Silfit Z 91 for TiO_2 extension in good hiding, solvent-free straight acrylic paint

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Status Quo

- Features of modern interior emulsion paints:
  - ✓ Good optical properties
  - ✓ High mechanical resistance and durability
  - ✓ Low-emission, free of solvents and plastisizers
- 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.
- Partial replacement of white pigment by TiO_2 extenders is widely used

Objective

Assessment of the performance of the Calcined Neuburg Siliceous Earth grade Silfit Z 91 in an interior straight acrylic emulsion paint:

- 19 % Titanium dioxide
- PVC 66 %
- Solids content 59 %
- Solvent-free

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

Base Formulation

		Parts by weight
Water deionized	-	300
Natrosol 250 HBR	Thickener	4
Sodium hydroxide, 20 % in water	Neutralising agent	2
Dispex AA 4135	Dispersing additive	3
Calgon N New, 25 % in water	Wetting / Disperging additive	2
Parmetol MBX	Can preservation	1
Foamaster MO 2134	Defoamer	2
Tronox CR-828	TiO_2 Pigment	**190**
Plustalc H15	Filler	20
Micro Mica W 1	Filler	50
Omyacarb 2 GU	Filler	65
Omyacarb 5 GU	Filler	165
Foamaster MO 2134	Defoamer	2
Acronal ECO 6270 (Straight acrylic)	Emulsion binder	180
Water deionized	-	14
Total		**1000**

Solids content w/w	[%]	59.0
PVC	[%]	65.7

Formulation Variations

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

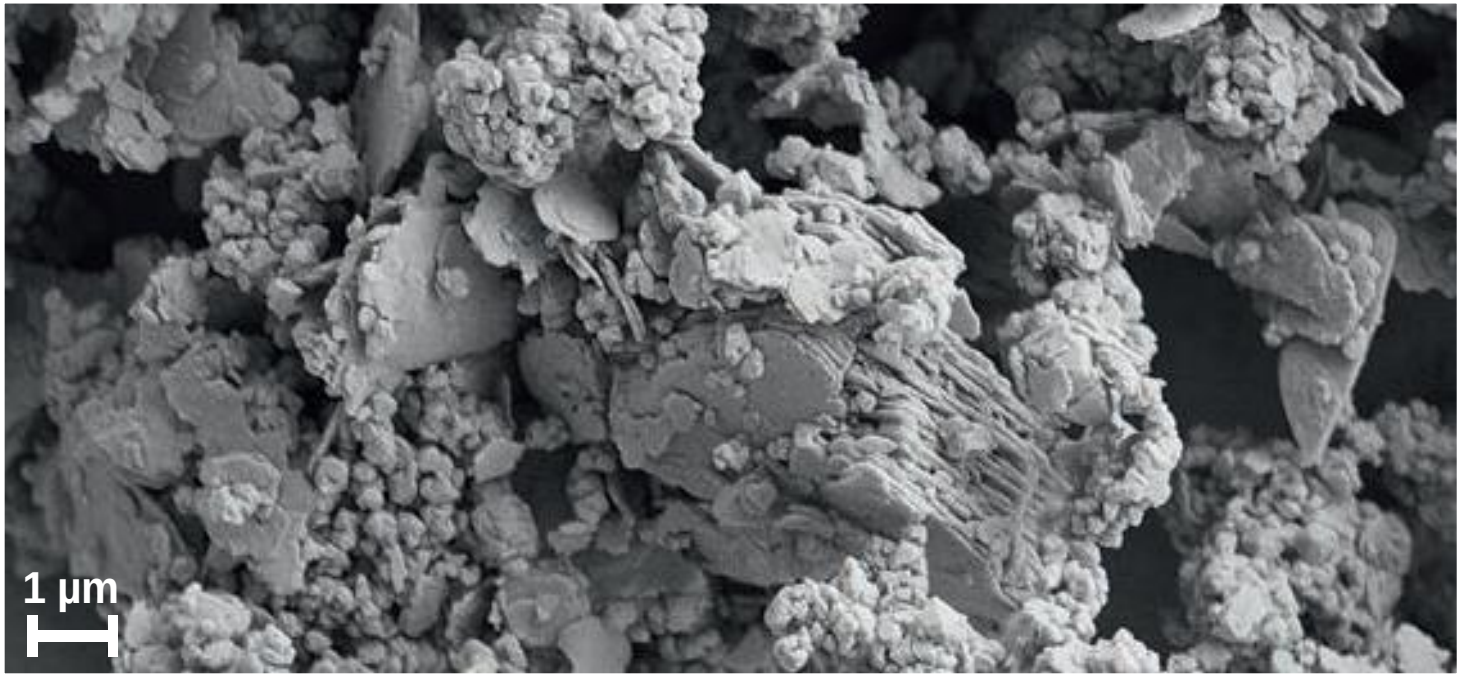
Control		TiO_2 Reduction								
TiO_2	190	150				135				
TiO_2 Extender Silfit Z 91	---	---	40	60	80	60	80	100	80	100
Arbocel B 600*	---	---				---			20	

* Natural cellulose fibre for optimization of wet-scrub resistance / hiding power

Solids content w/w	[%]	59.0	57.3	59.0	59.8	60.6	59.2	60.0	60.8	60.8	61.5
PVC	[%]	65.7	64.3	66.5	67.6	68.5	67.1	68.1	69.0	69.7	70.5

Characteristics
Silfit Z 91

	Particle size		Oil absorption	Density	Specific Surface BET	Color		
	d_{50} [µm]	d_{97} [µm]	[g/100g]	[g/cm³]	[m²/g]	L*	a *	b*
Silfit Z 91	2.0	10	55	2.6	8	95.5	- 0.1	0.7



Properties
Without Significant Difference

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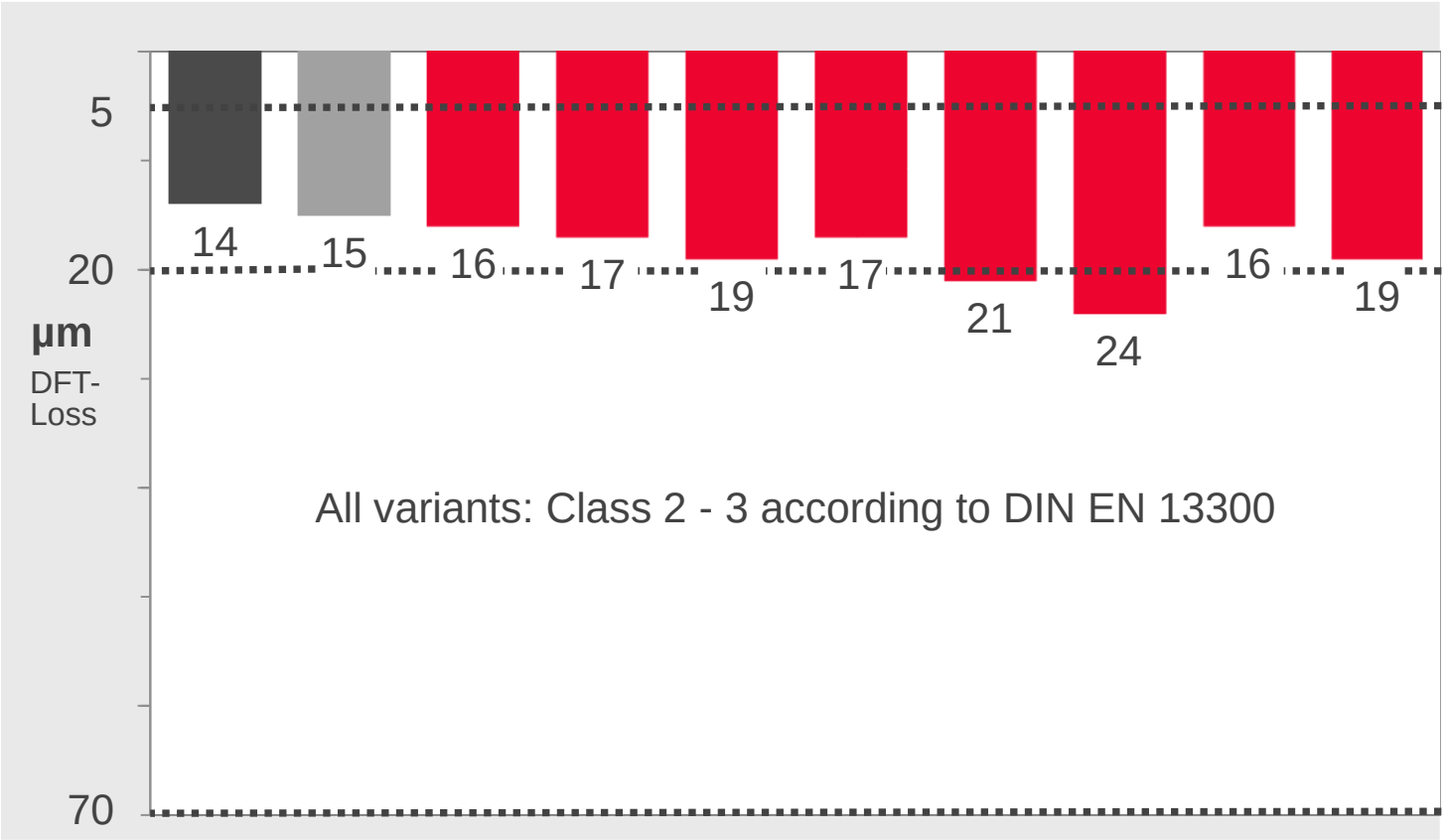
Incorporation Pigment / Filler	very good to good		
Dispersing process 20 min 15 m/s	no agglomerates, no foam formation		
Fineness of grind	15 µm, with cellulose fibres 40 µm		
Storage stability 6 months at 23°C	low phase separation; settling of sediment easy to re-stir and to homogenize		
Viscosity 23°C	Shear rate at	0.1 s^{-1}:	35 - 48 [Pa*s]
		1000 s^{-1}:	0.12 - 0.16 [Pa*s]
Gloss	dull matt, DIN EN 13000	85° < 5	

Preparation and Testing

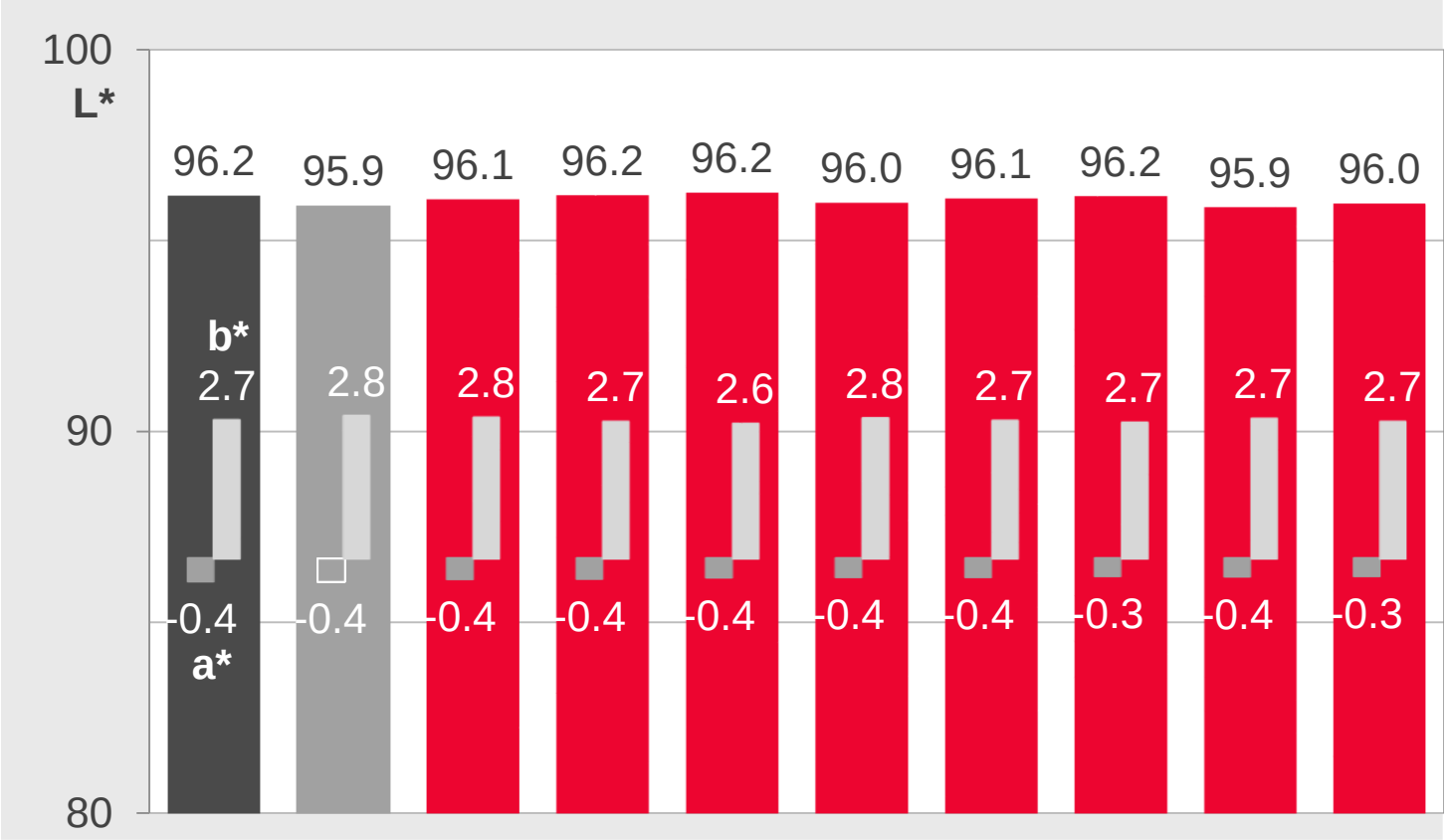
Wet-Scrub Resistance

TiO_2	190	150				135				
Silfit Z 91	---	---	40	60	80	60	80	100	80	100
Arbocel	---	---				---			20	



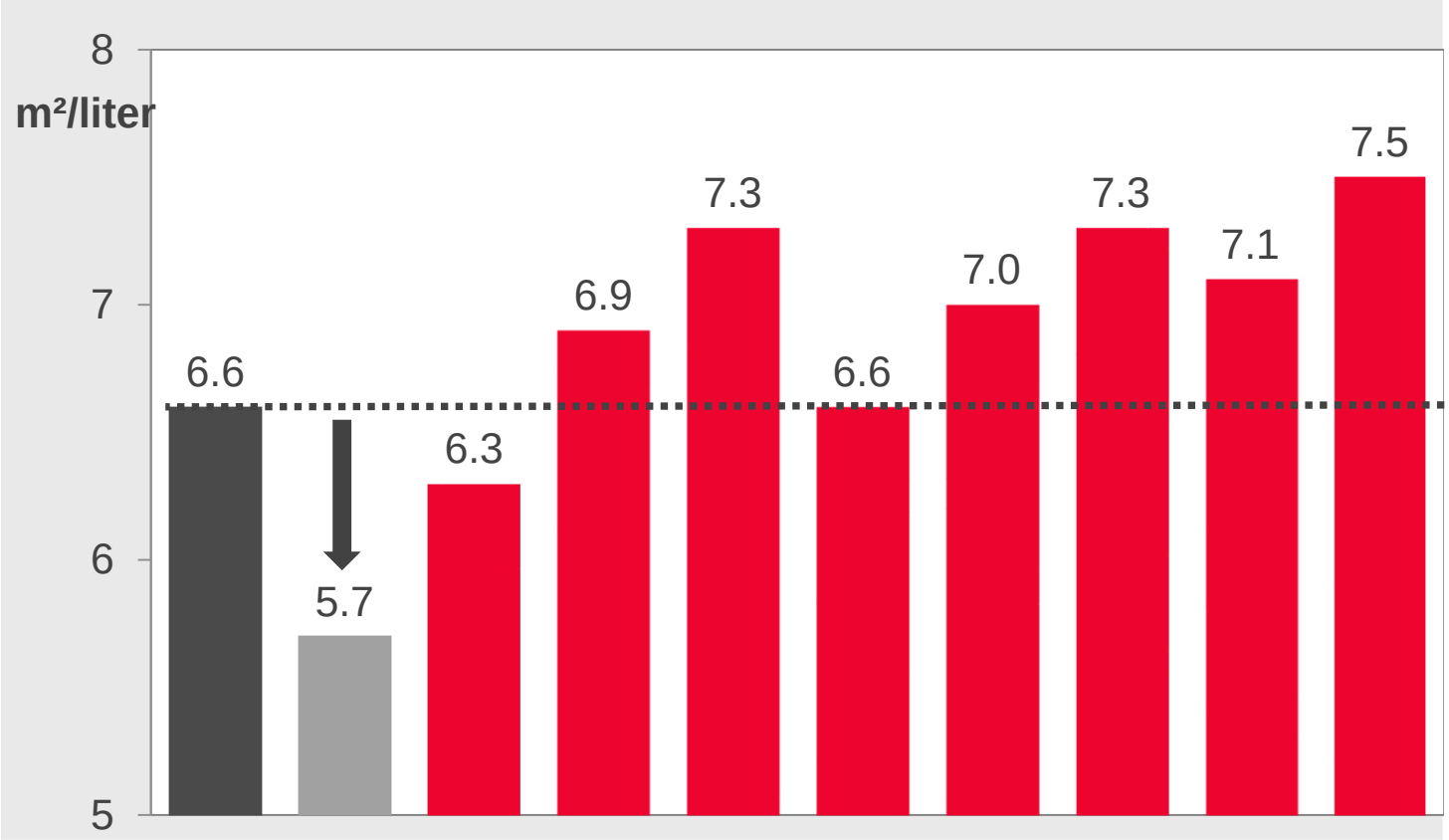
Color

TiO_2	190	150				135				
Silfit Z 91	---	---	40	60	80	60	80	100	80	100
Arbocel	---	---				---			20	



Spreading Rate at Contrast Ratio 98 %

TiO_2	190	150				135				
Silfit Z 91	---	---	40	60	80	60	80	100	80	100
Arbocel	---	---				---			20	



Cost / Performance

Germany 2019 / Contrast Ratio 98 %

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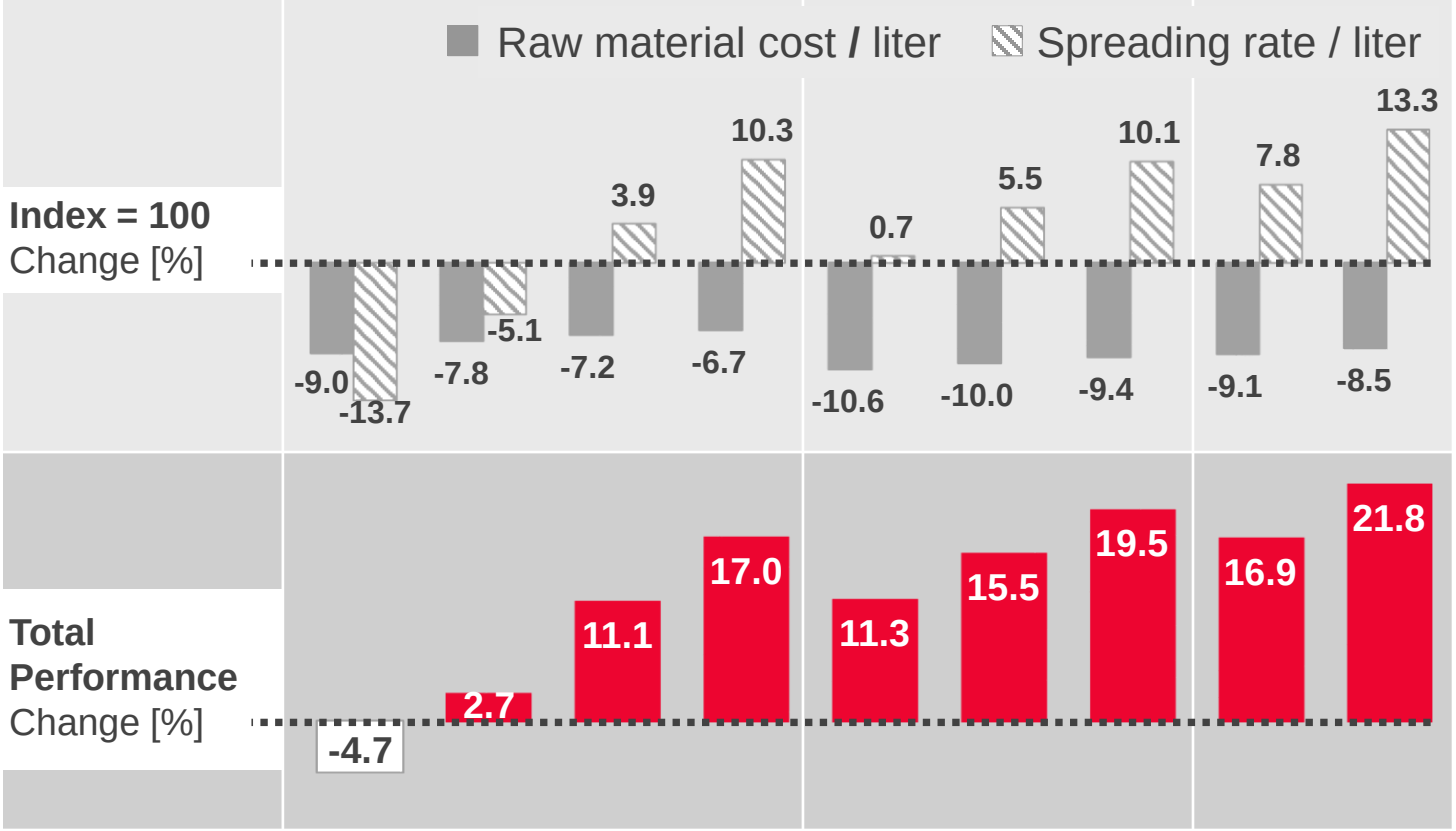
TiO_2	190	150			135				
Silfit Z 91	---	---	40	60	80	60	80	100	80	100
Arbocel	---	---				---			20	



Summary

Silfit Z 91 leads to the following performance profile:

- Equal processing properties, storage stability, color and gloss.
- Slightly increased wet-scrub abrasion; optimization by dosage of up to 2 % of cellulose fiber “Arbocel B 600”.
- Marked improvement of hiding power and spreading rates.

Silfit Z 91 at reduced TiO_2 level additionally offers:

- Compensation of loss in hiding power at a range of one to one and a half time the dosage of replaced TiO_2 while at the same time effectively reducing formulation cost.
- Increasing hiding power with higher Silfit dosage.

Silfit Z 91 gains the following benefits when used as TiO_2 extender:

✓ Improved performance, even at reduced TiO_2 level.

✓ Real cost cutting potential.

✓ White pigment savings.

Starting Formulations

INTRODUCTION

EXPERIMENTAL

RESULTS

SUMMARY

[1] High hiding power [2] High cost savings [3] Cost savings, Wet-scrub resistance		[1]	[2]	[3]
Water deionized			300	
Natrosol 250 HBR			4	
Sodium hydroxide, 20 % in water			2	
Dispex AA 4135			3	
Calgon N New, 25 % in water			2	
Parmetol MBX			1	
Foamaster MO 2134			2	
Tronox CR-828		150	135	135
Silfit Z 91		80	60 (bis 100)	80 (bis 100)
Arbocel B 600		---	---	20
Plustalc H15			20	
Micro Mica W 1			50	
Omyacarb 2 GU			65	
Omyacarb 5 GU			165	
Foamaster MO 2134			2	
Acronal ECO 6270 (Straight acrylic)			180	
Water deionized			14	
Solids content w/w	[%]	60.6	59.2	60.8
PVC	[%]	68.5	67.1	69.7

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Preparation

Mixing and dispersing	Mixing with dissolver, in sequence of mentioning in the formulation Peripheral speed of toothed disc (Cowles blade) 15 m/s for 20 min, water cooling with T max. = 60°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 for wet-scrub resistance, otherwise 7 d

Testing

Paint Preparation	
Incorporation, Foam formation	Subjective assessment
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, DFT* ~ 120 µm	
Wet-scrub resistance	200 Cycles on automated wet-scrub resistance tester according to ISO 11998. Classification along with DIN EN 13300
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.

*** Dry film thickness**

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