

Filler Comparison:

Neuburg Siliceous Earth

in water-based facade paints

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Summary

This study shows how the technical characteristics of aqueous facade paints can be optimized by the addition of Neuburg Siliceous Earth.

The objective of the study was to provide recommended recipes for high performance facade paints, bearing in mind the importance of cost factors in this market.

Our tests show that a noticeable saving in costs, together with a significant improvement in the characteristics of the paint can be achieved by adding Neuburg Siliceous Earth. The use of Sillitin V 88 and Aktisil MAM is particularly recommended.

After the addition of Neuburg Siliceous Earth, all recipes demonstrated considerably improved drying and water vapor permeability characteristics, compared to the standard recipe. In terms of capillary water absorption - a measure of the ability to withstand driving rain - the addition of finer types of Neuburg Siliceous Earth (Sillitin Z 86 and Sillitin Z 89) resulted in slightly lower values compared to the standard recipe. Here we recommend to use Aktisil MAM where a higher level of quality is required.

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1 Introduction

Facade paints have to comply to a wide range of criteria. Apart from their purely decorative function, i. e., optical enhancement, they must also protect the wall structure of the building.

The market for aqueous facade paints can be divided into three main categories¹:

- pure polymer emulsions
- potassium silicate plus polymer emulsion (silicate paints)
- silicon emulsion plus polymer emulsion

Apart from their very high material costs, the relatively poor elasticity of silicon-polymer emulsions is a negative aspect. However, in terms of water vapor permeability and capillary water absorption, these paint systems offer the highest performance at present.

The tests described in this report take this as a starting point. It is known that silicate fillers improve the water vapor permeability of polymer emulsions². Such fillers provide a means of lessening one of the main drawbacks of these systems while coming close to the threshold values for capillary water absorption, as required of silicon-polymer emulsion paints.

Other tests have also shown that silicate fillers, especially those with a very large volume structure and very fine grain, provide an excellent spacer effect, ensuring effective pigment exploitation³. Last but not least, high water vapor permeability ensures fast and even drying⁴.

2 Objectives

Our objective was to show that the water vapor permeability and capillary water absorption characteristics of polymer emulsion paints can be improved, at the same time taking economic considerations into account. Reference values were obtained with silicon-polymer emulsion paints.

¹ Koßmann, Heribert "Farbe + Lack" 97 No. 5/1991

² HOFFMANN MINERAL "Filler Comparison Neuburg Siliceous Earth in solvent-based Facade Paints"

³ HOFFMANN MINERAL "Titanium Dioxide Reduction in Interior Water Paints"

⁴ HOFFMANN MINERAL "Filler Optimization in Road-Marking-Paint Recipes"

3 Testing

3.1 Recipes

Recipe optimization was based on a uniform standard recipe, with variations made to the filler/pigment component. The pigment volume concentration (PVC) was kept constant.

Standard recipe R0			
Kronus Titanium Dioxide in Dispersion Paints, 1989			
Raw material	% of mass	Description	Manufacturer
Water	20.7		
Bentone LT	0.6	Thickener (layered silicate)	Kronos AG
Parmetol A 23	0.15	Preservation	Schülke & Mayr
Calgon N neu	0.1	Wetting agent	Benckiser & Knapsack
Coatex P 90	0.25	Wetting agent	Dimed GmbH
Genapol PN 30	0.2	Wetting agent	Hoechst AG
Agitan 280	0,2	Defoamer	F. B. Silbermann
Texanol	2.0	Flowing agent	Krahn Chemie
Propylene glycol	2.0	Solvent/flowing agent	
Acronal 290 D	26.7	Binder (styrol acrylate emulsion)	BASF AG
Ammonia	0.1	pH/corrector	
Pigment/filler	47/46.2 ⁵		

3.2 Preparation of Formulations

Batches (1.5 kg each) were made up with the Dispermat F 105 dissolver from the company VMA Getzmann according to the following uniform method:

- add water, Bentone LT, Parmetol A 23, Calgon N neu, Coatex P 90, Genapol PN 30 and Agitan 280, stir for 10 to 15 minutes;
- stir in pigments and filler and after 20 minutes disperse in the dissolver at a rotation speed of 15 to 20 m/sec.;
- add ammonia, propylene glycol and Texanol;
- add Acronal 290 D, homogenize for approx. 10 minutes and filter the batch through a 150 µm sieve.

3.3 Making up of specimen and test methods

After a settling period of 24 h (allows silicate to swell up fully), the paints were adjusted with water to a working viscosity of 55 ± 5 sec (DIN flow cup 6 mm).

All paint coats were applied with the Universal Film Applicator and Dryer Model 509/3 from the company Erichsen.

⁵ Due to the difference in density, less Sillitin than talc is used to keep the PVC constant.

3.3.1 Optical testing

Contrast boards Form 14H-BW from the Leneta Company were used as base material for optical testing. The paint was applied in wet film thickness of 100, 150, 200 and 400 µm. After a drying period of 48 h at room temperature, the values for the test boards were measured.

Standard color value Y and Z

These values were measured using the MiniScan spectrophotometer (measured optically at d/8°) from the company Hunterlab. Normal light type D 65 was used as a light source; the observation angle was set at 10°.

Dry and wet contrast ratio

Three different wet coatings (100, 150 and 200 µm) from each recipe were applied to determine the contrast ratio (CR). After drying, the light remission of the coating was measured with the spectrophotometer over a white (Y_w) and black (Y_s) background.

$$CR = \frac{Y_s}{Y_w} \cdot 100$$

The calculated contrast ratio was plotted against the dry coating thickness of the applied coatings. The contrast ratio at a dry coating thickness of 50 µm was read off the resulting curves.

In order to measure the wet contrast ratio, the dried specimen was placed in deionized water for 15 minutes to enable all the micropores to fill completely with water. This excludes light refraction at the porose surface (excludes high-dry hiding effects). The test boards were then removed from the water and immediately covered with a thin transparent PVC foil in order to prevent the water evaporating. The wet contrast ratio was determined and calculated as described above.

Gloss (measured optically at 85°)

The degree of gloss was determined for the top coats according to DIN 67 530 using a Mini Glossmaster from the company Erichsen.

3.3.2 Physical testing

Resistance to abrasion

The principle of this test is based on the measured resistance a coating has against mechanical pressure (abrasion).

Abrasion resistance was tested based on DIN 53 778 Part 2 with the aid of an abrasion tester Model 494 from the company Erichsen.

Resistance to cracking

Also known as "mud cracking", cracking is assessed by applying the paint automatically by wiper with a V-slit. Cracking first starts after a specific dry film thickness has been reached when a fault is reached. The thickness of the coating is determined at the fault as a measurement for cracking. Only those cracks not resulting from trapped air bubbles were assessed. Cracking tolerance for facade paints is at least 900 µm dry film thickness, due to the unevenness of the base surface.

Drying characteristics

Drying speed is important for the application process, as well as for top coatings where several layers are applied.

Testing for drying is performed at a wet film thickness of 200 µm, applied to strips of crystal glass. Two different testing methods are used, in order to determine two different drying rates, as described below:

Method 1: The time required for the paint to reach dust dryness (dryness grade 1 according to DIN 53 150) was determined. Glass beads (diameter: 0.2 mm) were dropped onto the coating from an applicator moving at a constant speed over the specimen. After application, the beads were carefully brushed off with a fine brush. The location where glass beads still adhere to the coating is the measuring point for dust dryness. The time needed to reach dust dryness is calculated from the known speed of the applicator and the path traveled to the measurement point.

Method 2: The time required for the paint to reach full dryness was determined. A wire is drawn over the paint at a defined application pressure and constant speed. Full dryness is measured at the location where the track left by the device ends. Drying time is calculated similarly to the method used for dust dryness.

3.3.3 Climate testing

Capillary water absorption

Capillary water absorption was tested based on DIN 52 617, using sand-lime bricks as a base material (dimensions: 11.5 cm x 7.0 cm = surface area of 80.5 cm² and a height of 4.0 cm). After drying for 24 h, the coated specimens were tempered at 50 °C and placed in a standardized climate for 48 hours before testing. Testing lasted 24 h, with the specimens (3 bricks per recipe) weighed hourly over the first eight hours, and once at 24 hours. The weights obtained were then evaluated according to DIN 52 617.

Water vapor permeability

This test was performed based on DIN 52 615. Physically speaking, water vapor diffusion is a gas diffusion mechanism caused by transportation due to gradients in water vapor partial pressure. The test method used here is based on diffusion through the specimen as a dividing layer. A constant, different water vapor partial pressure is set up on both sides (with the same high total pressure) of the dividing layer.

Resistance to UV light

To test for resistance to UV light, a wet coating thickness of 400 µm was applied. Testing started after a drying period of 48 h. The specimen was exposed to UV light for 400 h in a Sun Tester from the company Heraeus. Assessment was based on the criteria of the standard color value Y and gloss (optical measurement: 85°).

4 Results

4.1 Paint characterization

The characteristics relevant for processing, viscosity and solid content were determined and are summarized in the table below:

Recipe	Solid content in %	Viscosity ⁶ in mPas
R0 (standard recipe)	59.2	210
R1 (Sillitin V 85)	59.6	462
R2 (Sillitin V 88)	59.8	343
R3 (Sillitin V 88)	58.5	383
R4 (TP 92/25)	57.4	428
R5 (Aktisil MAM)	59.1	434
R6 (Sillitin N 85)	61.0	466
R7 (Sillitin Z 86)	59.9	464
R8 (Sillitin Z 89)	59.4	475

⁶ Rotation viscosimeter Viscolab LM from the company Physica, at 500 s⁻¹

4.2 Test of the coating

4.2.1 Optical testing

The optical characteristics (standard color value Y and Z, gloss and contrast ratio) are very important for decorative paints.

4.2.1.1 Standard color value Y according to DIN 53 778, Part 3

The standard color value Y - from the strict physical point of view, the green part of visible light - is used to determine brightness.

Figure 1 shows that the brightness values of different types of Neuburg Siliceous Earth are reflected in the brightness of the finished paint. The recipes R2, R3 (Sillitin V 88) and R8 (Sillitin Z 89) lie within the region of the standard recipe R0.

All test recipes comply with the minimum requirement of Y = 85 according to DIN 53 778.

4.2.1.2 Standard color value Z

Here slightly lower Z values must be taken into account for formulations using Neuburg Siliceous Earth.

Sillitin N 85 and Sillitin Z 86 (recipes R6 and R7) are less suitable for white and "cold" colors due to the lower Z values.

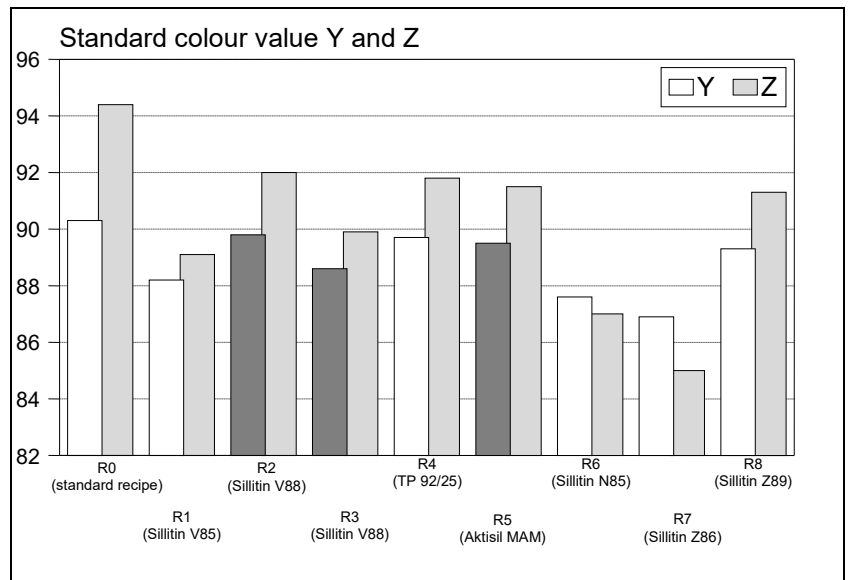


Fig. 1 Standard colour value Y and Z

4.2.1.3 Dry contrast ratio

The contrast ratio describes the covering power of a paint. A small amount of paint with a high contrast ratio gives full optical covering of the base.

Figure 2 shows the spacer effect of the Neuburg Siliceous Earth. Trend: the finer the type, the higher the contrast ratio.

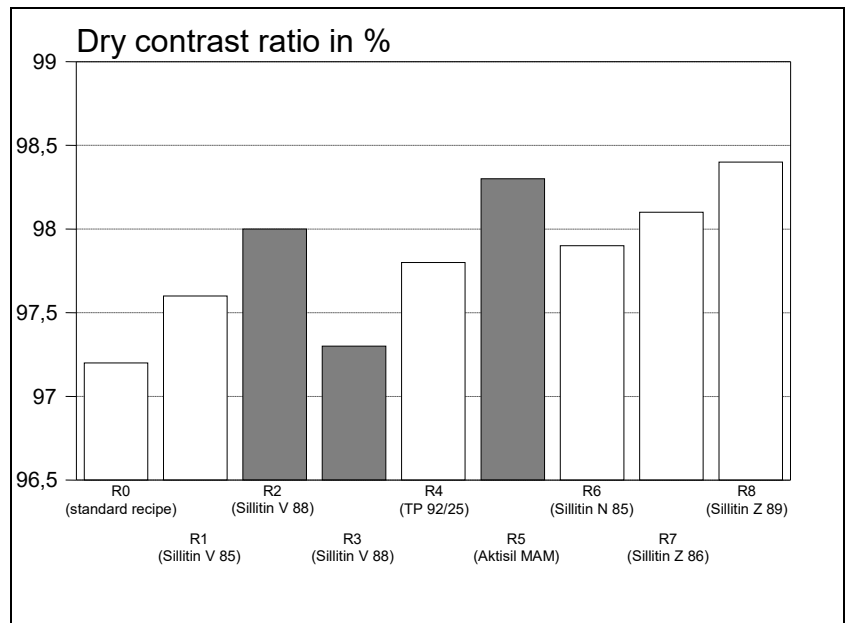


Fig. 2 Dry contrast ratio in %

Apart from that, surface treatment also provides useful effects. Peak values are achieved by Aktisil MAM which has a better compatibility (interaction) with the binder as a result of its surface treatment with a methylmethacryl functional group.

4.2.1.4 Wet contrast ratio

A high wet contrast ratio is favorable in terms of material consumption as it can make multi-coating unnecessary. The cost of improvements can be considerably reduced and the overall quality of the coating improved as over-lapping edges can be avoided.

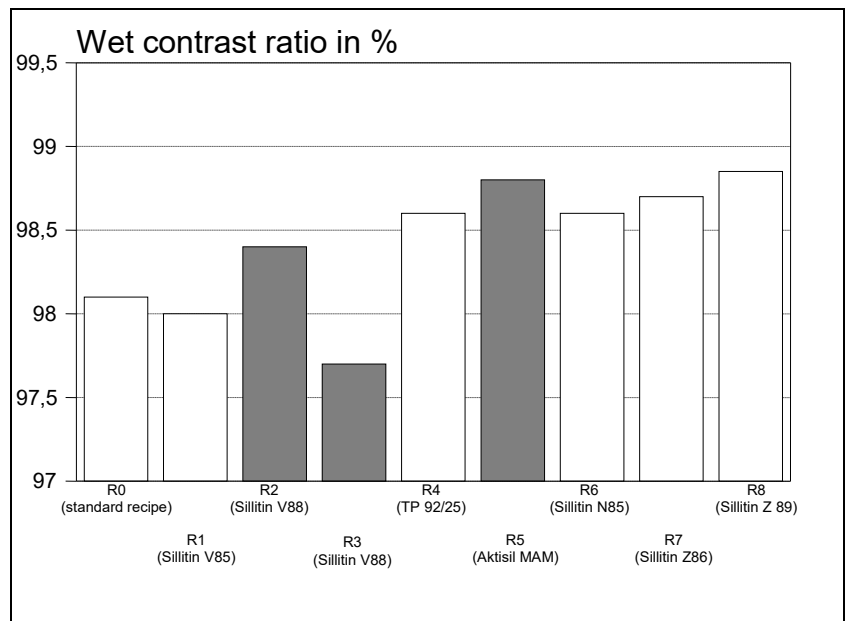


Fig. 2 Wet contrast ratio in %

Contrary to the dry contrast ratio, there is no grain size dependence when measuring the wet contrast ratio.

However, surface

treatment does have a conspicuous influence. The coated types TP 92/25 (recipe R4) and Aktisil MAM (recipe R5) increase the wet contrast ratio.

4.2.1.5 Gloss according to DIN 67 530

Gloss is a major part of the complex of optical characteristics. The degree of gloss for aqueous facade paints can be adjusted by the type and dose of fillers used. However, background, coating thickness and the method of application must also be taken into account.

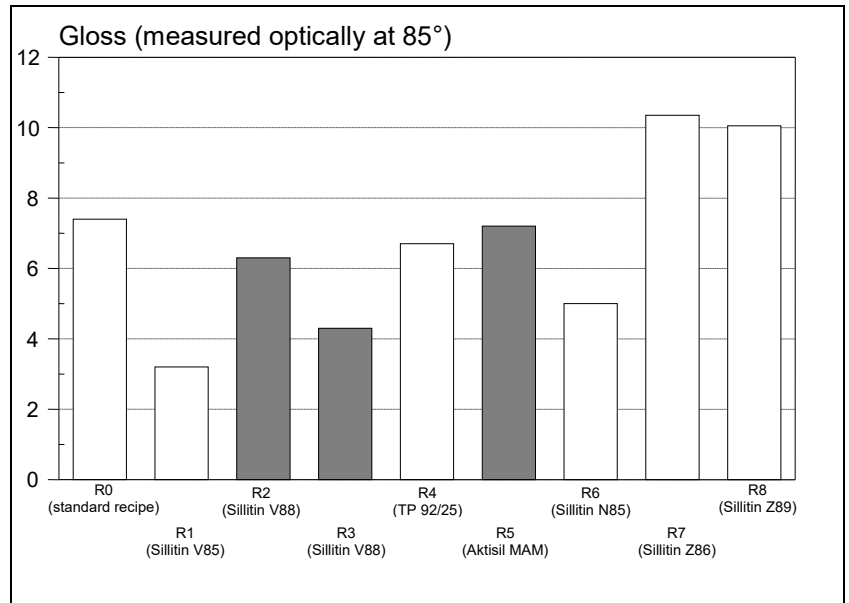


Fig. 3 Gloss

Depending on the type of product chosen, a lower (Sillitin V 85; recipe R1) or a higher gloss (Sillitin Z 89; recipe R8) can be selected.

4.2.2 **Physical testing**

4.2.2.1 Abrasion resistance and cracking

All recipes achieved abrasion values > 100,000 abrasion cycles. No relevant difference could be determined using this method.

Due to the wiper characteristics and the particulate content of the paints, the maximum dry coating tested was 700 µm. None of the recipes tested showed any signs of cracking at this film thickness. However, it can be assumed that the specified dry film thickness of 900 µm is reached by all recipes.

4.2.2.2 Drying characteristics

The addition of Neuburg Siliceous Earth results in considerably shorter drying time, compared to the standard recipe. Recipe R4 with the coated product TP 92/25 had by far the shortest drying time.

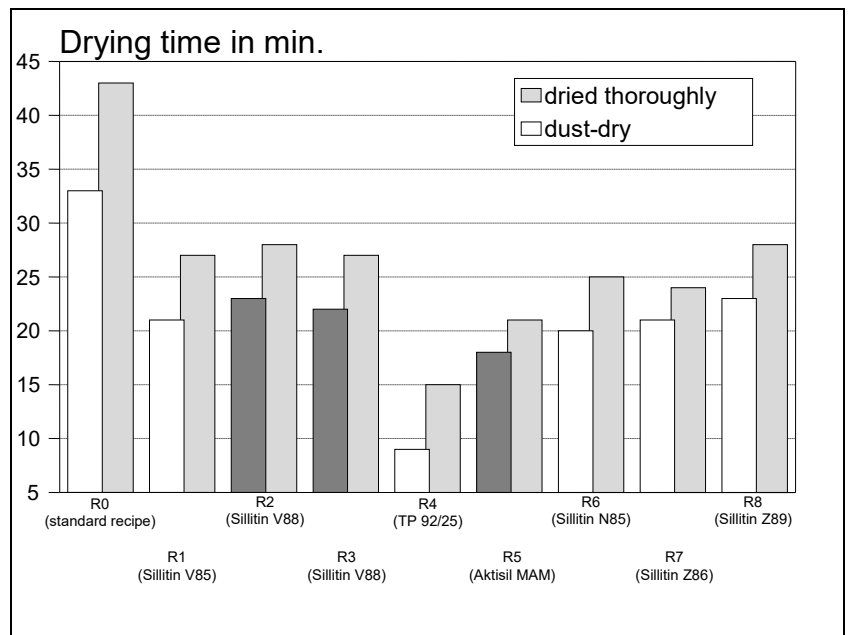


Fig. 4 Drying time in min.

4.2.3 **Climate testing**

4.2.3.1 Water vapor permeability and capillary water absorption

Both factors considerably influence the moisture content of the coatings, and thus their physical characteristics.

The water absorption coefficient w in $\text{kg}/(-\text{m}^2\text{h}^{0.5})$ according to DIN 52 617 is an important factor. In order to guarantee the protective function of the facade paint, the water absorption coefficient must be lower than that of the wall material.

In contact with water, the coating starts to adsorb moisture and swells. Once it has reached saturation point, a slow process of moisture transportation through the coating to the base material starts. The

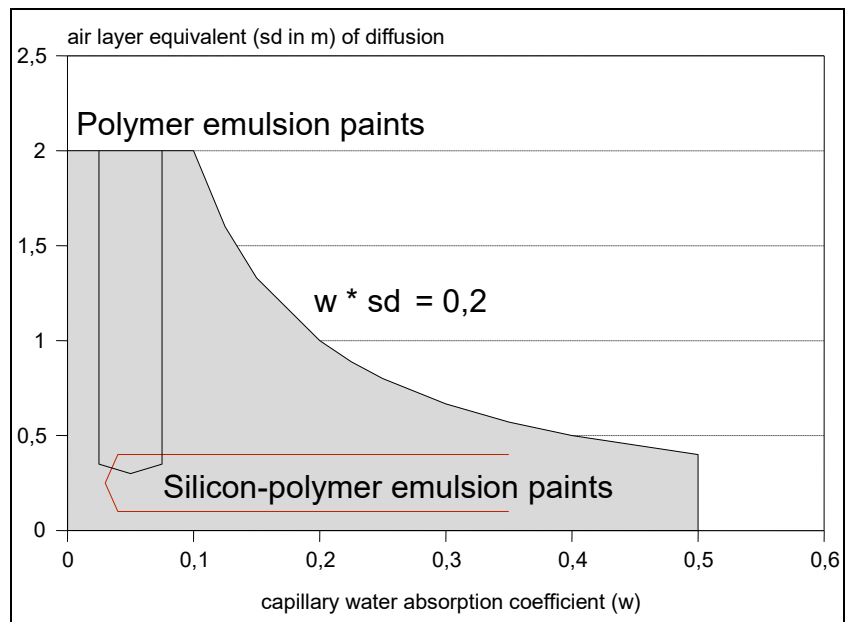


Fig. 5 Permeability of facade paints

value measured described the water absorption of the base material, as slowed by the coating. The speed of this process is determined by the quality of the coating, and is identical to its water permeability. Water permeability is characterized by w (measured in $\text{kg}/(\text{m}^2\text{h}^{0.5})$) as it generally deviates from both the water absorption coefficient of the pure coating, as well as from the pure base material.

Apart from water absorption, water vapor permeability is extremely important in terms of the quality of a facade paint. That is why a higher value is required for this factor than for the wall bonding, so that water vapor cannot condense at the interface between the base and the paint. This ensures that the coating will not separate or break off on freezing.

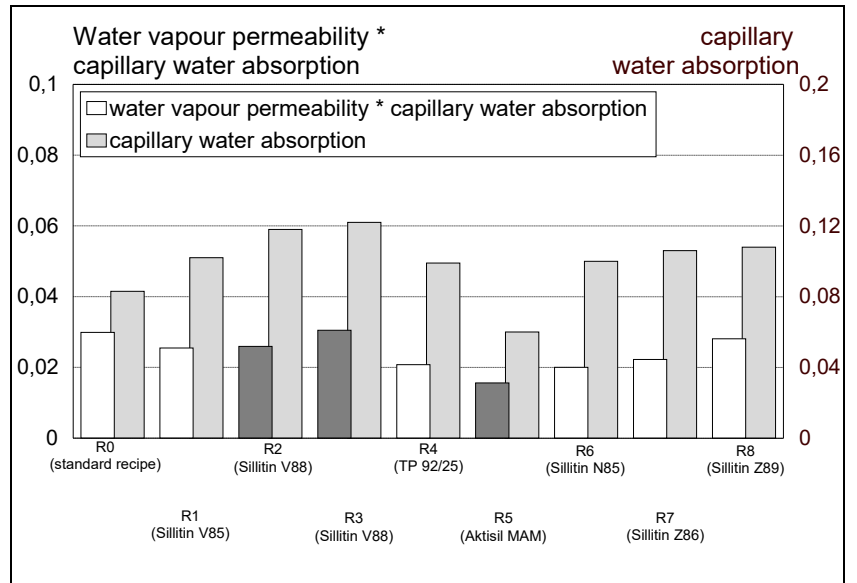


Fig. 6

In practice, water vapor permeability is given as water vapor diffusion, expressed as the air layer equivalent (sd) of diffusion. All types of Neuburg Siliceous Earth improve water vapor diffusion, i. e. a paint's ability to "breathe".

Our results show that the Neuburg Siliceous Earth not only easily fulfils the requirements of DIN 18 558, but actually achieves nearly the same levels as those obtained with silicon facade paints.

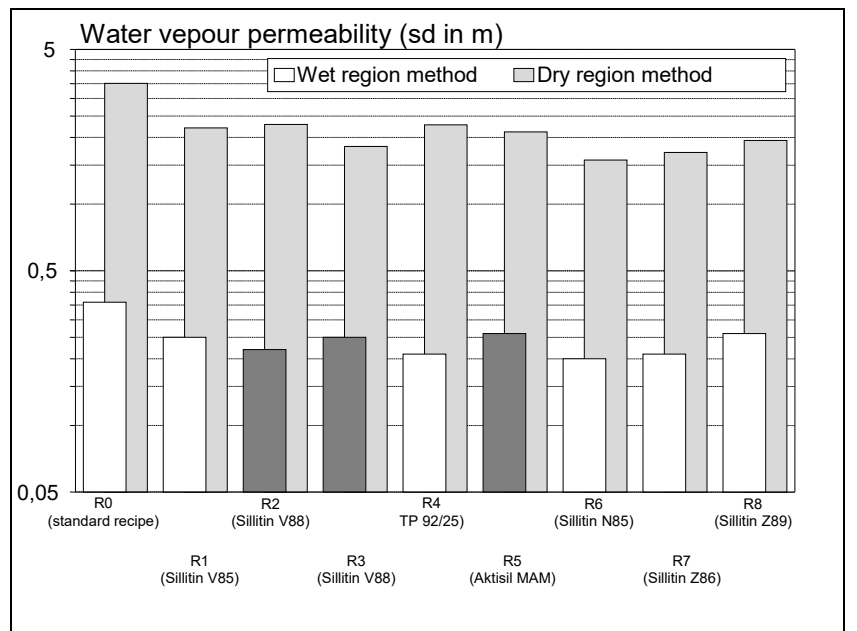


Fig. 7

4.3.2 Resistance to UV light (Xenotest)

Measurement of UV resistance is performed with a Xenotester, with the samples measured (two samples per recipe) before weathering and after 400 hours. For facade paints gloss and standard color value Y are used as the criteria.

Loss of gloss (Fig. 10) is slightly lower in the case of the Neuburg Siliceous Earth than the standard recipe R0.

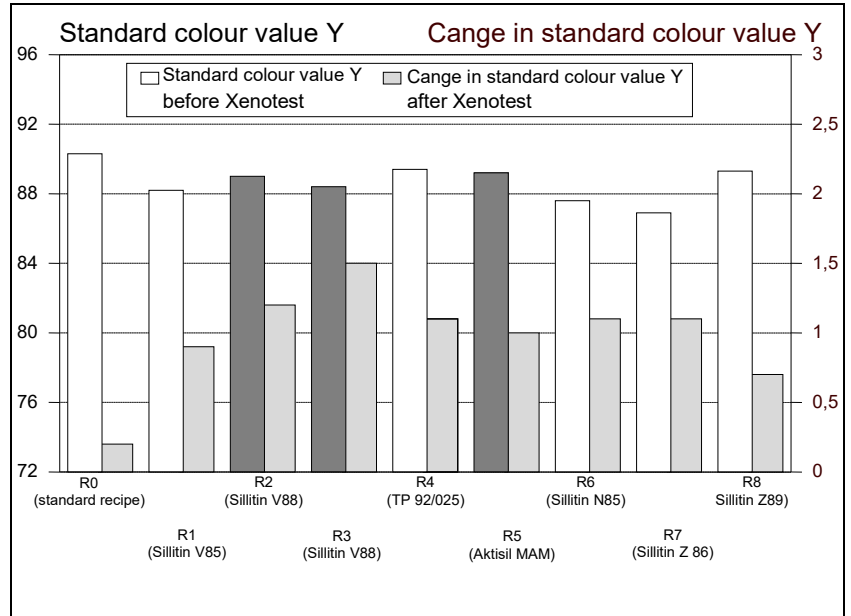


Fig. 8 Standard color value Y before and after 400 h Xenotest

UV light generally results in a slight increase in the standard color value Y. This effect is caused by binder loss at the paint surface, as the exposed surface causes light to scatter due to the difference in the refractive index between the mineral and air.

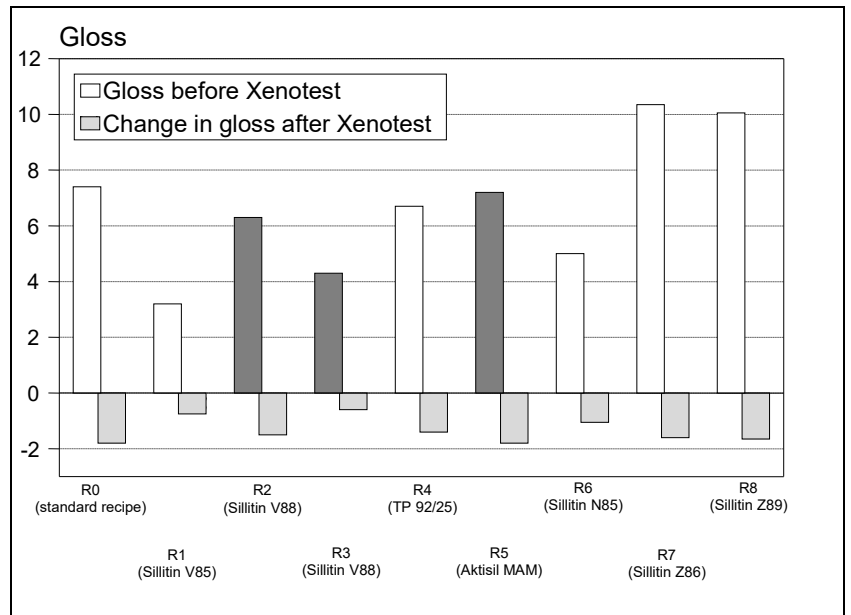


Fig. 9 Gloss before and after 400 h Xenotest

5 Assessment

Apart from specific advantages gained during application, there are some very attractive economic aspects.

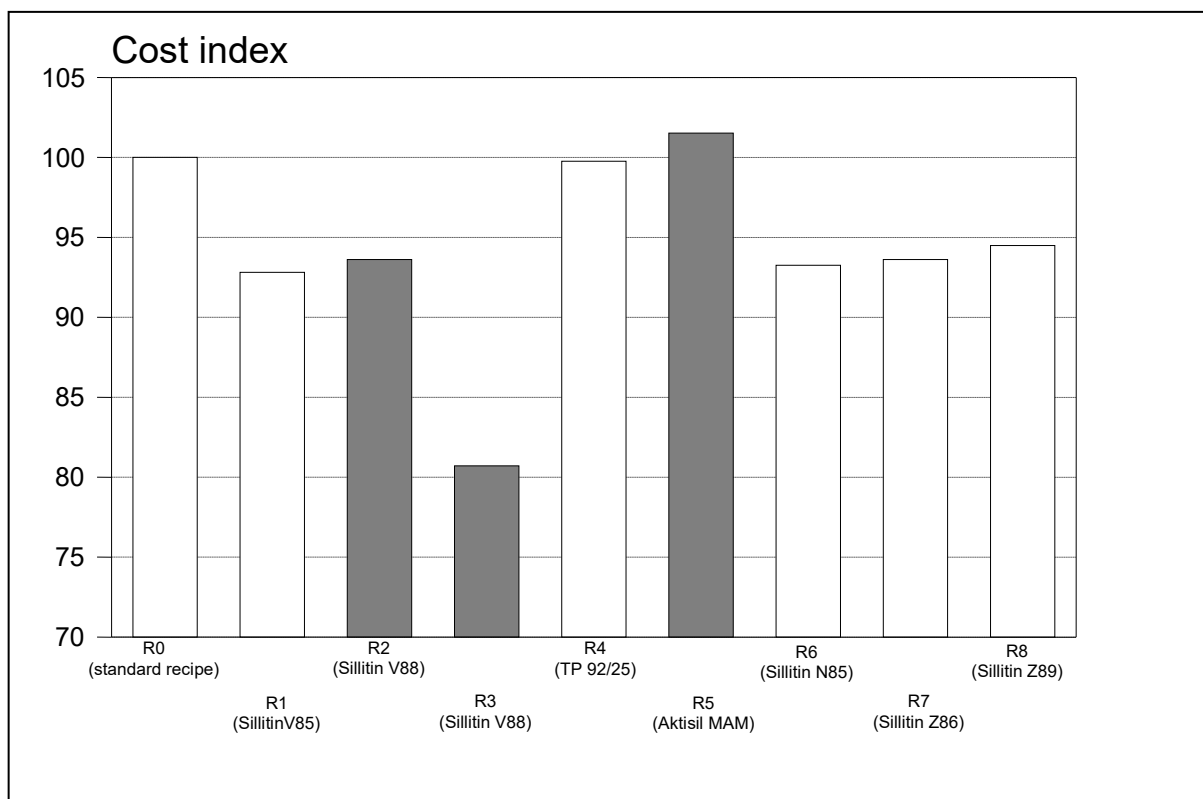


Fig. 11

The use of Neuburg Siliceous Earth results in a general improvement in the price/performance ratio. The increased costs of recipe R5 are more than compensated by the improvements obtained in technical values.

TiO₂ was also reduced in the recipe R3 (Sillitin V 88), in favor of Neuburg Siliceous Earth. In both cases this resulted in reduced raw material costs compared to the standard recipe R0.

Sillitin V 88 is an attractive functional filler that can be used in a wide range of applications with aqueous facade paints. Good to excellent results are achieved in nearly all criteria. Noticeable advantages in terms of recipe cost are also obtained, compared to the standard recipe. The excellent emulsion properties of the Neuburg Siliceous Earth results in further advantages in production.

For particularly high-quality applications we recommend the use of Aktisil MAM.

Our technical service suggestions and the information contained in this report are based on experience and are made to the best of our knowledge and belief, but must nevertheless be regarded as non-binding advice subject to no guarantee. Working and employment conditions over which we have no control exclude any damage claims arising from the use of our data and recommendations. Furthermore, we cannot assume any responsibility for any patent infringements which might result from the use of our information.

Filler and Pigment Content of the recipes

	Standard recipe	SILLITIN V 85	SILLITIN V 88	SILLITIN V 88	TP 92/25	AKTISIL MAM	SILLITIN N 85	SILLITIN Z 86	SILLITIN Z 89
Recipe	R0	R1	R2	R3	R4	R5	R6	R7	R8
Titanium dioxide	20,5	20,5	20,5	17,5	20,5	20,5	20,5	20,5	20,5
Calcite	12	12	12	6	12	12	12	12	12
Mica	2	2	2		2	2	2	2	2
CoarseTalc	7,5								
FineTalc	5								
SILLITIN V 85		11,7							
SILLITIN V 88			11,7	21,5					
TP 92/25					11,7				
AKTISIL MAM						11,7			
SILLITIN N 85							11,7		
SILLITIN Z 86								11,7	
SILLITIN Z 89									11,7