Accelerated Performance Evaluation of Railcar Coatings: A State of the Art Update

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Testing Paints – Fitness for Use

Standardized Testing Methods – Physical/Performance Properties

- **ASTM D5894** Standard Practice for Cyclic Salt-Fog/UV Exposure of Painted Metal (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet)
- **ASTM B117** Standard Practice for Operating Salt Spray (Fog) Apparatus
- **ASTM D4587** Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings
- **ASTM D4585** Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation
- **ASTM D4541** Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
- **ASTM D522** Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
- **ASTM D2794** Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation
- **ASTM D4060** Standard Test method for Abrasion Resistance of Organic Coatings with Taber Abraser
- **ASTM D870** Standard Practice for Testing Water Resistance of Coatings Using Water Immersion
- **ASTM G8** Standard Test Methods for Cathodic Disbonding of Pipeline Coatings
- **ASTM G95** Standard Test Method for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method)
- **ISO 20340 (NORSOK)** Paints and varnishes — Performance requirements for protective paint systems for offshore and related structures
- **ISO 12944** Paints and varnishes – Corrosion protection of steel structures by protective paint systems
### Standardized Lab Test Equipment

**PHYSICAL PROPERTIES**
- Impactors
- Taber abrasion tester (dual)
- Conical mandrel tester
- Cylindrical mandrel tester
- Heavy-duty fixed radial tester
- Hydraulic press
- Ovens
- Gravelometer

**PERFORMANCE PROPERTIES**
- Electrochemical Potentiostats/Multiplexers/Function Analyzers
- Atlas cells / Corrocells
- Reaction flasks for full immersion testing
- Oil baths
- Water baths
- Salt fog chambers
- Q-Fogs
- Programmable Cyclical Environmental Chambers
- Humidity chambers
- QUV cabinets
- Cleveland Condensation cabinets
- Cathodic Disbondment Tanks
- Xenon Arc Weatherometers
Physical Testing - Lab

- Adhesion
- Flexibility
- Impact
- Abrasion
Performance Testing

• Weathering/Durability
  • Color
  • Gloss

• Corrosion Resistance
  • Rusting
  • Blistering
  • Delamination
  • Undercutting
Weathering Tests – Lab

- Q-UV
- Xenon Arc Weatherometer
Weathering Testing - *Exterior*

- **Solar concentrator:** Low-Temperature EMMA®/EMMAQUA®
- **Natural Exposures**
Corrosion Testing – *Lab*

- Salt-Fog ASTM B-117
- Wet/Dry Cyclic Testing ASTM G-95
- Cyclic Corrosion/Weathering Testing ASTM D-5894
Test Methods – Product Development

Mimic the Service Environment

Accelerate the correct rate determining step

Required Correlation: (Lab vs. ‘in service’)

- Rank order performance
- Degradation (rusting/blistering/delamination)
- Intact paint (polymer/resin chemistry changes)
- Damaged sites (structure/morphology/chemistry of corrosion products)

Results obtained depend on the test method – not on the coating!
Corrosion – *Electrochemistry*

- **Electrochemical Impedance Spectroscopy (EIS)**
  - Coatings performance ranking.
  - Performance changes before visual detection.

- **Electrochemical Noise Method (ENM)**
  - Coatings performance ranking
  - Mechanistic information
  - Performance predictions (?)
LAboratory Testing – Representative Protocols
- ISO, NACE, ASTM, Materials System Specifications

Atmospheric Immersion
Chemical resistance
**Autoclave**
Adhesion
Abrasion resistance
Flexibility
**Temperature resistance**
Cathodic disbondment
Hardness
Atlas Cell
Application properties
Cure time
Solvent content
DFT
VOC
What’s **New** in Protective Coatings/Testing/Technology?

**Roadmap to the Future!**

“If you **always** do what you **always** did, you will **always** get what you **always** got”

- ALBERT EINSTEIN
Industry Trends – 2016

Drives Need for Improved Testing Procedures

- Regulations force change (lower or 0 VOC’s/solvent free/0 HAPs)
- Fewer coats \( (2\text{-coats } \rightarrow 1\text{-coat}) \)
- Less surface preparation/more surface tolerant
- Faster return to service
- Longer working time/pot life
- Less maintenance
- Single component
- Improved performance/service life
Advancements in Coatings Technology

- High Performance Acrylics - *cross-linking, 0 VOC*
- WB High Build Acrylic Epoxies – *high performance*
- 100% DTM/WB Urethanes – *high performance > S/B ($$)*
- Polysiloxanes – *appearance, durability ($$)*
- Polyaspartics – *durability, working times, 1-coat ($$$)*
- Fluoropolymers – *appearance, life cycle costs ($$$$)*
- Styrene-free Vinyl Esters - *safety, HAPS free, ‘green’*
Lab vs. Field - Correlation

• **Replicate** *rate determining steps in degradation*
• **Measure/monitor** – *electrochemistry, analytical*
Lab vs. Field - *Correlation*

Accelerated Weathering Testing

% Gloss Retention and Color vs. Time

- **Accelerated Weathering (QUV)**
  - Fluoropolymer
  - WB Urethane
- **Solvent Based Polyurethanes**

Assess value of this additional time period of higher performance?
Lab vs. Field – Correlation
Where will the future take us?

*Improved Test Methods Are Available!*

- Water - 1K waterborne = 2K solventborne for steel/atmospheric
- Waterborne tank linings
- New polymer designs
- Nanotechnology
- Engineered surfaces
- Self-healing and smart coatings
- Renewable – resources/biobased