LITHOPONE in paints and coatings

Great Solutions with Small Particles

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Efficiency is a vital factor in market survival and one of the many factors that decide efficiency is correct materials selection, which must balance the need for quality, on the one hand, with the need for the lowest possible costs, on the other.

Titanium dioxide is one of the main raw material in the production of emulsion paints. LITHOPONE can play a key role as an alternative, with no loss of quality. Increasingly large quantities of LITHOPONE are being incorporated into emulsion paints for this reason. The following article examines the benefits offered by LITHOPONE in emulsion paints and describes in detail the procedure for adjusting paint formulations for the use of LITHOPONE.

LITHOPONE –
Rules for modifying formulations

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There are 6 simple rules which should be noted when modifying an emulsion paint to use LITHOPONE:

- **Rule 1**
  Around 20 to 60% of the TiO_2 in the formulation can be replaced with LITHOPONE 30% L.
- **Rule 2**
  The ratio for replacement of TiO_2 : LITHOPONE 30% L is
  1 : 2.5–3.0
- **Rule 3**
  The original volume of pigment and extenders can be kept constant by reducing the volume of the coarsest extender.
- **Rule 4**
  Binder content is reduced, since the total surface area of the pigments and extenders has changed.
- **Rule 5**
  The wetting-agent content is reduced, since the total surface area of the pigments and extenders has changed.
- **Rule 6**
  Water content (or solvent content) is reduced.

These rules are discussed in more detail below. The example of an interior emulsion paint is used to calculate replacement of 50% of TiO_2 content with LITHOPONE, while simultaneously increasing pigment surface concentration (PSC) to 95%.

Rules for modifying formulations

Rule 1:

Around 20 to 60% of the titanium dioxide in the original formulation can be replaced with LITHOPONE. The precise percentage of partial replacement in any specific formulation should be determined in advance by means of testing, using a test series (replacement of e.g. 20%, 40% and 60% of the titanium dioxide), for example, and assessment of the results.

Application	PVC in %	Replaceable TiO_2 content in %	Replacement ratio TiO_2 : LITHOPONE 30% L
Interior emulsion paint	approx. 75	40–60	1 : 2.5–3.0
Universal emulsion paint	approx. 60	30–50	1 : 2.5
Exterior emulsion paint	approx. 40	20–30	1 : 2.2–2.5

Rule 2:

One part titanium dioxide by weight is normally replaced by 2.5 to 3.0 parts LITHOPONE 30% L by weight. The actual replacement ratio depends both on total pigment volume concentration (PVC) and on the quantity of titanium dioxide which it is desired to replace.

Definition of
Pigment **V**olume **C**oncentration:

$$PVC = \frac{V_P + V_F}{V_P + V_F + V_B}$$

V_P: Pigment volume
V_F: Extender volume
V_B: Binder-solids volume

Example (application of rule 1+2)

Interior emulsion paint, in which 50% of the TiO_2 content is to be replaced, while pigment surface concentration is raised simultaneously to 95%.

- **Rule 1**
  50% of the TiO_2 is to be replaced (reduced from 60 parts by weight to 30 parts by weight) and
- **Rule 2**
  Replacement ratio of TiO_2 : LITHOPONE 30% L is to be 1:3 (90 parts LITHOPONE 30% L by weight instead of 30 parts TiO_2 by weight).

	Parts by weight g		Density g/cm³	Volume cm³	
	Basic	Modification		Basic	Modification
LITHOPONE 30%L	0.00	90.00	4.30	0.00	20.93
SACHTLEBEN R210	60.00	30.00	4.00	15.00	7.50
Durcal 2	120.00	120.00	2.80	42.90	42.90
Durcal 5	200.00	200.00	2.80	71.43	71.43
Durcal 10	100.00	100.00	2.80	35.70	35.70
Acronal 290 D (50%)	90.00	90.00	(solid) 1.10	40.90	40.90
Calgon N	1.50	1.50	**Total**	**205.93**	**219.36**
Dispex G 40	2.00	2.00	**PVC in %**	**80.14**	**81.35**
Tylose MHB 15000	5.50	5.50			
Agitan 280	2.00	2.00			
CA 24	2.00	2.00			
Ammonia	4.00	4.00			
Texanol	15.00	15.00			
Water	344.50	344.50			

PVC in this replacement procedure would increase from 80.14 to 81.35 parts by volume if no further adjustments were to be made. The coarsest extender content - Durcal 10, in this case - is correspondingly reduced, in order nonetheless to keep PVC constant.

Rules for modifying formulations

Rule 3:

The pigment and extender content by volume is to remain constant in this replacement procedure. The coarsest-extender content should be reduced correspondingly, in order to maintain the original volume ratio.

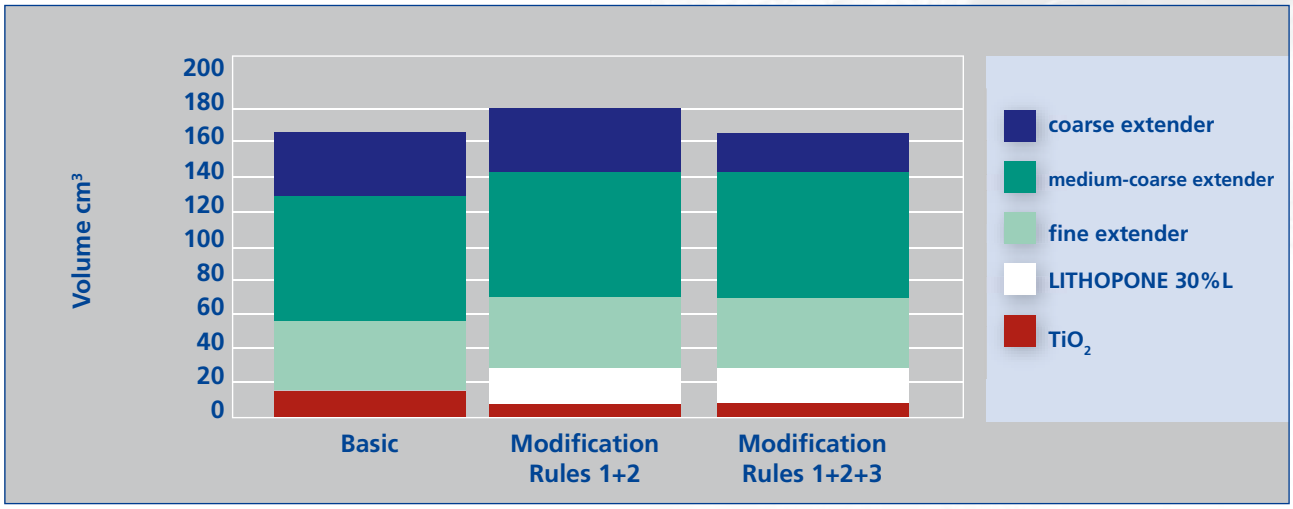
Modification volume	- Basic volume	= Volume of reduced extender content
219.4 cm^3	- 205.9 cm^3	= 13.5 cm^3

The coarsest extender is Durcal 10, with a density of 2.8 g/cm^3

13.5 cm^3 x 2.8 g/cm^3 = 37.8 g

Original amount	- calculated reduction	= new amount
100.0 g	- 37.8 g	= 62.2 g

The formulation modified with LITHOPONE now contains only 62.2 parts Durcal 10 by weight, instead of the previous 100.



An emulsion paint modified using LITHOPONE as described above exhibits equally good and in some cases actually better scattering power, lightness, colour shade, viscosity, abrasion resistance and storage stability than the original formulation.

Example (application of rule 1+2+3)

Interior emulsion paint, in which 50% of the original TiO_2 content is to be replaced, while raising PSC to 95% simultaneously.

- **Rule 1**
  50% of the TiO_2 is to be replaced (from 60 parts by weight to 30 parts by weight)
- **Rule 2**
  Replacement ratio of TiO_2 : LITHOPONE 30% L
  is to be 1:3 (90 parts LITHOPONE 30% L by weight instead of 30 parts TiO_2 by weight).
- **Rule 3**
  The coarsest extender content is reduced until the original PVC is reached.

	Parts by weight g		Density g/cm³	Volume cm³	
	Basic	Modification		Basic	Modification
LITHOPONE 30%L	0.00	90.00	4.30	0.00	20.93
SACHTLEBEN R210	60.00	30.00	4.00	15.00	7.50
Durcal 2	120.00	120.00	2.80	42.90	42.90
Durcal 5	200.00	200.00	2.80	71.43	71.43
Durcal 10	100.00	62.20	2.80	35.70	22.21
Acronal 290 D (50%)	90.00	90.00	(solid) 1.10	40.90	40.90
Calgon N	1.50	1.50	**Total**	**205.90**	**205.87**
Dispex G 40	2,00	2,00	**PVC in %**	**80.13**	**80.13**
Tylose MHB 15000	5.50	5.50			
Agitan 280	2.00	2.00			
CA 24	2.00	2.00			
Ammonia	4.00	4.00			
Texanol	15.00	15.00			
Water	344.50	344.50			

Rules for modifying formulations

Rule 4:

The amount of binder in the formulation can also be adjusted, since a pigment/extender system modified with LITHOPONE 30% L has a lower binder demand than the original formulation. The surface area becomes smaller, since LITHOPONE has a specific surface area of only 3 m^2/g, whereas titanium dioxides can have specific surface areas of more than 25 m^2/g.

Washability and abrasion resistance are increased if binder input is not reduced. It has been observed in some cases that the scattering coefficient does not quite achieve the value of the original formulation. Reduction of binder content and/or an increase in PVC improves the light scattering coefficient by enhancing the paint's "dry-hiding effect". The binder content can be reduced to the point at which the desired washability and scrub resistance are achieved.

A measure of binder quantity is provided by the so-called pigment surface concentration (PSC).

Definition of **P**igment **S**urface **C**oncentration:

$$PSC = \frac{S_P + S_F}{V_B}$$

S_P: Pigment surface
S_F: Filler surface
V_B: Binder solids volume

Experience indicates that the PSC level in the modification should be around 85% to 95% of that of the basic formulation.

Definition of **P**igment **S**urface **C**oncentration Level:

$$PSC\text{-}Level = \frac{PSC_{Mod}}{PSC_B}$$

PSC_{MOD}: Pigment surface concentration of the modification
PSC_B: Pigment surface concentration of basic formulation

The following results from this for binder-solids concentration, using the definition of PSC:

$$V_{BMod} = \frac{(S_{PMod}+S_{FMod}) \times V_{BBasis}}{PSC\text{-}level \times (S_{PBasic}+S_{FBasic})}$$

$$V_{BMod} = \frac{1916.30 \times 40.90}{0.95 \times 2360.00} = 34.96\ cm^3$$

W_{BMod} = V_{BMod} x ρB x Binder concentration

W_{BMod} = 34.96 x 1.10 x (100/50) = 76.91

W_{BMod} = Parts binder by weight in the modification
ρ_B = Binder density

Rule 5:

LITHOPONE 30% L has a significantly lower specific surface area than titanium dioxide and therefore requires less wetting agent to achieve optimum wetting of its surface. A reduction in wetting-agent content is also necessary because of the fact that an excess of this substance has negative effects on the mechanical strength, and thus on the washability and scrub resistance, of the product.

Wetting-agent requirement:

$$V_{\text{wetting-agent, mod}} = \frac{V_{\text{wetting-agent, basic}} \times S_{\text{(P+F)mod}}}{S_{\text{(P+F). basic}}}$$

$$V_{\text{Calgon, mod}} = \frac{1.5 \times 1916.13}{2360.00} = 1.22$$

$$V_{\text{Dispex G40}} = \frac{2.0 \times 1916.13}{2360.00} = 1.62$$

Example (application of rule 1+2+3+4+5)

Interior emulsion paint, in which 50% of the original TiO_2 content is to be replaced, while raising PSC to 95% simultaneously.

- **Rule 1**
  50% of the TiO_2 is to be replaced (from 60 parts by weight to 30 parts by weight)
- **Rule 2**
  Replacement ratio of TiO_2 : LITHOPONE 30% L
  is to be 1:3 (90 parts LITHOPONE 30% L by weight instead of 30 parts TiO_2 by weight).
- **Rule 3**
  The coarsest extender is reduced in content until the original PVC is reached.
- **Rule 4**
  The binder content is adjusted so that the PSC level is 95% of that of the basic formulation.
- **Rule 5**
  Wetting-agent content is reduced.

	Parts by weight g		Specific surface area m²/g	Surface area m²	
	Basic	Modification		Basic	Modification
LITHOPONE 30%L	0.00	90.00	3.00	0.00	270.00
SACHTLEBEN R210	60.00	30.00	21.90	1,314.00	657.00
Durcal 2	120.00	120.00	3.30	396.00	396.00
Durcal 5	200.00	200.00	2.50	500.00	500.00
Durcal 10	100.00	62.20	1.50	150.00	93.30
Acronal 290 D (50%)	90.00	76.91	**Total**	**2,360.00**	**1,916.30**
Calgon N	1.50	1.22	**PSC**	**57.70**	**46.8**
Dispex G 40	2.00	1.62			
Tylose MHB 15000	5.50	5.50			
Agitan 280	2.00	2.00			
CA 24	2.00	2.00			
Ammonia	4.00	4.00			
Texanol	15.00	15.00			
Water	344.50	344.50			

Rules for modifying formulations

Rule 6:

Finally, water/solvent content should be modified, in order to equalize the solids volume concentration of the basic and modified formulations.

Definition
Solid **V**olume **C**oncentration

$$V(solids)\ \% = \frac{V_{[P+F+B(solids)]}}{V_{total}} \times 100$$

$V_{[P+F+B(solids)]}$: Volume of Pigments, Fillers and Solids of Binder

V_{Total} : Total Volume

$$V(solids)_{Basic}\ \% = \frac{205.9 \times 100}{582.4} = 35.35\ \%\ \text{solids volume}$$

$$V(solids)_{Mod}\ \% = \frac{199.78 \times 100}{582.4} = 34.30\ \%\ \text{solids volume of modification}$$

There results from this, for the total volume of the modification:

$$V_{Tot\ Mod} = \frac{199.78 \times 100}{35.35} = 565.15\ cm^3$$

$$V_{Water} = V_{Tot} - (V_{[P+F+B(solid)]} + V_{Additives} + V_{Water\ from\ binder})$$

$$V_{Water\ from\ binder} = \frac{V_B \times (100 - V_{B(solid)})}{100}$$

$$= \frac{34.81 \times (100 - 50)}{100} = 17.41\ cm^3$$

$$V_{Water} = 559.77 - (197.88 + 31.30 + 17.41) = 311.28\ cm^3$$

Example (application of rule 1+2+3+4+5+6)

Interior emulsion paint, in which 50% of the original TiO_2 content is to be replaced, while raising PSC to 95% simultaneously.

- **Rule 1**
  50% of the TiO_2 is to be replaced (from 60 parts by weight to 30 parts by weight)
- **Rule 2**
  Replacement ratio of TiO_2 : LITHOPONE 30% L is to be 1:3 (90 parts LITHOPONE 30% L by weight instead of 30 parts TiO_2 by weight).
- **Rule 3**
  The coarsest extender is reduced in content until the original PVC is reached.
- **Rule 4**
  The binder content is adjusted so that the PSC level is 95% of that of the basic formulation.
- **Rule 5**
  Wetting-agent content is reduced.
- **Rule 6**
  Water content is reduced

	Parts by weight g		**Density g/cm³**	**Volume cm³**	
	Basic	Modification	g/cm³	Basic	Modification
LITHOPONE 30%L	0.00	90.00	4.30	0.00	20.93
SACHTLEBEN R210	60.00	30.00	4.00	15.00	7.50
Durcal 2	120.00	120.00	2.80	42.90	42.90
Durcal 5	200.00	200.00	2.80	71.43	71.43
Durcal 10	100.00	56.88	2.80	35.70	20.31
Acronal 290 D (50%)	90.00	76.58	(solid) 1.10	40.90	34.81
Calgon N	1.50	1.20	1.00	1.50	1.20
Dispex G 40	2.00	1.60	1.00	2.0	1.60
Tylose MHB 15000	5.50	5.50	1.00	5.50	5.50
Agitan 280	2.00	2.00	1.00	2.00	2.00
CA 24	2.00	2.00	1.00	2.00	2.00
Ammonia	4.00	4.00	1.00	4.00	4.00
Texanol	15.00	15.00	1.00	15.00	15.00
Water	344.50	311.28	1.00	344.50	313.18
			Total	**582.40**	**542.36**

Examples

Outdoor exposure results data are available for a number of LITHOPONE-modified formulations. In terms of weathering stability, coatings containing LITHOPONE exhibit no damage from cracking, although they do darken with time slightly more than the original formulation. Only chalking is increased slightly, as PVC levels rise. After five years exposure, the greenish coatings containing LITHOPONE 30% L exhibit an excellent brilliant warm shade, whereas the control samples containing no LITHOPONE 30% L exhibit a greyish discolouration and bleaching. A number of formulations have been modified and are described in the annex, in order to make application of this procedure to your formulation as simple as possible.

Example of the use of LITHOPONE 30% L in interior emulsion paints with 50% replacement of TiO_2.

		Parts by weight g	
		Basic	**Modification**
Titanium dioxide replacement, %		-	20.00
LITHOPONE equivalent		-	2.50
LITHOPONE 30% L		0.00	80.00
SACHTLEBEN R210		160.00	128.00
Durcal 2		75.00	75.00
Finntalc M15		50.00	30.00
Durcal 5		125.00	115.00
Acronal 290D		300.00	172.00
Water + additives		287.00	280.50
Calgon N		1.00	0.90
Coatex P 90		2.00	1.70
Total		1,000.00	983.10
Total PVC		49.00	51.00
Solids content %		56.00	57.40
Light scattering coefficient mm^{-1}		145.00	139.00
Colorimetric system	L*	95.40	95.38
	a*	0.27	0.04
	b*	4.23	3.78
Viscosity, mPas		1,230.00	1,260.00
Storage stability		good	good

Example of the use of LITHOPONE 30% L in interior emulsion paints with 45% and 60% replacement of TiO_2.

		Parts by weight g Basic	Modification 45%	Modification 60%
Titanium dioxide replacement, %		-	45.00	60.00
LITHOPONE equivalent		-	2.70	2.70
LITHOPONE 30% L		-	222.00	297.00
SACHTLEBEN R210		183.00	101.00	73.00
Durcal 2		94.00	94.00	94.00
Durcal 5		187.00	101.00	73.00
Microdol 1		141.00	141.00	141.00
Acronal 290D		144.00	122.00	115.00
Wasser + Additive		244.00	243.50	243.50
Calgon N		1.50	1.20	1.00
Dispersion agent A		2.00	1.50	1.00
Total		996.50	1,027.2	1,038.90
Total PVK		75.00	78.00	79.00
Solids content %		67.90	70.10	70.80
Light scattering coefficient	mm^{-1}	178.00	185.00	175.00
Colorimetric system	L*	95.48	95.70	95.71
	a*	-0.04	-0.50	-0.62
	b*	3.73	3.42	3.32
Viscosity, mPas		1,220.00	1,210.00	1,200.00
Scrub resistance		> 5,000	> 5,000	> 5,000
Storage stability		good	good	good

Examples

Example of the use of LITHOPONE 30% L in interior emulsion paints with 50% replacement of TiO_2.

	Parts by weight g	
	Basic	**Modification**
Titanium dioxide replacement, %	-	50.00
LITHOPONE equivalent	-	3.00
LITHOPONE 30% L	-	90.00
SACHTLEBEN R210	60.00	30.00
Durcal 10	100,00	63.00
Durcal 5	200.00	200.00
Durcal 2	120.00	120.00
Acronal 290D	90.00	75.00
Water + additives	373.00	367.00
Calgon N	1.50	1.30
Dispex G40 Ciba	2.00	1.70
Total	946.50	948.00
Total PVK	80.00	83.00
Solids content %	55.50	57.00
Light scattering coefficient mm^{-1}	120.00	118.00
Colorimetric system L*	95.59	95.79
a*	-0.20	-0.36
b*	3.20	3.41
Viscosity, mPas	1,670.00	1,710.00
Storage stability	good	good

Powder-coating systems

Alongside emulsion paints, powder-coating systems are the focus of innovative formulation modifications. In this case, too, the basic concept consists of the replacement of titanium dioxide by a correspondingly higher quantity of LITHOPONE. Thanks to its good dispersibility, LITHOPONE 30% DS is particularly suitable for use in powder-coating systems. In formulations containing extenders, the extender contents should be reduced proportionally, as in the case of emulsion paints. A guideline for the use of 25% of the original titanium dioxide content assumes the use of twice the amount of LITHOPONE, and can be recommended. Detailed and conclusive tests should be performed in advance for each individual system, however. A number of examples are shown below.

	Parts by weight g	
PUR System	**Basic**	**Modification**
Rucote 102[1)]	47.40	41.16
Vestagon B 1530[2)]	11.85	10.29
Resiflow PL 200[3)]	0.50	0.50
Benzoin[4)]	0.25	0.25
SACHTLEBEN R210[8)]	40.00	33.50
LITHOPONE 30% DS[8)]	0.00	4.30
Total	**100,00**	**100.00**

Curing parameters: 20 min. , 180 °C

	Parts by weight g	
Hybrid System	**Basic**	**Modification**
Rucote 560[1)]	35.67	30.99
Beckopox EP 304[5)]	23.78	20.66
Additol[3)]	0.30	0.30
Benzoin[4)]	0.25	0.25
SACHTLEBEN R210[8)]	40.00	33.50
LITHOPONE 30% DS[8)]	0.00	14.30
Total	**100.00**	**100.00**

Curing parameters: 20 min. , 180 °C

	Parts by weight g	
Primid System	**Basic**	**Modification**
Rucote 811[1)]	56.05	48.64
Primid XL 552[7)]	2.95	2.56
Resiflow V88[3)]	0.75	0.75
Benzoin[4)]	0.25	0.25
SACHTLEBEN R210[8)]	40.00	33.50
LITHOPONE 30% DS[8)]	0.00	14.30
Total	**100.00**	**100.00**

Curing parameters: 20 min. , 180 °C

1) Bayer Material Science
2) Degussa International AG
3) Worlee Chemie GmbH
4) Inter Organa, Cologne
5) Vianova Resins GmbH
6) UCB Chemicals
7) EMS-Primid, Dormat, Switzerland
8) Sachtleben Chemie GmbH

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