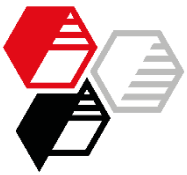


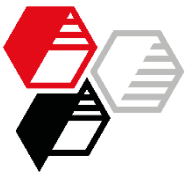


Black building profiles according to DIN 7863 and RAL-GZ 716/1 Alternatives to carbon black: Aktisil VM 56



Content

- Introduction
- Experimental
- Results
- Summary



Status Quo

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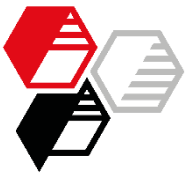
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SUMMARY

- Typical formulations for black window sections and glazing profiles are based on EPDM, carbon black and paraffinic mineral oil. This means the major part of the raw materials is petroleum based.
- According to the crude oil price, the raw material prices are subject to considerable variations. The long term trend is clearly pointing upwards.
- The price of mineral fillers is only marginally affected by the crude oil price; over the long term there will be a slight increase, and this without big variations.



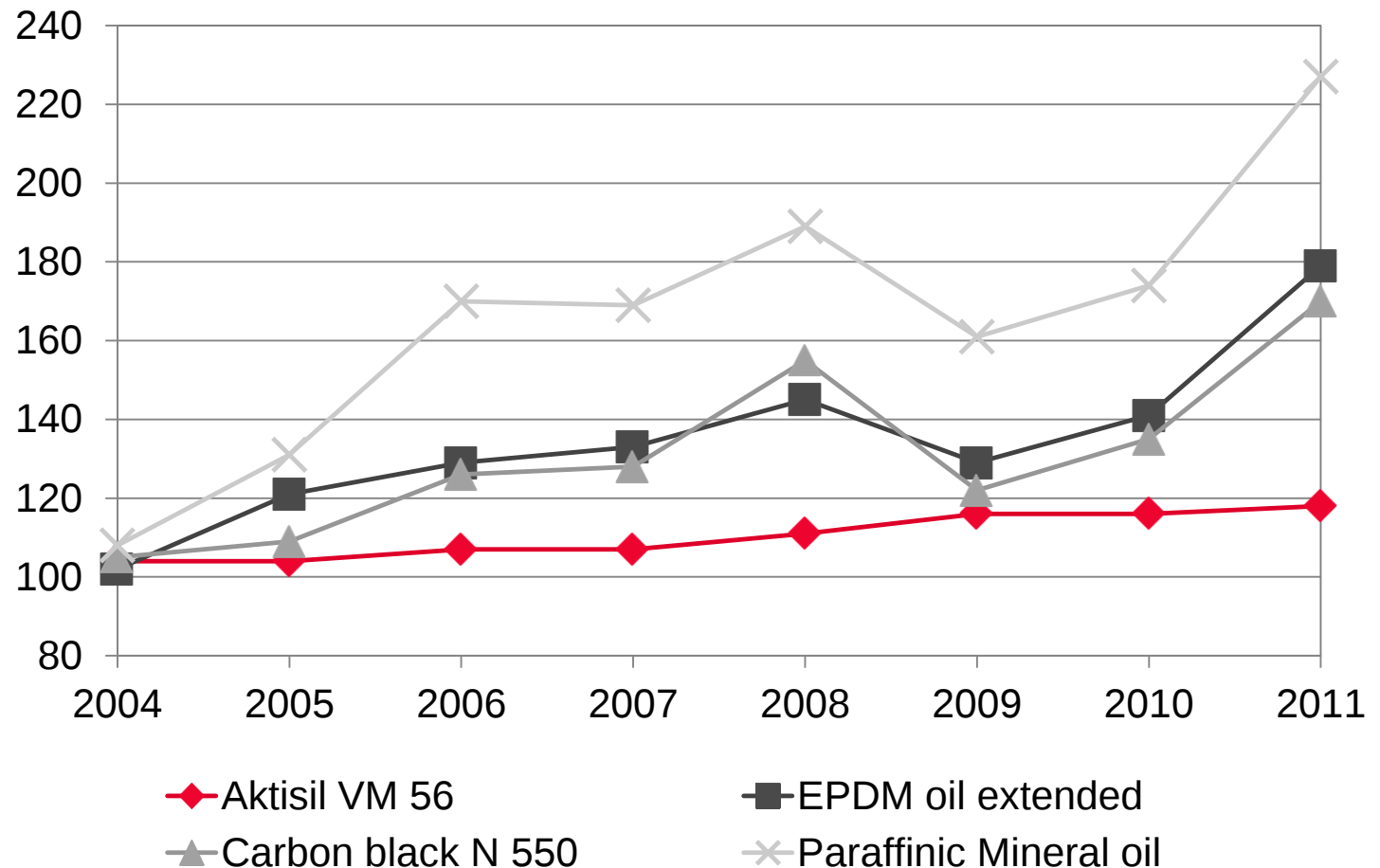
Status Quo

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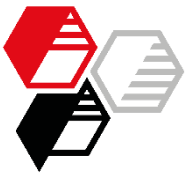
Cost development – Yearly averages

Index points

Base: 2002 = 100



Source: WDK and Hoffmann Mineral

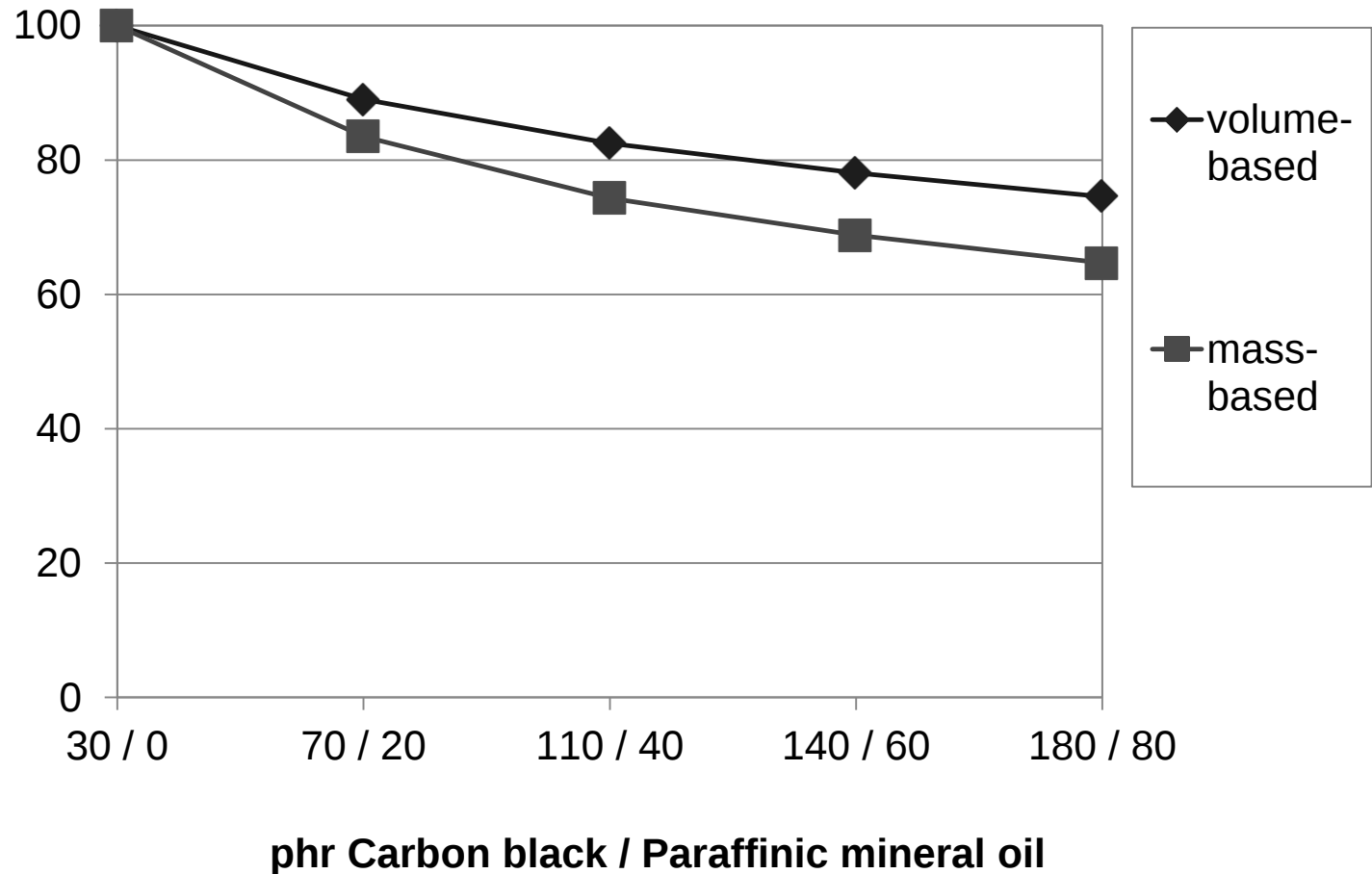


Costs – Carbon black / Plasticizer loading

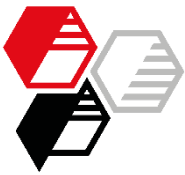
**HOFFMANN
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Equivalent hardness about 65 Shore A

Index points



phr Carbon black / Paraffinic mineral oil



Objective

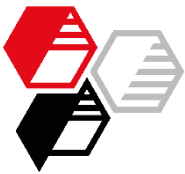
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- To demonstrate an alternative formulation approach in order to reduce the petroleum based raw materials.
- As a cost optimized starting point, a formulation with a carbon black / plasticizer loading of 180 / 80 phr was selected.
- As guidelines were the mechanical requirements of the German standard DIN 7863 and RAL-GZ 716/1.
- Calcium carbonate represents the traditional cost reducing filler, but at high loadings it does not impart sufficiently high mechanical properties.
- By contrast, **Aktisil VM 56** even at high loadings allows to obtain good mechanical results along with very good processing properties.

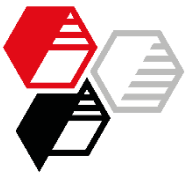


Base Formulation

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EPDM – 65 Shore A

	phr
Keltan 8340 A	100.0
PEG 4000	2.0
Processing aid	3.0
Carbon black N 550	180.0
Paraffinic mineral oil, Plasticizer	80.0
Calcium oxide	10.0
TAC GR 50 %	3.0
Perkadox 14/40 pd	8.0
Total	386.0



Design of Experiments



Formulation variations in phr

phr

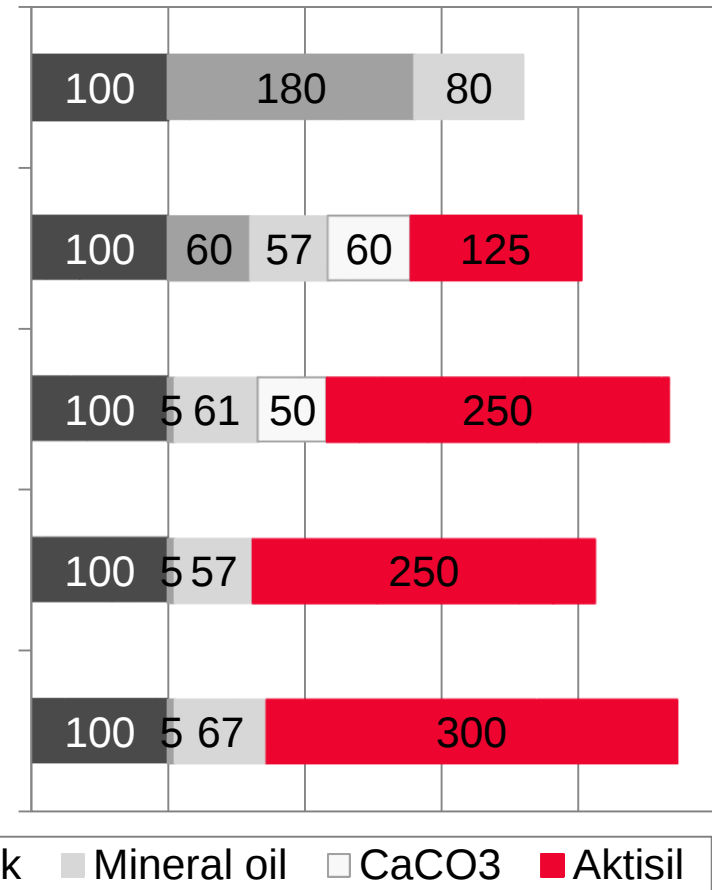
Carbon black only

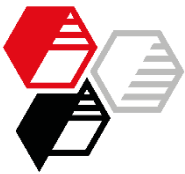
Carbon black partially replaced with Aktisil VM 56, with CaCO₃

Carbon black totally replaced with Aktisil VM 56, with CaCO₃

Carbon black totally replaced with Aktisil VM 56, without CaCO₃

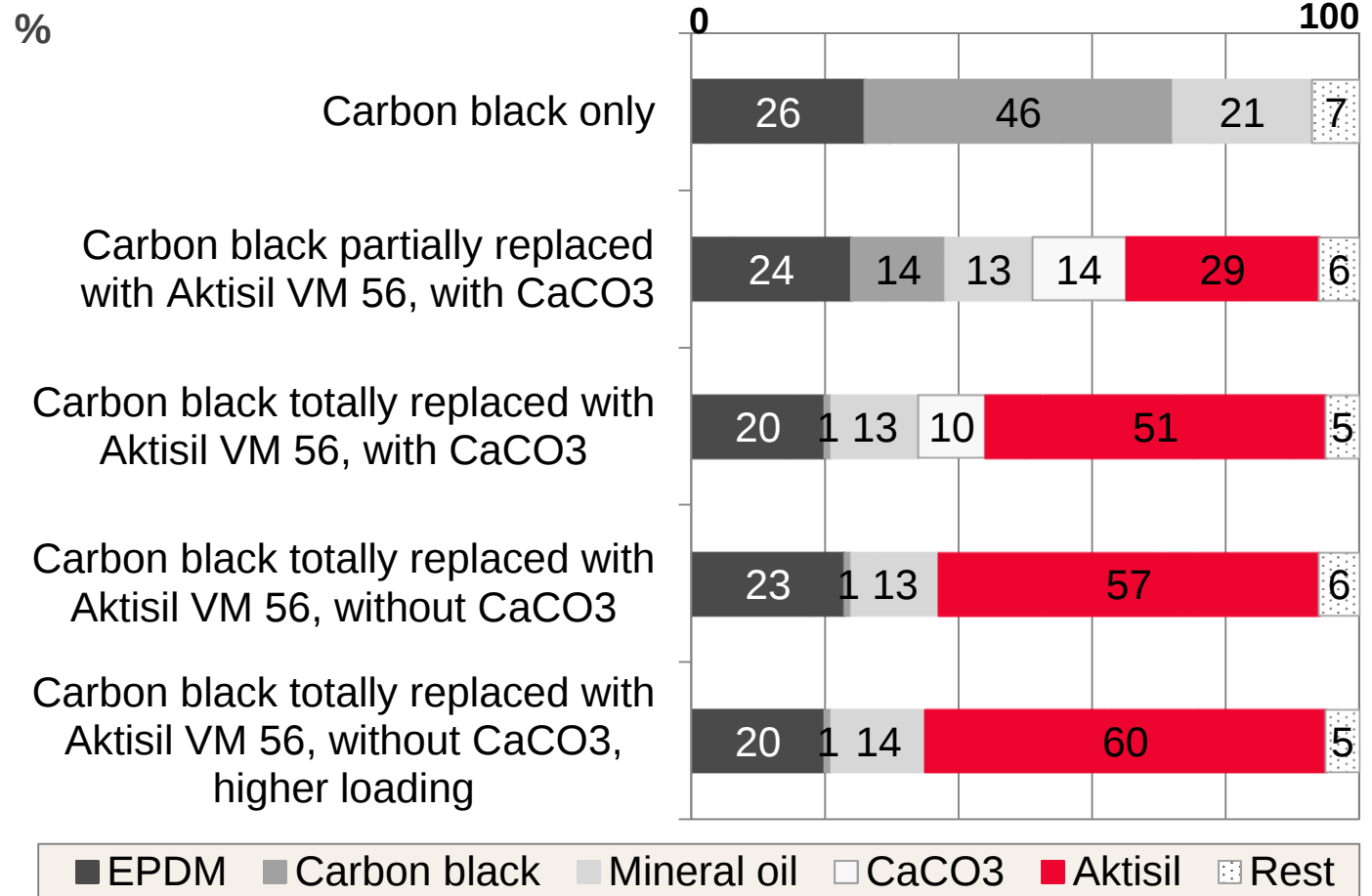
Carbon black totally replaced with Aktisil VM 56, without CaCO₃, higher loading

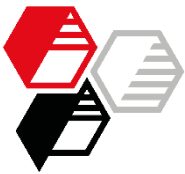




Design of Experiments

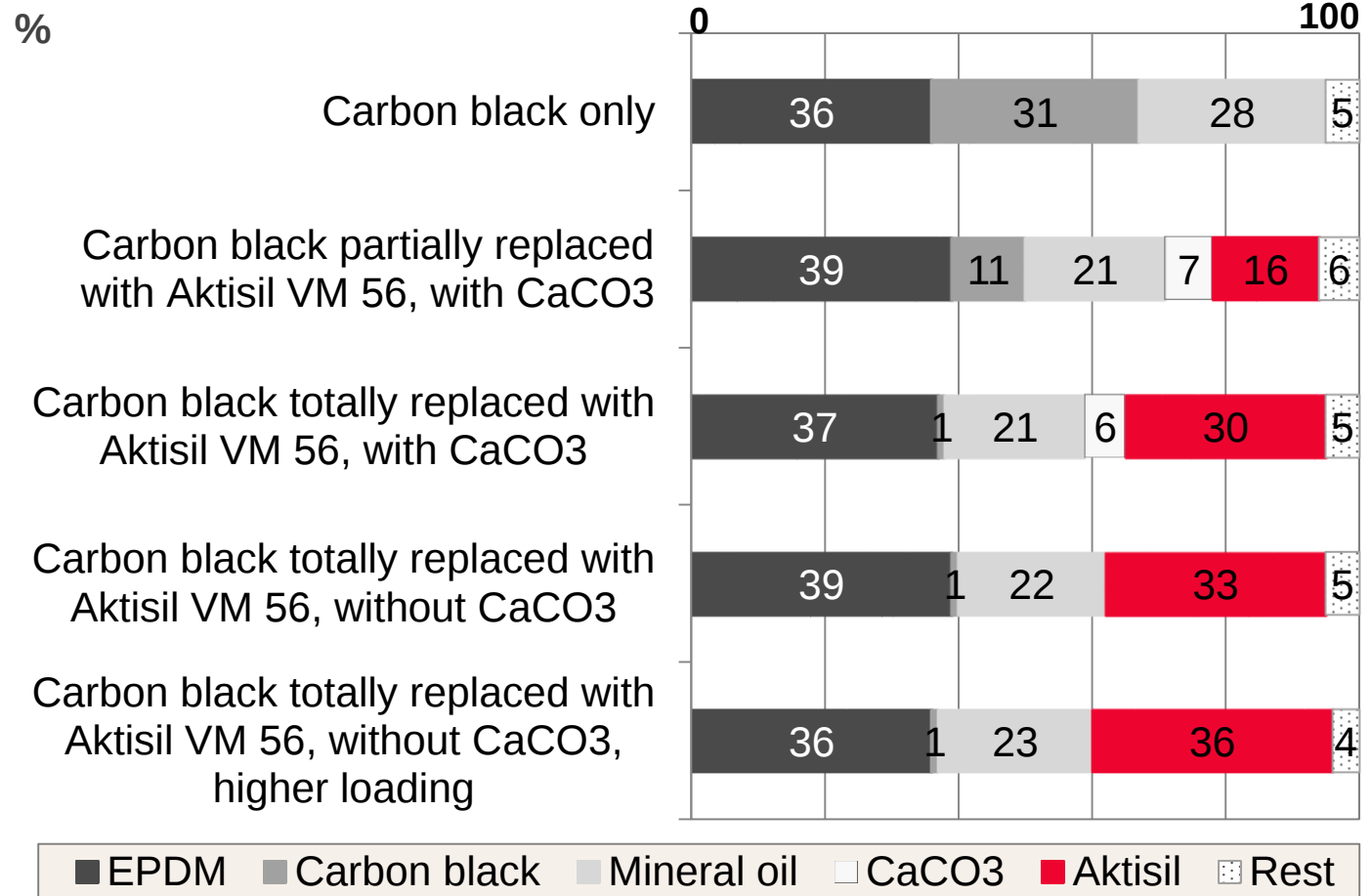
Formulation variations in mass percent

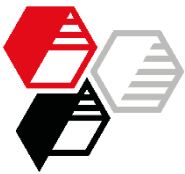




Design of Experiments

Formulation variations in volume percent





Fillers, Characteristics

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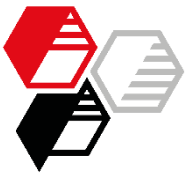
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		Carbon black N 550	Calcium- carbonat surface treated	Aktisil VM 56
Density	[g/cm ³]	1.8	2.7	2.6
Particle size d ₅₀	[μm]		2.7	2.0
Particle size d ₉₇	[μm]		25	9
Sieve residue >40 μm	[mg/kg]	<= 300	14	4
Sieve residue 45 μm (Siev No. 325)	ppm	10		
Oil absorption	[g/100g]		19	50
DBP absorption	[ml/100 g]	121		
Specific surface area BET	[m ² /g]	41	2.1	11
CTAB Surface area	[m ² /g]	42		
Surface treatment		none	Stearate	vinyl functionalized



Preparation and Curing of the Compound

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- **Mixing**

Open mill Ø 150 x 300 mm

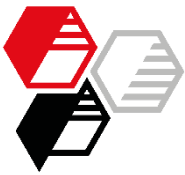
Batch volume: approx. 600 cm³

Temperature: 50 °C

Mixing time: approx. 20 min.

- **Curing**

Press, 180 °C, $t_{90} + 10 \%$



Mooney Viscosity

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DIN 53 523 Part 3, ML 1+4 100 °C



ME

0 20 40 60 80 100

Carbon black only

81

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

70

Carbon black totally replaced with
Aktisil VM 56, with CaCO₃

78

Carbon black totally replaced, with
Aktisil VM 56, without CaCO₃

74

Carbon black totally replaced with
Aktisil VM 56, without CaCO₃,
higher loading

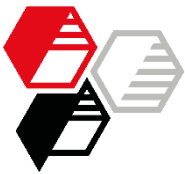
75

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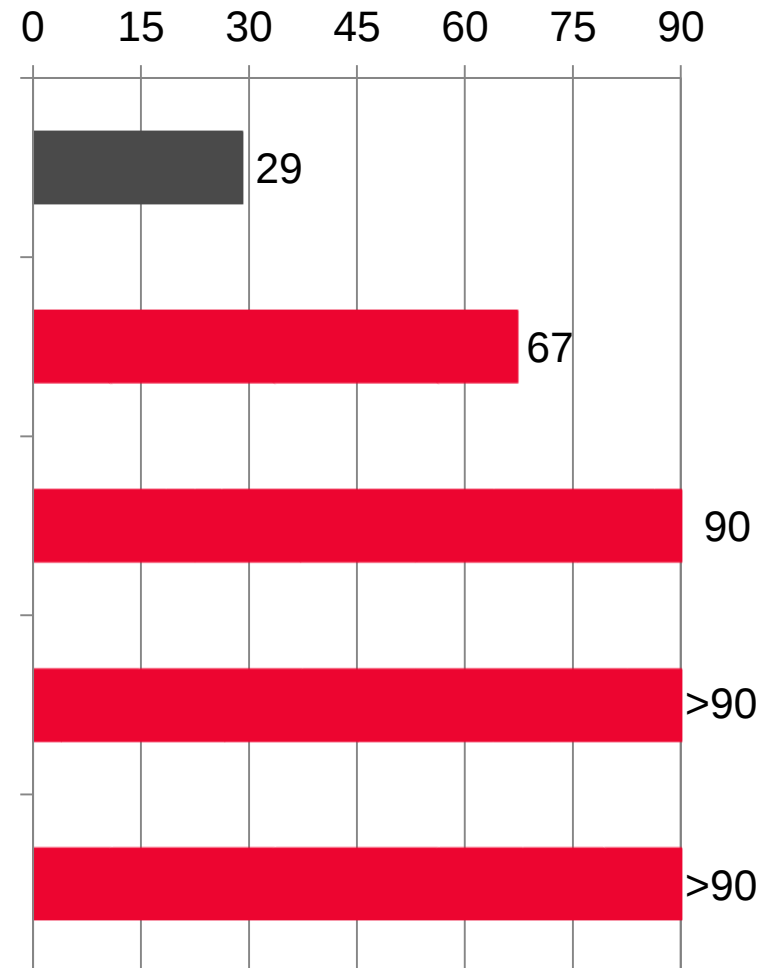
Mooney Scorch Time

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DIN 53 523 Part 4, ML +5 120 °C



min.



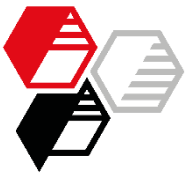
Carbon black only

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

Carbon black totally replaced
with
Aktisil VM 56, with CaCO₃

Carbon black totally replaced,
with
Aktisil VM 56, without CaCO₃

Carbon black totally replaced
with
Aktisil VM 56, without CaCO₃,...



Torque Minimum

DIN 53 529-A3, 180 °C, 0.2° deflection – Göttfert Elastograph



Nm

0,00 0,05 0,10 0,15 0,20

Carbon black only

0.18

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

0.11

Carbon black totally replaced with
Aktisil VM 56, with CaCO₃

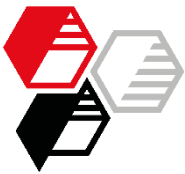
0.14

Carbon black totally replaced, with
Aktisil VM 56, without CaCO₃

0.13

Carbon black totally replaced with
Aktisil VM 56, without CaCO₃,
higher loading

0.14



Torque Maximum

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MINERAL®

DIN 53 529-A3, 180 °C, 0.2° deflection – Göttfert Elastograph



Nm

0,00 0,20 0,40 0,60 0,80 1,00

Carbon black only

0.63

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

0.70

Carbon black totally replaced with
Aktisil VM 56, with CaCO₃

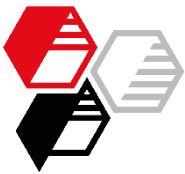
0.82

Carbon black totally replaced, with
Aktisil VM 56, without CaCO₃

0.83

Carbon black totally replaced with
Aktisil VM 56, without CaCO₃,
higher loading

0.79

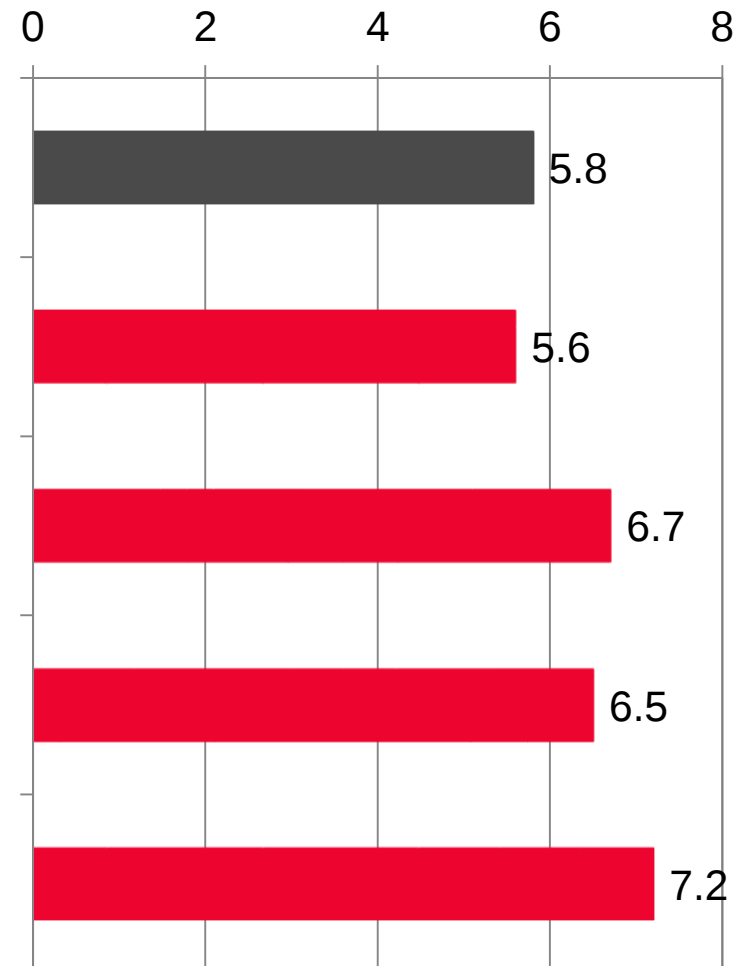


Conversion Time t_{90}

DIN 53 529-A3, 180 °C, 0.2° deflection – Göttfert Elastograph



min.



Carbon black only

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

Carbon black totally replaced
with
Aktisil VM 56, with CaCO₃

Carbon black totally replaced,
with
Aktisil VM 56, without CaCO₃

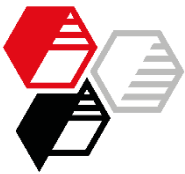
Carbon black totally replaced
with
Aktisil VM 56, without CaCO₃,...

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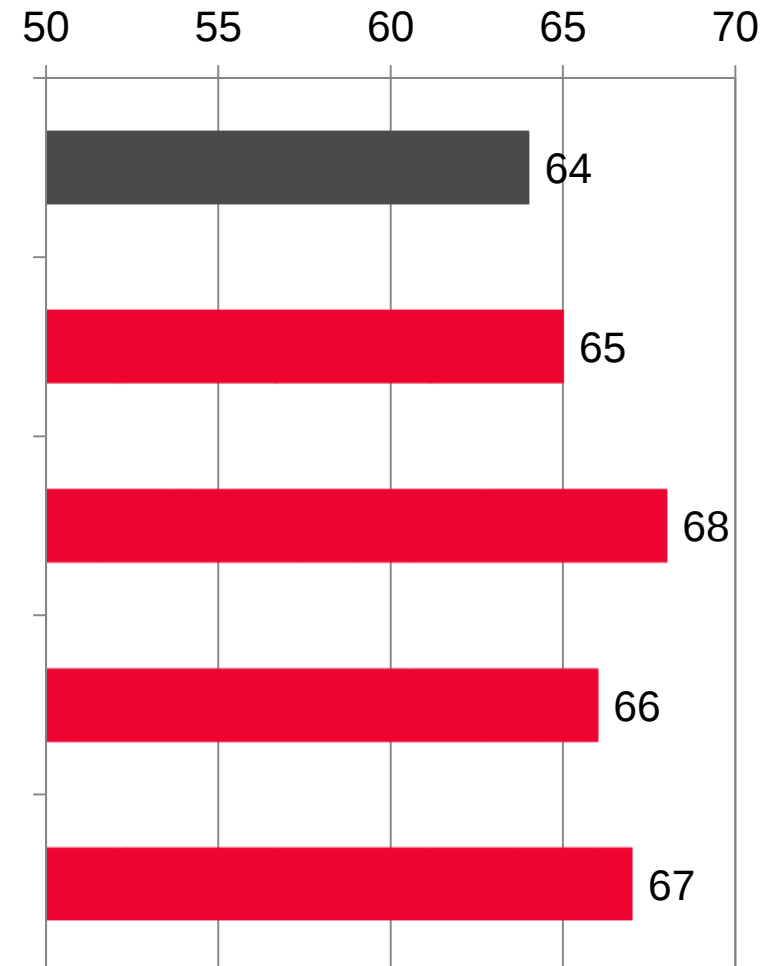
Hardness

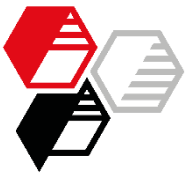
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DIN 53 505-A, piled-up S2 dumbbells



Shore A





Tensile Strength

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DIN 53 504, S2

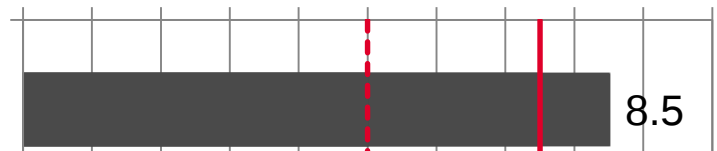
— DIN 7863, Facade + RAL GZ 716/1
- - - DIN 7863, Window



MPa

0 1 2 3 4 5 6 7 8 9 10

Carbon black only



8.5

Carbon black partially replaced
with Aktisil VM 56, with CaCO3



8.4

Carbon black totally replaced
with
Aktisil VM 56, with CaCO3



7.7

Carbon black totally replaced,
with
Aktisil VM 56, without CaCO3

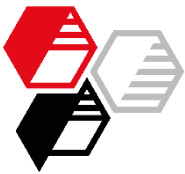


8.3

Carbon black totally replaced
with
Aktisil VM 56, without CaCO3,...



7.8



Elongation at Break

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DIN 53 504, S2

%

— DIN 7863 + RAL GZ 716/1



0 50 100 150 200 250 300 350

Carbon black only

303

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

279

Carbon black totally replaced with
Aktisil VM 56, with CaCO₃

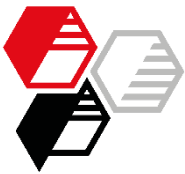
254

Carbon black totally replaced, with
Aktisil VM 56, without CaCO₃

222

Carbon black totally replaced with
Aktisil VM 56, without CaCO₃,
higher loading

256



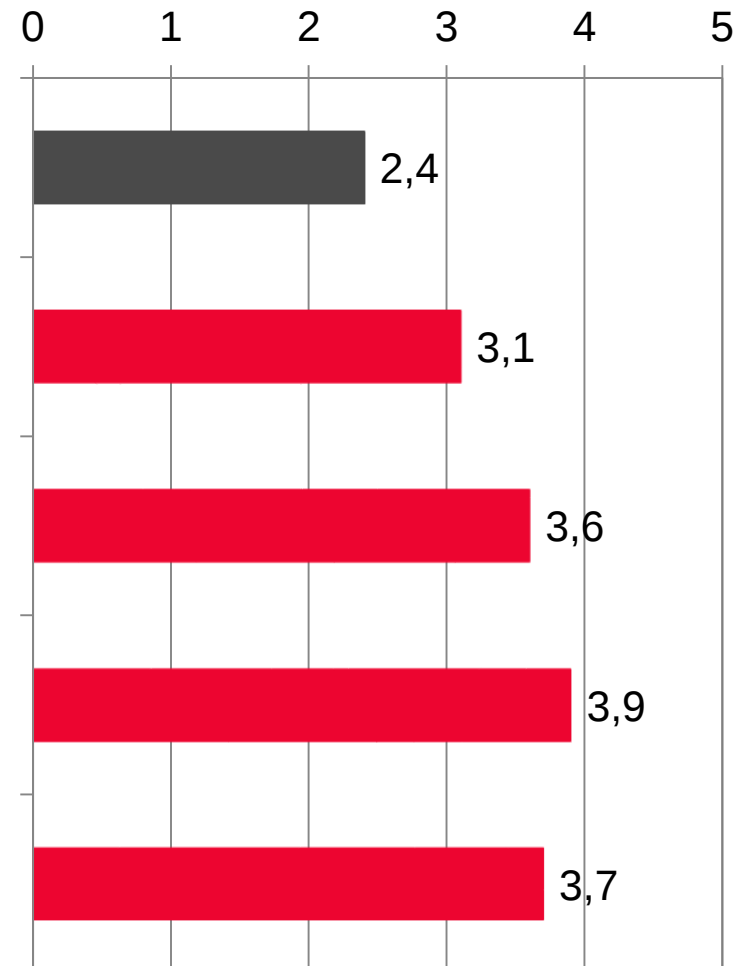
Modulus 100 %

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DIN 53 504, S2



MPa



Carbon black only

Carbon black partially replaced with Aktisil VM 56, with CaCO₃

Carbon black totally replaced with Aktisil VM 56, with CaCO₃

Carbon black totally replaced, with Aktisil VM 56, without CaCO₃

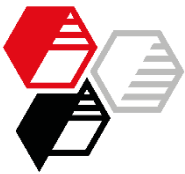
Carbon black totally replaced with Aktisil VM 56, without CaCO₃,...

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Compression Set

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DIN 53 517 I, 24 h / 100 °C

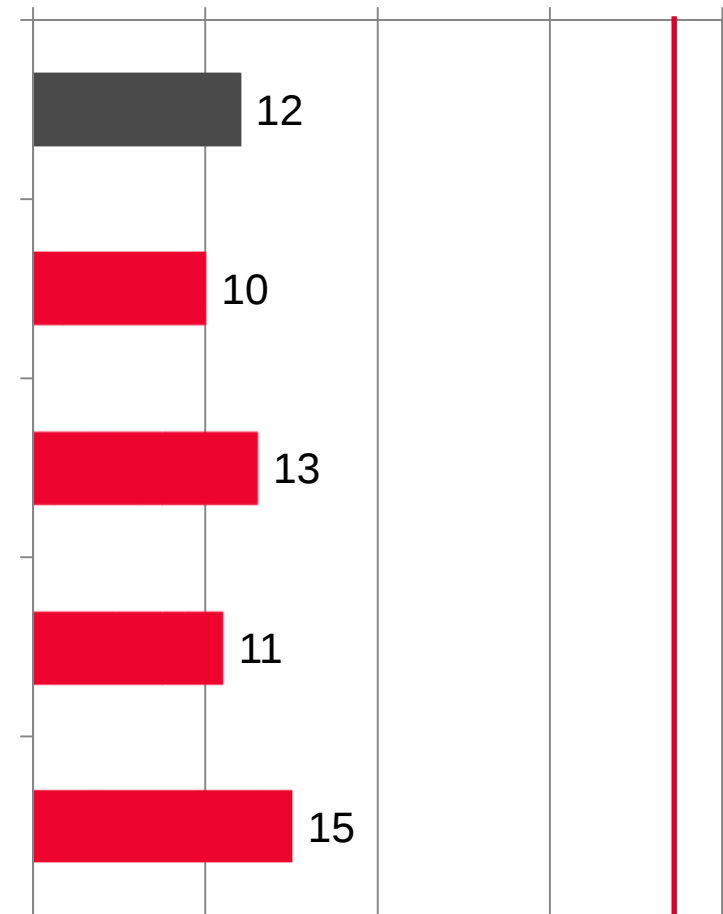
— DIN 7863 + RAL GZ 716/1



%

0 10 20 30 40

Carbon black only

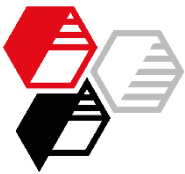


Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

Carbon black totally replaced
with
Aktisil VM 56, with CaCO₃

Carbon black totally replaced,
with
Aktisil VM 56, without CaCO₃

Carbon black totally replaced
with
Aktisil VM 56, without CaCO₃, ...



Compression Set

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DIN 53 517 I, 22 h / 23 °C

— RAL GZ 716/1



%

0 5 10 15 20

Carbon black only

14

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

9

Carbon black totally replaced
with
Aktisil VM 56, with CaCO₃

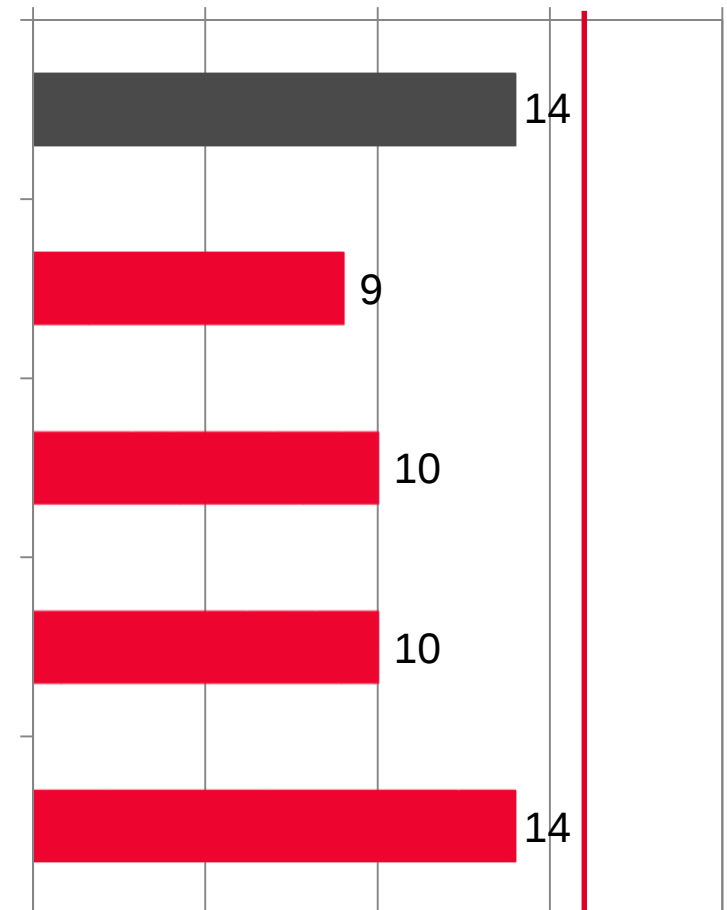
10

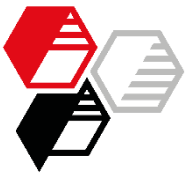
Carbon black totally replaced,
with
Aktisil VM 56, without CaCO₃

10

Carbon black totally replaced
with
Aktisil VM 56, without CaCO₃,...

14





Low Temperature Exposure Change of Hardness

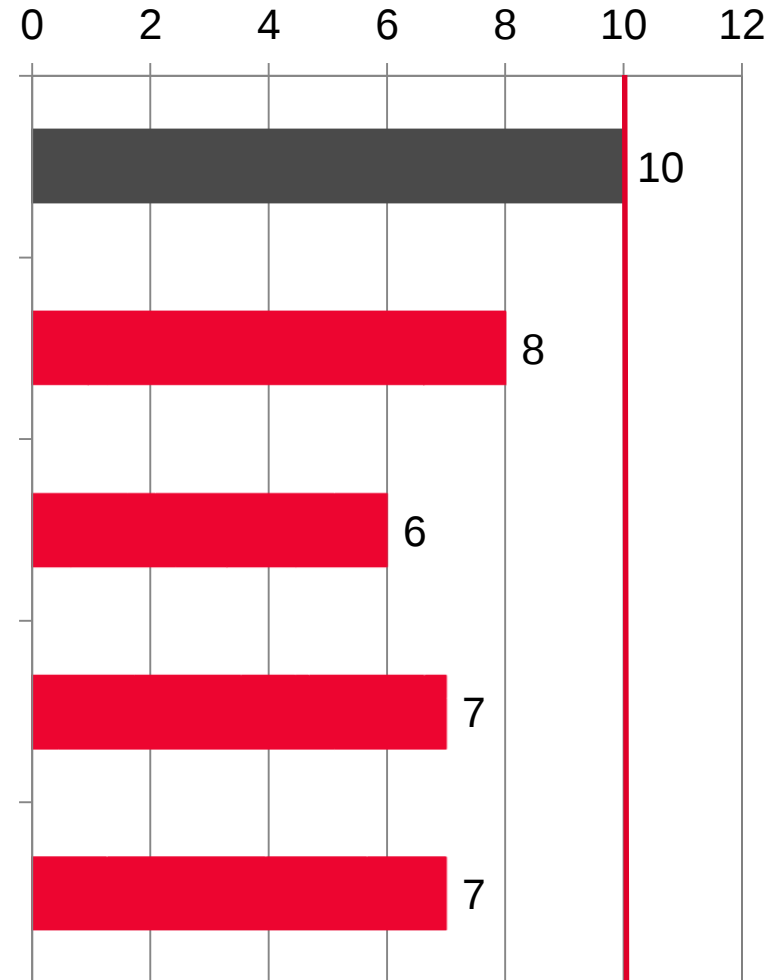
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22 h / -10 °C

— DIN 7863 + RAL GZ 716/1



Shore A



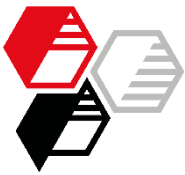
Carbon black only

Carbon black partially replaced
with Aktisil VM 56, with CaCO₃

Carbon black totally replaced with
Aktisil VM 56, with CaCO₃

Carbon black totally replaced, with
Aktisil VM 56, without CaCO₃

Carbon black totally replaced with
Aktisil VM 56, without CaCO₃,
higher loading



Summary

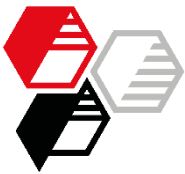
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- **Aktisil VM 56** allows to meet the essential requirements of the DIN 7863 and RAL-GZ 716/1.
- According to the circumstances, a refining optimization approach such as a reduction of the peroxide concentration, can be useful.
- This way, it is possible to considerably decrease the portion of petroleum based raw materials in the compound, which leads to more safety in planning of the raw material costs.
- On the technical side, according to the formulation used the following results can be attained:
 - lower viscosity
 - increased scorch safety
 - increased tensile moduli
 - improved compression set
 - lower change of hardness at -10 °C



Wir geben Stoff für gute Ideen!

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E-Mail: info@hoffmann-mineral.com

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