Above Ground Coatings for New Construction and Maintenance Painting

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Appalachian Underground Corrosion Short Course

Learning Objectives

- Explain why paints and coatings are used
- Explain how coatings protect
- Describe how coatings cure
- Describe the risks and considerations when overcoating
- Identify basic aboveground coatings including the
  - Benefits
  - Limitations
  - Uses

Steel wants to go back to iron ore!

Above Ground Coatings

- Primers
  - Zinc (IOZ, MCU, Epoxy)
  - Epoxy
  - Acrylic
  - Alkyd
- Surface Tolerant Epoxies
- Moisture Cured Urethanes (MCU)

Intermediate Barrier Coats

- Topcoats
  - Polyurethane
  - FluoroUrethane
  - Polyaspartic Urethanes
  - Polysiloxane
  - Acrylic
  - Alkyd

How Coatings Protect Surfaces

- Inhibitive
- Sacrificial
- Barrier

Corrosion Prevention
Stop the deterioration of a substrate. Corrosion is a natural process that displays the tendency of materials to "give up" energy and return to its natural state.

Inhibitive

- Some pigments used in manufacturing primers control corrosion by forming inhibitive compounds.

- Compounds are slightly soluble in water, and upon contact with water vapor, passivate the substrate.

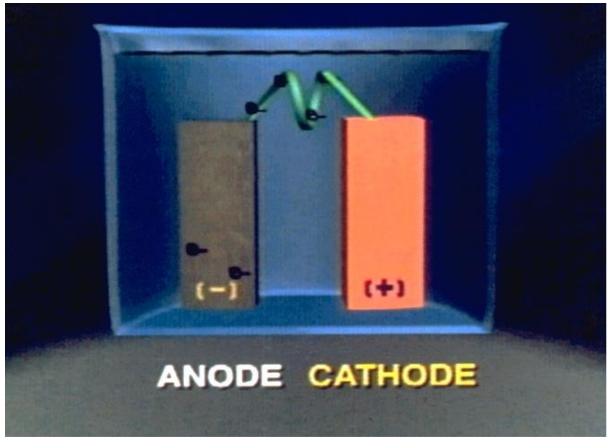
Rust inhibitive primers should never be specified or recommended for use in immersion service.

How Coatings Protect Surfaces

- Inhibitive
- Sacrificial
- Barrier

Sacrificial

- When a zinc coating is applied to steel, the zinc, being more active (anodic) than the steel, *sacrifices* itself to protect the steel from corrosion.
- This is based on the galvanic series.



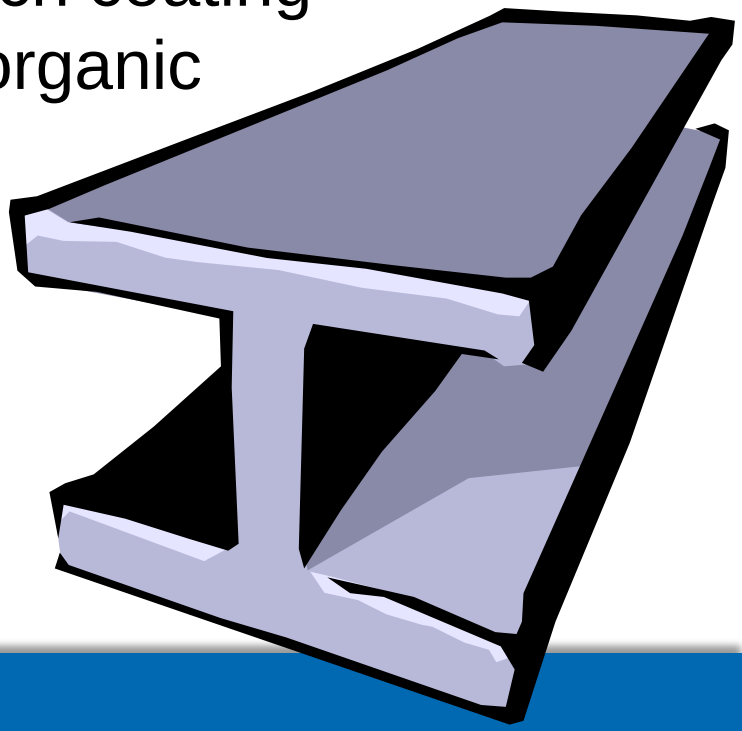
Active/Anodic

Magnesium
Zinc
Aluminum
Cadmium
Tin
Lead
Steel
Iron
Copper
410 Passive
304 Passive
Silver
Graphite
Gold
Platinum

Passive/Cathodic

Zinc-Rich Primers

- Two or three-component, solvent-based, inorganic, ethyl silicate, zinc-rich coating
- Two or three-component, water-based, inorganic, zinc silicate coating
- Two or three-component catalyzed polyamide epoxy, organic zinc-rich coating
- Three-component water based organic amine
- adduct zinc-rich coating
- Moisture-cured urethane (MCU) zinc primer



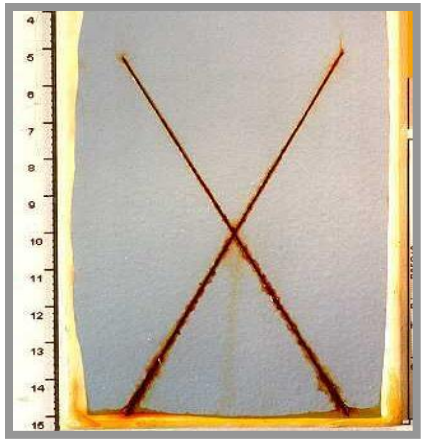
Zinc-Rich Primers

Contain High Percentage of Zinc Dust in the Dried Film So That There Is Direct Contact Between Zinc Particles and Steel

- Level 1 — equal to or greater than 85%
- Level 2 — equal to or greater than 77% and less than 85%
- Level 3 — equal to or greater than 65% and less than 77%

(per SSPC-Paint 20 Zinc-Rich Coating Type I – Inorganic and Type II – Organic)

- Sacrificial / Galvanic Protection (like galvanizing)
- Corrosion Protection Prevention of Undercutting



How Zinc-Rich Primers Cure

- IOZ = Solvent Evaporation / Moisture Curing or CO_2 *(Zinc-Clad II)*
- OZ = Solvent Evaporation / Chemical Reaction (Epoxy) *(Zinc-Clad III HS)*

  Solvent Evaporation / Moisture Curing (MCU) *(Corothane I Galva-Pac Zinc)*

Inorganic Zinc Rich Primers

- Better Surface Preparation Required
  (*Requires Angular Surface Profile)*
- Requires Special Application and Mixing Equipment
- Recommended pH Range of 5.0 - 9.0 (untopcoated)
- Prone to “Mud Cracking” at high DFT
- Shop Application

- Performance Similar to Galvanizing
- Heat Resistance to 750 F
- Low Temperature Application

Organic Zinc Rich

- Tolerates Less Stringent Surface Preparation

- Used to Touch-up Inorganic Zinc (IOZ)

MCU OZ Primers

- Can be applied during high humidity
- Ease of Application
- Fast Recoat / Fast Cure Times
- Low Temperature Application 20° F.
- Single Package Zinc-Rich Available
- Part of NSF 61 Approved System (drinking water storage)
    - Special Reducers Required
    - Unused Portion Has Limited Shelf Life
    - Needs Relative Humidity to Cure

How Coatings Protect Surfaces

- Inhibitive
- Sacrificial
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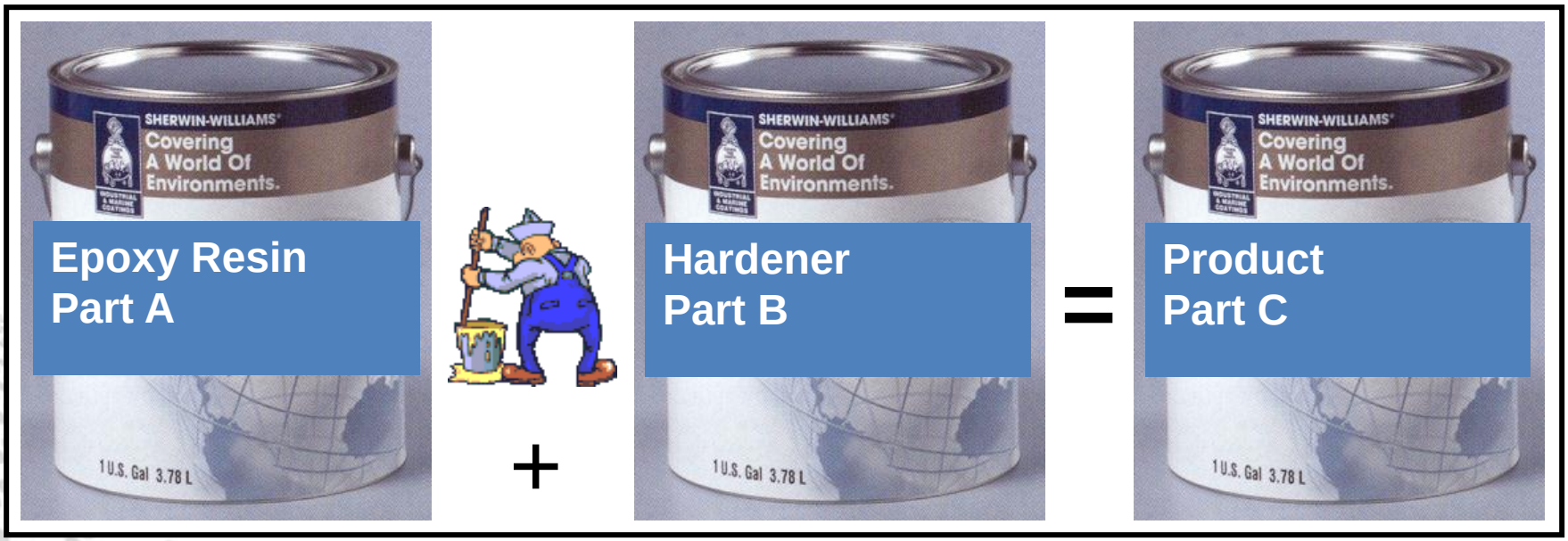
Corrosion Prevention
Stop the deterioration of a substrate. Corrosion is a natural process that displays the tendency of materials to "give up" energy and return to its natural state.

Barrier

- Most coatings serve as a protective barrier by isolating the substrate (metal, concrete, wood etc.) from the environment (moisture, heat, cold, UV, impact, abrasion etc.).

- Film reinforcement ,such as glass flakes or Micaceous Iron Oxide, further slows this action down.

Catalyzed Epoxies



Epoxy Coatings

- Epoxy Resins or Emulsions of Epoxy Resins Which Cross-Link with Polyamides, Amines, or Other Hardeners.
- They Cure by Polymerization –

  The chemical joining of polymer chains

Solvent Based Epoxies

- Excellent Alkali, Solvent, and Water Resistance
- Good Abrasion Resistance
- Good Acid Resistance
- Good Exterior Durability *but ...*
- High Film Builds Possible in One Coat
- Low Temperature Application Available
- Dry Heat Resistance to 250° F

Solvent Based Epoxy Limitations

- Two-Component
  - Induction Time (Sweat-In)*
  - Limited Pot Life*
- Recoat Window Restrictions*
- Chalks and Fades on Exterior Exposure
- Solvent Odor
- Special Application Equipment May be Required

*Temperature dependent!

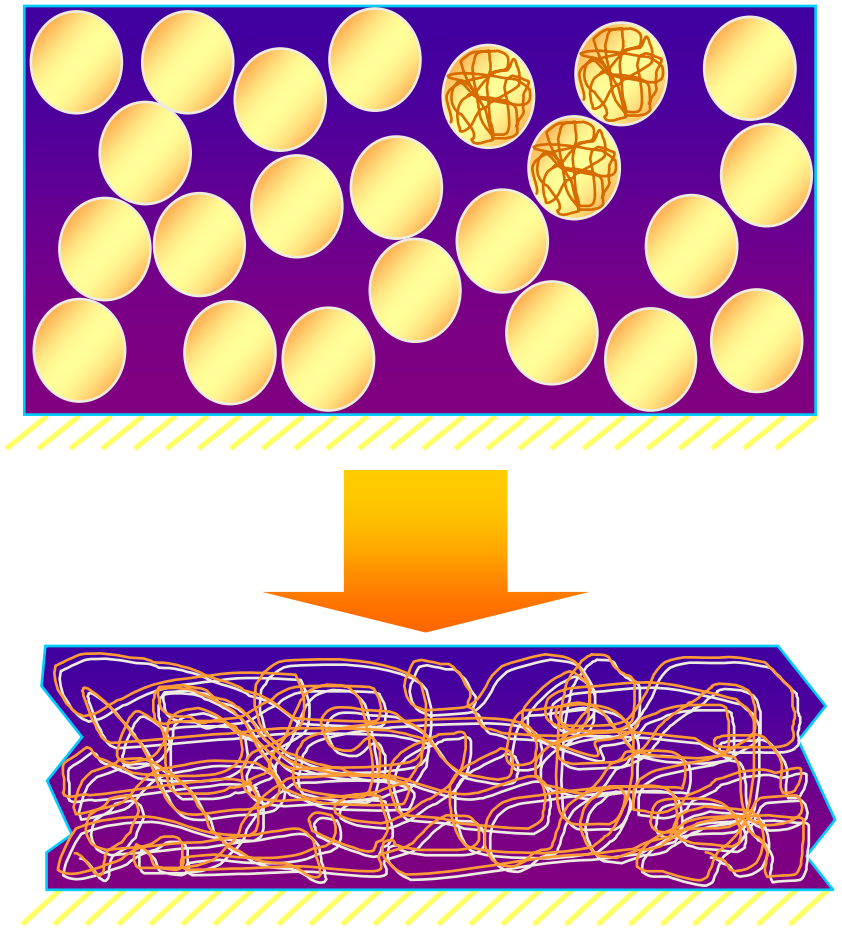
Waterborne Acrylic Coatings

- Single Component Water Based
- Fast Dry
- Fast Re-Coat
- Excellent Corrosion Protection
- Primer Contains Inhibitors

Sensitive to Temperature and Humidity During Application AND Curing (up to 30 days for cure)

Industrial Acrylics

- Cure by Solvent Evaporation AND Coalescence
- Co-Solvents (coalescing solvents) act as plasticizers for acrylics. These co-solvents contribute VOC's to WB coatings. Co-solvents must remain in the film until evaporation.

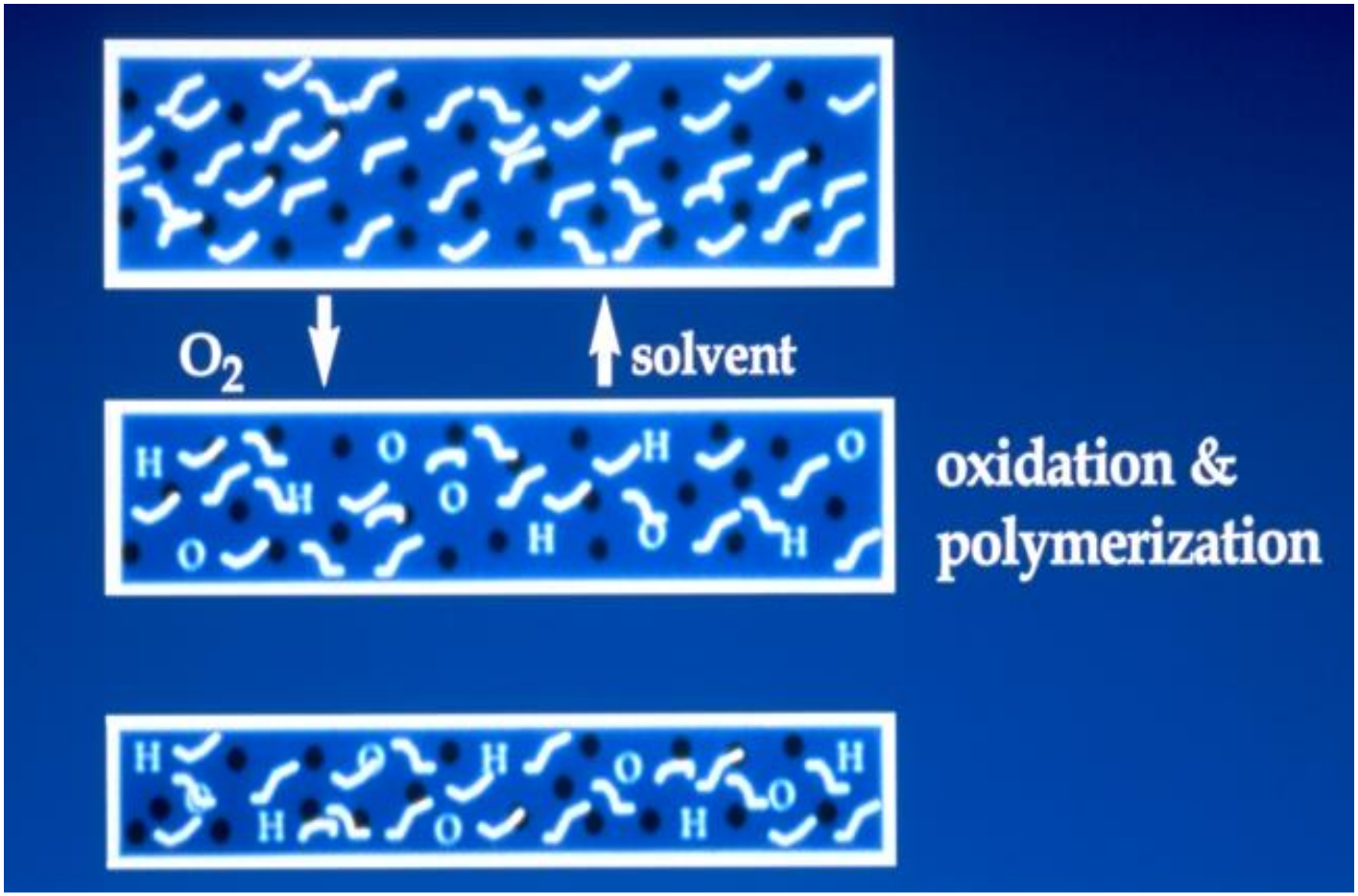


Alkyd Primers & Finishes

Synthetic Resins Derived From a Reaction Between an Alcohol and an Acid. The Resins are Blended With Drying Oils and Cure by Oxidation

- Application as low as 40°F
- Single Package / Ease of Application
- *Primers (Kem Bond UP) and Finishes (Ind. Enamel or ProIndustrial)*
- Heat Resistance to 200-250° F
- Embrittle With Age
- Prone to Disbond (saponify) over Concrete & Galv.

Cure by Oxidation



Drying Oil Amount

Short Oil Alkyd Medium Oil Alkyd Long Oil Alkyd

Fast Dry			Slow Dry
Aromatic Solvent Res.			Aliphatic Solvent Res.
Poor Penetration			Penetrates Rust
Fast Recoatability	(2	Hrs)	Long Recoat Time
Harder Film Quickly Embrittles			Softer / Pliable Film
Quickly Chalks			Good Exterior Durability

Surface Tolerant Over-coating Systems

- Assessment of Current Paint
  - Percentage of corrosion (30% rule of thumb)
  - Adhesion to substrate and other coats
  - Thickness (DFT 20 mils DFT max.)
  - Cracking, checking, aligatoring blistering, ...
  - Gloss, chalking, checking blistering, etc.
- *Consider*: Ultra-High Pressure (UHP) Water
  - Remove all the paint on most surfaces
  - no abrasive dust or waste disposal
- *Consider*: Wet Abrasive Blast Cleaning
  - dustless

Coating Maintenance Programs

Advantages of Real-Time "Condition Evaluations

- Provides an accurate assessment of the asset, not projected
- Data able to be reviewed and discussed prior to execution
- Provides a true budget and forecast
- Provides an accurate coating selection based on conditions/environment
- Completed without a fee
- Involves collaboration between owner, applicator, manufacturer

"it is critical to have a very good relationship with the manufacturer to ensure that the coating system chosen for the structure is appropriate for the environment in which that structure will serve." *(Lou* Vincent, Phorgotten Phenomena, Service Life Extension for Protective Coatings, Material Performance, March 2009).

Risks of Over-coating

- Curing and solvent stress on existing paint with new coating *(apply a test area!)*
- Premature failure of the overcoat system
- Delamination
- -what is the thickness of aged system?)
- -what is the thickness of the new system?
- Life expectancy is hard to determine
- Future repair and / or replacement

Cost Considerations

- Over-coat systems: Typically 40% to 65% vs. the cost of complete removal / replacement
- Removal / Replacement: Expensive and dependent on several factors
- Present Cost of Overcoat vs. Future Value of complete removal / replacement
- Project Schedule / Operations - impact of adjacent operations.

Key Points in Decision Process

- Coating budget typically determines overcoat / removal
- Adhesion results of existing coating
- DFT of existing coating (</= 20 mils)
- Is lead paint present?
- Environmental impact
- Bid Process: Time & Materials vs. Hard Dollar
- Scope of Work: Defining unforeseen conditions and events

Surface Tolerant Epoxy

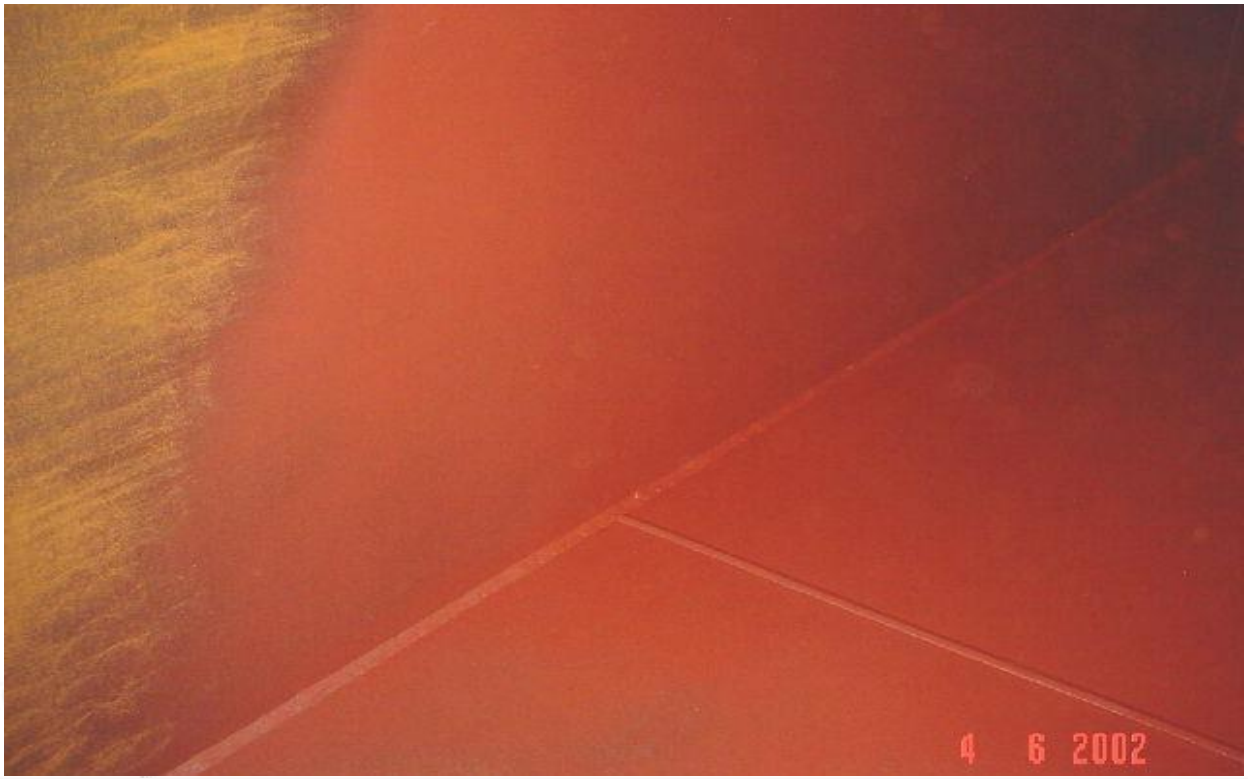
- Tradition epoxy mastic
  - Aluminum filled
  - Slow, non-aggressive solvents, high vol. solids
- Penetrating pre-prime epoxy
- New solvent-free technology
  - Developed for marine applications (immersion)
  - Applied without dew point restrictions and over damp steel surfaces
  - Very good chemical and abrasion resistance
  - Can be applied over hydro, abrasive, wet-abrasive, or power tool cleaning

MOISTURE TOLERANT

- Can Be Applied Over Damp Surfaces (*not a film or curtain of water)
- No Dew Point Restrictions
- Additional benefit: cold weather

SURFACE TOLERANT

- Can Be Applied Over Flash Rust and Tight Adherent Corrosion, *good wetting properties*

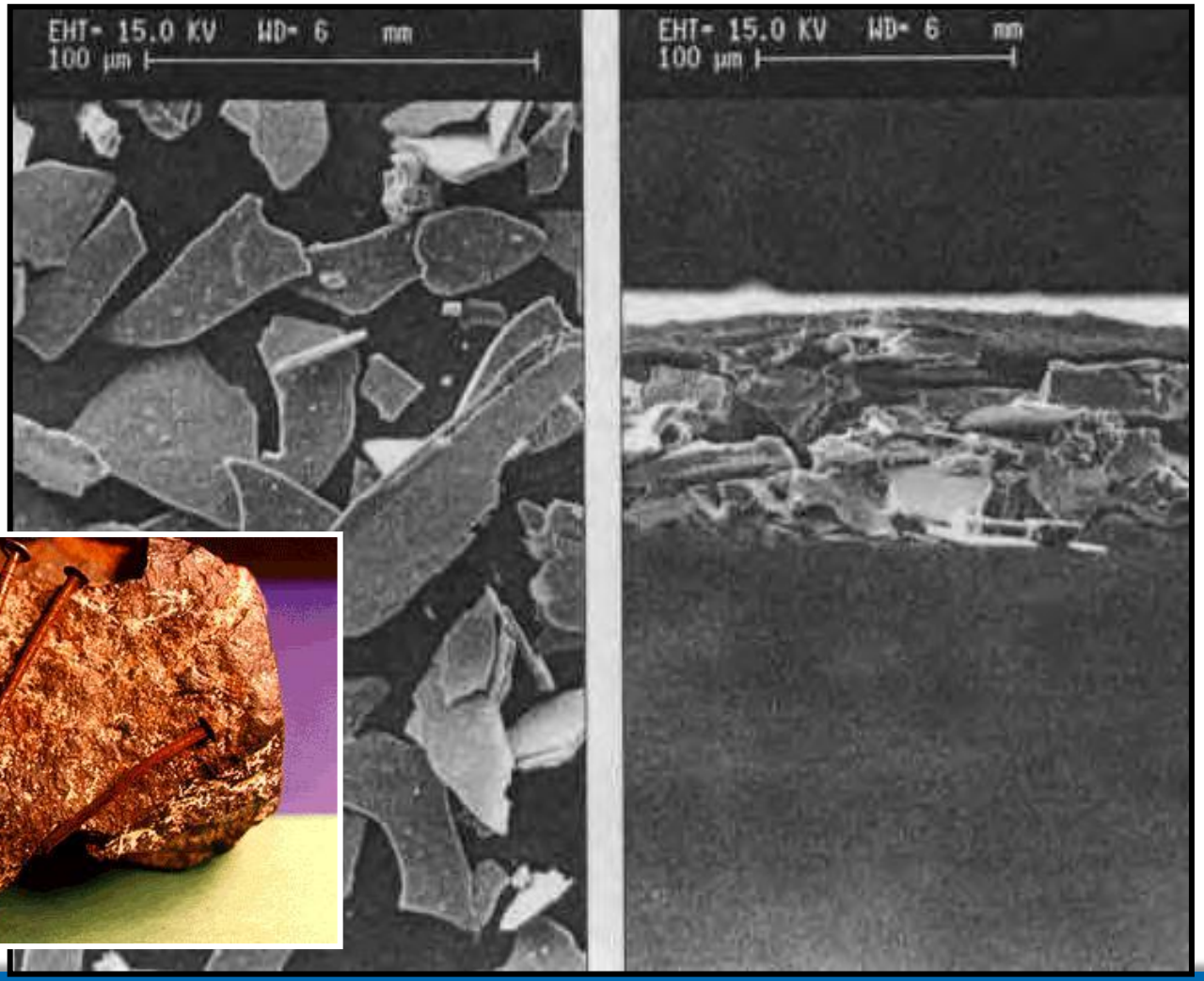


Moisture Cured Urethanes-MCU

- Complete line: primer, intermediate and finish coats
- Penetrating pre-prime MCU, surface tolerant
- Can be applied during high humidity
- Ease of application, single component
- Fast cure / fast recoat
- Low temperature application to 20° F.
- Compatible with epoxy and polyurethane
- Reinforced with micaceous iron oxide

Micaceous Iron Oxide (MIO)

Crystals of MIO are fractured into thin flakes.



Flakes then align in parallel fashion.

What makes MIO so good?

- Micaceous Iron Oxide (MIO) is iron oxide in a form that resembles mica, a highly structured, layered mineral. When MIO is ground into smaller, finer particles, they tend to separate along their layers revealing flat, shiny faces that act like tiny mirrors. These mirrors reflect UV light, protecting the resin from degradation and give an attractive “sparkle”. The shape also offers additional barrier protection.
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- MIO is chemically stable and it cannot rust further. The lamellar shape of this iron oxide offers greatly enhanced barrier protection.

- This is an excellent choice as an overcoat or intermediate coat over zinc as the high load MIO will protect the zinc thus forming a “double umbrella”

Intermediate Barrier Coats

Available for use:

- Epoxy
- Moisture Cured Urethanes (MCU)
- Acrylic
- Alkyd

High Performance Steel Topcoats

Polyurethanes

- A polyurethane coating is that derived from the reaction product of an isocyanate component and a resin blend component.
- Polyol + Isocyanate = Polyurethane + CO_2
- Good Chemical Resistance
- Hard, Yet Flexible Films
- Excellent Color and Gloss Retention
- Low-Temp, Formula Dependent Application
- No Sweat-In Time Required

Types of Polyurethanes

Aliphatic

- Excellent Color Retention
- Excellent Gloss Retention
- Primarily Used as Finish Coats
- More Expensive than Aromatics

Aromatic

- *Yellows & Chalks in Sunlight*
- *Yellows & Chalks in Bright Artificial Light*
- *Primarily Used as Tank Linings*

High Performance Aliphatic

- SSPC Paint 36
- “2K UV-Stable Polyurethane topcoats”

ASTM D4587	Level	Standard of Measurement
500h	Level I	“color change less then 2 delta E and gloss loss less then 30 units”
1000h	Level II	ASTM D2244 & ASTM D523
2000h	Level III	

Two component, limited pot life.
Sensitive to moisture during application & cure.

Mildew Resistant Polyurethane

- Mildew Resistant aliphatic acrylic polyurethane
- Excellent color and gloss retention

(Hi-Solids Polyurethane or Acrolon Ultra MR)

Aliphatic Moisture Cured Urethane

(Corothane I Aliphatic Finish Coat)

Isocyanate + Humidity = Amine + CO_2

Amine + Isocyanate = Polyurethane (Urea Linkage)

Fluoropolymer Urethane

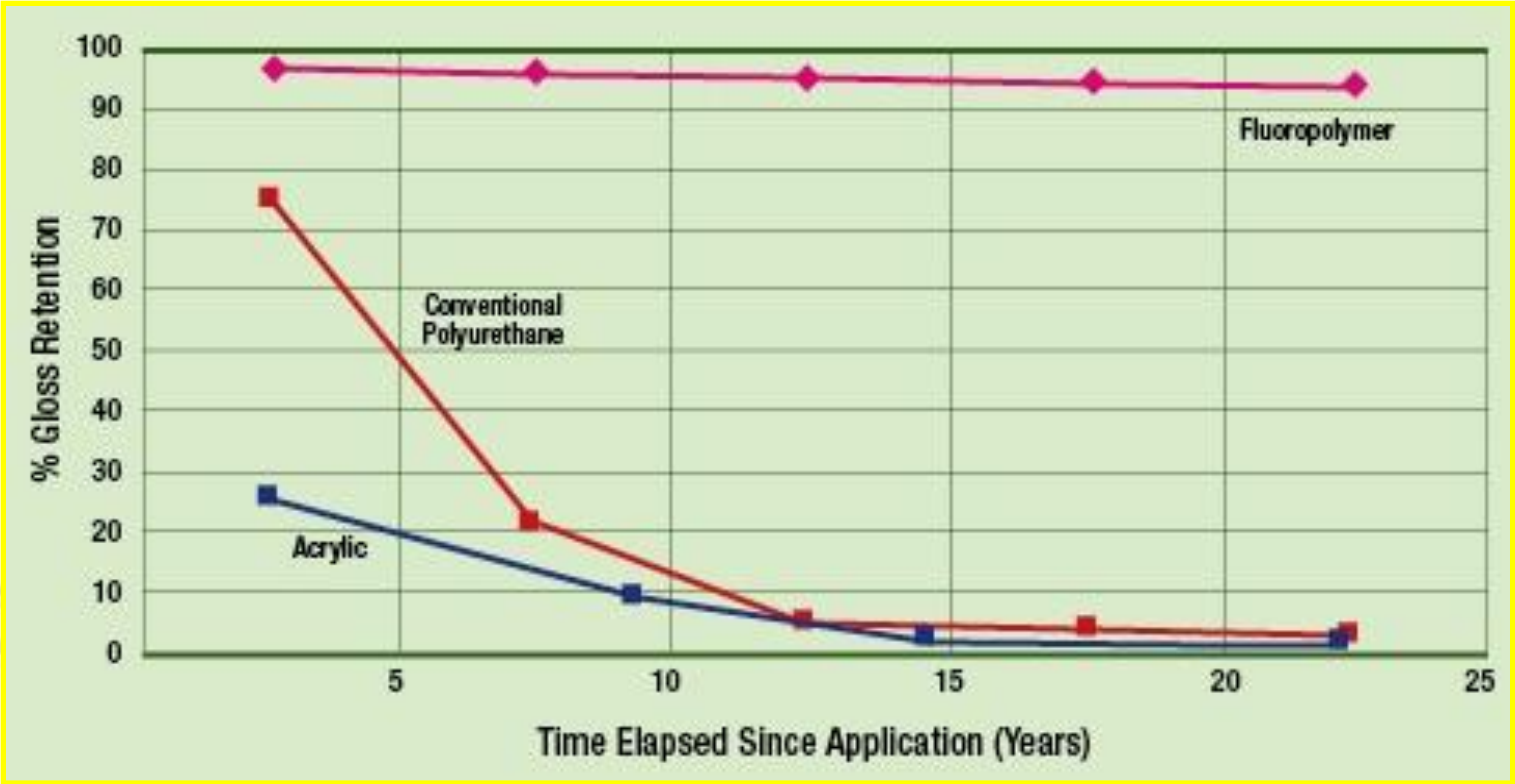
(Fluorokem HS)

- Ambient cured
- Superior color and gloss retention
- Available in a wide range of colors
- Graffiti resistant

Like Liquid Kynar

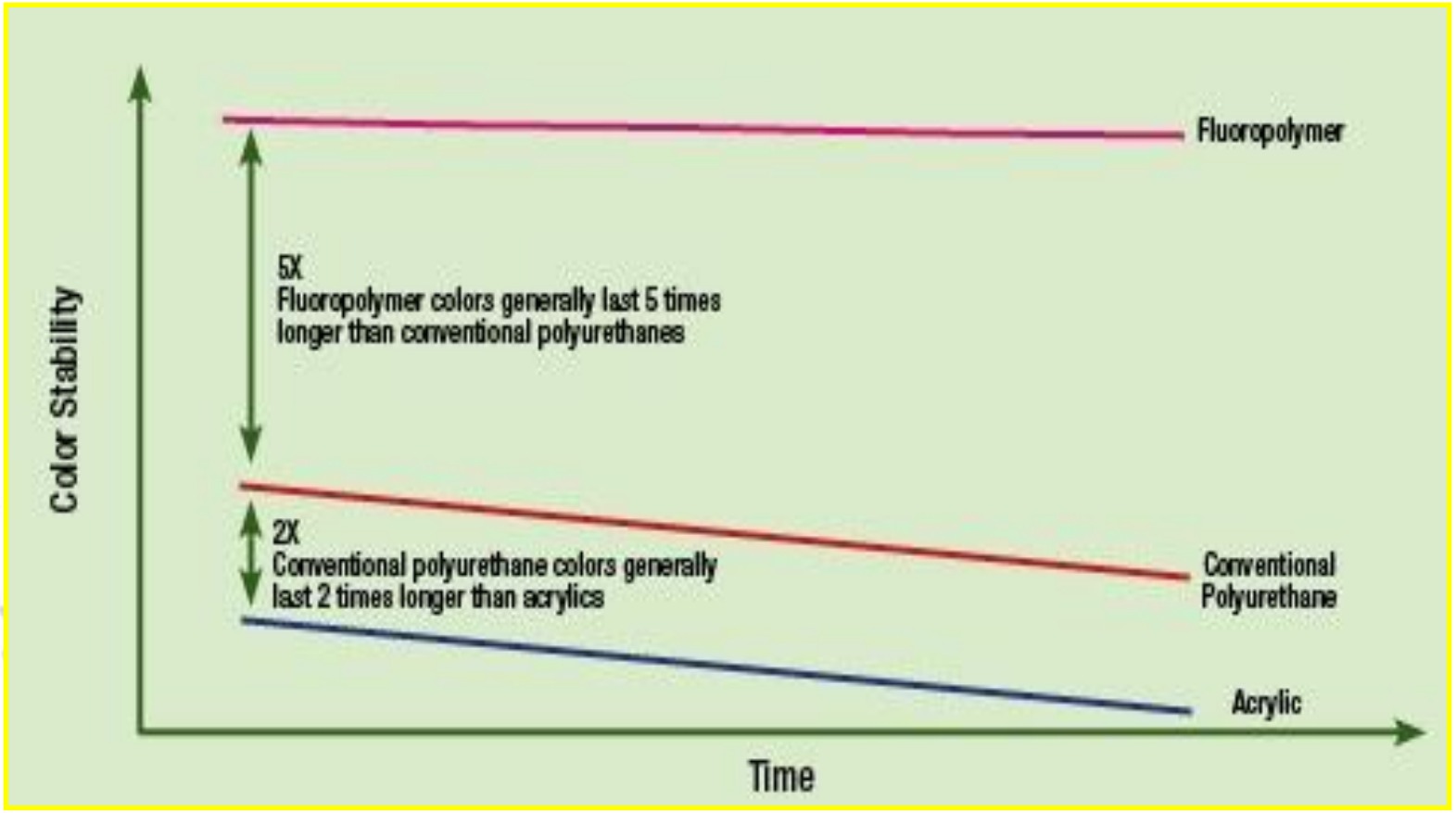
FluoroUrethane (hybrid urethane)

Gloss Retention



FluoroUrethane

Color Retention



Polyaspartic Urethane

- One or Two Coat System
- High throughput applications
- High humidity & blushing resistant
- High build with good color/gloss retention
- Corrosion protection
- Low temperature (35ºF) application

Polyaspartic Urethane

Polysiloxane

Polysiloxanes have dual reactivity:

Siloxane component – reaction with atmospheric moisture. Imparts exterior durability and chemical resistance to the coating.

Epoxy component – reaction with amine. Imparts toughness and corrosion resistance to the coating.

Polysiloxane Technology

- High solids epoxy siloxane combines the properties of both a high performance epoxy and a polyurethane in one coat
- *Isocyanate-free*
- Replaces a two coat epoxy/polyurethane system alone or over zinc-rich primer
- High-gloss, self-priming coating
- High solids, low VOC
- Long term color and gloss performance
- Corrosion and chemical resistant
- Outstanding application properties

High Performance Acrylics

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- Ambient Cure
- Cross-linking / branching
- Superior Color & Gloss Retention

Modified Alkyd Topcoats

- Silicone

(Steel Master 9500 30% Silicone Alkyd)

- Urethane

(Pro Industrial Urethane Alkyd Enamel)

Summary

- Explain why paints and coatings are used
- Explain how coatings protect
- Describe how coatings cure
- Describe the risks and considerations when overcoating
- Identify basic aboveground coatings including the
  - Benefits
  - Limitations
  - Uses

THANK YOU

Questions ?

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