VMX3123

Vamac® Ethylene Acrylic Elastomer - Technical Data

Description

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. VMX3123 is the latest polymer that has been added to this product range.

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
VMX3123	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. VMX3123 offers a similar solution for intermediate viscosity AEM polymer <u>with lower oil swell</u> to allow extrusion of 70-75 ShA compounds.

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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.

VMX3123 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 VMX3123, even at higher carbon black loading.

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 DuPont™ 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

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No scorch retarder based on Octadecylamine was added to the compounds, as Vamac® Ultra HT-OR and VMX3123 are polymers with low Cure Site Monomer level. Compounds of VMX3123 and Vamac® 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	VMX 3123	Ultra HT-OR, 50 FEF	VMX 3123, 50 FEF	VMX 3123, 70 FEF	VMX 3123, high cure	VMX 3123, low cure	VMX 3123, SRF
Vamac® Ultra HT-OR	100		100					
VMX3123		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, VMX3123 and Vamac® Ultra HT-OR. As expected however, the Compound Mooney viscosity is significantly lower for VMX3123 based compounds, compared to Vamac® Ultra HT-OR based compounds, at same filler level.

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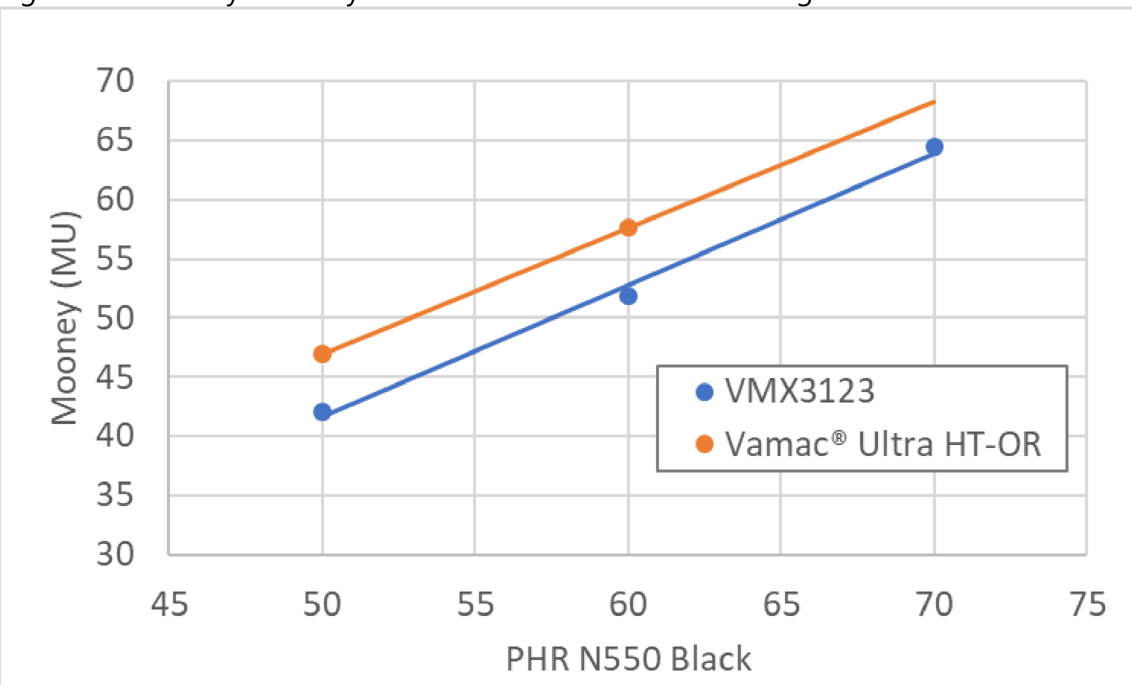
Figure 1 illustrates the relation between FEF filler loading, compound Mooney viscosity, and Shore A Hardness of slabs (press-cured 10 minutes at 180°C / post-cured 4 hours at 175°C) of Table 1. It can be expected that Mooney viscosities for VMX3123 based compounds are comparable to Vamac® Ultra HT-OR 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.

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



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Rheology

Table 3 shows rheological data for the compounds in Table 2. Scorch times for compounds with VMX3123 are similar to Vamac® Ultra HT-OR at 121°C. At 180°C, cure times observed for VMX3123 were slightly longer than for Vamac® Ultra HT-OR. As expected minimum and maximum torque level are lower for the VMX3123 based compounds due to lower Mooney viscosity.

Table 3 – Extrusion Compounds Rheology

Rheology	Ultra HT-OR	VMX 3123	Ultra HT-OR, 50 FEF	VMX 3123, 50 FEF	VMX 3123, 70 FEF	VMX 3123, high cure	VMX 3123, low cure	VMX 3123, SRF
MDR, 15 min., 180°C, arc 0.5°, ISO 6502								
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
Mooney Scorch, 45 min, 121°C, ISO289-2								
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

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 VMX3123 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.

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

Original Properties	Ultra HT-OR	VMX 3123	Ultra HT-OR, 50 FEF	VMX 3123, 50 FEF	VMX 3123, 70 FEF	VMX 3123, high cure	VMX 3123, low cure	VMX 3123, SRF
Stress-Strain at 23°C								
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
Stress-Strain at 150°C								
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
De Mattia Crack Growth, 23°C, ISO 132								
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
Compression Set at 175°C								
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

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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 HT-OR and VMX3123 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.

Table 5 – Dry Heat Ageing Results

Physical Properties	Ultra HT-OR	VMX 3123	Ultra HT-OR, 50 FEF	VMX 3123, 50 FEF	VMX 3123, 70 FEF	VMX 3123, high cure	VMX 3123, low cure	VMX 3123, 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

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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	VMX 3123	Ultra HT-OR, 50 FEF	VMX 3123, 50 FEF	VMX 3123, 70 FEF	VMX 3123, high cure	VMX 3123, low cure	VMX 3123, SRF
Fluid Ageing at 504 h / 160 °C (ISO 1817)								
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

Part 2 - Compounds with Higher Curative Levels for Moulded Parts

For moulded 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 demoulding 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.

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VMX3123 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 VMX3123 is used in blends with other low MA Vamac® polymers like Vamac® Ultra IP. Longer cycle times may be expected with VMX3123 compared to the higher cure site AEM grades.

Formulations in Table 7 were used for study of possibilities using VMX3123 in moulded 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 VMX3123 typically do not need such a retarder to provide good Scorch resistance.

Table 7 – Formulations for Molded Parts, Comparison of VMX3123 to Vamac® GLS and Ultra LS

Ingredient (phr)	GLS High Curative	GLS Low Curative	Ultra LS Low Curative	VMX3123 High Curative	VMX3123 Low Curative	VMX3123 Low Cure no Retarder
Vamac® GLS	100	100				
Vamac® Ultra LS			100			
VMX3123				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, VMX3123 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 VMX3123 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	VMX3123 High Curative	VMX3123 Low Curative	VMX3123 Low Cure no Retarder
Mooney Viscosity ML1+4, 100°C, MU	39.6	3.5	6.6	52.4	50.9	5.6
MDR, 15 min at 180°C, arc 0.5°						
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
Mooney Scorch, 45 min at 121°C						
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 demoulding 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
- VMX3123 with low curative level
- VMX3123 without retarder

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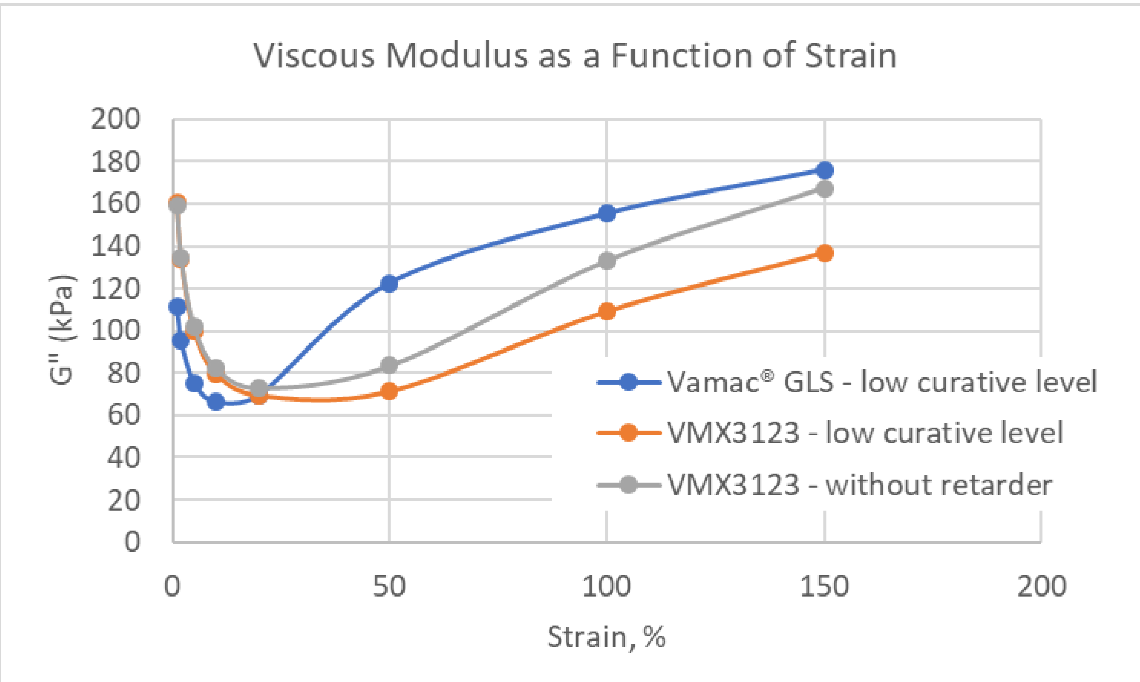
Results are shown in Chart 2. The Vamac® GLS based compound cures faster than the other two compounds, showing faster initial decrease of G′′. At about 15% strain, G′′ for the Vamac® GLS compound reaches its minimum already, and then starts to increase quickly. Both VMX3123 based compounds cure slower (G′′ reaches its minimum later), and then only smoothly show an increase in G′′. The VMX3123 compound without retarder shows, as expected, a faster increase in G′′. This test gives indication that demolding of VMX3123 based parts should be easier with lower tendency to crack, compared to Vamac® GLS.

Chart 2 – **RPA Results**



Physical Properties

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

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VMX3123 shows clearly better combinations of Tensile Strength, Elongation at Break and Tear Strength at low and high temperature over Vamac® GLS. This indicates again that VMX3123 compounds should be better in processing and demolding than Vamac® GLS. VMX3123 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® GLS with high curative level.

Compared to Vamac® Ultra LS, VMX3123 shows only slightly lower physical properties, and with its lower viscosity and longer Scorch times, VMX3123 aids with better material flow for complex parts or for compounds with high Hardness levels.

Heat ageing results are also very positive for VMX3123, with superior retention of Tensile Strength and Elongation at Break.

Table 9 – Physical Properties, Compression Set and Heat Ageing

Physical Properties	GLS High Curative	GLS Low Curative	Ultra LS Low Curative	VMX3123 High Curative	VMX3123 Low Curative	VMX3123 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
Stress-Strain at 23°C						
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
Stress-Strain at 175°C						
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

Table 9 (continued) – Physical Properties, Compression Set and Heat Ageing

Physical Properties	GLS High Curative	GLS Low Curative	Ultra LS Low Curative	VMX3123 High Curative	VMX3123 Low Curative	VMX3123 Low Cure no Retarder
Compression Set (ISO815-1, Type B)						
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
Heat Ageing at 504 h / 175 °C (ISO 188)						
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 VMX3123 Compounds

Part 2 showed significantly longer cure times for VMX3123 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 VMX3123. 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 VMX3123 and different curative packages.

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Table 10 – Accelerate VMX3123 Curing Study

Ingredient (phr)	Vamac® GLS	VMX3123 no Retarder	VMX3123 DBU-70
Vamac® GLS	100		
VMX3123		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
Mooney Scorch, 45 min at 121 °C (ISO 289-2)			
Ts1, min	6.1	6.5	5.7
Ts2, min	7.4	8.1	7.0
MDR cure rate 12 minutes at 180 °C, arc 0.5° (ISO 6502)			
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

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Table 10 (continued) – Accelerate VMX3123 Curing Study

Rheology, and Physical Properties	Vamac® GLS	VMX3123 no Retarder	VMX3123 DBU-70
MDR cure rate 12 minutes at 185 °C, arc 0.5° (ISO 6502)			
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
Original Properties at 23 °C			
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® 18D and use of stronger basic accelerator DBU-70 leads to significant reduction of cure times compared to the Vamac® GLS control compound. Higher MH combined with nearly identical cure times can be obtained. Increase in mould temperature by 5°C will also provide comparable cure times. Such a cure temperature increase may be possible with the better physical properties of VMX3123 at high temperatures.

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