Toolkit #8

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National Coil Coating Association

Coil Coating Topcoat Systems

The objective of this toolkit is to provide a practical chemistry background of the various coatings (*i.e.*, paints) chemistries used in the coil coatings industry, and for the differentials observed in the performance chart (Appendix A). Each coating has its strengths and weaknesses and was originally developed for a specific need within the marketplace. The following are assumptions used in the discussion of a coating's comparative performance:

1. The coatings are optimized for performance.
2. Pigmentation is equivalent.
3. Primers and/or adhesives are used to prevent delamination.
4. ASTM tests are the measure of performance.

Plastisol:

Abrasion resistance, flexibility, and thick film capability are the strengths of this poly vinyl chloride chemistry. Dispersions of PVC are made which incorporate a plasticizer as the liquid phase. Addition of solvent is used sparingly to control (lower) viscosity (less than 20% by weight solvent is typical). Plastisols with a significant solvent addition are termed "organosols".

Application and paint manufacture of plastisols requires considerable care due to air entrapment and the thicker films typically applied. Control of the rheology of dispersions is considerably different than that of coatings chemistry.

The weaknesses of plastisols are solvent resistance and exterior durability (gloss and color retention). Improvements in both areas are possible with incorporation of crosslinkable polymers, U.V. stabilizers, anti-oxidants, etc. Plastisols currently are used in the specialty market and residential trim/siding.

Solution Acrylic:

These solvent-based products provide average weathering performance, good application and appearance and very good hardness and mar resistance. Examples include the truck trailer and sign stock markets. Solution acrylics are thermosetting (*i.e.*, they do not soften once baked) utilizing hydroxy functionality and/or self-crosslinkable monomers, which are further reacted with melamine crosslinking materials. The level of weathering performance varies considerably, depending upon the level of styrene and other monomers in the acrylic resin.

This coating offers any color at any gloss, a versatile system that in many aluminum applications does not use a primer. One disadvantage is its lack of flexibility.

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Polyester:
Differentiation between interior- and exterior-quality coatings stems from the choice of monomer reactants in the polyester resin formulation. The reactants control the performance of the polyester with choices being a balancing act of physical properties, weathering performance, application and cost. Advantages of polyesters are flexibility and higher solids.

Silicone Polyesters:
This solvent-based paint chemistry has its roots in the building industry beginning in the 1970s. This product's exterior durability represented an improvement from the other commercial coil coatings. Advantages today include economics (when compared to PVDF coatings discussed below), abrasion resistance and general acceptance in the marketplace for a recognized level of performance. The chemistry of this product utilizes a silicone intermediate modification to a polyester resin backbone, or cold-blended (*i.e.*, not reacted) silicone resin. One disadvantage is lower flexibility due to the highly crosslinked and branched structure of these polymers.

Acrylic Latex:
This type of coating represents technology where the volatile organic content (VOC) is substantially lower than solvent-based coatings, such as polyesters. These products also were developed in the 1970s shortly after the Silicone Polyester acceptance. Today the primary market is residential trim and siding. Weathering performance and flexibility are normally superior to solution acrylics, depending on acrylic monomer composition. Application challenges and clean up are disadvantages.

Polyvinylidene Fluoride (PVDF):
These solvent-based topcoats represent the most durable weathering properties of coil coatings offered. Developed in the 1960s by the Pennwalt Corporation, the vinylidene fluoride monomer is homopolymerized to give a discreet molecular weight and particle size suitable for coil application.

A PVDF is composed of an acrylic/melamine in conjunction with the PVDF. A 70% PVDF/30% acrylic vehicle composition is most common ratio of resins used for optimal weathering performance and physical properties. Commercially, this represents the most expensive, highest performing coil-applied paint.

Another class of fluoropolymers, Fluoroethylene Vinyl Ether (FEVE), is also available. This coating offers higher gloss than PVDF dispersion paints because it is a solution fluoropolymer. This chemistry is significantly different from PVDF paints, allowing crosslinking which provides increased coating hardness. Disadvantages include decreased flexibility and higher cost relative to 70% PVDF coatings.

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Polyurethane:
This is another type of a polyester coating, but one where an isocyanate crosslinker is used instead of a melamine crosslinker. In all cases the isocyanate crosslinker is blocked or capped off to prevent its reactivity until the coating is baked. Upon baking, unblocking occurs releasing the blocking agent, making available the isocyanate functionality for reaction with the hydroxy groups on the polyester. Reaction of the isocyanate with hydroxy forms a urethane linkage. This chemistry represents an improvement in weathering performance from conventional polyester-melamine coatings.

The flexibility and forming capabilities are also improved through isocyanate crosslinking. Three issues of concern with this chemistry are potential health hazards, increased cost and slower reaction rates for short coil dwell times. Typically, the isocyanate crosslinkers cost two to three times more than conventional melamines.

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COMPARATIVE PROPERTIES AND PERFORMANCE CHART - COIL COATING TOPCOATS

		Generic Coating Type (Topcoat only)							
				Polyester					
Physical and Resistance Properties	ASTM Method	Plastisol	Solution Acrylic	Interior Use Only	Exterior Use	Silicone Polyester	Poly (vinylidene) Fluoride (PVDF)	Acrylic Latex	Polyurethane
Impact Resistance	D2794	5	2	3-5	3	3	4	3	4
Mar Resistance	D3363, D2197	3	4	4	4	4	3	3	3
Metal Marking Resistance	No method	3	4	4	4	4	3	4	3
Resistance to Pressure Mottling in Coil	D3003	3	4	4	4	4	3	3	3
Solvent (MEK) Resistance	D5402	N/A	4	3-5	5	5	3	4	3
Grease and Oil Resistance	D5402, D1308	4	3	3-5	4	4	4	3	3
Stain Resistance	D1308	3	4	3-5	4	4	4	3	3
Resistance to Acidic/Caustic Conditions	D2248, D1308	5	3	3-4	3	3	4	4	3
Resistance to Water Immersion	D870	4	4	4	4	4	4	2	3
Humidity Resistance	D1735, 2247, D4585, G60	4	4	4	4	4	4	2	4
Abrasion Resistance	D4060, D968	5	3	3-5	3	3	4	3	3
Resistance to Industrial Pollution	D1308, G87	5	3	3	3	3	4	3	3
Corrosion Resistance (Salt Spray)	B117, G85	4	3	4	4	4	3	3	4
Flexibility / Drawability	D2794, 3281, 4145, D522, D4146	5	2	3-5	3	2	4	3	4
Dry Heat Resistance	D6491	5	3	4	4	4	4	4	5
Chalk: 10 years Florida, 45° South	G7, D1014, D4214	2-3	3	N/A	3-4	4	5	3-4	3-4
Color Retention: 10 years Florida, 45° South	G7, D1014, D2244	2-3	3	N/A	3-4	4	5	3-4	3-4
Gloss Retention: 10 years Florida, 45° South	G7, D1014, D523	2-3	3	N/A	3-4	4	5	3-4	3-4

5=Excellent, 4=Very Good, 3=Good, 2=Fair, 1=Poor

Chart should only be used in combination with description page.

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