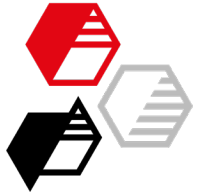
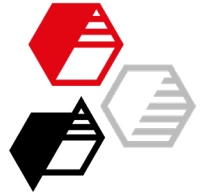


Aktifit VM and alternative products for application in cable isolation EPDM peroxide cured



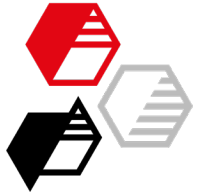
Contents

- Introduction
- Experimental
- Results
 - Rheological properties
 - Mechanical properties
 - Hot air aging
 - Volume resistivity before and after storage in water
- Summary
- Appendix (tabled results)



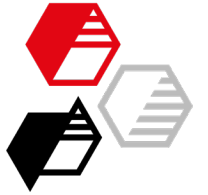
Objective

To offer our customers alternatives to Aktifit VM from our product range, we evaluated the performance of various Neuburg Siliceous Earth types in an EPDM-based cable insulation formulation for low-voltage applications and summarized the results here.



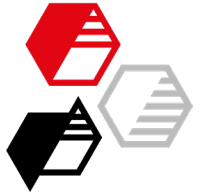
Fillers and Characteristics

Filler	Description	Calcination	Functionalisation	Particle size D_{50} [μm]	CIE-LAB-System		
					L*	a*	b*
Aktifit VM	Neuburg Silicious Earth	yes	Vinyl	2.3	96.6	-0.1	0.8
Gloxil bright VM	Calcined Kaolin	yes	Vinyl	1.6	98.1	-0.2	2.4
vinyl-functionalized calcined Kaolin	Competitor	yes	Vinyl	3.0	98.4	-0.2	2.5
Aktisil VM 56	Neuburg Silicious Earth	no	Vinyl	2.4	94.2	1.0	9.9
Aktisil VM 56/89	Neuburg Silicious Earth	no	Vinyl	2.4	96.5	0.1	3.6
Aktisil Q	Neuburg Silicious Earth	no	Methacryl	5.0	94.8	0.3	4.2



Base Formulation

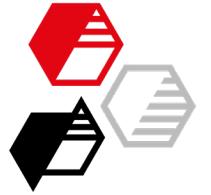
Material	Description	phr
Keltan 3973	Ethylene-Propylene-Diene-Rubber +mineral oil (30 phr), ML 1+4 (125 °C): 34 MU	130
Filler	Neuburg Silicious Earth / vinylf. calc. Kaolin	200
Stearic Acid	Processing aid	1
Zinkoxyd aktiv	Zinc oxyde active	5
Process Oil P 460	Paraffinic plasticizer	15
Paraffin Type 5405	Paraffinic wax	4
Vulkanox HS / LG	TMQ, Antioxidant	1
Vulkanox MB-2 / MG-C	4- and 5-methyl-2-mercaptobenzimidazole (MMBI), Antioxidant	0.5
TAC GR 50	Triallyl cyanurate; 50%-ig, Coactivator	2
Perkadox 14-40B-pd-s	Di(tert-butylperoxyisopropyl)benzol, Peroxide, Cure Agent	6
Total		364.5



Preparation and Curing of the Compound

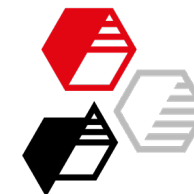
Preparation	
Open mill	Ø 150 x 300 mm
Batch volume	approx. 900 g
Temperature	50 °C
Mixing cycle	approx. 30 min.

Curing	
Temperature	180 °C
Time	$t_{90} + 10 \%$ or minimum 5 min.

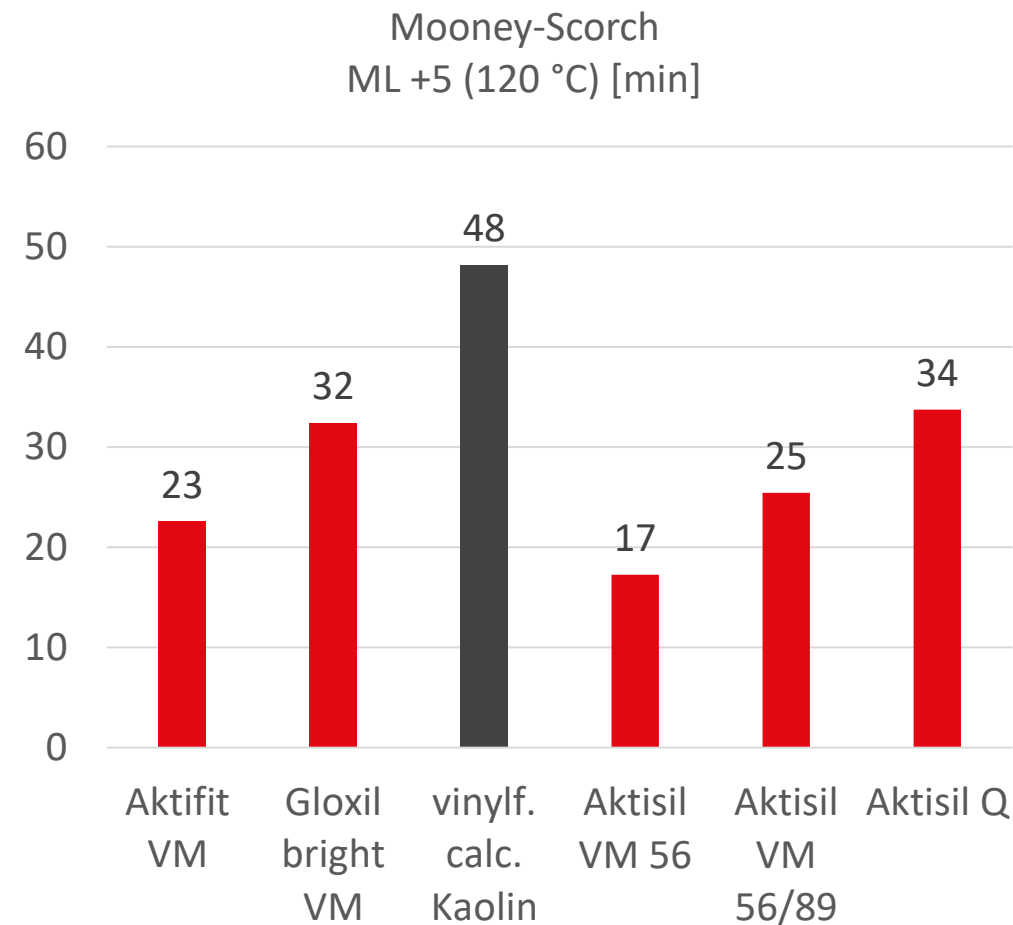
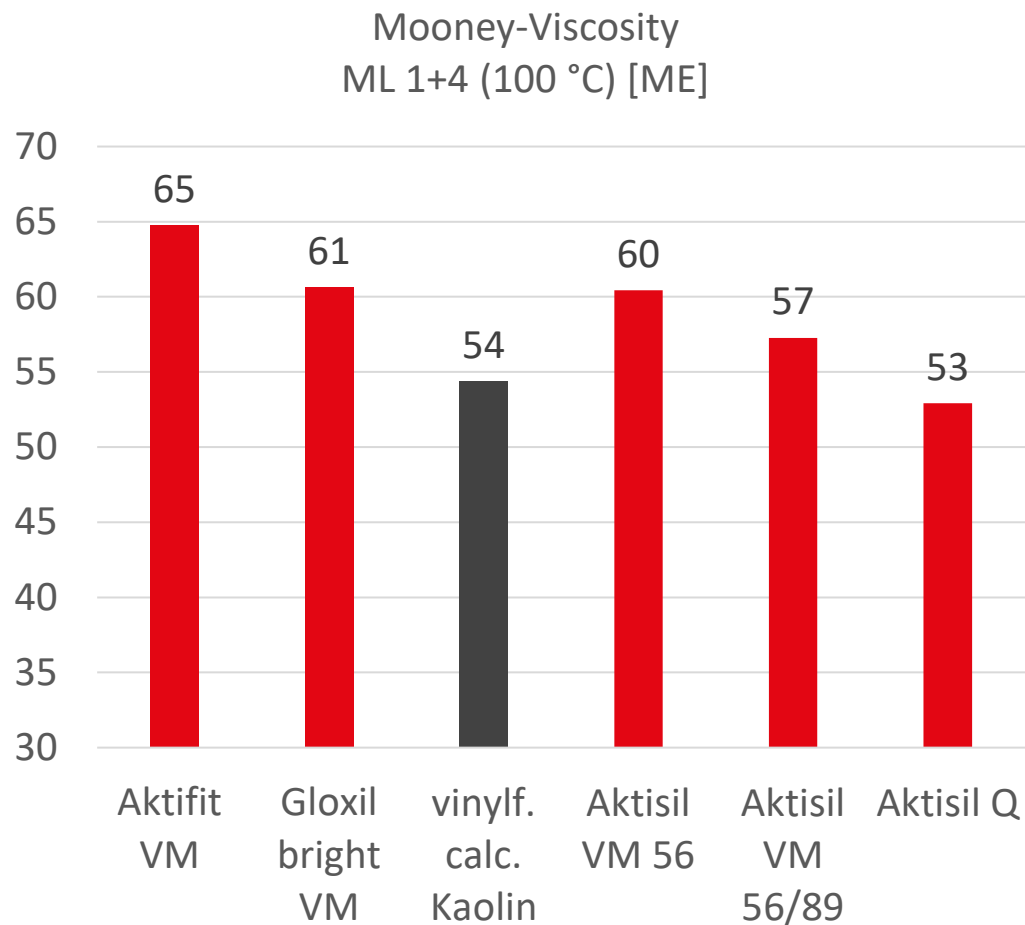


Test Standards

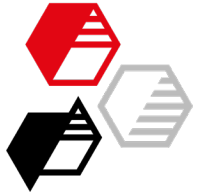
Test	Standard
Hardness	DIN ISO 48-4, part 4
Mooney-Viscosity ML 1+4 (100°C)	DIN ISO 289-1
Mooney-Scorch ML +5 (120 °C)	DIN ISO 289-2
Vulcanization Characteristics	DIN 53 529, part 1 – 4
Tensile strength	DIN 53 504, S2 / ISO 37
Elongation at break	DIN 53 504, S2 / ISO 37
Tear resistance	DIN ISO 34-1, A + B
Compression set	DIN ISO 815-1, B
Volume resistivity	DIN IEC 62631-3-1
Hot air aging	ISO 188, D



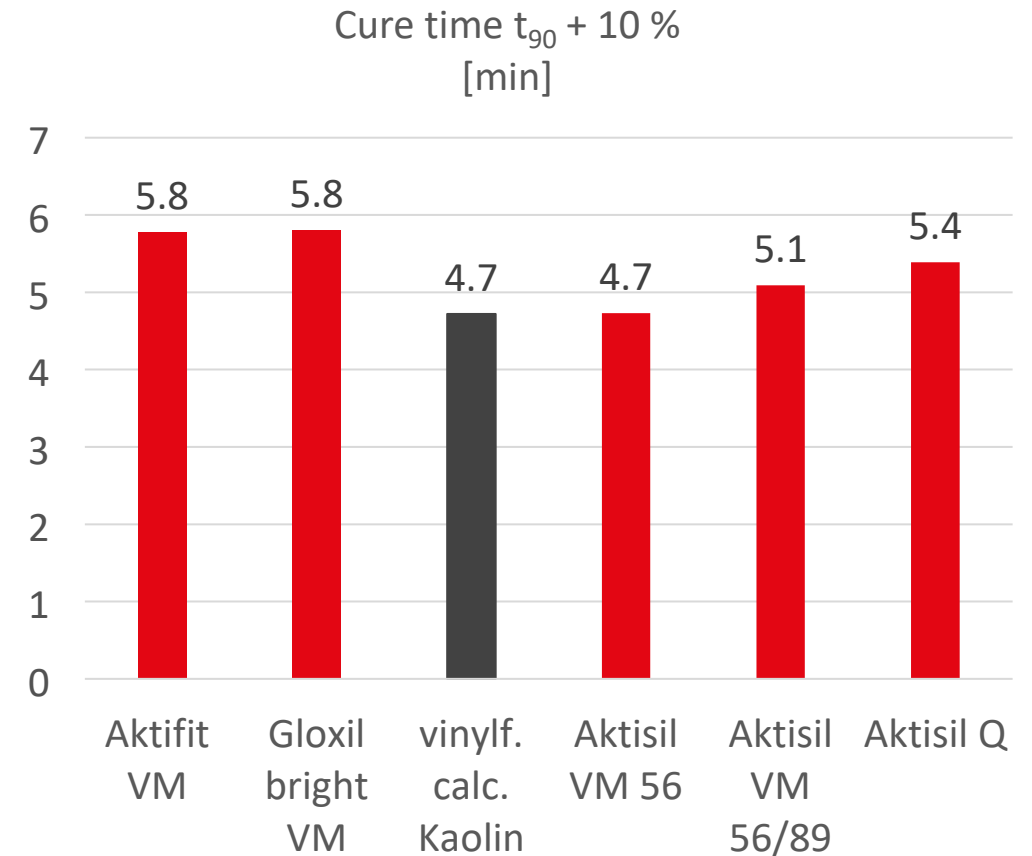
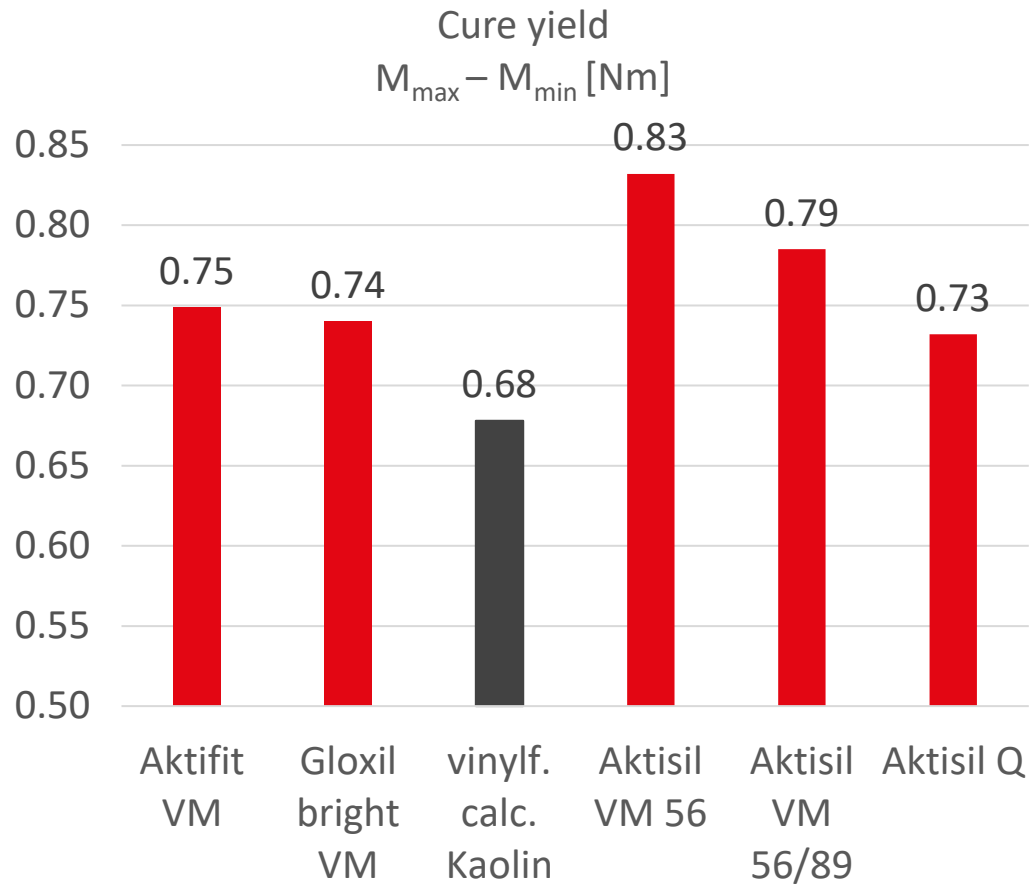
Rheological properties



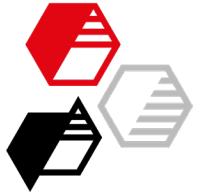
The viscosity is a bit lower for all alternative products, the scorch time generally slightly higher (except for Aktisil VM 56).



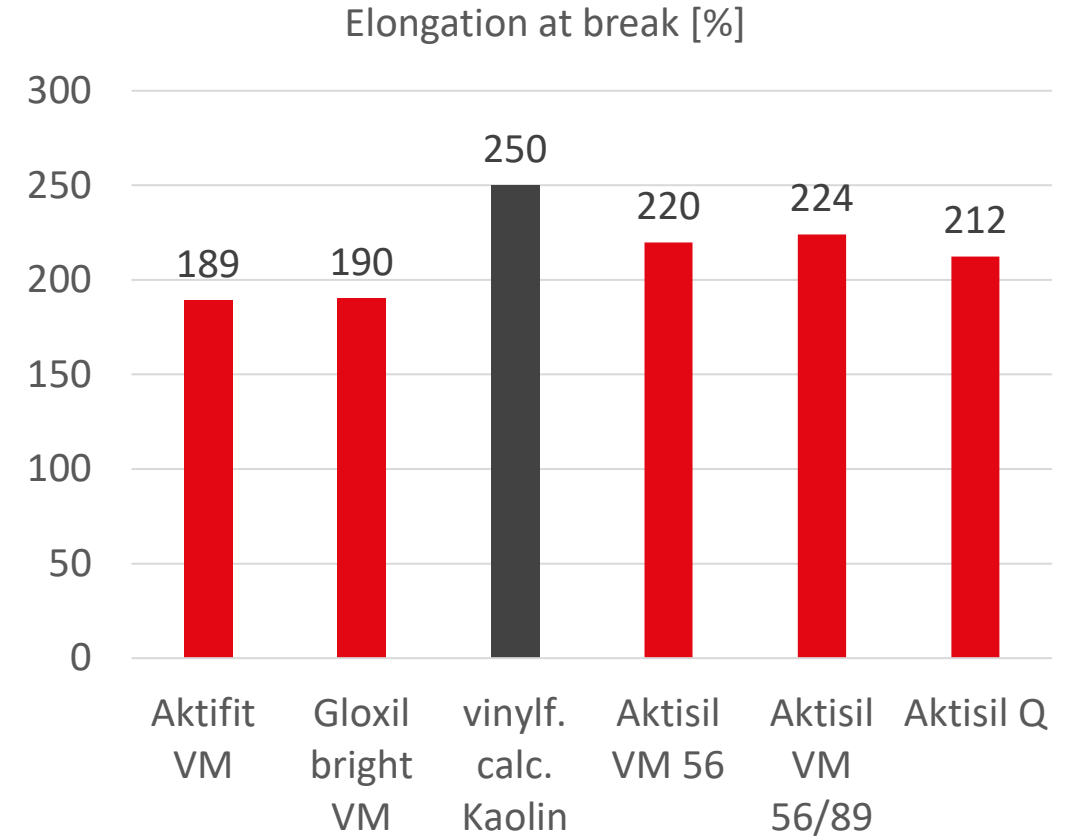
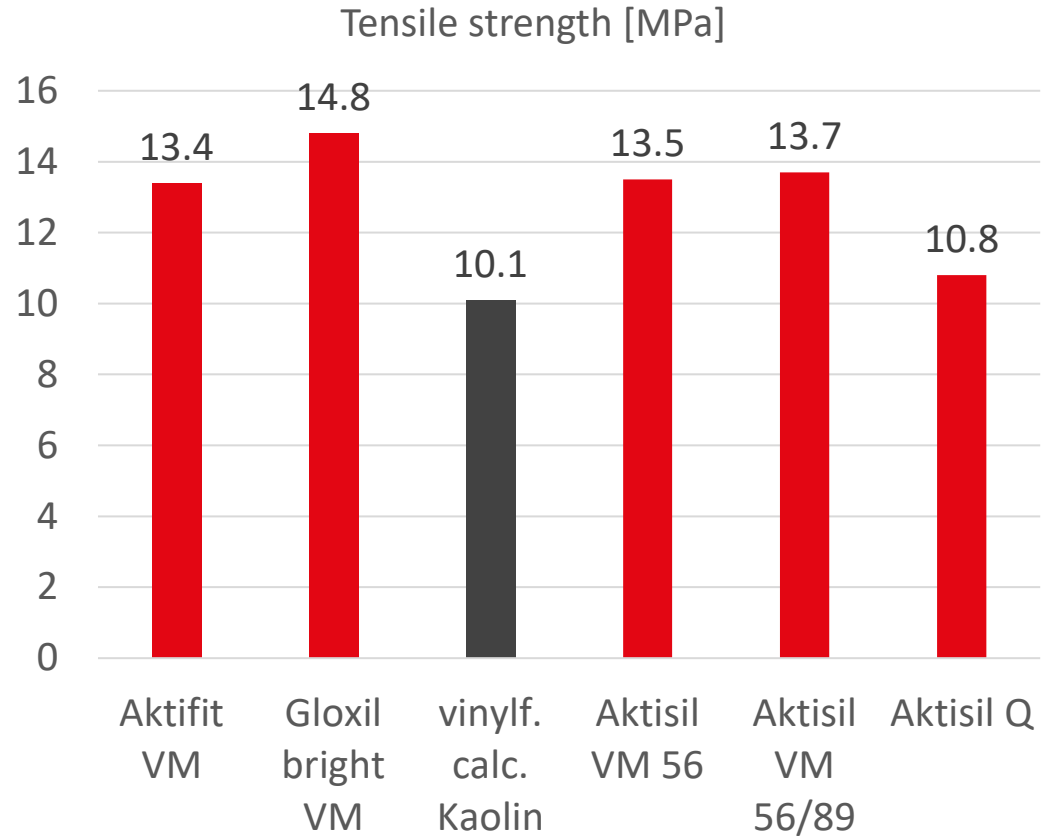
Rheological properties



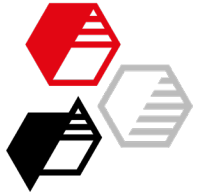
Gloxil bright VM and Aktisil Q show similar results in cure yield, Aktisil VM 56 and VM 56/89 even higher. The curing time is on a similar level for all products.



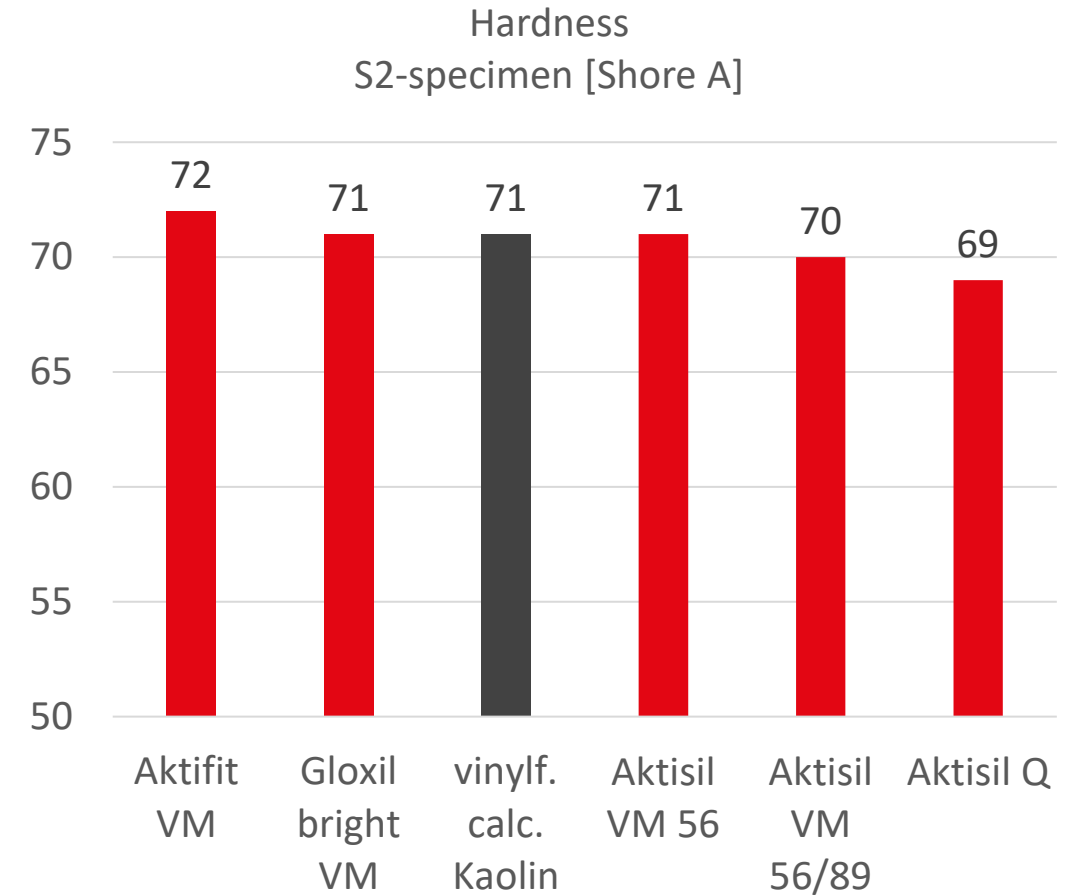
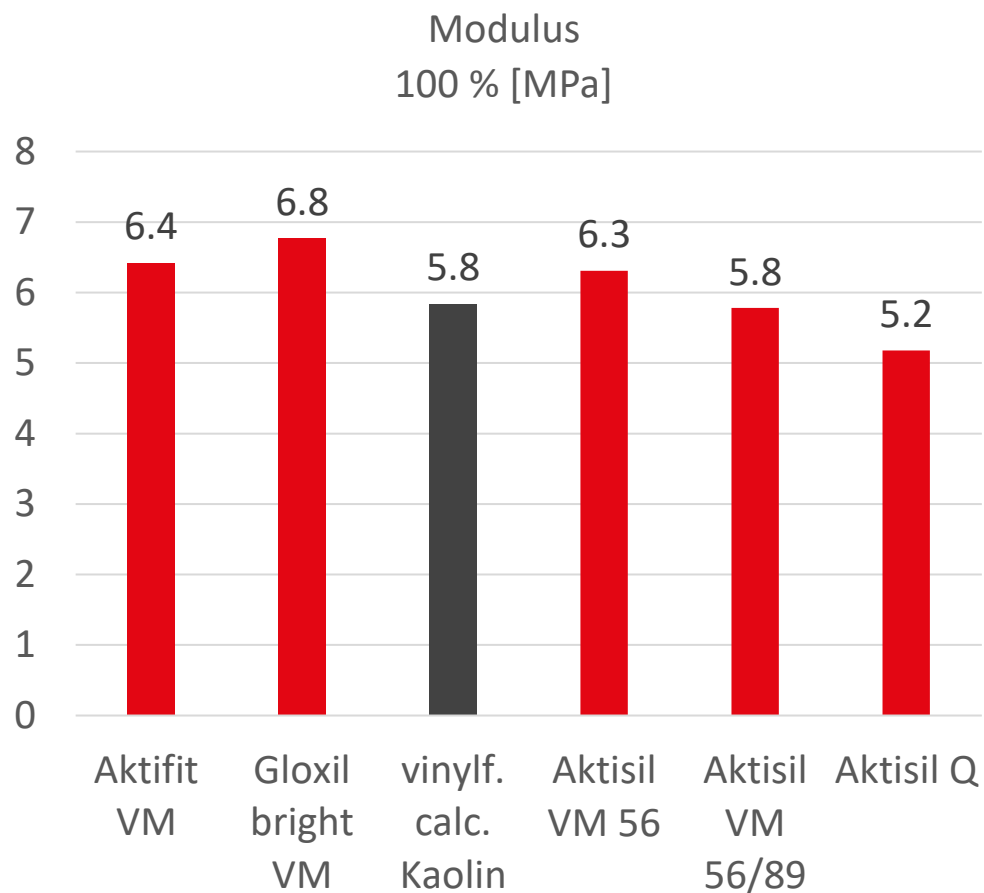
Mechanical properties



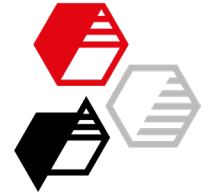
The tensile strength of Gloxil bright VM is slightly higher than that of Aktifit VM, for Aktisil Q it's a bit lower. In terms of elongation at break all uncalcined products are at a slightly higher level.



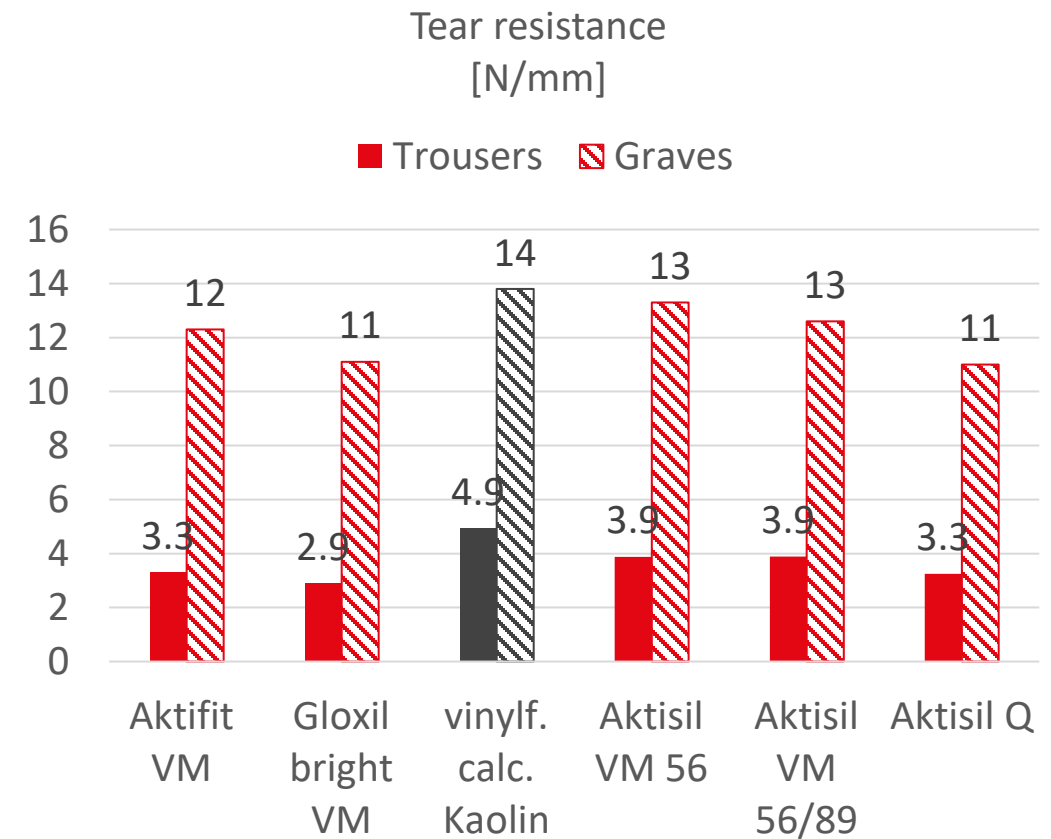
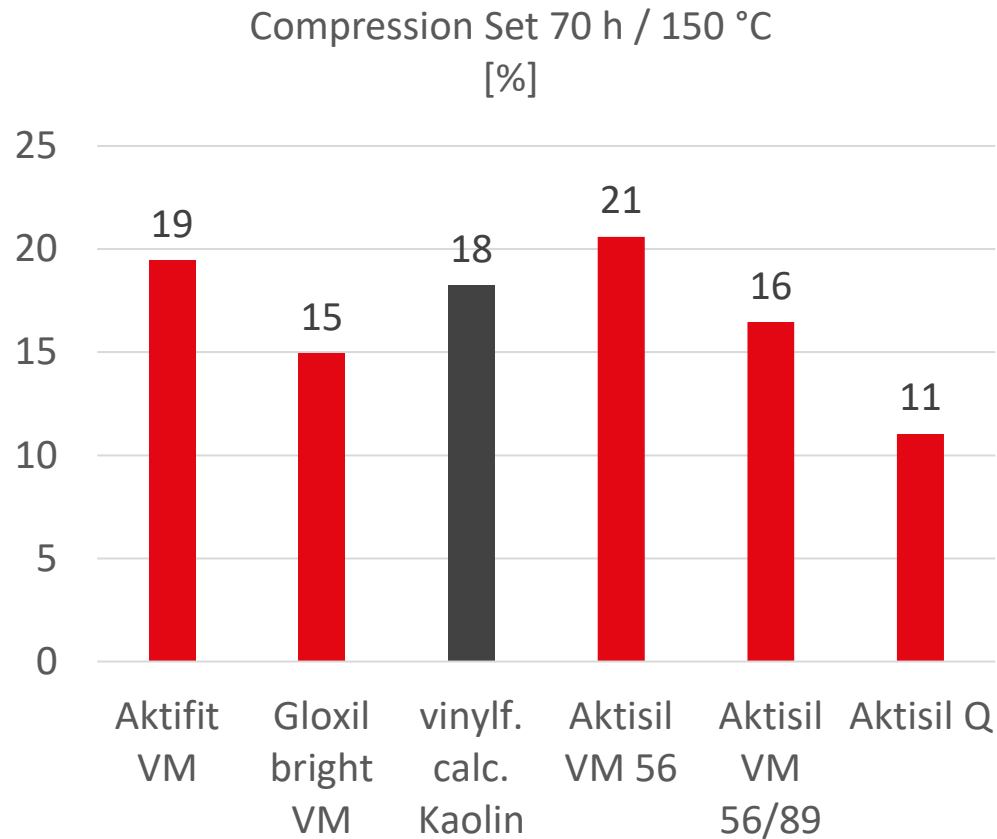
Mechanical properties



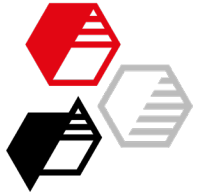
For modulus 100% and hardness all products show only minor differences.



Mechanical properties

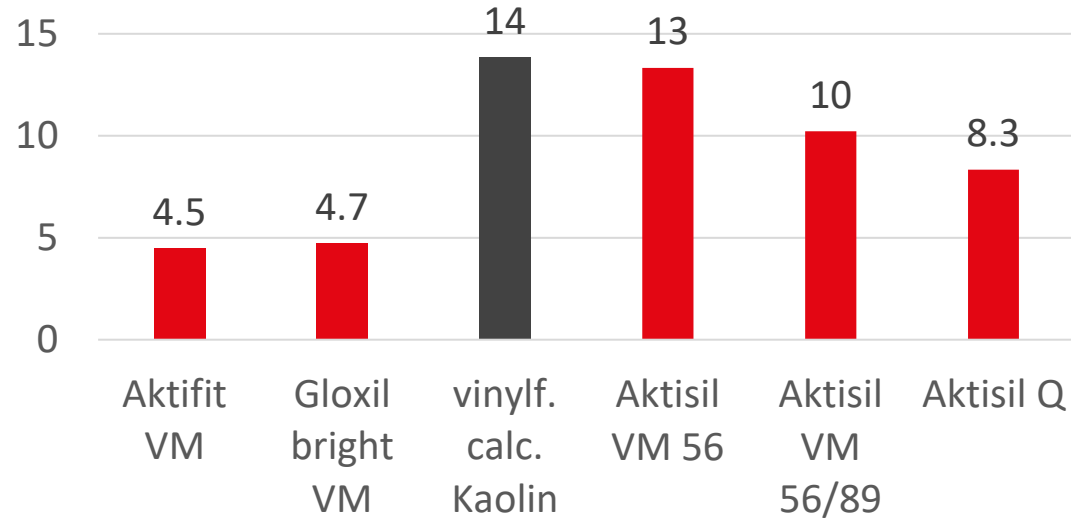


All products perform very similarly in terms of tear resistance.
Gloxil bright VM achieves a better result than Aktifit VM in terms of
compression set, though Aktisil Q achieves the best result.

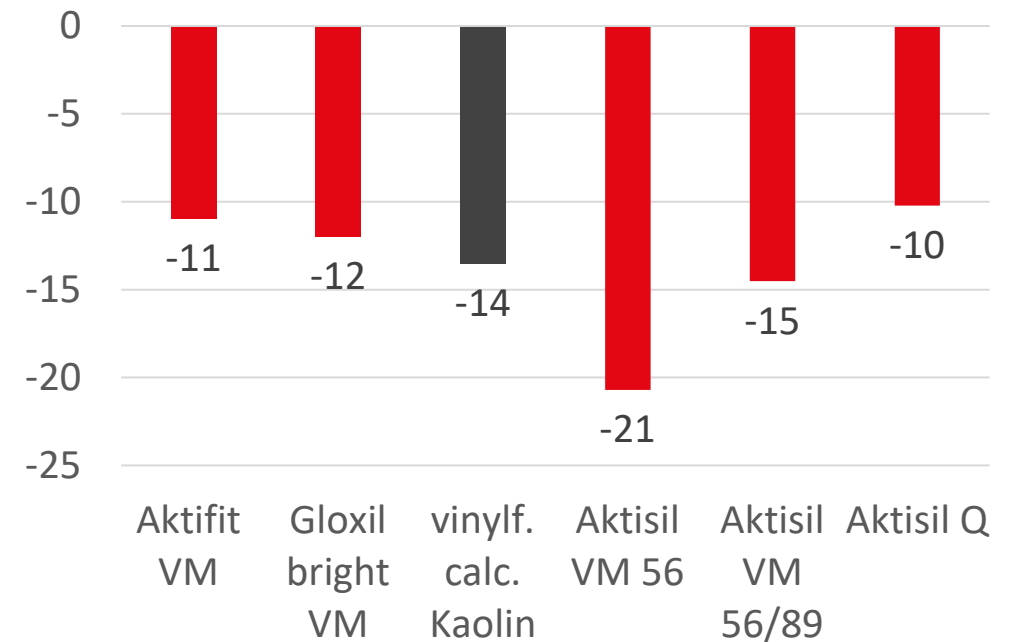


Hot air aging 168 h / 135 °C

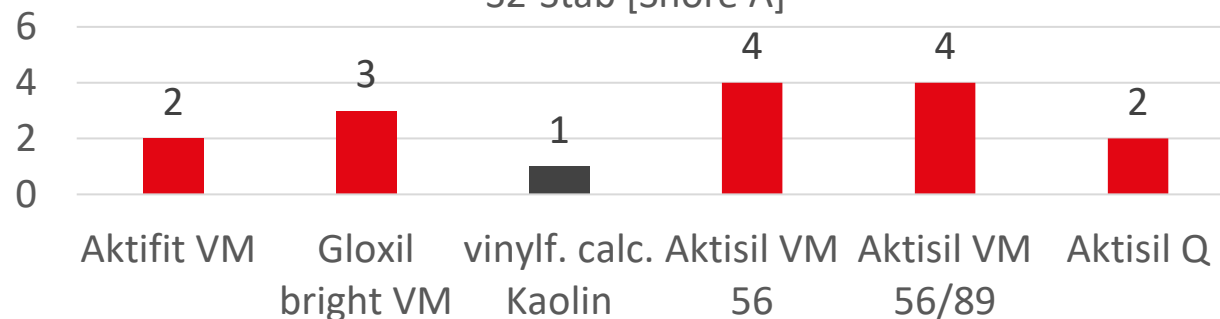
Change of tensile strength [%]



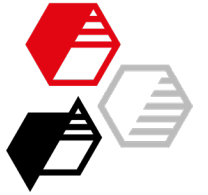
Change of elongation at break [rel.%]



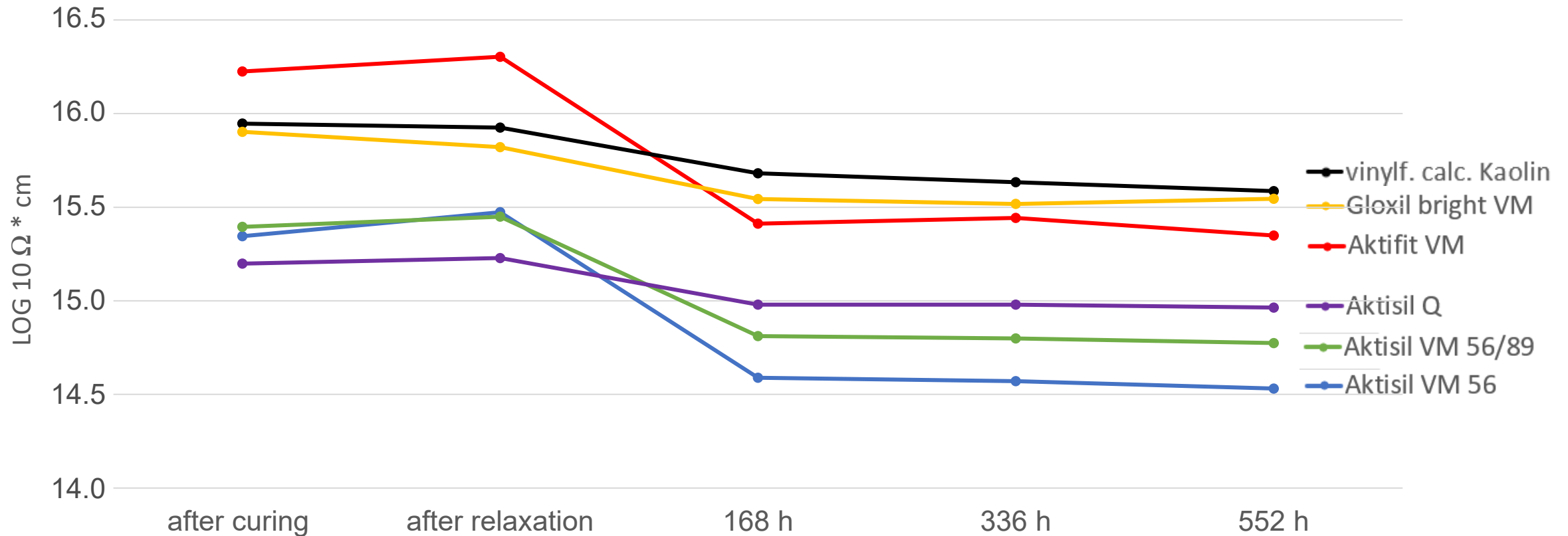
Change of hardness
S2-Stab [Shore A]



In terms of hot air aging, Gloxil bright VM is very similar to Aktifit VM.
Calcined products exhibit a slightly better aging profile in terms of tensile strength and elongation at break.

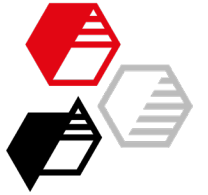


Volume Resistivity before and after storage in water, 70 °C



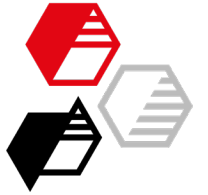
Although Gloxil Bright VM does not quite achieve the peak values of Aktifit VM in the dry state, it remains highly stable over the course of water storage.

In the low-voltage range, the non-calcined alternative products exhibit fully adequate and stable isolating properties.



Alternative products vs. Aktifit VM

70 Shore A	Gloxil bright VM	Aktisil VM 56	Aktisil VM 56/89	Aktisil Q
Viscosity	+	+	+	+
Cure speed	=	=	=	=
Cure time	=	=	=	=
Tensile strength	+	=	=	
Elongation at break	=	+	+	+
Modulus 100 %	+	=	=	
Tear resistance trousers	=	=/+	=/+	=
Tear resistance graves	=	=/+	=	=
CS ISO 150 °C	+	=	+	+
Volume resistivity after storage in water (70°C)	=			
Hot air aging 135 °C	=			=

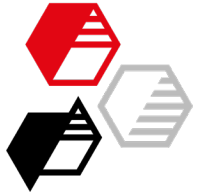


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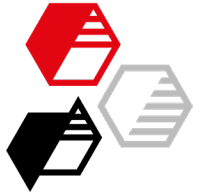
Phone: +49 8431 53-0
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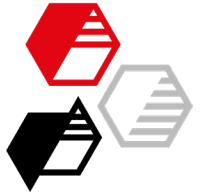
Results in Tabular Form - Rheology + Mechanic

		Aktifit VM	Gloxil bright VM	vinylf. calc. Kaolin	Aktisil VM 56	Aktisil VM 56/89	Aktisil Q
Mooney-Viscosity, ML 1+4, 100 °C	ME	65	61	54	60	57	53
Mooney-Scorch, ML +5, 120 °C	min	23	32	48	17	25	34
Cure Yield Mmax-Mmin 180°C	Nm	0.75	0.74	0.68	0.83	0.79	0.73
Cure Time (t ₉₀ + 10%)	min	5.8	5.8	4.7	4.7	5.1	5.4
Cure Time	min	5.8	5.8	5.0	5.0	5.1	5.4
Tensile Strength	MPa	13.4	14.8	10.1	13.5	13.7	10.8
Elongation at Break	%	189	190	250	220	224	212
Modulus 100 %	MPa	6.4	6.8	5.8	6.3	5.8	5.2
Hardness	Shore A	72	71	71	71	70	69
Rebound	%	58	58	57	56	58	62
Tear Resistance (Trousers)	N/mm	3.3	2.9	4.9	3.9	3.9	3.3
Tear Resistance (Graves)	N/mm	12	11	14	13	13	11
Compression Set 70 h / 150 °C, 25 % deflection	%	20	15	18	21	17	11



Results in Tabular Form - Hot Air Aging

		Aktifit VM	Gloxil bright VM	vinylf. calc. Kaolin	Aktisil VM 56	Aktisil VM 56/89	Aktisil Q
Hot Air Aging; 168 h / 135 °C; Measured after 30 min							
Hardness	Sh. A	74	74	72	75	74	71
Tensile Strength	MPa	14.0	15.5	11.5	15.3	15.1	11.7
Modulus 50%	MPa	3.1	3.0	3.1	3.6	3.1	2.5
Modulus 100 %	MPa	7.4	7.7	6.8	8.2	7.1	5.7
Elongation at Break	%	168	167	216	174	192	191
Δ Hardness	Sh. A	2	3	1	4	4	2
Δ Tensile Strength	%	4.5	4.7	14	13	10	8.3
Δ Modulus 50%	%	19	11	13	25	18	8.2
Δ Modulus 100%	%	15	13	16	30	23	11
Δ Elongation at Break	% rel.	-11	-12	-13	-21	-15	-10



Results in Tabular Form – Volume Resistivity

Test voltage 1000 V		Aktifit VM	Gloxil bright VM	vinylf. calc. Kaolin	Aktisil VM 56	Aktisil VM 56/89	Aktisil Q
After Curing	LOG $\Omega^* \text{ cm}$	16.23	15.90	15.95	15.34	15.40	15.20
After Relaxation		16.30	15.82	15.93	15.47	15.45	15.23
Immersion in Water 168 h / 70 °C		15.41	15.54	15.68	14.59	14.81	14.98
Immersion in Water 336 h / 70 °C		15.44	15.52	15.63	14.57	14.80	14.98
Immersion in Water 552 h / 70 °C		15.35	15.55	15.59	14.53	14.77	14.96