#8

Tool Kit

www.coilcoating.org

A Publication of the National Coil Coating Association

National Coil Coating Association

Coil Coating Topcoat Systems

Clark Higginbotham, The Valspar Corporation
December, 2004

The objective of this paper is to provide a practical chemistry background for the differentials observed in our performance chart (Appendix A). Each of the coatings has its strengths and weaknesses and originally was developed for a specific need within the marketplace. Following are assumptions used in this expansion of the coatings 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. There is no dissolution of the PVC by the plasticizer. Addition of solvent is used sparingly to control (lower) viscosity (less than 20% by weight solvent is typical). Technically, plastisols with 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 solution polymers (polyesters).

Weaknesses of plastisols are solvent resistance and exterior durability (gloss and color retention). Improvements in both areas are possible with changes in the formulation to include crosslinkable polymers, U.V. stabilizers, anti-oxidants, etc. These products currently are used in the specialty market and residential trim/siding.

Solution Acrylic:
A solvent based product with average weathering performance, good application and appearance, very good hardness and mar resistance, and above all a history of satisfied customers. Examples include the truck trailer and sign stock market. These products are thermoset utilizing hydroxy functionality and/or self-crosslinkable monomers, which are further reacted with melamines. The level of weathering performance varies considerably, depending upon the level of styrene and other monomers in the acrylic.

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.

Polyester:
Differentiation between interior and exterior quality stems from the choice of reactants and the presence of an oil component. The reactants, acid and hydroxy portions, 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:
Another solvent based paint with roots in the building industry beginning in the '70's. This product's exterior durability represented a step up from the commercial coatings. Advantages today include economics, abrasion resistance and general acceptance in the market place for a recognized level of performance. The chemistry of this product utilizes the silicone intermediate modifications to a polyester either co-reacted or cold blended. The silicones being variations of the phenyl/methyl substitution with hydroxy functionality that reacts into the polyester. Multiple variations of these resins have been tried, but concern for application on line overrides the choices available, limiting it to highly phenylated silicones. One disadvantage is lower flexibility due to the highly crosslinked and branched structure of these polymers.

Acrylic Latex:
Environmentally the best choice with VOCs less than 3 pounds per gallon. A development initiated on performance, which soon became a "green" effort. Emulsions are very high in molecular weight. These products also were developed in the '70's 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 Flouride:
Initially known as "Kynar 500" coatings these solvent based topcoats represent the most durable weathering properties of coil coatings offered. Begun in the '60's by the Pennwalt Corporation, the monomer is homopolymerized to give a discreet molecular weight and particle size suitable for coil application.

This product is composed of an acrylic/melamine in conjunction with the PVDF. A 70% PVDF/30% acrylic vehicle composition is most common for optimal weathering performance and physical properties. Commercially, this represents the most expensive, highest performing coil applied paint which has received a significant warranty from the beginning.

Another class of flouropolymers, Fluoro Ethyl Vinyl Ether (FEVE) has now become competitive to the PVDF coatings. 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 for increased coating hardness. Disadvantages include decreased flexibility and higher cost relative to 70% PVDF coatings.

Polyurethane:
Simply the modification of a polyester with either an isocyanate extension of the resin itself and/or in combination with a blocked isocyanate crosslinker. In all cases the isocyanate is blocked or capped off to protect its reactivity. Upon baking at a specific PMT, the 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 a step up 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 the 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.

Appendix A

Comparative Properties and Performance Chart

Coil Coating Topcoats

The *Comparative Properties and Performance Chart* has been created to provide a description of the physical and performance properties of various coil coating topcoats. This chart has been prepared to provide only general information. It is neither a performance standard, nor a specification. It describes broad performance criteria, and should never be used on its own to select a particular coating technology for a specific application. A wide range of performance criteria exist within any generic coating category. It is advisable to consult the coating suppliers regarding your specific needs.

The values on the chart are ratings (*not rankings*), and every effort has been made to realistically rate each technology on its own merits. In all cases, the opinions of industry experts were solicited in an effort to accurately reflect the performance of each technology. The *Comparative Properties and Performance Chart* is intended, therefore, for the individual who does not have extensive knowledge of coil coating technologies.

The physical properties (e.g., pencil hardness, impact resistance, flexibility) were rated assuming that excellent adhesion to the substrate (for one-coat systems) or to the primer (for two-coat systems) exists. Resistance properties (e.g., humidity resistance, salt spray resistance) are highly dependent upon the quality of the substrate, and in all cases it is assumed that adequately pretreated, first-quality substrate is used for the evaluation. The performance of the "system" is the result of a complex interdependency among the substrate, pretreatment, primer (where applicable) and topcoat. Since the *Comparative Properties and Performance Chart* addresses only the topcoat, the chart can only describe the performance of the "system" in the most general terms.

Use of the *Comparative Properties and Performance Chart*

1. The numerical ratings in the chart have the following meaning:
   5 = Excellent
   4 = Very good
   3 = Good
   2 = Fair
   1 = Poor
   The ratings are for topcoats only. Primer technology has not been included in the rating protocol.

2. While the major usage of coil coatings is for construction products (e.g., pre-painted wall and roof panels, residential siding, garage and entry doors), efforts have been made to consider other important uses of pre-painted metal (e.g., appliance, packaging, transportation).

3. With the exception of plastisol, it has been assumed that the coatings are applied at a nominal dry film thickness of 1 mil. Plastisol coatings are generally applied between 4 mils and 10 mils dry film thickness.

Note that the "Polyester" category includes the subcategories "Interior Use Only" and "Exterior Use." This division represents the predominance of polyester coatings technology in the pre-paint marketplace, and their wide applicability, both for interior applications (e.g., metal furniture) and exterior applications (e.g., building panels).

Since coating technology is constantly evolving to provide better performance properties, the values on this chart may change over time. To determine the best coating system for your individual needs, contact the coating suppliers for specific information and guidance.

COMPARATIVE PROPERTIES AND PERFORMANCE CHART
- COIL COATING TOPCOATS

		Generic Coating Type (Topcoat only)							
Physical and Resistance Properties	ASTM Method	Plastisol	Solution Acrylic	Polyester		Silicone Polyester	Poly (vinylidene) Fluoride (PVDF)	Acrylic Latex	Polyurethane
				Interior Use Only	Exterior Use				
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	No method	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, D2247, 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, D3281, D4145, D522, D4146	5	2	3-5	3	2	4	3	4
Dry Heat Resistance	No method	5	3	4	4	4	4	4	5

Weathering Properties	ASTM Method	Pastisol	Solution Acrylic	Polyester		Silicone Polyester	Poly (vinylidene) Fluoride (PVDF)	Acrylic Latex	Polyurethane
				Interior Use Only	Exterior Use				
Gloss Retention 10 years Florida, 45° South	G7, D1014, D523	2-3	3	N/A	3-4	4	5	3-4	3-4
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

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

Chart should only be used in combination with description page.