13.8 | 15.6 | 10.8 |
| Fill Factor, % | 76 | 57 | 49 | 53 | 38 | 45 | 42 | 57 | 51 | 65 |
| Physical Properties at RT—Original, Cured 5 min at 177 °C (351 °F), No Post-Cure | | | | | | | | | | |
| M10, MPa | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 0.7 | 0.8 | 0.8 | 0.8 | 0.9 |
| M100, MPa | 1.8 | 2.5 | 2.5 | 2.9 | 3.5 | 3.5 | 3.8 | 3.4 | 4.2 | 4.7 |
| Tb, MPa | 6.1 | 8.7 | 9.2 | 11.9 | 13.9 | 13.6 | 13.5 | 14.9 | 16.6 | 15.4 |
| Eb, % | 671 | 476 | 456 | 408 | 347 | 333 | 323 | 394 | 323 | 273 |
| Hardness, A, pts | 65 | 64 | 64 | 66 | 68 | 68 | 69 | 69 | 69 | 71 |

continued

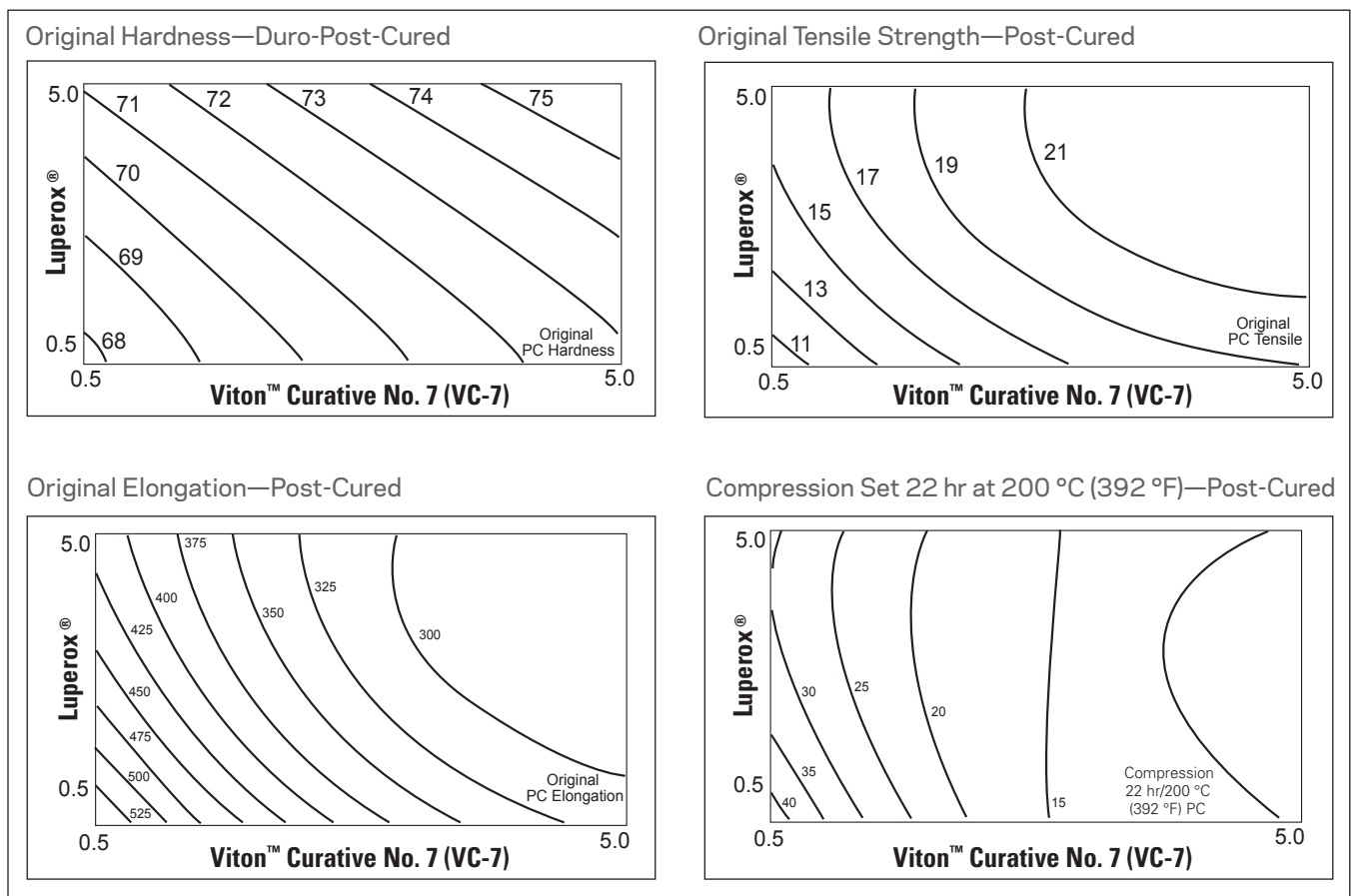
Table 4. Viton™ GBL-600S—Screening DOE on Viton™ Curative No. 7 (VC-7) Peroxide Levels (continued)

| | A42-01 | A42-02 | A42-03 | A42-04 | A42-05 | A42-06 | A42-07 | A42-08 | A42-09 | A42-10 |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Viton™ Curative No. 7 (VC-7) level | 0.5 | 0.5 | 0.5 | 2.75 | 2.75 | 2.75 | 2.75 | 5 | 5 | 5 |
| Luperox® 101XL level | 0.5 | 2.75 | 5 | 0.6 | 2.75 | 2.75 | 5 | 0.5 | 2.75 | 5 |
| Physical Properties at RT—Original, Cured 5 min at 177 °C (351 °F), Post-Cured 2 hr at 232 °C (450 °F) | | | | | | | | | | |
| M10, MPa | 0.8 | 0.9 | 1.0 | 0.9 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.2 |
| M100, MPa | 2.0 | 3.0 | 3.1 | 3.6 | 4.2 | 4.3 | 4.6 | 4.1 | 5.4 | 6.3 |
| Tb, MPa | 9.1 | 14.3 | 15.9 | 18.1 | 19.8 | 19.8 | 20.4 | 18.0 | 22.9 | 23.1 |
| Eb, % | 567 | 440 | 424 | 380 | 335 | 314 | 315 | 312 | 300 | 278 |
| Hardness, A, pts | 68 | 69 | 71 | 70 | 72 | 72 | 74 | 73 | 74 | 76 |
| Compression Set, Method B, O-Rings, 22 hr at 200 °C (392 °F) | | | | | | | | | | |
| No Post-Cure | 63 | 36 | 43 | 24 | 23 | 21 | 24 | 20 | 20 | 23 |
| Post-Cured 2 hr at 232 °C (450 °F) | 44 | 29 | 32 | 13 | 16 | 20 | 13 | 17 | 17 | 17 |
| Physical Properties at RT—Heat-Aged 70 hr at 250 °C (482 °F) in Oven (Run on Post-Cured Samples) | | | | | | | | | | |
| M100, MPa | 2.6 | 3.0 | 3.0 | 3.4 | 4.0 | 4.0 | 4.6 | 4.0 | 5.0 | 5.7 |
| Tb, MPa | 13.7 | 14.0 | 13.4 | 19.0 | 18.4 | 18.6 | 18.0 | 20.3 | 20.6 | 20.9 |
| Eb, % | 592 | 503 | 470 | 430 | 386 | 384 | 356 | 341 | 303 | 310 |
| Hardness, A, pts | 72 | 72 | 74 | 72 | 74 | 74 | 75 | 73 | 75 | 78 |
| Pt Change | 4 | 3 | 3 | 2 | 2 | 2 | 1 | 0 | 1 | 2 |
| % Change, M100 | 30 | 0 | -3 | -6 | -5 | -6 | -1 | -2 | -8 | -9 |
| % Change, Tb | 51 | -3 | -16 | 5 | -7 | -6 | -12 | 12 | -10 | -10 |
| % Change, Eb | 4 | 14 | 11 | 13 | 15 | 22 | 13 | 9 | 1 | 12 |
| Physical Properties at RT—Heat-Aged 70 hr at 275 °C (527 °F) in Oven | | | | | | | | | | |
| M100, MPa | 2.2 | 2.3 | 2.4 | 3.0 | 3.2 | 3.4 | 3.6 | 4.0 | 4.5 | 5.0 |
| Tb, MPa | 9.8 | 8.6 | 8.1 | 13.7 | 12.5 | 12.9 | 12.0 | 15.5 | 14.6 | 13.9 |
| Eb, % | 548 | 503 | 478 | 390 | 397 | 394 | 379 | 378 | 336 | 327 |
| Hardness, A, pts | 72 | 72 | 73 | 72 | 73 | 74 | 75 | 74 | 76 | 79 |
| Pt Change | 4 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 3 |
| % Change, M100 | 11 | -23 | -25 | -16 | -23 | -20 | -23 | — | -18 | -20 |
| % Change, Tb | 8 | -40 | -49 | -24 | -37 | -35 | -41 | -14 | -36 | -40 |
| % Change, Eb | -3 | 14 | 13 | 3 | 19 | 26 | 21 | 21 | 12 | 17 |
| Physical Properties at RT—ASTM Test Oil 1006, Aged 168 hr at 150 °C (302 °F) in Oven | | | | | | | | | | |
| M100, MPa | 2.9 | 3.9 | 4.1 | 4.4 | 5.5 | 5.2 | 6.1 | 4.9 | 6.7 | 7.2 |
| Tb, MPa | 9.0 | 10.3 | 9.9 | 12.0 | 12.0 | 12.0 | 11.9 | 12.6 | 12.6 | 13.2 |
| Eb, % | 344 | 236 | 224 | 215 | 183 | 184 | 177 | 205 | 161 | 168 |
| Hardness, A, pts | 72 | 73 | 75 | 73 | 75 | 76 | 77 | 74 | 77 | 78 |
| Pt Change | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 1 | 3 | 2 |
| % Change, M100 | 45 | 32 | 30 | 23 | 32 | 23 | 32 | 19 | 23 | 14 |
| % Change, Tb | -1 | -28 | -37 | -34 | -39 | -39 | -42 | -30 | -45 | -43 |
| % Change, Eb | -39 | -46 | -47 | -43 | -46 | -41 | -44 | -34 | -46 | -40 |
| Volume Change, % | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Physical Properties at RT—Fuel C, Aged 168 hr at 40 °C (104 °F) in Oven | | | | | | | | | | |
| M100, MPa | 1.2 | 2.0 | 2.2 | 2.5 | 3.3 | 3.4 | 3.6 | 2.9 | 4.0 | 4.4 |
| Tb, MPa | 7.8 | 12.8 | 13.3 | 13.7 | 15.4 | 14.8 | 15.5 | 14.5 | 15.8 | 16.0 |
| Eb, % | 628 | 433 | 437 | 327 | 298 | 277 | 294 | 311 | 247 | 246 |
| Hardness, A, pts | 72 | 73 | 75 | 73 | 75 | 76 | 77 | 74 | 77 | 78 |
| Pt Change | 4 | 4 | 4 | 3 | 3 | 4 | 3 | 1 | 3 | 2 |
| % Change, M100 | -41 | -31 | -29 | -32 | -22 | -21 | -22 | -29 | -27 | -30 |
| % Change, Tb | -15 | -11 | -16 | -24 | -22 | -25 | -24 | -19 | -31 | -31 |
| % Change, Eb | 11 | -2 | 3 | -14 | -11 | -12 | -7 | 0 | -18 | -11 |
| Volume Change, % | 13 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |

Table 4. Viton™ GBL-600S—Screening DOE on Viton™ Curative No. 7 (VC-7) Peroxide Levels (continued)

| | A42-01 | A42-02 | A42-03 | A42-04 | A42-05 | A42-06 | A42-07 | A42-08 | A42-09 | A42-10 |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Physical Properties at RT—Water, Distilled, Aged 168 hr at 100 °C (212 °F) in Oven | | | | | | | | | | |
| M100, MPa | 2.1 | 2.9 | 3.0 | 3.6 | 4.3 | 4.1 | 4.5 | 4.0 | 5.4 | 5.6 |
| Tb, MPa | 11.7 | 15.6 | 16.4 | 16.3 | 18.6 | 18.6 | 19.3 | 17.2 | 19.8 | 20.1 |
| Eb, % | 573 | 469 | 448 | 358 | 329 | 344 | 345 | 352 | 318 | 287 |
| Hardness, A, pts | 69 | 70 | 70 | 70 | 71 | 71 | 72 | 72 | 72 | 74 |
| Pt Change | 1 | 1 | -1 | 0 | -1 | -1 | -2 | -1 | -2 | -2 |
| % Change, M100 | 5 | -3 | -3 | 1 | 3 | -4 | -3 | -2 | -1 | -11 |
| % Change, Tb | 29 | 9 | 3 | -10 | -6 | -6 | -5 | -5 | -14 | -13 |
| % Change, Eb | 1 | 7 | 6 | -6 | -2 | 10 | 10 | 13 | 6 | 3 |
| Volume Change, % | 5 | 3 | 6 | 4 | 4 | 3 | 5 | 3 | 4 | 4 |
| Physical Properties at RT—Sulfuric Acid 96% Aged 168 hr at 70 °C (158 °F) | | | | | | | | | | |
| M100, MPa | 2.5 | 3.6 | 3.9 | 3.9 | 4.9 | 4.7 | 5.5 | 4.3 | 5.8 | 6.5 |
| Tb, MPa | 11.3 | 16.8 | 17.9 | 19.2 | 20.8 | 21.0 | 21.4 | 20.3 | 22.3 | 24.3 |
| Eb, % | 525 | 420 | 383 | 379 | 326 | 339 | 322 | 345 | 295 | 288 |
| Hardness, A, pts | 71 | 72 | 72 | 71 | 73 | 74 | 75 | 73 | 75 | 77 |
| Pt Change | 3 | 3 | 1 | 1 | 1 | 2 | 1 | 0 | 1 | 1 |
| % Change, M100 | 27 | 21 | 25 | 9 | 18 | 11 | 19 | 5 | 6 | 4 |
| % Change, Tb | 25 | 17 | 13 | 7 | 6 | 6 | 5 | 13 | -3 | 5 |
| % Change, Eb | -7 | -5 | -10 | 0 | -3 | 8 | 2 | 10 | -2 | 4 |
| Volume Change, % | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 |

Figure 1.



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 1414 |
| 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) (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/sec (20 in/min) |
| Stiffness, Torsional, Clash-Berg | ASTM D1043 |
| Temperature Retraction | ASTM D1329 |
| Volume Change In Fluids | ASTM D471 |

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

For more information, visit Viton.com

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