One Component, Many Options: The Growing Role of Acrylcs in Industrial Coatings

October 23, 2014
Agenda

• Waterborne Acrylics 101: The Basics

• Market Perspective
  – Market background
  – Trend analysis

• Game Changing Technologies: Redefining the Limits
  – Changing the way latexes interact with pigments
  – Pushing the limits on VOC
  – New hybrid technologies for 2K coatings

• New Applications
  – Insulation coatings
  – Sound damping coatings
Waterborne Acrylics 101: The Basics
What are Waterborne Acrylic Coatings?

- Paints and coatings based on WB acrylic polymers (acrylic latex or acrylic emulsion)
- Non acrylic latex polymers (SBR and vinyl acetate)
- Most commonly associated with architectural coatings, but are used in numerous industrial paints and coatings

Two Types of Coatings Systems

- **One-component**
  - Thermoplastic acrylics
  - Self-crosslinking thermoplastic acrylics
  - Elastomeric acrylics
- **Two-component**
  - Acrylic / epoxy
  - Acrylic polyurethane
Why Use Acrylics in Paints and Coatings?

- Excellent resistance to ultraviolet light (UV), which translates into excellent exterior durability
  - Color and gloss retention
  - Maintain clarity
  - Resistance to chalking

- Toughness
- Maintain flexibility and resistance to embrittlement
- Resistant to grain cracking over wood
- Hydrolytically stable
- Wide range of compositions attainable (i.e., can tailor composition for various applications)
Waterborne Acrylics in Industrial Coatings

- Field-applied industrial maintenance coatings for metal and concrete
- Traffic and roadmarking paints
- Elastomeric roof coatings
- General industrial finishing
- Plastic coatings
- Concrete and metal roof tiles
- Fiber cement siding
- Wood and wood composite coatings: e.g., cabinets, furniture, joinery
- Coil coatings
Types of Waterborne Acrylic Coatings Available

Waterborne acrylic resins are used in a variety of industrial maintenance and commercial architectural coatings:

**Primers**
- Wash primers
- Anti-corrosive primers
- Block fillers
- Masonry primers

**Direct-to-substrate finishes**
- DTM finishes
- Elastomeric wall & roof coatings

**Topcoats**
- Gloss to flat sheens
- Clear or pigmented

**Functional coatings**
- Thermal insulation
- Sound Damping
- Formaldehyde abatement
Benefits & Challenges of Waterborne Acrylic Coatings

**Benefits**

- Low VOC = less impact on environment
- Low odor
- Less concern over worker exposure to hazardous solvents
- Better “cycle time” for various trades
- Lower risk of fire from handling flammable solvents
- Easy and safer cleanup
- Less waste and hazardous disposal
- Ease of use
- Proven performance in real world applications

**Challenges**

- Application window, i.e., length of painting season
- Drying rate dependent on humidity
- Reduced water resistance
  - Surfactants
  - Salts
- Often reduced substrate wetting
  - Higher surface tension of water
- Open time
- Film formation
Market Perspective
U.S. Coatings Market

2011 Consumption
- 1.4 Billion gallons
- Valuation of $23.1 Billion
  - 60% of value is from Industrial segments

U.S. Coatings Market (Gallons Consumed)

Special Purpose: 53%
Architectural: 24%
OEM: 23%

U.S. Coatings Market by Technology

WB: 55%
SB: 33%
Powder: 5%
100% Solid: 4%
E-coat: 2%
Radcure: 1%

WB by Segment
- Architectural – 72%
- Special Purpose – 18%
- OEM – 10%

Industrial Maintenance Applications Using WB Acrylics

- Storage tanks
- Bridges
- Railcars
- Metal Buildings
- Commercial Architectural
- Shipping Containers
- Structural Steelwork
- Water Towers
- Pipes
Industrial Maintenance Market

Technology Distribution
Distribution by volume, total volume 52.1 MM gallons (2010)

- Epoxy: 35%
- Polyurethane: 15%
- WB Acrylic: 24%
- Alkyd: 12%
- Other: 14%

Bridge

Key Attributes
Low VOC
Color and Gloss retention
1K ease of use
Barrier properties – corrosion resistance

Where Used?
Steel and concrete bridges – primers and topcoats
Often used over primers of other chemistry, e.g., Zn rich
Specified and used by states such as CA, GA, NC, FL, etc.
Rail & Container

**Where Used?**
- Boxcars, hopper cars, gondola cars – exterior DTMs
- Shipping containers – primers/topcoats

**Key Attributes**
- Low VOC
- Fast dry
- Gloss
- Color and Gloss retention
- 1K ease of use
- Barrier properties – corrosion resistance
Commercial Architecture

Key Attributes
- Low VOC, low odor
- Color and Gloss retention
- 1K ease of use
- Barrier properties – corrosion and water resistance
- Chemical / solvent resistance
- Abrasion resistance

Where Used?
- Interior and exterior walls – concrete, drywall
- DTMxs for steel structures
- Roof coatings
- Interior floor coatings
Industry Specifications Based on Waterborne Acrylis

**SSPC Paint Standards**
- Paint # 23: Latex Primer for Steel Surfaces (revised 2013)
- Paint # 24: Latex Exterior Topcoat for Steel Surfaces (currently under revision)

**DOT Steel Bridge Specifications**
- Various states such as CA, GA, NC

**MPI Examples**
- MPI-153: Light Industrial Coating, Interior, Water-based, Semi-gloss
- MPI-163: Light Industrial Coating, Exterior, Water-based, Semi-gloss
- MPI-147: Latex, Interior, Institutional Low Odor/VOC, Semi-gloss
Key Trends and Drivers in Industrial Space

- **Sustainability/Regulations**
  - Trend toward WB, high solids
  - VOC/odor reduction
  - Carbon footprint
  - Human health & safety

- **Performance**
  - Surface compatibility
  - Improved durability/resistance
  - Extreme environment corrosion protection

- **Cost Effectiveness**
  - Reduced prep, application time/number of coats
  - Extended pot life
  - Optimized processing
Game Changing Waterborne Acrylic Technologies
Game Changing Waterborne Acrylic Technologies

New developments in WB acrylic technology are pushing the limits of their performance.

Redefining the interaction between polymer and pigment

Pushing the limits on VOC

New hybrid technology for 2K coatings
Challenges of Improving Corrosion Resistance

Corrosion resistance in 1K thermoplastic acrylic DTM relies mainly on barrier properties of the film.

**Barrier properties are dominated by…**

- Quality of film formation
- Film hydrophobicity
- Pigment distribution

**Redefine the Interaction Between Polymer and Pigment**

- In WB coatings, we are generally concerned with interactions between particles that maintain particle-particle separation
- New technology changes interaction between latex particles and pigment particles, promoting formation of latex-pigment composite particles
- Composite particles change the structure of wet paint and dry film
Film Formation of Conventional Latex Paint

Application

Evaporation and Particle Compaction

Polymer Diffusion

Acrylic latex

Pigment
Film Formation with Latex-Pigment Composites

Optimizing pigment dispersion through formation of latex-pigment Composite Particles in the wet state

Composite particle formation
Benefits of New Technology: Latex-Pigment Composites

Unique self-assembly mechanism defines the interaction with the pigment, and offers improvements in:

– Corrosion resistance
– Gloss
– Gloss retention
– Hiding
– Adhesion to difficult metals
Corrosion Resistance: Effect of Pigment Dispersion on Barrier Properties

35 Day Salt Spray Exposure

- 18 PVC gloss white DTM
- No inhibitive pigments
- One coat, 3 mil DFT
- Blasted HRS (SSPC-SP 5)

Conventional acrylic latex

New technology: Latex-pigment composites
Challenges of Lowering VOC Levels

Trend in maintenance coatings is towards lower VOC, e.g., SCAQMD limit for IM coatings is currently at 100 g/L.

Challenges presented when lowering VOC...
- Hardness
- Block and print resistance
- Dirt pickup resistance
- Maintaining good film formation

Market also wants higher performance...
- Gloss and Durability
- Corrosion resistance
- Hiding
Development Objectives for Low VOC Acrylic DTM Resin

Significant reduction in VOC: Capability of < 50 g/L

- Anticipating future industrial coating regulations
- DTMs are increasingly used in the architectural space

Maintain (or improve) properties relative to higher VOC binders

- Hardness properties
- High performance of recent generation of DTM binders (e.g., based on latex-pigment composites)
- Corrosion resistance
- Gloss / Gloss retention

Broad utility in both industrial and architectural applications
Benefits of New Technology
WB Acrylic DTM with <50 g/L VOC

- VOC
- Gloss
- Dirt Pickup Resistance
- Humidity Resistance
- Adhesion to CRS
- Corrosion Resistance (1000 hrs)
- Block Resistance (1 day oven block)
- Gloss retention (7 wk QUV A)
- Low temp coalescence

DTM-1
COM-1
COM-2
COM-3
Hardness properties such as block resistance can be difficult to maintain when lowering VOC levels.

1 Day Block Resistance

- Low VOC DTM
- Commercial #1 <200 VOC
- Commercial #2 <50 VOC
- Commercial #3 <100 VOC

1 Day, 30 min. Oven Block
1 Day, Room Temp. Block
Corrosion Resistance
1,000 Hours Salt Spray Exposure over Cold Rolled Steel

New technology
8% coalescent
< 50 g/L

Commercial DTM #1
<200 VOC
Stopped @ 576 hours

Commercial DTM #2
<50 VOC
Stopped @ 576 hours

Commercial DTM #3
<100 VOC
Challenges of Improving Performance of 2K WB Coatings

Current 2K WB coatings based on epoxy chemistry are used in industrial and commercial applications, but have some limitations.

**Challenges for epoxy-amine systems**
- Short pot life
- Slow dry times
- Poor durability

**Challenges for epoxy-acrylic systems**
- Slow reaction (acid / epoxy reaction)
- Long time to develop full properties
## Current 2K Waterborne Coatings

<table>
<thead>
<tr>
<th></th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part A</td>
<td>Liquid epoxy resin (LER)</td>
<td>WB epoxy dispersion</td>
<td>WB acrylic latex</td>
</tr>
<tr>
<td>Part B</td>
<td>WB amine hardener</td>
<td>WB amine hardener</td>
<td>WB epoxy dispersion</td>
</tr>
</tbody>
</table>

![Diagram of mixing processes for different types of 2K waterborne coatings]
New Technology: Acrylic-Epoxy Hybrids

Part A = Acrylic-Epoxy Hybrid Resin

- Acrylic and epoxy in the same particle
- Epoxy-functional
- Colloidal properties similar to acrylic latex
- EEW similar to SER (low hardener demand)
## Benefits of New Technology: Acrylic-Epoxy Hybrids

- <50 g/L VOC capability
- Long pot life (~ 4 – 10 hour pot life)
- Fast cure (amine-epoxy reaction)
- Fast dry time (lacquer dry of acrylic)
- Fast hardness development
- Good durability (due to acrylic)
- Low viscosities for easy 2K mixing (i.e., a latex system)
- Potential for multi-substrate use in industrial and commercial architectural applications
Gloss Retention on UV exposure

60 Degree Gloss

QUVA Exposure Time (Hours)

Acrylic component facilitates improved UV durability
New Applications for Waterborne Acrylics
New Applications for Waterborne Acrylics

- **Thermal Insulation Coatings**
- **Sound Damping Coatings**
Thermal Insulation Coatings: A New Way to Insulate

- Insulation is used to prevent heat loss (or gain)
  - Energy conservation ($)
  - Process control
  - Safety – personnel protection (e.g., from burns)

- Formulated with WB acrylic resins and low thermal conductivity fillers
- Applied using traditional coating application methods, i.e., spray
- Easily applied on complex geometries where traditional insulation is difficult to install
- Insulation coating is fully adhered to the substrate/primer (CUI issue)
- Suitable for up to ~350 °F service temperature
Energy Efficiency: Energy Use in a Model Scenario

Energy consumption (kWh) to maintain various internal temperatures for a six-hour period with a 125 mil DFT insulation coating.

22 – 36% less energy used
Benefits of Thermal Insulation Coatings

WB Acrylic binders facilitate easy formulation of thermal insulation coatings, which offer:

- Low thermal conductivity (k-value)
- Personnel protection (safe touch)
- Insulating properties / Energy management
- Energy savings
- Improved inspection for CUI
- Ease of installation vs. traditional insulation
What is Liquid Applied Sound Damping?
• The use of coatings to reduce sound and vibration
• Typically used in the Automotive industry as a replacement for bitumen or asphaltic pads used on interior of body
• Applied by airless spray

Where else could LASD be utilized?
Any application that can benefit from sound management and reduced noise, vibration, and harshness (NVH):
• Marine/Rail
• Automotive
• Agriculture & Construction Equipment
• Refrigerators
• HVAC Units
• Air Conditioners
• Floors/Roofs
• HVAC Ducts
• Elevator Shafts
• Service Conduits
• Boiler Rooms
Changes in Tg and other emulsion construction variables allow the tailoring of damping performance to individual specifications.

**Range of Temperature Conditions and Performance Options**

**Loss Factor Performance**
- ASTM E-756 Base Beam: 0.8 mm x 12.7 mm x 200 mm (260 mm total length)
- Bake: 30 min (25°C), 30 min (150°C), Frequency Interpolation: 200 Hz
Benefits of Sound Damping Coatings

• Customizable solutions for sound damping

• Applications
  Any application that can benefit from sound management and reduced noise, vibration and harshness (NVH):
  – Automotive *(Passenger Car, Truck, Van)*
  – Commercial Transportation *(Marine, Rail, Bus)*
  – Agriculture & Construction Equipment *(ACE)*
  – Appliances *(Washing Machine, Dishwasher, Air Conditioner)*

• Excellent choice for LEED and Well Building Standard enhancements

• Benefits vs. traditional solutions:
  – Improved damping performance & noise reduction
  – Up to 35% lower weight compared to alternative technology
  – Improved health & safety profile
Conclusions

• Waterborne acrylics are one of the major technologies used in Industrial and Commercial Coatings

• Wide range of compositions and corresponding performance is available

• New advances are pushing the limits on performance, such as:
  – Corrosion resistance
  – VOC capability
  – Improved balance of properties for 2K coatings

• New types of functional coatings are expanding the use of acrylics:
  – Insulation coatings
  – Sound damping coatings