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Talc in Protective Coatings to obtain Good Barrier and Anti-Corrosion Properties

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INTRODUCTION

One of the most important development targets in the paint and coating industry for many years has been to reduce the volatile organic compounds (VOC) in the formulations. The development of high solids and water based coatings has been an attempt to reduce VOC emissions. In the movement towards low VOC solvent borne coatings, little attention has been given to pigmentation.

With a new generation of polymer binders, adequate pigmentation is absolutely necessary to provide a paint film with the necessary optical and protective properties. With these new developments extenders have become more specific and more functional than before. In the sectors of metal protection, maintenance and marine coatings, all development tendencies are towards low VOC systems.

Talc is the preferred extender in traditional protective coatings due to its good barrier and anti-corrosion properties. In many cases, talc's high resin demand (high oil absorption number) restricts its use at high loadings in low VOC coatings. A new talc product with a low oil absorption number combined with good anti-corrosion and a sharp top cut has been developed. This new type of talc product, FINNTALC D30E, is based on pure, macro-crystalline talc ore, purified by the flotation process. Both ends of its PSD are classified. The coarse end of its PSD is sharpened in such a way that the fineness requirement is met; no particles bigger than 45 µm. The fines content is then reduced to lower the resin demand to a level that enables the production of VOC compliant coatings.

The purpose of this study is to compare the performance of the new low oil absorption talc, FINNTALC D30E, with the performance of three other commonly used talc types. The talc grades were tested in a commercial solvent based 2 pack epoxy primer whose pigment volume concentration (PVC) and solid content were relatively high.

TALC GRADES USED IN THIS STUDY

The properties of talc grades used in this study are given in Table 1. All the talc grades had the same fineness of grind (Hegman fineness), but they varied in mineralogical composition and in the shape of their PSD curve.

The oil absorption value of the talc used in protective coating is very important. The oil absorption of talc is effected by its mineralogical composition, morphology and PSD. Pure and platy talc has a quite high oil absorption at a given fineness. When talc contains by-minerals such as magnesite ($MgCO_3$), dolomite (Ca,Mg-carbonate) or chlorite (Al-Mg-silicate) its oil absorption value is lowered. The platiness of talc varies from deposit to deposit and has a big impact on the oil absorption value. Talc grades that consist of small plates have lower oil absorption than talcs with big plates. The lower platiness is beneficial from an oil absorption point of view, but the protective properties are reduced compared with platy talc. The best protection is therefore achieved by pure platy talc whose oil absorption value is reduced by modifying its PSD. Figure 1 shows how the PSD and mineralogical composition affect the oil absorption value of talc product at a constant fineness of grind.

PROPERTY	UNIT	METHOD	PURE, PLATY, STANDARD TALC	MAGNESITE RICH TALC	CHLORITE RICH TALC	FINNTALC D30E
COMPOSITION						
TALC	%	XRD + LOI + Acid solubles	97	63	50	96
$MGCO_3$	%		1.5	37		2.5
CHLORITE	%		1.5		50	1.5
DOLOMITE	%					
LOSS ON IGNITION	%	1000 °C / 0,5 h	5.8	20.6	8.2	6.6
ACID SOLUBLES	%	1 M HCL, 100 °C	3.0	36.9	6.7	3.5
PARTICLE SIZE						
HEGMAN FINENESS	µm	ASTM D 1210-79	4	4	4	4
AVERAGE PS, D50	µm	Sedigraph 5100	4.5	4.5	5.2	9.0
TOP CUT, D98	µm	Sedigraph 5100	20	20	20	20
OIL ABSORPTION	g/100 g	ISO 787/5	43	36	29	29
SPECIFIC SURFACE AREA	m^2/g	BET, ISO 4652	6.1	6.6	4.2	5.0
WHITENESS, RY	%	DIN 53163	83.0	77.0	82.0	81.5

Table 1: The properties of talc grades used in the study

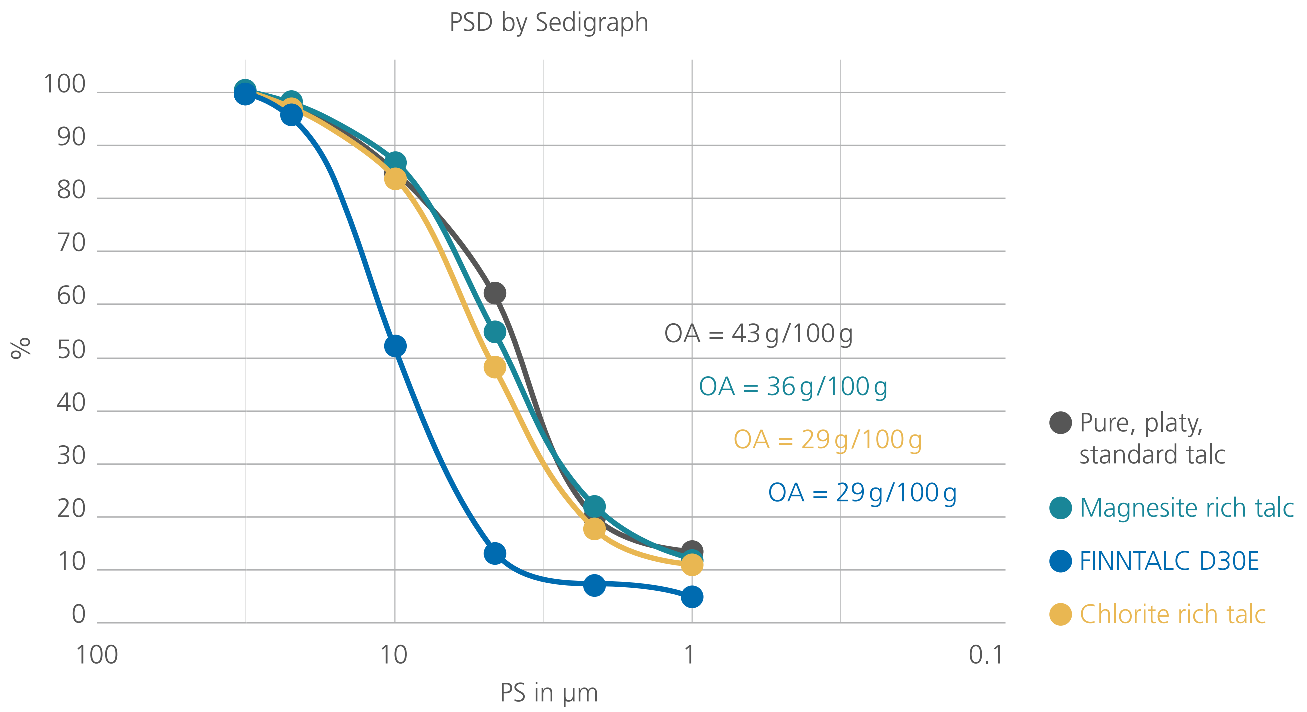

Figure 1: Particle size distribution of traditional types of talc and low oil absorption talc at the same fineness of grind (Hegman 4)

DESCRIPTION OF EXPERIMENTS

The paint formulation used was a solvent based 2 pack epoxy primer based on solid epoxy resin and a polyamide hardener. The components were mixed in the stoichiometric ratio 4:1 by volume. The starting formulation was a commercial general purpose anti-corrosion primer for steel protection.

Two series of paints were evaluated. In the first series each talc grade was milled to the PVC and solid content which gave the same application viscosity as the starting formulation using the reference talc. The target viscosity was 3000–4000 cP measured by Brookfield RVDV-II+ viscometer (spindle 6, 50 rpm). In practice the amount of talc and solvent content were changed in the formulations. In the second series the PVC was kept constant (PVC = 51 v%) and the solids content was changed in such a way that the same application viscosity was achieved as in the first test series. In this series the amount of solvent was changed and the other components in the formulation were kept constant. Magnesite rich talc was not used in the second test series because it had worse loadability than the standard talc.

RAW MATERIAL	w%
Solid epoxy	19.47
Auxiliary resin	1.80
Acrosolv PM	3.00
Thickener	0.93
Wetting agent 1	0.26
Wetting agent 2	0.26
Talc, pure, platy standard type	24.88
$BaSO_4$	18.93
TiO_2	7.03
Pigment	1.08
Xylene	15.68
Iso-butanol	6.71
Total, w%	100
PVC_{tot}, v%	51
Solid content by weight, w%	68.9
Solid content by volume, v%	45.1
Density, g/ml	1.514
VOC, g/l	471

The test formulation

The anticorrosion properties of the paints were studied according to ISO-standards:

- continuous neutral salt spray, 381 h (ISO 7253) and
- water condensation, 240 h (ISO 6270).

The paints were applied on sand blasted steel panels (Sa 21/2) by using a high pressure airless spray gun. The dry film thickness was 80–90 µm. After the application the panels were left to dry at room temperature for one week before the start of tests. Three parallel test panels were prepared for each paint. Visible defects on the test panels (degree of rusting and blistering) were evaluated immediately after the end of the test according to ISO 4628 standard. The adhesion tests were carried out according to ISO 4624 standard by using a hydraulic pull-off tester.

Photo 1: Salt spray chamber

RESULTS AND DISCUSSIONS

The anticorrosion performance of different talc grades in the first test series is given in Table 2. There were no surface defects (blistering or rust dots) in any of the paints after humidity testing for 240 hours. The adhesion was also good for all the paints after the humidity test. However, the drop of adhesion was smallest with FINNTALC D30E.

After the salt spray test (381 h), blisters with the size of class 2 and some rust dots appeared on all test panels. The reference talc and magnesite talc had a few small rust dots all over the panels and the rusting class of these talc grades was between 0 and 1. The reference talc had also a few blisters all over the panels. The other panels contained a few blisters and some rust dots only at the scratch site. The amount of rust dots and blisters were lowest with FINNTALC D30E. It must be noted that the paint with FINNTALC D30E had a higher solid content and PVC than the reference paint, but it still had better anti-corrosion properties.

The anti-corrosion performance of different talc grades in the second test series is given in Table 3. In this series the PVC was kept constant and the amount of solvents was reduced to get the same application viscosity as the reference paint had. The highest solid content was achieved by FINNTALC D30E which means that its VOC content could be reduced by more than 10 % while still the anti-corrosion properties were best.

	PURE, PLATY, STANDARD TALC = REF.	MAGNESITE RICH TALC	CHLORITE RICH TALC	FINNTALC D30E
PVC_{tot}, v%	51	50	53	56
SOLIDS BY VOLUME, v%	45.1	44.3	46.9	49.3
SOLIDS BY WEIGHT, w%	68.9	68.0	70.6	72.7
TALC CONTENT, w%	24.9	22.8	27.3	31.2
DENSITY OF PAINT, g/ml	1.514	1.495	1.547	1.595
VOC, g/l	471	478	455	435
ADHESION (ISO 4624) BEFORE TESTS IN MPA AND TYPE OF BREAKAGE	5.6 (100 % B)	5.6 (100 % B)	6.5 (100 % B)	6.0 (100 % B)
CONDENSATION (ISO 6270, 240 h)				
VISIBLE SURFACE DEFECTS (ISO 4628)	–	–	–	–
ADHESION AFTER TEST, MPa	4.8 (100 % B)	4.8 (100 % B)	6.3 (100 % B)	6.5 (100 % B)
SALT SPRAY TEST (ISO 7253, 381 h)				
DEGREE OF RUSTING (ISO 4628)	Ri = 0-1; a few rust dots all over the panel.	Ri = 0-1; a few rust dots all over the panel.	Ri = 0; a few rust dots at scratch.	Ri = 0; a few rust dots at scratch.
BLISTERING (ISO 4628)	2 (S2); blister all over the panel.	2 (S2); blisters at scratch.	1 (S2-3); a few blisters at scratch.	1 (S2); a few blisters at scratch.
ADHESION AFTER TEST, MPa	4.8 (100 % B)	6.9 (100 % B)	6.2 (100 % B)	6.3 (100 % B)
OVERALL PERFORMANCE	Adequate	Adequate	Good	Very good

Table 2: Anti-corrosion properties of different talc types in solvent based 2 pack epoxy primer at constant application viscosity

B = cohesion type breakage of coating film

	PURE, PLATY, STANDARD TALC = REF.	CHLORITE RICH TALC	FINNTALC D30E
PVC_{tot}, v%	51	51	51
SOLIDS BY VOLUME, v%	45.1	49	51.1
SOLIDS BY WEIGHT, w%	68.9	72.2	73.8
TALC CONTENT, w%	24.9	26.1	26.7
DENSITY OF PAINT, g/ml	1.514	1.575	1.603
VOC, g/l	471	438	420
ADHESION (ISO 4624) BEFORE TESTS IN MPA AND TYPE OF BREAKAGE	5.6 (100 % B)	6.6 (100 % B)	6.9 (100 % B)
CONDENSATION (ISO 6270, 240 h)			
VISIBLE SURFACE DEFECTS (ISO 4628)	–	–	–
ADHESION AFTER TEST, MPa	4.8 (100 % B)	5.5 (100 % B)	7.1 (100 % B)
SALT SPRAY TEST (ISO 7253, 381 h)			
DEGREE OF RUSTING (ISO 4628)	Ri = 1; a few rust dots all over the panel.	Ri = 0; a few rust dots at and below scratch.	Ri = 0; a few rust dots at scratch.
BLISTERING (ISO 4628)	2 (S2); blister all over the panel.	2 (S2); blisters at scratch.	1 (S2); a few blisters at scratch.
ADHESION AFTER TEST, MPa	4.8 (100 % B)	6.4 (100 % B)	7.0 (100 % B)
OVERALL PERFORMANCE	Adequate	Good	Very good

Table 3: Anti-corrosion properties of different talc types in solvent based epoxy primer at constant PVC and at constant application viscosity

B = cohesion type breakage of coating film

CONCLUSIONS

The anti-corrosion performance of the low oil absorption talc, FINNTALC D30E, was compared with three other commercial talc types in commercially used solvent borne general purpose epoxy primer. The formulation was based on solid epoxy resin and a polyamide hardener. The components were mixed in the stoichiometric ratio 4:1 by volume. The test formulation had a high pigment volume concentration (PVC = 51 v%) and a relatively high solid content. All the talc grades had the same top cut (Hegman fineness 4), but the mineralogical composition varied.

The study showed that by pure, platy and low oil absorption talc (FINNTALC D30E) the solid content and PVC in the paint formulations could be increased without increasing the viscosity compared with traditional high solvent containing formulations and at the same time the anti-corrosion properties were improved. This means that FINNTALC D30E type talc helps to develop VOC compliant paint with reduced formulation costs and with improved coating performance. The benefits of the low resin and diluent demand of FINNTALC D30E can be utilised in all the paint and coating systems where an increased solids content is desired.

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