Facade emulsion paints:

Silfit Z 91 vs. precipitated sodium aluminum silicate

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SUMMARY

- Excellent optical appearance as well as demands for resistance and functionality are essential characteristics for modern facade emulsion paints.
- High price level for white pigments like titanium dioxide as a result of increased raw material costs and rise in demand.
- Targeting economical and efficient alternatives without performance loss.
- Titanium dioxide extension by precipitated sodium aluminum silicate is widely used.

Objective

Assessment of the performance of the Calcined Neuburg Siliceous Earth grade Silfit Z 91 compared to precipitated sodium aluminum silicate.

Special attention is paid to optical properties as well as resulting formulation costs while evaluating further relevant properties.

Evaluation in European standard emulsion paint for facades based on a styrene acrylic dispersion with:

- 19 % Titanium dioxide
- PVC 50 %
- Solids content 61 %

Base Formulation

		Parts by weight
Water deionized	-	180
Natrosol 250 HR	Thickener	2
Ammonia, conc. 25 %	Neutralising agent	2
Dispex AA 4030	Dispersing additive	2
Calgon N New, 10 % in water	Wetting- / Dispersing	3
Parmetol MBX	Can preservation	2
Foamaster MO 2134	Defoamer	2
Propylene glycol : Butyl diglycol : Texanol = 1 : 1 : 1	Cosolvent	30
Kronos 2190	TiO_2 Pigment	**190**
TiO_2-Extender		**varied X**
Omyacarb 5 GU	Filler	220
Finntalc M 15	Filler	50
Acronal S 790 (Styrene acrylic)	Emulsion Binder	320
Foamaster MO 2134	Defoamer	3
Acticide MKB 3	Film preservation	10
Rheovis PE 1330	Thickener	12
Water deionized	-	12
Total		**1040 + X**

Formulation Variations

Variation of the Pigment / TiO_2-Extender package
All other formulation ingredients remain unchanged

	Control, without TiO_2-Extender	with TiO_2-Extender									
		Full TiO_2					- 10 % TiO_2				- 20 % TiO_2
TiO_2	190	190					171				152
Na/Al Silicate	---	20	40	---	---	---	20	40	---	---	---
Silfit Z 91	---	---	---	20	40	60	---	---	60	98	98
Solids content w/w [%]	61.0	61.8	62.5	61.8	62.5	63.1	61.1	61.8	62.5	63.8	63.2
PVC [%]	49.6	51.2	52.7	50.9	52.1	53.3	50.5	52.0	52.6	54.8	54.2

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TiO2-Extender

	Particle size		Oil absorption	Density	Specific Surface BET	Color		
	d_{50} [µm]	d_{97} [µm]	[g/100g]	[g/cm³]	[m²/g]	L*	a *	b*
Precipitated Na/Al Silicate	5.0	18	140	2.1	95	98.9	- 0.1	0.6
Silfit Z 91	2.0	10	55	2.6	8	95.5	- 0.1	0.7
Other Fillers in Formulation (for comparison only)								
Omyacarb 5 GU	5.5	26	16	2.7	2	96.0	- 0.2	0.7
Finntalc M 15	4.5	17	41	2.8	6	92.8	- 0.5	1.1

Results

Preparation and Storage	
Incorporation Pigment / Filler	good to moderate
Foam formation	none
Fineness of grind	25 µm
Storage stability 23°C, 6 months	no phase separation, settling or sediment

Properties without significant differences			
Viscosity 23°C	Shear rate at	$0.1\ s^{-1}$ $1000\ s^{-1}$	40 - 60 [Pa*s] 0.3 - 0.4 [Pa*s]
Liquid Water Permeability DIN EN 1062-1	Class W_3 Low		0.020 - 0.026 [kg/(m²*h^0,5)]
Water Vapor Transmission Rate DIN EN 1062-1	Class V_2 Medium		20.0 - 23.5 [g/(m²*d)]
Gloss	dull matt, DIN EN 13000		85° < 5

Preparation and Testing

Wet-Scrub Resistance

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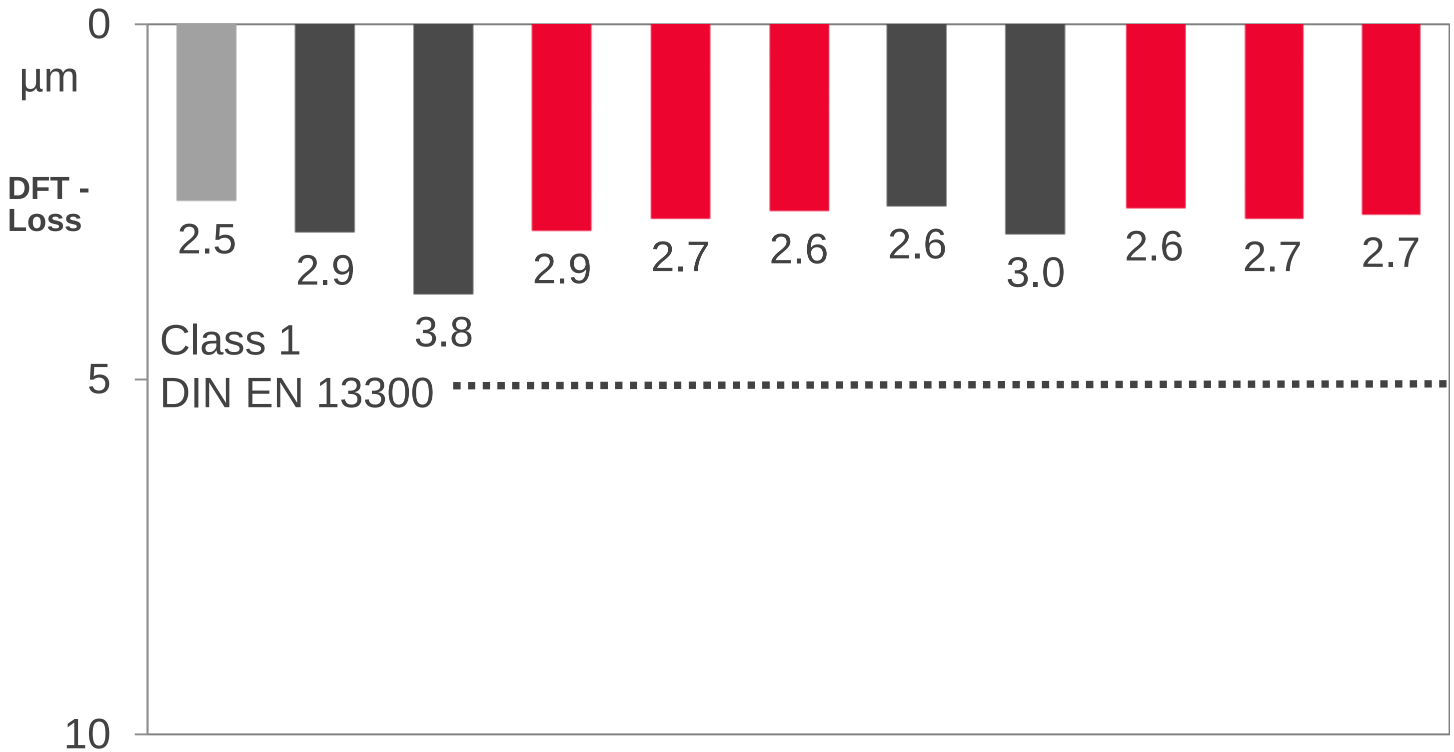
Silfit Z 91	---	---	---	20	40	60	---	---	60	98	98



Color

TiO_2	190	190					171				152
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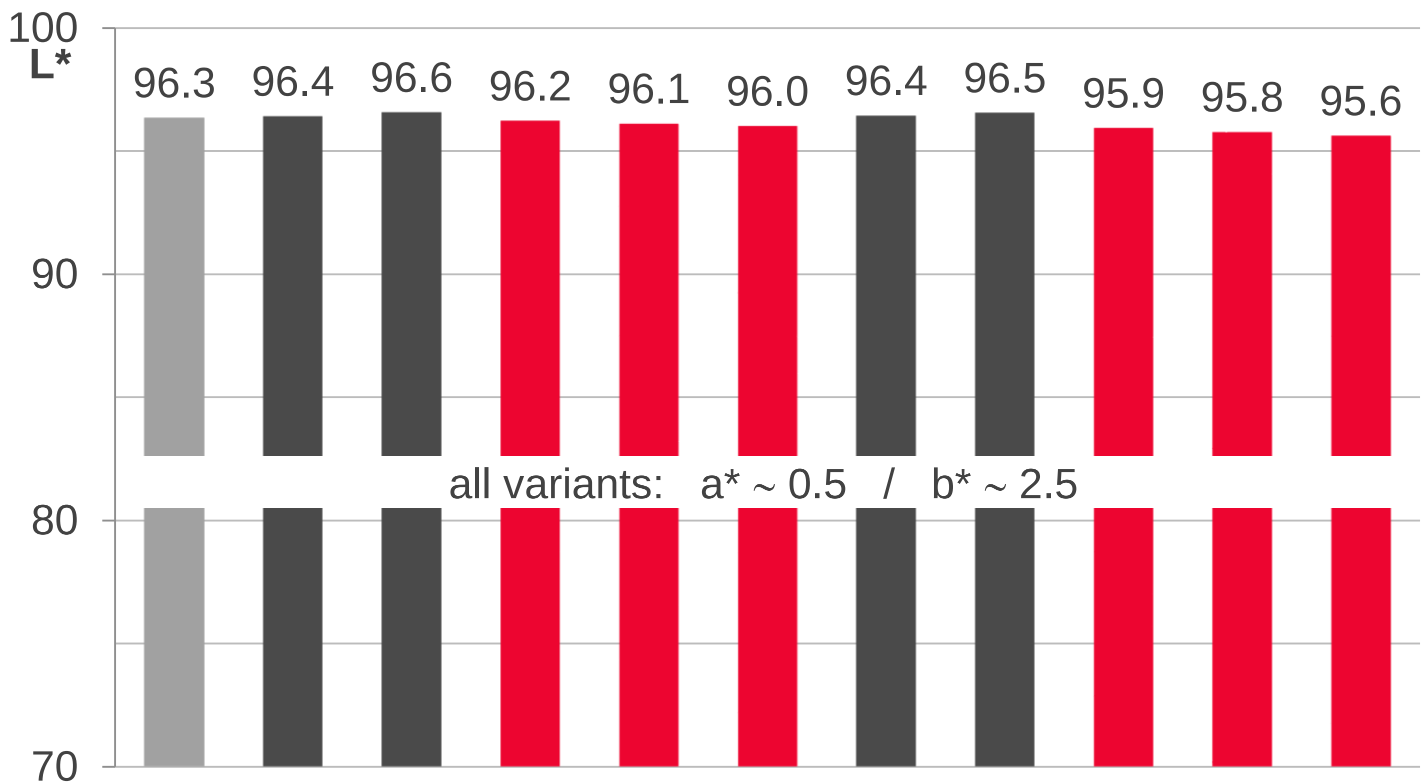

Hiding Power
EU Ecolabel

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General:

- Identifies products that meet high standards of environmental performance and quality.

Criterias relating to facade paints:

- Spreading rate
  $\geq$ **6 m² / liter** at contrast ratio 98 %

- Content of white pigments (refractive index $\geq$ 1.8)
  $\leq$ **38 g / m²** dried paint film at contrast ratio 98 %

Eco LABEL

Spreading Rate at Contrast Ratio 98 %

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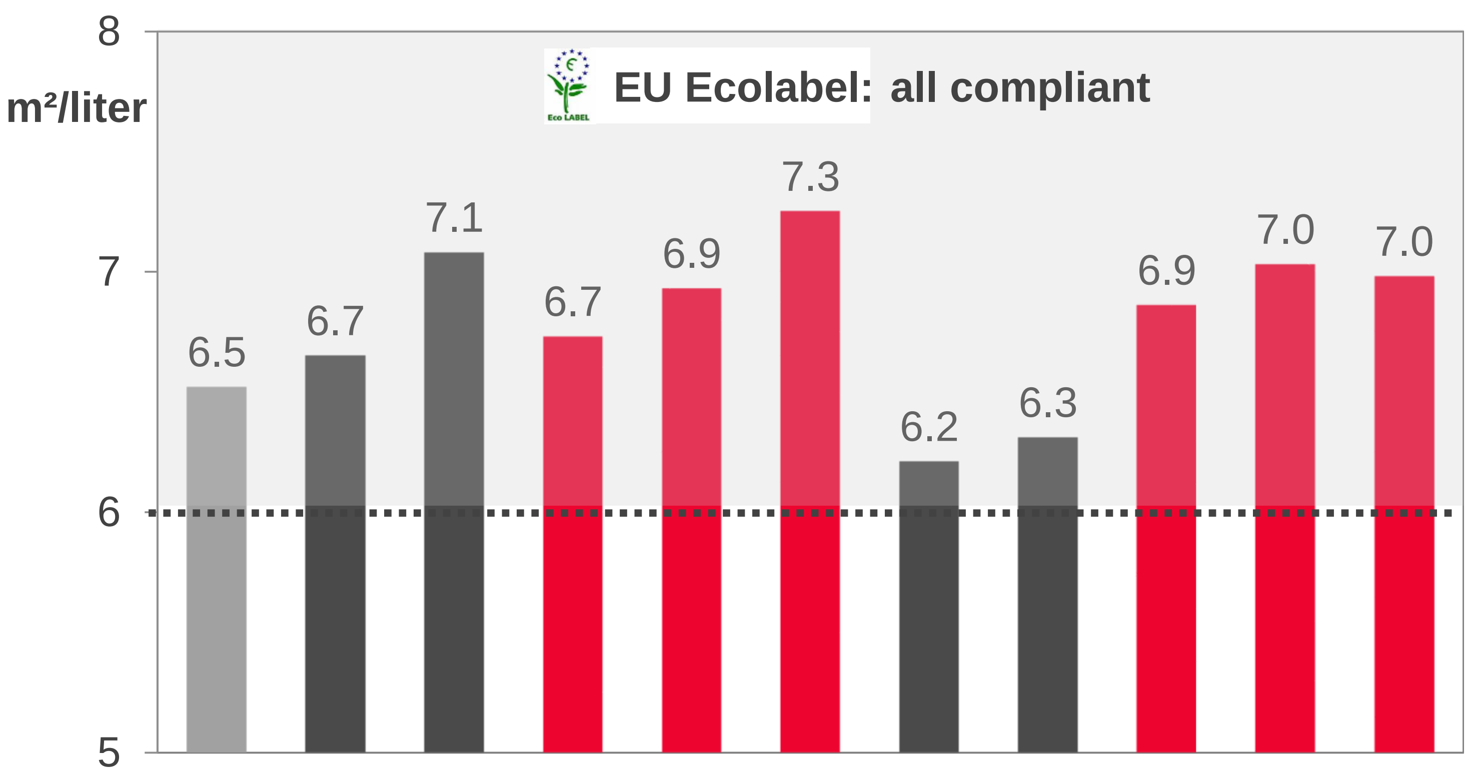

TiO_2-Content per m²
at Contrast Ratio 98 %

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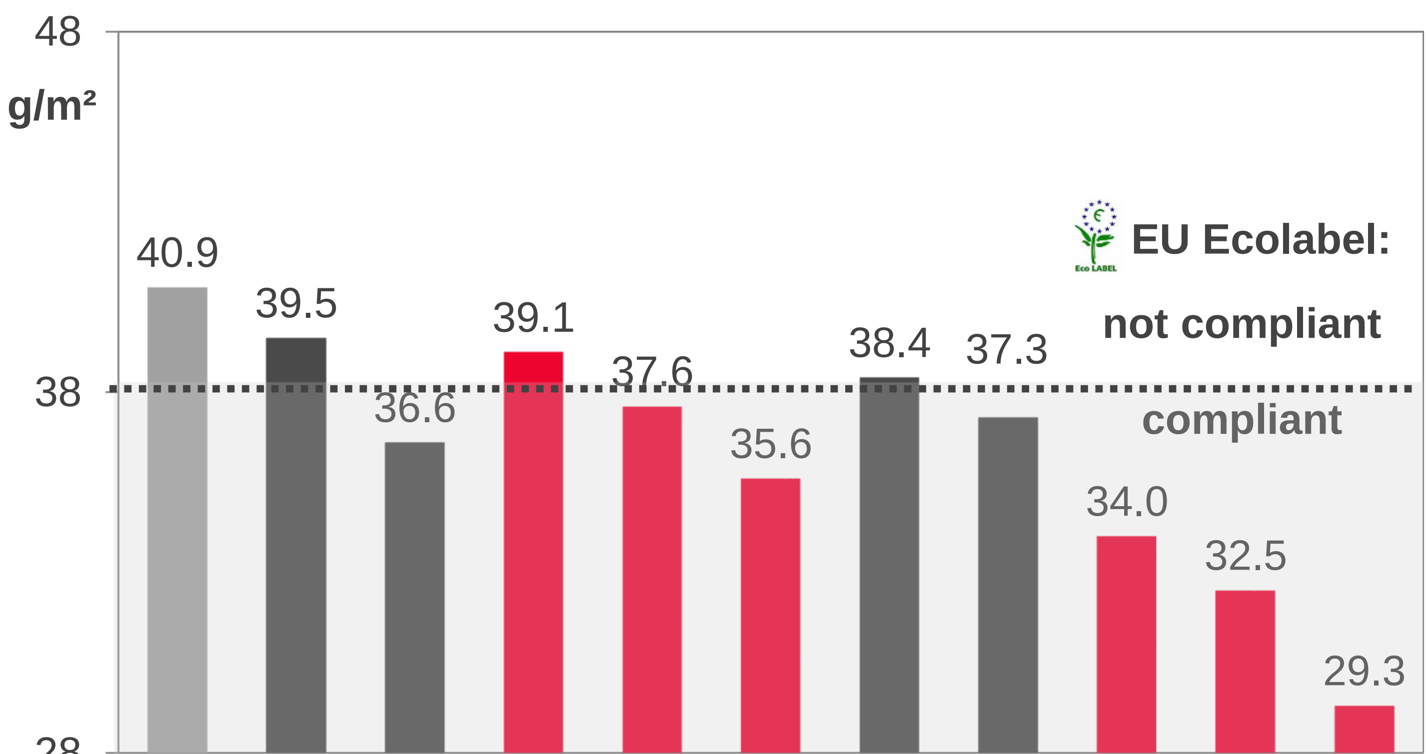

Cost / Performance

Germany 2019 / Contrast Ratio 98 %

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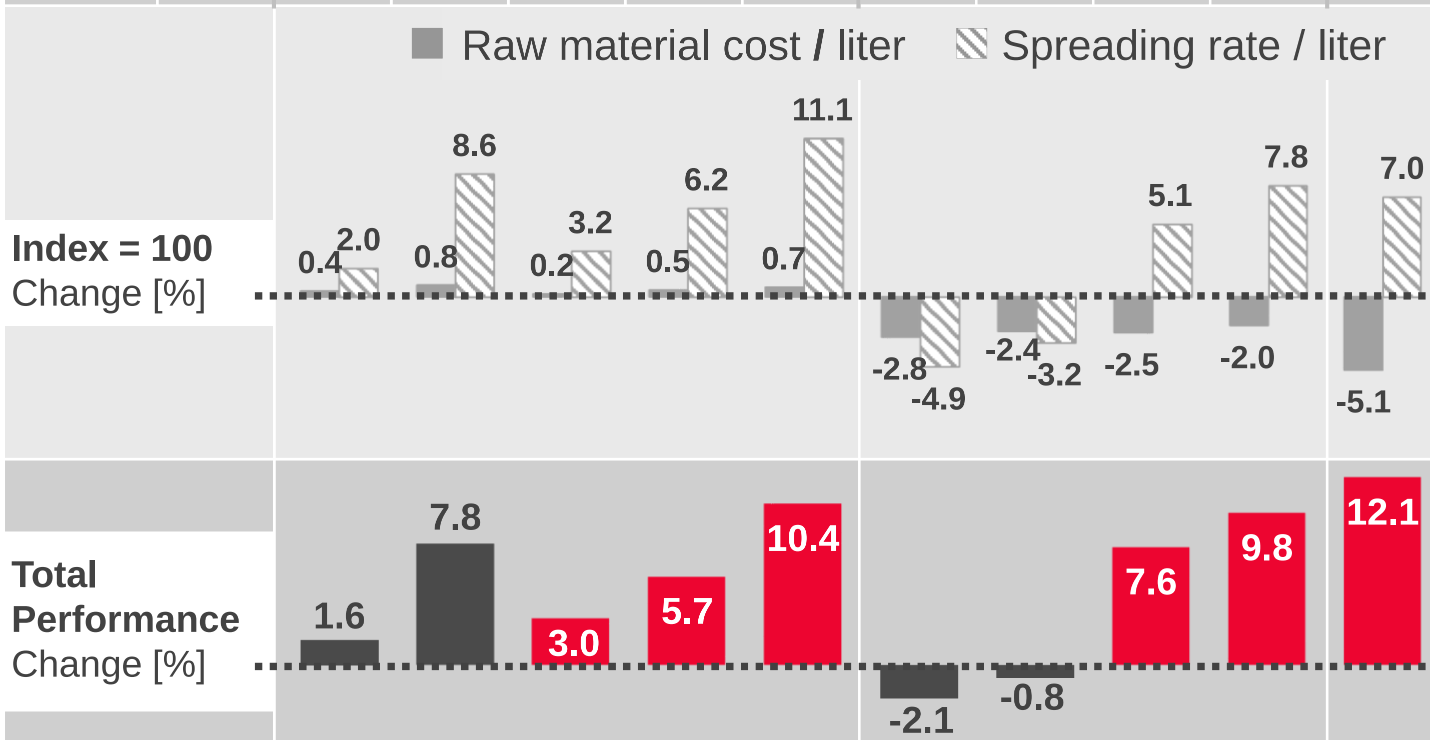

Summary

The use of the TiO_2-Extenders leads to:

- Almost comparable processing properties, storage stability, color, gloss, liquid water permeability and breathability.
- Wet-scrub resistance reduced with Na/Al Silicate; with Silfit Z 91 largely maintaining the very good level.
- Optimized hiding power at additive dosage; with Silfit Z 91 moreover raw material cost savings.
- At 10 % reduced TiO_2 loading: Loss in hiding power cannot be compensated with Na/Al silicate;

  with Silfit Z 91 markedly improved hiding power even better than control with full TiO_2 level + reduced formulation costs;

  synergy effect up to 20 % TiO_2 reduction with additional cost saving potential

Conclusion

Compared to precipitated Sodium Aluminum Silicate the

Silfit Z 91 gains the following combined benefits when used as a TiO_2-Extender in facade paints

- ✓ Maintaining mechanical resistance and durability of the coating
- ✓ Markedly improvement of hiding power and spreading rates while reducing formulation costs
- ✓ TiO_2 reduction offering real white pigment savings without loosing performance
- ✓ Paint meeting EU Ecolabel requirements clearly below limits for white pigments

Starting Formulations

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[1] highest brightness [2] best hiding power + high brightness [3] high cost savings + high hiding power		[1]	[2]	[3]
Water deionized			180	
Natrosol 250 HR			2	
Ammonia, conc. 25 %			2	
Dispex AA 4030			2	
Calgon N New, 10 % in water			3	
Parmetol MBX			2	
Foamaster MO 2134			2	
Propylene glycol : Butyl diglycol : Texanol = 1 : 1 : 1			30	
Kronos 2190		190	190	171 to 152
Silfit Z 91		20 to 40	40 to 60	60 to 98
Omyacarb 5 GU			220	
Finntalc M 15			50	
Acronal S 790			320	
Foamaster MO 2134			3	
Acticide MKB 3			10	
Rheovis PE 1330			12	
Water deionized			12	
Solids content w/w	[%]	61.8	63.1	63.2
PVC	[%]	50.9	53.3	54.2

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Preparation

Mixing and dispersing	Mixing with dissolver, in sequence of mentioning in the formulation Maximum peripheral speed of toothed disc (cowles blade) 15 m/s for 20 min Water cooling with T max. = 50°C
Let Down	With Binder and further additives
Maturation	Over night
Application	Undiluted with doctor blade on automated film applicator or as indicated
Substrate	As indicated, depending on testing
Conditioning	Drying conditions before / during tests: 23 °C / 50 % relative humidity (RH) Drying time before testing: 28 days or as indicated

Testing

Paint Preparation	
Filler incorporation Foam formation	Subjective assessment during preparation
Wet Paint	
Fineness of grind	Grindometer 0 – 50 µm
Viscosity	1d after preparation, Rheometer 23°C, Searle system
Storage stability	Undiluted in 1l-metal can, 6 months 23°C
Application with doctor blade gap 300 µm on Leneta film Dry film thickness (DFT) ~ 70 µm	
Wet-scrub resistance	200 Cycles on automated wet-scrub resistance tester according to ISO 11998. Classification along with DIN EN 13300

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Application 400 ml in total equal to 2 coats with 5 m²/l each, DFT ~ 180 µm	
Liquid Water Permeability W	Priming + 2 coats brush-applied on sand lime bricks Testing according to DIN EN 1062-3 Classification along with DIN EN 1062-1
Water-Vapor Transmission Rate V	2 coats brush-applied on filter paper grade 1575 Testing according DIN EN ISO 7783, wet-cup method; classification along with DIN EN 1062-1
Application: gap 100 - 400 µm gradually with doctor blade on Cardboard	
Color / Gloss	L*, a*, b* over white, 85°-Gloss (Sheen) at full hiding film with DFT 120 µm
Hiding Power	Contrast ratio over black/white depending on dry film thickness. Calculation of minimum dry film thickness to comply with DIN EN 13300 classifications and resulting spreading rates, contrast ratio at given spreading rate respectively

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