

# Vamac® Ultra XF-OR



## Ethylene Acrylic Elastomer - Technical Data

### Description

Vamac® Ultra XF-OR (formerly VMX3123) is a lower Mooney viscosity version of Vamac® Ultra HT-OR. Table 1 gives an overview on Vamac® AEM grades with low Cure Site Monomer content. This range of products was developed to provide customers materials with outstanding scorch resistance with smooth surface finishing after extrusion. Cured parts have the highest levels of Elongation at Break and Tear Resistance amongst all AEM grades and therefore these grades have become the preferred materials for extruded applications with high requirements to dynamic flexing fatigue such as Turbo Charger Hoses.

Table 1 – AEM Polymers with Low Cure Site Monomer Content

Grade	Mooney Viscosity ML (1+4) at 100 °C	Tg °C (by DSC)	Key Feature
Vamac® GXF	17.5	-30	Dynamic fatigue resistance
Vamac® Ultra XF	23	-30	Intermediate viscosity
Vamac® Ultra HT	29	-30	High temperature
Vamac® Ultra HT-OR	31	-24	High temperature and oil resistance
Vamac® Ultra XF-OR	24	-24	Intermediate viscosity with high temperature and oil resistance

Vamac® Ultra HT-OR was developed shortly after Ultra HT as an alternative to ACM for some specifications where lower oil swell is required (e.g VW TL 52634 for HT-ACM TCH), and AEMs superior resistance to oil/acid blends or to aggressive newer oils is required.

Both Vamac® Ultra HT-OR and Ultra HT have Mooney Viscosities of about 30 MU (ML 1+4, 100°C). Typical compounds made of these two polymers show good extrusion behavior when formulated to abt. 55-65 ShA, as requested in TL52634. Higher Hardness compounds lead to high die pressure during extrusion, sometimes too high to allow safe and stable processing.

The commercialization of Vamac® Ultra XF, a 23 Mooney version of Ultra HT, allowed extrusion of compounds with 70-75 Shore A for automotive hoses or tubes with an optimized combination of cost and performance. Higher hardness does not only provide better collapse resistance and easier assembly of cured hoses, but also brings potential for cost savings due to higher filler loading. Ultra XF-OR offers a similar solution for intermediate viscosity AEM polymer with lower oil swell to allow extrusion of 70-75 ShA compounds.

### Major Performance Properties and Applications

For long-lasting functionality of turbo charger hoses, the interlayer adhesion between inner and outer hose layer through the loops of a knitted aramid reinforcement is important. Very often the outer layer of a hose is made from lower viscosity compounds to achieve good flow through the knitted aramid reinforcement, and good interlayer adhesion.

Vamac® is known to have lower viscosity and lower tendency to scorch during mixing and extrusion, compared to ACM compounds. In some cases, Vamac® is used as the outer layer for hoses with an ACM compound as the inner layer, to achieve good interlayer adhesion. For best compatibility to ACM, Vamac® Ultra HT-OR provides the best fit in terms of polarity with ACM.

Ultra XF-OR and Ultra HT-OR have the same chemical composition and polarity, close to ACM's polarity. Compared to Vamac® Ultra HT-OR, better interlayer adhesion can also be expected due to lower viscosity of Ultra XF-OR, even at higher carbon black loading.

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### 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 bulletin, *Safe Handling and Processing of Vamac®*.

### Compounding and Physical Properties

#### Part 1 - Compounds for Extrusion

Typical compounds for extruded hoses for dynamic applications such as Turbo Charger Hoses include low level of curatives to provide good flexibility with high Elongation at Break levels and good Tear Strength. In a first test series, standard compounds were tested with variations including:

- Carbon Black level and type
- Curative levels

No scorch retarder based on Octadecylamine was added to the compounds, as Vamac® Ultra HT-OR, and Ultra XF-OR are polymers with low Cure Site Monomer level. Compounds of Vamac® Ultra XF-OR and Ultra HT-OR were mixed in a 1.7 litre Francis Shaw Intermix for about 3 minutes, and dumped at temperatures of about 90°C.

Table 2 – Formulations for Extrusion Compounds, Mooney and Hardness

Ingredient (phr)	Ultra HT-OR	Ultra XF-OR	Ultra HT-OR, 50 FEF	Ultra XF-OR 50 FEF	Ultra XF-OR, 70 FEF	Ultra XF-OR, high cure	Ultra XF-OR, low cure	Ultra XF-OR, SRF
Vamac® Ultra HT-OR	100		100					
Vamac® Ultra XF-OR		100		100	100	100	100	100
FEF N 550	60	60	50	50	70	60	60	
SRF N 772								80
Alcanplast® PO80	10	10	10	10	10	10	10	10
Antioxidant	2	2	2	2	2	2	2	2
Ofalub® SEO	1	1	1	1	1	1	1	1
Stearic Acid	1	1	1	1	1	1	1	1
HDMC Curative	1.1	1.1	1.1	1.1	1.1	1.3	0.9	1.1
Vulcofac® ACT 55	2	2	2	2	2	2	2	2
<u>Properties</u>								
Mooney (ML 1+4, 100°C), MU	57.6	51.8	46.9	42.1	64.4	48	50.4	44.8
Hardness Shore A (1s), pts	73	72	67	66	78	71	71	75

The same formulations give similar hardness levels for both, Vamac® Ultra XF-OR, and Ultra HT-OR. As expected however, the Compound Mooney viscosity is significantly lower for Vamac® Ultra XF-OR based compounds, compared to Ultra HT-OR based compounds, at same filler level.

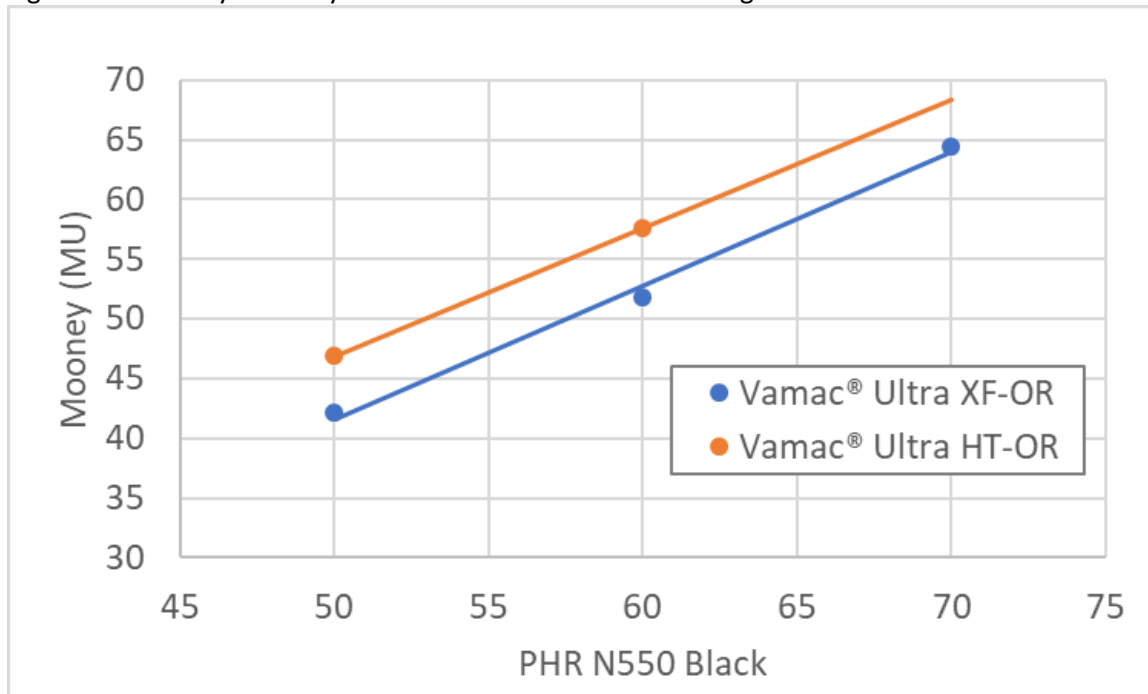
Figure 1 illustrates the relation between FEF filler loading, compound Mooney viscosity, and Shore A Hardness of slabs (press-cured 10 minutes at 180°C / post-cured 4 hours at 175°C) of Table 1. It can be expected that Mooney viscosities for Vamac® Ultra XF-OR based compounds are comparable to Ultra HT-OR based compounds at 5-6 phr FEF N550 higher carbon black loadings. Even higher additional loadings are possible with less reinforcing carbon blacks such as SRF N772.

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Figure 1 – Mooney Viscosity vs. FEF N550 Carbon Black loading



### Rheology

Table 3 shows rheological data for the compounds in Table 2. Scorch times for compounds with Vamac® Ultra XF-OR are similar to Ultra HT-OR at 121°C. At 180°C, cure times observed for Ultra XF-OR were slightly longer than for Ultra HT-OR. As expected minimum and maximum torque level are lower for the Ultra XF-OR based compounds due to lower Mooney viscosity.

Table 3 – Extrusion Compounds Rheology

Rheology	Ultra HT-OR	Ultra XF-OR	Ultra HT-OR, 50 FEF	Ultra XF-OR, 50 FEF	Ultra XF-OR, 70 FEF	Ultra XF-OR, high cure	Ultra XF-OR, low cure	Ultra XF-OR, SRF
<u>MDR, 15 min., 180°C, arc 0.5°, ISO 6502</u>								
ML (dNm)	0.74	0.65	0.50	0.46	0.93	0.58	0.65	0.76
MH (dNm)	11.3	10.2	9.4	8.7	11.9	10.7	8.6	11.6
TS2 (min)	1.14	1.30	1.34	1.52	1.15	1.40	1.33	1.17
T10 [min]	0.79	0.83	0.82	0.88	0.79	0.91	0.76	0.78
T50 [min]	2.7	2.9	2.8	3.0	2.9	3.3	2.6	3.0
T90 [min]	9.3	9.4	9.3	9.6	9.5	10.0	8.9	9.8
<u>Mooney Scorch, 45 min, 121°C, ISO289-2</u>								
Ts1 [min]	5.6	5.8	6.1	6.3	5.3	5.8	6.0	5.8
Ts2 [min]	7.1	7.2	7.7	8.0	6.5	7.4	7.6	7.2

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### Physical Properties

Table 4 provides physical properties after press-cure for 15 minutes at 180°C, followed by 4 h post-cure at 175°C. Properties measured at room temperature and at 150°C show that lower molecular weight of Ultra XF-OR does not result in significantly lower Tensile Strength, Elongation at Break or Tear Strength. Results for DeMattia Crack Growth and Compression Set also show well comparable data for both products, despite of differences in Molecular Weight.

Table 4 – Physical Properties, DeMattia Crack Growth and Compression Set

Original Properties	Ultra HT-OR	Ultra XF-OR	Ultra HT-OR, 50 FEF	Ultra XF-OR, 50 FEF	Ultra XF-OR, 70 FEF	Ultra XF-OR, high cure	Ultra XF-OR, low cure	Ultra XF-OR, SRF
<u>Stress-Strain at 23°C</u>								
Tensile Strength, MPa	17.2	16.6	18-2	16.7	16.1	17.1	15.7	16.7
Elongation at Break, %	345	344	407	385	290	328	364	297
25% Modulus, MPa	1.37	1.36	1.03	1.05	1.78	1.32	1.29	1.48
100% Modulus, MPa	4.7	5.0	3.2	3.9	6.2	5.1	4.0	4.8
Tear Die C, N/mm	31.4	29.4	26.8	26.2	32.5	28.3	30.1	31.0
<u>Stress-Strain at 150°C</u>								
Tensile Strength, MPa	6.2	6.1	5.9	5.3	6.6	6.1	5.8	5.1
Elongation at Break, %	129	131	155	148	120	125	161	124
25% Modulus, MPa	1.04	0.96	0.78	0.74	1.07	1.02	0.78	1.01
100% Modulus, MPa	4.5	4.4	3.2	3.2	5.0	4.7	3.2	3.9
Tear Die C, N/mm	6.6	6.1	5.7	5.6	6.9	5.9	6.8	6.4
<u>De Mattia Crack Growth, 23°C, ISO 132</u>								
Kcl to 4.5mm	5	5	155	155	3	5	13	4
Kcl to 8.5mm	6535	6907	10235	11090	1808	2555	33635	3255
Kcl to 12.5mm	20475	20975	28155	33185	9070	6866	70215	23580
<u>Compression Set at 175°C</u>								
70h (ISO 815-1, Type B), %	38	37	36	36	40	36	43	41
22h (VW PV3307), %	71	79	72	73	72	64	82	71

### Heat Ageing

Two of the currently most severe heat ageing conditions included in some OEM specifications for standard AEM compounds were chosen for study. Results are shown in Table 5.

Results between Vamac® Ultra XF-OR and Ultra HT-OR are comparable for identical formulations. All compounds retain their elastic properties and meet major specification requirements, which are very often mentioning maximum losses for Tensile Strength of -30% and for Elongation at Break maximum 40 to 50% loss.

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Table 5 – Dry Heat Ageing Results

Physical Properties	Ultra HT-OR	Ultra XF-OR	Ultra HT-OR, 50 FEF	Ultra XF-OR, 50 FEF	Ultra XF-OR, 70 FEF	Ultra XF-OR, high cure	Ultra XF-OR, low cure	Ultra XF-OR, SRF
<u>Heat Ageing at 504 h / 175 °C (ISO 188)</u>								
Hardness Shore A (1s), pts	81	82	73	73	87	80	81	86
Delta Hardness, %	8	10	6	7	9	9	10	11
Tensile Strength, MPa	12.1	11.6	12.1	11.4	10.7	12.7	9.8	10.5
Delta Tensile Strength, %	-30	-31	-33	-32	-33	-25	-37	-37
Elongation at Break, %	225	224	291	259	167	214	246	188
Delta Elongation at Break, %	-35	-35	-29	-33	-42	-35	-32	-37
100% Modulus, MPa	6.2	6.4	4.1	4.6	8.1	6.6	5.2	6.6
Delta 100% Modulus, %	32	27	28	17	31	29	28	38
<u>Heat Ageing at 1008 h / 160°C (ISO 188)</u>								
Hardness Shore A (1s), pts	78	78	70	70	84	78	76	83
Delta Hardness, %	4	6	3	4	6	7	5	8
Tensile Strength, MPa	13.6	13.0	13.5	13.5	13.0	14.1	11.4	13.0
Delta Tensile Strength, %	-21	-22	-26	-19	-19	-17	-28	-22
Elongation at Break, %	284	277	346	332	235	261	317	238
Delta Elongation at Break, %	-18	-19	-15	-14	-19	-20	-13	-20
100% Modulus, MPa	5.9	6.1	3.8	4.6	7.7	6.2	4.7	5.9
Delta 100% Modulus, %	26	23	17	18	24	20	17	24

### Fluid Ageing

As Vamac Ultra HT-OR are identical in their chemical composition, no changes were found after fluid ageing in reference engine fluid Lubrizol® OS 206304.

Table 6 – Fluid Ageing Results, Lubrizol® OS 306304

Physical Properties	Ultra HT-OR	Ultra XF-OR	Ultra HT-OR, 50 FEF	Ultra XF-OR, 50 FEF	Ultra XF-OR, 70 FEF	Ultra XF-OR, high cure	Ultra XF-OR, low cure	Ultra XF-OR, SRF
<u>Fluid Ageing at 504 h / 160 °C (ISO 1817)</u>								
Hardness Shore A (1s), pts	76	74	70	67	81	75	74	79
Delta Hardness, %	2	2	3	1	4	4	3	4
Tensile Strength, MPa	17.5	17.1	17.6	16.7	16.7	15.8	15.9	15.1
Delta Tensile Strength, %	1	3	-3	0	4	-7	1	-10
Elongation at Break, %	266	273	313	308	212	210	270	187
Delta Elongation at Break, %	-23	-21	-23	-20	-27	-36	-26	-37
100% Modulus, MPa	6.6	6.5	5.0	4.3	8.5	7.0	5.4	7.5
Delta 100% Modulus, %	40	31	54	11	37	36	34	57
Weight Change, %	2.2	3.1	2.5	3.0	3.1	2.4	3.1	2.8
Volume Change, %	4.4	5.6	4.7	5.4	5.5	4.8	5.6	5.2

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### Part 2 - Compounds with Higher Curative Levels for Molded Parts

For molded parts, typically polymers with high Cure Site monomer content are chosen for fast cure and short cycle times, and for lower oil swell, AEM grades like Vamac® GLS or higher viscosity Vamac® Ultra LS are preferred.

Whilst both have been successfully used for many years, Vamac® GLS shows higher mold fouling potential and lower Tear Strength for good demolding or tear trim than Ultra LS. On the other side, Ultra LS based compounds may be too high in viscosity for injection molding processes and good compound flow, especially for compounds with Hardness levels higher than 70 Shore A with low plasticizer content.

Vamac® Ultra XF-OR is the first medium viscosity AEM polymer with high MA content. It has lower short-chain fraction than Vamac® GLS, which is a major contributor to mold fouling. Even though cure site monomer content is somewhat lower than for Vamac® GLS and Ultra LS, it may offer a good compromise to Ultra LS, when good injectability and compound flow is required. This may be especially the case, when Ultra XF-OR is used in blends with other low MA Vamac® polymers like Vamac® Ultra IP. Longer cycle times may be expected with Ultra XF-OR compared to the higher cure site AEM grades.

Formulations in Table 7 were used for study of possibilities using Ultra XF-OR in molded parts. The 70 Shore A compounds contain higher levels of HMDC curative than compounds for extrusion in Part 1. The last compound was formulated without the Octadecylamine based Armeen® 18D, which is acting as cure retarder. AEM polymers with low cure site monomer content such as Ultra XF-OR typically do not need such a retarder to provide good Scorch resistance.

Table 7 – Formulations for Molded Parts, Comparison of Vamac® GLS and Ultra LS to Ultra XF-OR

Ingredient (phr)	GLS High Curative	GLS Low Curative	Ultra LS Low Curative	Ultra XF-OR High Curative	Ultra XF-OR Low Curative	Ultra XF-OR Low Cure no Retarder
Vamac® GLS	100	100				
Vamac® Ultra LS			100			
Vamac® Ultra XF-OR				100	100	100
FEF N 550	60	60	60	60	60	60
Alcanplast® PO 80	10	10	10	10	10	10
Naugard® 445	2	2	2	2	2	2
Ofalub® SEO	1	1	1	1	1	1
Armeen® 18D	0.5	0.5	0.5	0.5	0.5	
Stearic Acid Reagent (95%)	1	1	1	1	1	1
Vulcofac® HDC	1.5	1.3	1.3	1.5	1.3	1.3
Vulcofac® ACT 55	2	2	2	2	2	2

As expected, Ultra XF-OR with its low cure site monomer content needs longer cure times, but at the same time provides better Scorch Safety. Removing the retarder from the formulation would be a first measure to reduce cure times for Ultra XF-OR and to get closer to cycle times obtained for Vamac® GLS and Ultra LS.

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Table 8 – Mooney Viscosity, Rheology and Scorch

Rheology	GLS High Curative	GLS Low Curative	Ultra LS Low Curative	Ultra XF-OR High Curative	Ultra XF-OR Low Curative	Ultra XF-OR Low Cure no Retarder
<u>Mooney Viscosity ML1+4, 100°C, MU</u>	39.6	3.5	6.6	52.4	50.9	5.6
<u>MDR, 15 min at 180°C, arc 0.5°</u>						
ML, dNm	0.42	0.44	0.76	0.62	0.61	0.66
MH, dNm	12.6	10.9	13.7	11.1	10.3	11.6
Ts1, min	0.68	0.68	0.65	0.96	0.97	0.84
Ts2, min	0.95	0.97	0.9	1.51	1.54	1.28
T10, min	0.73	0.69	0.72	0.98	0.95	0.88
T50, min	2.2	2.1	2.3	3.8	3.6	3.2
T90, min	7.7	7.5	8.4	10.6	10.3	9.8
Tan delta at ML	1.21	1.18	1.17	1.23	1.23	1.18
Tan delta at MH	0.042	0.053	0.056	0.074	0.082	0.072
Peak rate, dNm/min	5	5	5	3	4	4
<u>Mooney Scorch, 45 min at 121°C</u>						
Ts1, min	4.9	4.8	5.6	6.4	6.7	5.7
Ts2, min	5.9	5.7	7.0	8.4	8.7	7.1

### RPA2000 Test – Simulation of Hot Tear Properties during Demolding

A simple test is proposed using a Rubber Process Analyzer (RPA) to simulate hot tear properties during demolding of freshly cured parts. A compound is cured at 180°C in the RPA standard test specimen, while the rotor is oscillating. After 2 minutes, the rotor starts to turn only in one direction and carries out a 'strain-sweep' to measure the  $G''$  vs the % strain.  $G''$  will show an increase when the ribs on the test specimen start to crack. For this test, three compounds of Table 7 were chosen and compared to each other.

- Vamac® GLS with low curative level
- Vamac® Ultra XF-OR with low curative level
- Vamac® Ultra XF-OR without retarder

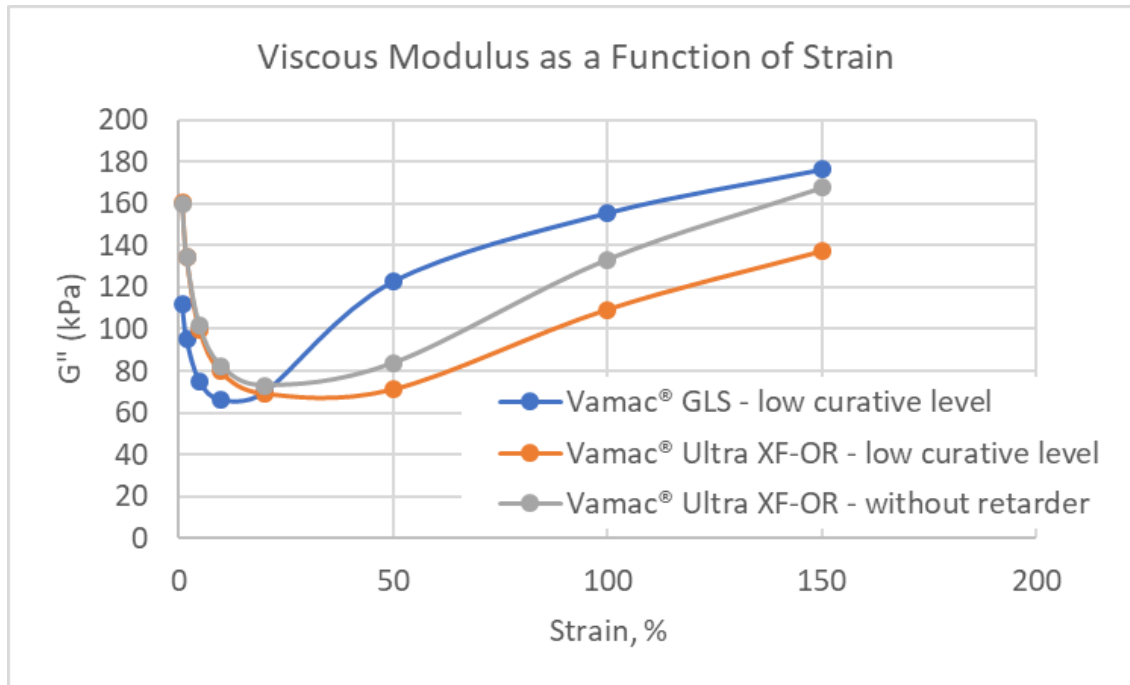
Results are shown in Chart 2. The Vamac® GLS based compound cures faster than the other two compounds, showing faster initial decrease of  $G''$ . At about 15% strain,  $G''$  for the Vamac® GLS compound reaches its minimum already, and then starts to increase quickly. Both Ultra XF-OR based compounds cure slower ( $G''$  reaches its minimum later), and then only smoothly show an increase in  $G''$ . The Ultra XF-OR compound without retarder shows, as expected, a faster increase in  $G''$ . This test gives indication that demolding of Ultra XF-OR based parts should be easier with lower tendency to crack, compared to Vamac® GLS.

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Chart 2 – RPA Results



### Physical Properties

Table 9 shows data for physical properties at room temperature and 175°C (demolding and peak application temperatures for AEM parts) and Compression Set after 10 minutes press-cure and 4 hours post-cure at 175°C.

Ultra XF-OR shows clearly better combinations of Tensile Strength, Elongation at Break and Tear Strength at low and high temperature over Vamac<sup>®</sup> GLS. This indicates again that Ultra XF-OR compounds should be better in processing and demolding than Vamac<sup>®</sup> GLS. Ultra XF-OR could provide help whenever GLS based compounds tend to be brittle during demolding or later in the application itself. Compression Set results for the compound without retarder are also comparable or even superior to Vamac<sup>®</sup> GLS with high curative level.

Vamac<sup>®</sup> Ultra XF-OR shows only slightly lower physical properties compared to Ultra LS, and with its lower viscosity and longer Scorch times, Ultra XF-OR aids with better material flow for complex parts or for compounds with high Hardness levels.

Heat ageing results are also very positive for Ultra XF-OR, with superior retention of Tensile Strength and Elongation at Break.

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Table 9 – Physical Properties, Compression Set and Heat Ageing

Physical Properties	GLS High Curative	GLS Low Curative	Ultra LS Low Curative	Ultra XF-OR High Curative	Ultra XF-OR Low Curative	Ultra XF-OR Low Cure no Retarder
Hardness Sh. A (1s), pts	72	72	75	75	73	73
Hardness Sh. A (3s), pts	70	71	73	73	70	70
<u>Stress-Strain at 23°C</u>						
Tensile Strength, MPa	17.3	16.5	18.3	16.5	17.2	18.1
Elongation at Break, %	228	260	280	271	316	305
50% Modulus, MPa	2.54	2.51	2.87	2.53	2.11	2.39
100% Modulus, MPa	6.5	5.74	6.5	5.8	4.9	5.5
Tear Die C, N/mm	25.0	24.1	26.2	28.7	29.6	28.4
<u>Stress-Strain at 175°C</u>						
Tensile Strength, MPa	4.3	4.6	5.7	4.7	4.9	5.5
Elongation at Break, %	80	94	104	104	116	112
50% Modulus, MPa	2.33	2.05	2.32	1.90	1.64	1.93
100% Modulus, MPa			5.5	4.5	4.0	4.6
Tear Die C, N/mm	3.7	3.8	4.7	4.4	4.9	4.6
<u>Compression Set (ISO815-1, Type B)</u>						
70 h / 175°C, %	32	35	32	37	36	33
168 h / 175°C, %	35	39	33	35	35	34
168 h / 175°C cooled in clamps 2h, %	37	42	40	41	43	40
VW PV 3307 22 h / 175°C, %	55	58	51	53	52	52
<u>Heat Ageing at 504 h / 175 °C (ISO 188)</u>						
Hardness Shore A (3s), pts	83	77	81	81	79	80
Delta Hardness, pts	13	6	8	8	9	10
Tensile Strength, MPa	10.7	10.8	12.8	13.4	13.1	12.9
Delta Tensile Strength, %	-38	-34	-30	-19	-24	-28
Elongation at Break, %	114	128	161	228	245	223
Delta Elongation at Break, %	-50	-51	-43	-16	-22	-27
100% Modulus, MPa	9.6	8.7	8.6	6.9	6.3	6.8
Delta 100% Modulus, %	48	51	31	18	29	22

### Part 3 – How to Accelerate Vamac® Ultra XF-OR Compounds

Part 2 showed significantly longer cure times for Vamac® Ultra XF-OR with its low cure site monomer content vs standard materials for injection or compression molding like Vamac® GLS and Vamac® Ultra LS. Avoiding the use of retarders like Octadecylamine is a first possibility to get to shorter cure cycles with Ultra XF-OR. As an additional step in compounding, accelerators with stronger basicity can be used. Table 10 compares three 60-65 Shore A compounds based on Vamac® GLS and Ultra XF-OR and different curative packages.

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Table 10 – Accelerate Vamac® Ultra XF-OR Curing Study

Ingredient (phr)	Vamac® GLS	Ultra XF-OR no Retarder	Ultra XF-OR DBU-70
Vamac® GLS	100		
Vamac® Ultra XF-OR		100	100
Spheron™ SOA (N 550)	45	45	45
Alcanplast® PO 80	10	10	10
Naugard® 445	2	2	2
Ofalub® SEO	1	1	1
Armeen® 18D	0.5		
Stearic Acid Reagent (95%)	1	1	1
Vulcofac® ACT 55	2	2	
Alcanpoudre® DBU-70			2
Vulcofac® HDC	1.3	1.3	1.3
<u>Mooney Scorch, 45 min at 121 °C (ISO 289-2)</u>			
Ts1, min	6.1	6.5	5.7
Ts2, min	7.4	8.1	7.0
<u>MDR cure rate 12 minutes at 180 °C, arc 0.5° (ISO 6502)</u>			
ML, dNm	0.26	0.39	0.37
MH, dNm	6.94	8.73	8.30
Ts1, min	0.89	1.02	0.82
Ts2, min	1.37	1.58	1.24
T10, min	0.73	0.92	0.72
T50, min	2.23	3.11	2.26
T90, min	7.45	8.40	6.19
<u>MDR cure rate 12 minutes at 185 °C, arc 0.5° (ISO 6502)</u>			
ML, dNm	0.25	0.37	0.37
MH, dNm	7.06	9.00	8.36
Ts1, min	0.75	0.88	0.71
Ts2, min	1.13	1.34	1.04
T10, min	0.64	0.82	0.63
T50, min	1.85	2.67	1.85
T90, min	6.80	7.72	5.26

# Vamac<sup>®</sup> Ultra XF-OR

## Ethylene Acrylic Elastomer - Technical Data

Table 10 (continued) – Accelerate Vamac<sup>®</sup> Ultra XF-OR Curing Study

Rheology, and Physical Properties	Vamac <sup>®</sup> GLS	Ultra XF-OR no Retarder	Ultra XF-OR DBU-70
<u>Original Properties at 23 °C</u>			
Hardness Shore A (ISO 48-4, 1s), pts	64	65	65
Hardness IRHD – (ISO 48-2 Method N), pts	61	62	61
Tensile Strength, MPa	13.6	16.2	15.7
Elongation at Break, %	284	358	322
25% Modulus, MPa	0.91	0.91	0.85
50% Modulus, MPa	1.54	1.58	1.43
100% Modulus, MPa	3.45	3.59	3.29

The combination of elimination of Armeen<sup>®</sup> 18D and use of stronger basic accelerator DBU-70 leads to significant reduction of cure times compared to the Vamac<sup>®</sup> GLS control compound. Higher MH combined with nearly identical cure times can be obtained. Increase in mold temperature by 5°C will also provide comparable cure times. Such a cure temperature increase may be possible with the better physical properties of Ultra XF-OR at high temperatures.