Titanium dioxide reduction

in interior emulsion paints

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VM-3/0599/05.2008

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Summary

This report shows how the usage of Titanium Dioxide can be reduced in interior emulsion paints. The results also serve as a guideline for other areas of application and binding systems.

The study is based on the fact that fine-grained fillers with a very loose granular structure such as Neuburg Siliceous Earth have good spacing properties without substantially affecting wash resistance.

We compared pure calcite as well as mixtures of calcite and talc, and also calcite and Neuburg Siliceous Earth.

Results:

- Addition of a silicate spacer considerably improves the contrast despite the reduction in Titanium Dioxide content.

- The partial replacement of Titanium Dioxide results in a lower performance in terms of scrub resistance. Using Neuburg Siliceous Earth this negative influence is considerably lower compared to formulations using talc.

C O N T E N T S

1 Introduction

Various strategies for enhancing the formulations of emulsion paints have been developed in view of the steady increase in costs for white pigment. A further important contribution in this direction has come from Huber[1]. Earlier studies on the use of Neuburg Siliceous Earth for road marking paints and facade paints[2] represent a further basis for this test concept. These tests show that both drying behavior as well as breathability and resistance to abrasion are positively influenced by these fillers.

There is very strong price pressure in the D-I-Y sector for cheap interior emulsion paints. For that reason, reducing production costs is an important factor in the success of new formulas. In order to do justice to more demanding users, raw materials with a balanced price/performance ratio must therefore be used.

Due to the different particle structure, Titanium Dioxide usage was reduced by substituting talc at a ratio of 1:2 and by Neuburg Siliceous Earth at a ratio of 1:4. To keep the pigment volume concentration constant, calcite was reduced proportionately in each case.

2 Objectives

Our objective was to reduce raw material costs by cutting back on the amount of Titanium Dioxide used, at the same time improving the operational characteristics of the paints.

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1 Huber, Heinz "farbe + lack" 96 H. 1/1990 p. 24 - 26

2 HOFFMANN MINERAL "Filler Optimization for Road Marking Paint"
HOFFMANN MINERAL "Filler Comparison for Solvent Based Facade Paint"

3 Testing

3.1 Raw Material Characteristics

The main values (taken from manufacturer data) are summarised in the tables below:

Filler/Pigment	Oil absorption in g/100 g	Particle size d_{50} in µm	Brightness (DIN 53 163)[3]		pH value	Price index[4]
			Y	Z		
Talc	50	2.5	96	103	8.6	2.8
Calcite	15	5	94	97	9	0.6
Sillitin Z 89	50	1.8	89	89	8.5	1.0
Titanium Dioxide	20	--	--	--	--	9.3

3.2 Recipes

All recipes were based on a uniform recipe (R0) where only the filler/pigment volumes were varied (see last page in report).

Raw materials	Mass	Use	Manufacturer
deionised water	20.3	solvent	
Tylose 6000xp (2 % solution in deionised water)	10.5	thickener	Hoechst AG
Nopco 8034	0.3	defoamer	Henkel KGaA
Additol XW 330	0.7	wetting agent	Hoechst AG
Ammonia, 25 % solution	0.2	pH correction	
Texanol	1.0	flow improving agent	Krahn Chemie
Acronal 290 D	10.0	binder	BASF AG
Titanium Dioxide (rutile 96 % TiO_2)	18	pigment	
Calcite	39	filler	

3 These values were evaluated in our laboratory by comparative measurements.
4 The price indices are based on the ex-works-price of Sillitin Z 89 (index = 1)

Filler and Pigment Content of the recipes with Talc

	R0	R1T	R2T	R3T	R4T	R5T	R6T
Titanium dioxide	18	16	14	12	10	8	6
Calcite	39	37	35	33	31	29	27
Talc		4	8	12	16	20	24
PVC [%]	79.64	79.83	80	80.16	80.31	80.49	80.64

Filler and Pigment Content of the recipes with Sillitin Z 89

	R0	R1Z89	R2Z89	R3Z89	R4Z89	R5Z89	R6Z89
Titanium dioxide	18	16	14	12	10	8	6
Calcite	39	33	27	21	15	9	3
Sillitin Z 89		8	16	24	32	40	48
PVC [%]	79.64	79.96	80.29	80.56	80.86	81.11	81.4

3.3 Making up of Test Articles

3.3.1 Preparation of Emulsions

1 kg batches were made up uniformly with the aid of a laboratory mixer "Dispermat F 105" from the VMA Getzmann company as follows:

- Take water, add 2 % Tylose solution;
- mix in Nopco 8034 D, Additiol XW 330, ammonia and Texanol;
- add pigment and filler and mix to an emulsion for 20 minutes at a mixing speed of 15 to 20 m/sec;
- add Acronal 290 D, homogenise for approx. 10 minutes and filter through sieve (150 µm);

The paints were conditioned at room temperature at least for 24 hours before further processing.

3.3.2 Preparation of Specimens

By adding water, the emulsion were made up to a viscosity of 18 ± 6 sec using a 6 mm DIN viscosity cup. Grain size was determined with a "Hegman Grindometer" according to DIN 53 203.

The films were applied using a "Micro-processor-controlled Film Applicator and Drying Time Recorder", model 509/3 from the Erichsen company.

Optical testing was performed by applying the coats to background contrast cards "Form 10 H-BW" from the Leneta company. A uniform wet film thickness of 200 µm was applied as the solid content in all recipes is nearly the same, giving the same dry film thickness for all test specimens. The specimens were measured after a 48 hours drying period at room temperature.

The abrasion testing was based on DIN 53 778. This involves applying a dry film thickness of 100 ± 5 µm to plastic strips, type 255 from the Erichsen company. The coated strips were stored for 28 days at room temperature before testing.

3.4 Characterization of Coatings

The pH value, viscosity and grain size of the recipes was determined. This showed that the type of filler combination had no significant effect on these characteristics. The pH values for talc tended to be very slightly higher.

4 Results

4.1 Optical Tests

4.1.1 Tristimulus Value Y

These values were measured using the MiniScan spectro-photometer (measured optically at d/8°) from the Hunterlab company. Normal light type D 65 was used as a light source with observation made at an angle of 10°.

The values were measured on two strips at three different points. The results were evaluated from the mean values.

All recipes fulfilled the mini-mum requirements specified by DIN 53 778.

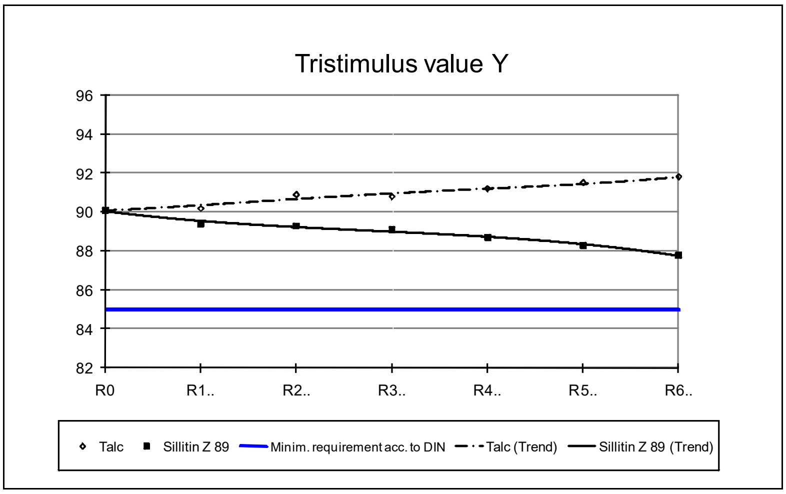

Figure 1

4.1.2 Tristimulus Value Z

The tristimulus value Z was measured in the same manner as described in 4.1.1. This value subjectively describes the yellowing of the specimen.

Discoloration by **Sillitin Z 89** leads to a reduction in the tristimulus value Z at higher doses.

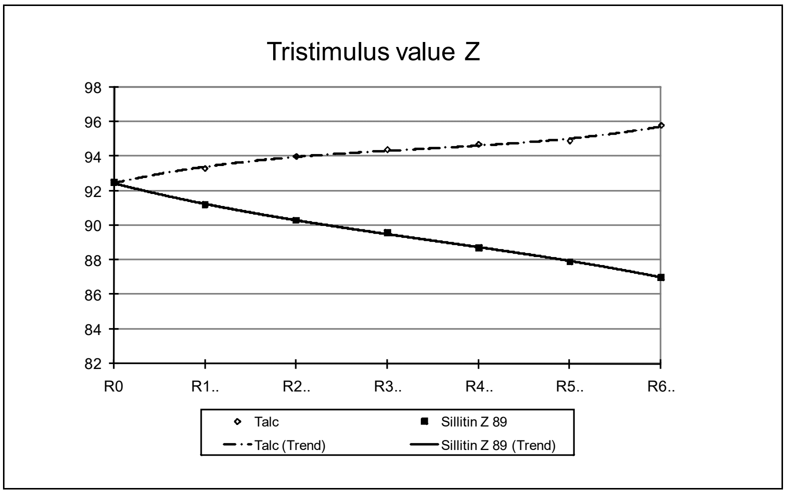

Figure 2

4.1.3 Contrast ratio (dry)

The value was obtained through the measurement of the Y value of the coating over the Black and White base. The contrast ratio was calculated according to the following formulae:

$$KV = \frac{Y_{(black)}}{Y_{(white)}} \times 100 \quad [\%]$$

Neuburg Siliceous Earth has a better dry contrast ratio (spacer effect) compared to talc, enabling a reduction in film thickness.

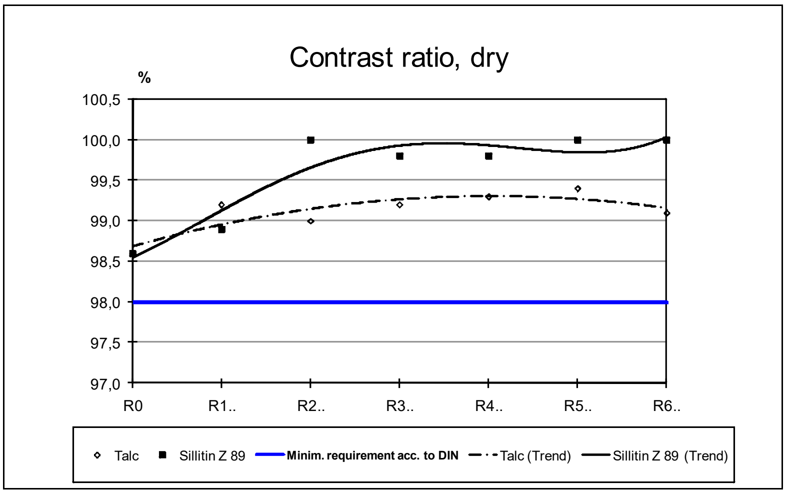

Figure 3

This not only reduces material costs, but also has a favorable effect on the breathability of the coat.

4.1.4 Contrast ratio (wet)

In order to measure the wet contrast ratio, dry coats were placed in de-ionized water for 15 minutes to allow the micropores to fill completely with water. This prevents light refraction at the pore surfaces (prevents high-drying hiding effects). After storing in water, the coats were covered with a thin transparent PVC foil to prevent the water from evaporating. The wet contrast ratio was then determined in the same manner as described under 4.1.3.

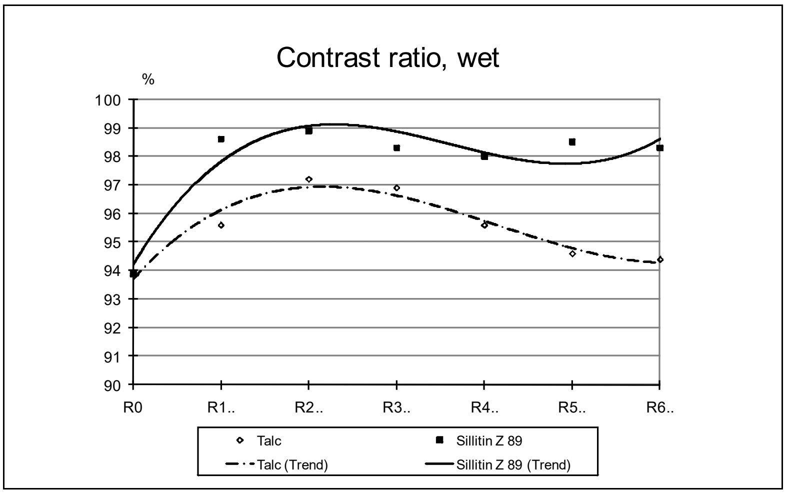

Figure 4

The higher the wet contrast ratio, the less number of coats required. This means a saving on material and application time. The costs of carrying out renovations at a later date can thus be considerably reduced.

The results show the same trend as for the dry contrast ratio. This underlines the excellent spacer effect of Neuburg Siliceous Earth. The wet contrast ratio falls considerably when higher doses of talc are applied.

4.1.5 Gloss according to DIN 67 530

Gloss was measured using a "Mini Glossmaster" from the Erichsen company.

Two test boards were coated per recipe and allowed to dry at room temperature for 48 hours. The test specimens were then subjected to 5 individual measurements each, and the arithmetic mean calculated from the 10 measured values.

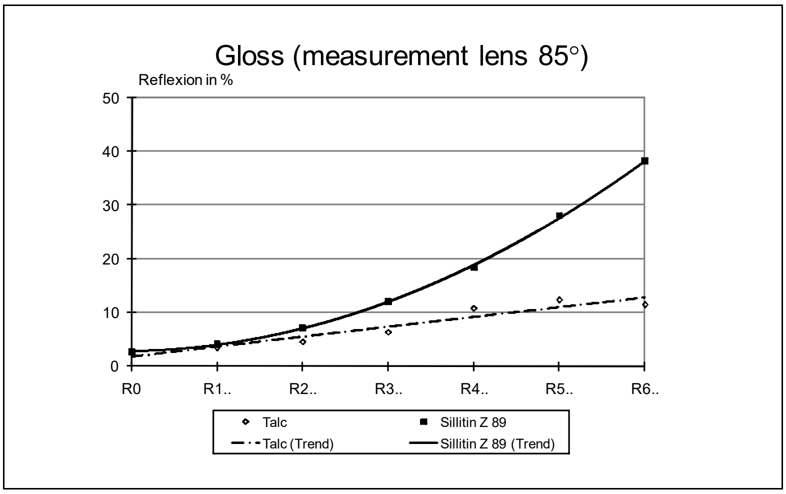

Figure 5

The base recipe R0 (with calcite) did not fulfill the requirements of DIN 53 778 for mat interior emulsion paints. Recipes R3T and R2Z89 each achieved the required value of 7 ± 1.

4.2 Wash and Scrub Resistance according to DIN 53 778 Part II

Wash and scrub resistance were tested according to DIN 53 778 Part II using an abrasion tester, model 494 from the Erichsen company. This test allows an assessment of the wash resistance of interior emulsion paints after repeated wash procedures.

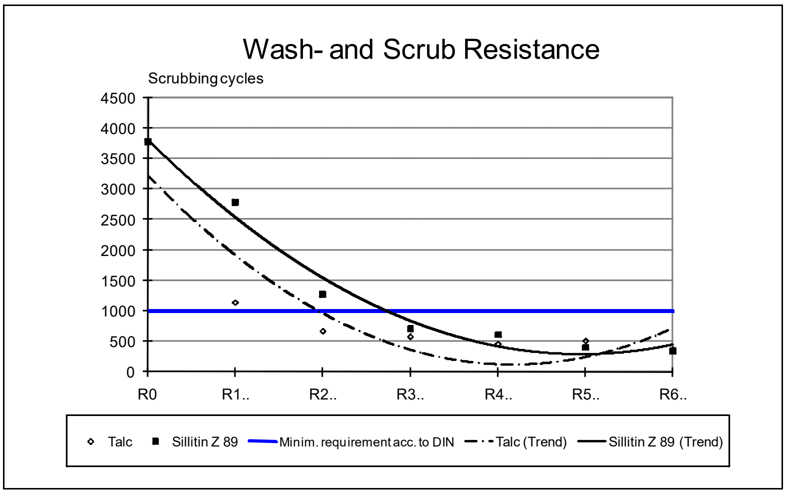

Figure 6

The test results show that scrub resistance generally decreases proportional to the increase in Titanium Dioxide. The addition of talc causes a sharper decrease in scrub resistance than occurs with Neuburg Siliceous Earth.

That means that by adding talc, the Titanium Dioxide content can be reduced by around 11 % (2 parts), whereas a reduction of around 22 % (4 parts) can be obtained by using **Sillitin Z**. In accordance with the DIN requirement, no less than 1000 scrubbing cycles were used to test for scrub resistance.

5 Conclusions

The results of our tests concur with those of Huber[1]. The hypothesis that the considerable spacing effect of very loosely structured fillers results in improved covering characteristics despite reduction of the pigment content (TiO_2) was confirmed.

Due to its special structure of the combination of corpuscular, crypto-crystalline and amorphous silica and lamellar kaolinite, Neuburg Siliceous Earth achieved a considerably better spacing effect than talc (pure lamellar structure).

The results of the scrub resistance tests were decisive in the overall assessment. This showed that while complying to the DIN requirement the addition of Neuburg Siliceous Earth resulted in a 22 % reduction of Titanium Dioxide, while only 11 % could be saved by using talc.

Sillitin Z 89 can be used to formulate more cost effective interior emulsion paints. The effect on material costs are shown in the table below.

Recipes	R0	R1T	R2T	R1Z89	R2Z89	R1SZ	R2SZ
Raw material costs index [5]	100	95	90	92	86	97	94

[5] Standard recipe R0 = 100; Raw material prices in Germany as of 1991.