



Crayvallac PC

SURFACE ENHANCING ADDITIVE FOR POWDER COATINGS BASED ON PRIMID, HYBRID AND TGIC TECHNOLOGIES.

Surface Enhancement

In general the basic requirements of a cured powder coating are good durability and good appearance. A good appearance requires careful management of surface defects such as cratering and micro-pinholing, elimination of thermal discoloration and good surface levelling. With surface levelling the main objective is the elimination of orange peel. Although surface defects and orange peel can be controlled through the use of flow modifiers and surface tension modifiers, when these are used in conjunction with CRAYVALLAC PC a substantial increase in surface appearance results. The general observation is that CRAYVALLAC PC enhances the following processes:

- Substrate wetting
- Degassing
- Flow and levelling

In addition to these CRAYVALLAC PC also displays the following:

- Very good compatibility with polyesters.
- Does not make the coating susceptible to thermal discoloration.
- Has little if any effect on the chemical and mechanical properties of the cured coating.

Consequently, the overall effect of using CRAYVALLAC PC is a cured coating with an enhanced surface appearance.

The Performance Enhancing Mechanism of Crayvallac PC

CRAYVALLAC PC does not bring about a surface enhancement by altering the coatings surface tension. This is clearly demonstrated through the measurement of precise surface tensions on polyester blends at 180°C (356°F): See Table 1.

Coating System

	Surface Tension: mNm ⁻¹
Polyester resin without acrylic flow agent	31.6 ± 0.1
Polyester resin + acrylic flow agent	22.4 ± 0.5
Polyester resin + acrylic flow agent + 1 % CRAYVALLAC PC	21.6 ± 0.1
Polyester resin +Acrylic flow agent + 2 % CRAYVALLAC PC	22.5 ± 0.2

Table 1: Surface tensions measured at 180°C (356°F) on Reafree 4500 polyester resin blended with an acrylic flow agent by the pendent drop method. Reafree 4500 is a polyester from Cray Valley for TGIC cured systems.

Further research has confirmed that the enhanced surface appearance brought by using CRAYVALLAC PC is the result of a substantial decrease in the coating's melt viscosity during stoving. This viscosity decrease facilitates substrate wetting, degassing, flow and surface levelling and explains how CRAYVALLAC PC also enhances the performance of the traditional powder coating additives e.g. acrylic flow and levelling agents. This beneficial decrease in viscosity is the direct consequence of CRAYVALLAC PC lowering the glass transition temperature of the coating (See Tables 2 and 3).

Coating System

	Glass Transition Temperature
Polyester resin without acrylic flow agent	61°C (142°F)
Polyester resin + acrylic flow agent	55°C (131°F)
Polyester resin + acrylic flow agent + 1 % CRAYVALLAC PC	53°C (127°F)
Polyester resin +Acrylic flow agent + 2 % CRAYVALLAC PC	49°C (120°F)

Table 2: DSC glass transition temperatures for Reafree 4500 polyester resin blended with an acrylic flow agent. Reafree 4500 is a polyester from Cray Valley for TGIC cured systems.

These results clearly show that the presence of CRAYVALLAC PC has a substantial effect on the powder coatings glass transition temperature, and this is mirrored by the results for melt viscosity (See Table 3).

Coating System

	Complex Viscosity at 180°C (356°F): Pa.s
Polyester resin without acrylic flow agent	10
Polyester resin + acrylic flow agent	7.9
Polyester resin + acrylic flow agent + 1 % CRAYVALLAC PC	6.8
Polyester resin +Acrylic flow agent + 2 % CRAYVALLAC PC	3.6

Table 3: Melt viscosities measured at 180°C (365°F) on Reafree 4500 polyester resin blended with an acrylic flow agent. Reafree 4500 is a polyester from Cray Valley for TGIC cured systems. This data was measured using a Rheometric Scientific SR 5000 rheometer fitted with a cone and plate geometry.

This last set of results clearly shows that CRAYVALLAC PC dramatically reduces the viscosity of the powder coating system during stoving. It is this substantial viscosity reduction that enhances the wetting, degassing, flow and levelling processes. The combined effect of these enhancements by CRAYVALLAC PC is a substantial improvement in the surface appearance of cured powder coatings.

Incorporation and Performance

The use of CRAYVALLAC PC results in an improved surface appearance when used in TGIC, Hybrid and PRIMID coatings. It is easily incorporated using conventional pre-mixing methods prior to extrusion. Good control of wetting, degassing, flow and levelling will generally be achieved using CRAYVALLAC PC at a level of 0.5 – 2.0 % on total formulation, depending on the nature of the coating.

Due to the very good compatibility of CRAYVALLAC PC with polyesters, the possibility exists for it to partially replace some of the acrylic flow agent and degassing agent. Therefore we propose that the following strategy be adopted when testing CRAYVALLAC PC in powder coating formulations for the first time:

1. Prepare the coating system in the normal manner but with 1% and 2% of CRAYVALLAC PC added. Premix the ingredients and then extrude the coating in the normal manner.
2. Convert the coating to powder, spray apply to test panels and stove as normal. These results will set the basic framework for optimising the coating system.
3. Repeat this exercise with 1% and 2% of CRAYVALLAC PC added but this time systematically reducing the level of acrylic flow agent until an acceptable optimum level is reached.
4. When the acrylic flow agent have been reduce to an acceptable level, systematically reduce the level of CRAYVALLAC PC until the system is fully optimised.

However, if yellowing from the degassing agent benzoin is a major concern, this exercise should be repeated making a systematic reduction in the benzoin level. It is worth noting here that this type of optimisation process may be more efficiently implemented by the used of an appropriate statistical experimental design technique. The advantage here being that you will clearly define any interactions and synergistic effects within your coating system and then be able to exploit them to your full advantage.

The following data highlights the enhanced performance to be gained by using CRAYVALLAC PC in a PRIMID based coating. For further details of the coating formulation please see the experimental section.

Cure on Steel

	CRAYVALLAC PC: 1%	CRAYVALLAC PC: 2%
Wave Scan %		
Longwave	23.3	18.8
Shortwave	35.5	34.5
Aspect at 75 micron	Good	Very Good
Gloss %		
20°	86.4	87.8
60°	96.1	96.1
85°	104.0	104.2
Colour		
L	95.95	96.2
a	-1.36	-1.44
b	0.93	1.11

Cure on Aluminium

	CRAYVALLAC PC: 1%	CRAYVALLAC PC: 2%
Haze		
Logarithmic	95	78
Linear	6.7	5.8
Aspect at 75 micron	Good	Very Good
Gloss %		
20	87.2	88.2
60	96.1	95.9
85	104.7	105.9
Colour		
L	96.44	96.62
a	-1.46	-1.67
b	1.30	1.44

These results show that the surface properties of this cured powder coating improve significantly with increasing level of CRAYVALLAC PC. The improvement to surface levelling is clearly shown by the reduction in the longwave value. The visual appearance or aspect also shows an improvement, especially at the 2% level. The results obtained using the BYK-Gardner haze gloss meter also confirm the benefits to be gained by using CRAYVALLAC PC.

In summary, the overall result of using CRAYVALLAC PC is an enhance sharpness of reflected images and a significant reduction in orange peel. In addition to the above, no micro-pinholing, or reduction in mechanical and chemical properties, was observed when using CRAYVALLAC PC.

Experimental

The results presented here were obtained using the following two PRIMID formulations cured at 180°C (356°F) for 15 minutes.

Components	Parts: w/w	Parts: w/w
CRAYVALLAC PC	1.0	2.0
Reafree 8585: Carboxylated polyester ⁽¹⁾	56.4	55.4
Reafree F300-B10: Master batch preparation of 10% acrylic polymer in hydroxylated polyester ⁽¹⁾	7.5	7.5
PRIMID XL- 552 ⁽²⁾	2.9	2.9
Anti-Popping Agent: Benzoin	0.2	0.2
Rutile Titanium Dioxide	32.0	32.0
Total	100.0	100.0

⁽¹⁾ REAFREE is a trademark of Cray Valley.

⁽²⁾ PRIMID is a tradename of EMS-Chemie.

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