What is Paint?

2017
PAINT IS...

- A LIQUID DESIGNED FOR APPLICATION TO A SURFACE IN A THIN FILM THAT CURES TO AN SOLID FILM.
- A COATING WHICH PROTECTS THE SURFACE OF AN OBJECT.
- USED TO CREATE DESIRED AESTHETICS THROUGH THE USE OF PIGMENTS

PAINT LAYERS

- Primers: prepare the substrate for painting by providing “bite” for adhesion and corrosion protection, directly support topcoat color and flexibility.
- Backers: provide color and limited protection, in some cases act as a substrate for adhesives.
- Topcoats: protection from outside elements and provide color and aesthetic appearance, formability, durability and weather ability.
COIL COATING CHARACTERISTICS

- Weatherability - Resistance to moisture, sunlight, temperature changes.
- Flexibility - Able to be formed without cracking.
- Appearance - Available in various gloss ranges.
- Color - Maximum color retention, wide variety of colors available.
- Application - Applies easily on the line resulting in the desired finish.
- Cure - Dries completely within the specified dwell time and temperature.
The coil coating process is about **25 times faster** than any other metal coating process.

No metal coating process requires a coating to cure as fast—15-30 seconds. A bake of 5-10 minutes is more common for many Industrial Coatings.

A typical coil coating paint system is about 1.4 mils (topcoat, primer, backer). That’s .0014 of an inch!!! Most other industrial coatings are in the neighborhood of 2-5 mils.

A car takes about 30 minutes to prime and topcoat; a metal building (say, 50 feet x 30 feet x 20 feet; wall and roof) is painted in about 5 minutes on a coil coating line.

No other coating is expected to have the usual 40+ years lifetime that coil coatings have. *What is the average car paint warranty?*

Most metal coating processes involve a pre-fabricated part; pre-painted metal is *always* post-formed. Therefore, a coil coating must be hard, damage resistant, and flexible enough to withstand the forming operations.
PRIMARY COMPONENTS OF PAINT

- Resin
- Pigment
- Solvent
- Additives
WHAT IS RESIN

• Resins can be any form from liquid to solid.
• Resins are made up of natural or synthetic components called monomers.
• The monomers are reacted together to create a finished resin, or polymer.
• Resin is often referred to as the “vehicle” or “binder” of the paint.
• The resin determines the primary physical and chemical properties of a coating.
COMMON COIL COATING RESINS

Kynar® 500
Silicone
Polyester
Epoxy
Acrylic
Urethane

Methyl methacrylate
Poly(methyl methacrylate)

Ethyl acrylate
Poly(ethyl acrylate)

Acrylonitrile Butadiene Rubber

R
\[ \text{OR} \]
\[ \text{OR}' \]

Base

Acetic acid

Ethylene Oxide

Cycloaliphatic

Fatty Acid

Phenol

Alcohol
WHAT ARE PIGMENTS?

- Pigments are substances that impart color to a paint.
- Pigments can be either naturally occurring or synthetically created.
- Pigments provide a protective barrier for the coating.

TYPES OF PIGMENTS

- Organic
- Inorganic
- Ceramic

Color
Resistance to Sunlight (UV)
Hide/Coverage
Gloss
Abrasion Resistance
Viscosity and Flow
Corrosion Resistance
Special Appearance
Water Resistance
Reflectivity
TYPES OF PIGMENTS (Cont.)

- White Pigment: Titanium Dioxide – primary hiding pigment
- Inert Pigment: Talc, Silica, Mica – gloss, viscosity, flow. Do not impart hide or color
- Reactive: Zinc, Chrome - Corrosion protection
- Metallic: Aluminum – Decorative, reflective
- Pearlescent: Mica – Decorative, reflective
METAMERISM

In colorimetry, **metamerism** is a perceived matching of the colors that, based on differences in spectral power distribution, do not actually match. Colors that match this way are called metamers.

*What this really means is that certain pigments or substances look visually different depending on the light source. These colors are referred to as **metameric**.*
WHAT ARE SOLVENTS?

• Solvents are liquids capable of dissolving or dispersing substances, consisting primarily of Petroleum Distillates

COMMONLY USED SOLVENTS:

Alcohols
Ketones
Aromatic Hydrocarbons
Glycol Ethers

The primary function of solvents is to dissolve the resin providing a consistency (viscosity) suitable for application.
WHAT ARE ADDITIVES?

- Additives are substances added to paint in relatively small amounts to impart or improve desirable properties or to suppress undesirable properties.
- Additives help fine-tune paint performance.
- Types of additives:
  - Wetting agents
  - De-foamers
  - Flow additives
  - UV absorbers
  - Acid Catalysts
Final QC Approval

• The QC lab measures all of the physical properties of the finished paint to ensure it meets the product line specifications. Typical properties are:
  – Grind
  – Viscosity
  – Weight per gallon
  – Color
  – Hardness
  – Flexibility
  – Gloss
  – MEK Resistance
  – Solar Reflectance

• When all specifications have been met the paint is filtered and canned.
Paint Types

Terephthalic acid + Ethylene glycol → Terylene - Polyester
Major Coil Paint Types

There are three major paint types, or polymer technologies, used in coil coatings:

- **Polyester**
- **Silicone Modified Polyester (SMP)**
- **Fluorocarbon (Kynar® or PVDF)**
POLYESTERS

Distinguishing Features

• Cost effective
• Good flexibility and hardness
• Wide range of colors/gloss
• Can be formulated in a range of performance qualities

Typical Applications

• Gutters, downspouts
• Residential trim
• Agricultural, commercial, and industrial building panels
• Appliance wrappers and other product finishes
SILICONE MODIFIED POLYESTERS (SMP)

- Silicone intermediate is reacted to a polyester to enhance exterior weatherability.
- Silicone modification can improve exterior weatherability.
- Performance is more dependent on polyester backbone selection than type and level of silicone modification.

**Distinguishing Features**
- Good exterior weatherability
- Wide Range of Colors
- Lower cost than PVDF coatings

**Typical Applications**
- Commercial, agricultural building sidewalls and roofs
FLUOROCARBONS

Fluorocarbons are known by several different names (below), but all refer to the same polymer. Kynar® and Hylar® are registered trademarks and a user must be licensed to call their Fluorocarbon by these names.

- PVF$_2$, PVDF
- Fluorocarbon
- Polyvinylidene Fluoride
- 70% Kynar, Kynar 500®
- 70% Hylar, Hylar 5000®

Kynar 500® is a registered trademark of Arkema, Inc.
Hylar 5000® is a registered trademark of Solvay Solexis, Inc.
PVDF polymers are formulated with acrylics and other modifying resins to adjust handling characteristics and performance attributes.

PVDF coatings, when properly formulated with ceramic pigments, are the most resistant coatings to date.

Distinguishing Features

- Excellent chalk/fade resistance
- Chemical resistance
- High cost / high performance
- Excellent formability

Typical Applications

- Architectural building panels and roofs where superior weatherability is required.
COOL ROOF

Cool Roof Coatings were introduced to the U.S. coil market in 2001. They utilize special infrared reflective pigments that stay cooler than traditional pigmentation.

- Solar radiation reaches the earth’s surface in three distinct wavelengths: UV(5%), IR(51%) and Visible(44%).
- The IR portion is responsible for the generation of heat on surfaces.
- Most visually dark pigments absorb IR radiation and thus get hotter than light colored pigments.
- “Cool” pigments have been altered chemically and physically to reflect IR wavelengths while still absorbing the same Visible light, therefore their appearance is still dark.

Thermal images of Atlanta, GA, from 1972 through 1993
Every change in color represents a 1 Degree Celsius increase in temperature
How is Cool defined or measured?

There are three regularly used terms:

Solar Reflectance – expressed as a percentage or decimal it is the amount of solar radiation reflected off a surface.

Emissivity (emittance) – expressed as a percentage or decimal it is the amount of heat a surface can dissipate away from itself.

Solar Reflectance Index (SRI) – a value calculated from solar reflectance and emissivity with factor such as air flow included.
Coating Failures
The three most common modes of a paint failure are:

• Excessive chalking

• Excessive color fade

• Delamination of either topcoat or primer

While these three failures are typically covered by the paint supplier warranty, improper application by the coater can have a huge influence in long term performance.
COATING FAILURES

Color Fade

Fading is caused when substances in the environment and UV rays attack the pigment portion of the paint and cause the color to change.
COATING FAILURES

Taiyo Steel

Kynar 500®  Silicone Polyester  Kynar 500®  Polyester  Acrylic  Kynar 500®

Funabashi, Japan  Valspar
COATING FAILURES

Taiyo Steel

Kynar 500®  Silicone Polyester  Kynar 500®  Polyester  Acrylic  Kynar 500®

Funabashi, Japan
after 24 month exposure

Valspar
Color and Delta E

Delta E is a numerical value that represents total color change; $\text{dE} = dL^2 + da^2 + db^2$. L, a and b represent color in three dimensions; light/dark (L), red/green(a) and yellow/blue(b).

The average, untrained, human eye can start to detect a visual change in color between $\text{dE} .50$ and 1.
Color Change and Delta E

\[ \Delta E = 1 \text{ from center chip} \]

Change is barely detectable.

\[ \Delta E = 5 \text{ from center chip} \]

Note: this is allowed in most warranties.
Color Change

Gray color change

dE = 5

dE = 7
Color Change

Blue color change

dE = 5

dE = 7
Color Change

Green color change

dE = 5

dE = 7
Color Change

Red color change

dE = 5

dE = 7
COATING FAILURES

Chalking

Chalking is caused by a degradation of the resin systems at the surface of the finish, due predominantly to ultraviolet (UV) rays.

As the resin system breaks down, resin particles along with imbedded pigment particles lose adhesion and take on a white appearance.
Delamination – loss of paint film adhesion to either the substrate or between primer and topcoat.

This is a failure that can have many root causes:
- Low Film
- Incorrect or insufficient pre-treatment
- Under cure
- Over cure
- Topcoat/primer incapability
- Mechanical damage
Pigment selection combined with proper resin formulation both affect fade and chalk.

Inorganic and Ceramic pigments will fade at a slower rate than organics. The amount and type of pigment combined with the overall film thickness act as a barrier to protect the resin, and thus prevent chalking.

\[
\text{Kynar} + \text{Ceramic Pigments} + \text{Correct Film Thickness} = \text{Long Term Color Retention and No Chalking}
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\[
\text{Kynar} + \text{Ceramic Pigments} + \text{Low Film Thickness} = \text{Premature Chalking and/or Delamination}
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