Polyaspartic Coatings
High-Profile Protective and Marine Applications

12/18/13  Mike Jeffries
Agenda

- Polyaspartic Coatings Overview
- Corrosion Protection
- Marine Applications
- Gen II Polyaspartic Improvements
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Polyaspartic Coatings

- Aliphatic polyureas based on polyaspartic esters + aliphatic isocyanate

\[
R'\text{-N}=\text{C}=\text{O} + \text{H-NN} \xrightarrow{X} \text{R'-N-C-N} \xrightarrow{X} \text{R'-N-C-N}
\]

Isocyanate   Aspartate   Aliphatic Urea

\[
R\text{-N}=\text{C}=\text{O} + \text{R'-OH} \rightarrow \text{R-N-C-OR'}
\]

Isocyanate   Polyol   Urethane
Polyaspartic Features

- Fast cure with potlife
- Aliphatic – Light Stable
- High film build
- Low VOC
- High Solids
- Corrosion resistance
- Spray, brush, or roll
## Polyaspartic Product Line

<table>
<thead>
<tr>
<th>Properties</th>
<th>PAE 1</th>
<th>PAE 2</th>
<th>PAE 3</th>
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<td>% Solids</td>
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<td>100</td>
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\(^1\)PAC/Polyisocyanate, NCO:NH Ratio 1.0, 65% solids in 1:1 MEK A-100
## Polyaaspartics for High Solids

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<td>PAE 3</td>
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### Aliphatic Polyisocyanates
Co-reactants for Polyaspartic Esters

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<tr>
<th>Type</th>
<th>Solid content approx. [%] (solvent)</th>
<th>NCO-content approx. [%]</th>
<th>Viscosity 23 °C approx. [mPas]</th>
<th>NCO functionality</th>
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<td>10.2</td>
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</table>

- **Low functionality:** $2.0 < F < 2.8$
- **Medium functionality:** $2.8 < F < 3.6$
- **High functionality:** $F > 3.6$

Viscosity, functionality and % NCO affect pot life and cure speed.
## Factor Effecting Cure

### Humidity

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**Laboratory operation area = yellow**
**Approximate equal dry time = green**
Polyaspartics for Corrosion Protection
Polyaspartics for Corrosion Protection

- Reducing the number of coats
  - Cost and labor savings
  - Combining the benefits of the epoxy and the PUR

![Diagram showing the layers of a coating system being replaced by a polyaspartic layer on steel](image-url)
## Fewer Coats – Corrosion Resistance

Alberta Transportation and British Columbia Ministry of Transportation CPTP Testing Program 2008  
3015 hours of ASTM D5894 Cyclic Weathering

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<th>Midcoat</th>
<th>Finish Coat</th>
<th>Scribe Undercut</th>
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<td>Phenalkamine</td>
<td>Acrylic Polyurethane</td>
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</table>

Data from a recent article published in JPCL 2013 authored by Mike O'Donoghue, Vijay Datta, Stan Walker, Terry Wiseman, Peter Roberts, and Norb Repman
Case History - Railcars

- Hopper cars coated with a DTM polyaspartic
  - Steel blasted to NACE No.3
- Two Painters
- ~16 mils WFT
- ~40 min/car
Case History - Railcars

- Excellent application in hard-to-coat areas
- ~30% Savings in time and labor

<table>
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<tr>
<th>Coating System</th>
<th>Material Usage</th>
<th>Labor Usage</th>
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<td>DTM Polyaspartic</td>
<td>36 Gallons</td>
<td>10.5 Hours</td>
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<tr>
<td>2-Coat Epoxy/Urethane</td>
<td>35 Gallons</td>
<td>15.5 Hours</td>
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Case History - Railcars

- 11 Years in Service
Case History – Bridge 1199 over I-84 in Danbury, CT

- Originally presented by Brian Castler from Conn DOT in 2003 at SSPC
- Quantify the economic benefit

- West-bound lanes painted with 3-coat system (12,264 ft²)
- East-bound lanes painted with 2-coat system (10,525 ft²)
Case History – Bridge 1199 over I-84 in Danbury, CT

Direct savings to the owners of $6.02/ft²
Case History – Bridge 1199 over I-84 in Danbury, CT

Field painting productivity
Calculating the square ft. per day

- 3-coat system was able to cover 383 ft² per day
- 2-coat system was able to cover 502 ft² per day

31% improvement to productivity
Case History – Marine Corps Museum

• Project completed in 2006
• Fabricator: Banker Steel Company, LLC.
• Painting Contractor: EPAcoat, Inc.
• This project had tight budget and production schedule
  • DTM polyaspartic, shop-applied
  • Fabricator able to move steel 2 hours after application of finish coat
Case History – Marine Corps Museum

• Centerpiece: 160-ft glass atrium supported by tapered steel girders
  • Girders: sizes up to 18” x 72” x 180 feet long
  • Shipped in two pieces and touched up on site
Case History - Dallas Cowboys Stadium

- Stadium completed 2009
- 2½ Years, $1.1 billion to build
- Design and engineering: HKS Inc.
- GC: Manhattan Construction
- Steel Fabricator: W&W Steel/AFCO Steel
Case History - Dallas Cowboys Stadium

- The steel was painted in the shop
- 2-coat system of epoxy primer with polyaspartic topcoat
  - Movement of the steel 2 hours after application of finish coat
  - High throughput kept production on schedule
  - Highly durable finish coat led to minimal touch up on site
Polyaspartics for Marine Application
Depending on the WPG location different corrosion categories* are required:

Category C3: Urban and industrial atmosphere with moderate pollution.

Category C5: Coastal and offshore areas with high salinity.
Case History – Offshore Wind Power

Industrial coating:
Category C3

Substitution of the primer by a DTM polyaspartic coating

*DTM = direct to metal

Corrosion protection:
Category C5

Substitution of the intermediate coat by polyaspartic coating

24-36 hrs

50% reduction in VOC
New Developments in Polyaspartics

- Polyaspartic coatings are a proven technology
- However some improvements were needed
  - Need for improved recoat window
  - Application difficulties in high temperature and humidity conditions
    - Shortened potlife
    - Changes in cure times
    - Increased roller marking, overspray melt-in
    - Higher solids (85%+) worsen the issue
Next Generation Isocyanate

Engineered IPDI / HDI
Aliphatic Prepolymer for Polyaspartics
Gen II polyaspartics – engineering performance

Benefits of Gen II Isocyanate

• More robust in high temperature and humidity
• Increased the recoat window from days to months
• Improved resistance to water
• Favorable mix ratio
• Improved ASTM 5894 cyclic salt spray/QUV
Gen II – Reducing Humidity Sensitivity

Cure Time at Elevated Conditions

- **Gen II**
  - 95°F / 90% RH
  - 77°F / 88% RH
  - 72°F / 50% RH

- **Gen I**
  - 72°F / 50% RH
Gen II – Improved Recoat Window

1 year in-field recoat in Baytown, TX

MCU Zinc Rich Primer
Gen II Polyaspartic Topcoat

Inorganic Zinc Rich Primer
Gen II Polyaspartic Topcoat

Pull off adhesion 1000-2400 PSI

Power wash @ 3000 PSI with 0° rotary tip 6-inch stand off distance
Gen II – Improved Water Resistance

Gen I

Gen II

4 days in Cleveland condensing cabinet
Gen II – Improved Cyclic Salt Spray/QUV

Inorganic Zinc Primer (3-4 mils)
Polyaspartic Topcoat (6-9 mils)

Gen I

MCU Zinc Primer (3-4 mils)
Polyaspartic Topcoat (6-9 mils)

Gen I

Gen II

Gen I

Gen II

7056 hours ASTM D 5894

7056 hours ASTM D 5894
Gen II – Adhesion to OZ and IOZ

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<tbody>
<tr>
<td>NH-1420/NH-1521/XP-2763</td>
<td>70%</td>
<td>30%</td>
<td>NH-1420/NH-1521/XP-2763</td>
<td>70%</td>
</tr>
</tbody>
</table>
Traditional PAE Concrete Coating

100 g/l Guide Formula - Flooring

<table>
<thead>
<tr>
<th>Raw Material</th>
<th>Weight</th>
<th>Volume</th>
<th>Weight Solids</th>
<th>Volume Solids</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Component I</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAE 2</td>
<td>15.24</td>
<td>1.73</td>
<td>15.24</td>
<td>1.73</td>
</tr>
<tr>
<td>PAE 3</td>
<td>30.49</td>
<td>3.47</td>
<td>30.49</td>
<td>3.47</td>
</tr>
<tr>
<td>Aldimine</td>
<td>6.10</td>
<td>0.84</td>
<td>6.10</td>
<td>0.84</td>
</tr>
<tr>
<td>Byk-306</td>
<td>0.37</td>
<td>0.05</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>Byk-A 530</td>
<td>0.74</td>
<td>0.11</td>
<td>0.04</td>
<td>0.00</td>
</tr>
<tr>
<td>Ektaprop EEP</td>
<td>8.30</td>
<td>1.05</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>SubTotal I</strong></td>
<td>61.25</td>
<td>7.24</td>
<td>51.92</td>
<td>6.04</td>
</tr>
<tr>
<td><strong>Component II</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDI Trimer</td>
<td>38.75</td>
<td>4.04</td>
<td>38.75</td>
<td>4.04</td>
</tr>
<tr>
<td><strong>SubTotal II</strong></td>
<td>38.75</td>
<td>4.04</td>
<td>38.75</td>
<td>4.04</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100.00</td>
<td>11.28</td>
<td>90.67</td>
<td>10.08</td>
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</table>

**Theoretical Results**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Wt/Gal</td>
<td>8.87</td>
</tr>
<tr>
<td>Mix Ratio (volume)</td>
<td>1.79 : 1</td>
</tr>
<tr>
<td>NCO:OH</td>
<td>1.07</td>
</tr>
<tr>
<td>Theoretical VOC</td>
<td>0.83</td>
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</tbody>
</table>

**Property**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry time</td>
<td>4 hours</td>
</tr>
<tr>
<td>Working Time / Potlife</td>
<td>5-10 minutes 30 minutes</td>
</tr>
<tr>
<td>Taber</td>
<td>60 mg loss</td>
</tr>
<tr>
<td>Weathering QUV-A 2000 hours</td>
<td>~98% retention</td>
</tr>
<tr>
<td>Tensile</td>
<td>~5000 psi</td>
</tr>
<tr>
<td>Elongation</td>
<td>~5%</td>
</tr>
<tr>
<td>Hot tire marking</td>
<td>No marking</td>
</tr>
</tbody>
</table>
Next Generation PAE Concrete Coating

<table>
<thead>
<tr>
<th>Property</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry time</td>
<td>4 hours</td>
</tr>
<tr>
<td>Working Time / Potlife</td>
<td>10-15 minutes 30-40 minutes</td>
</tr>
<tr>
<td>Taber</td>
<td>80 mg loss</td>
</tr>
<tr>
<td>Weathering QUV-A 2000 hours</td>
<td>~90% retention</td>
</tr>
<tr>
<td>Tensile</td>
<td>~3500 psi</td>
</tr>
<tr>
<td>Elongation</td>
<td>~3%</td>
</tr>
<tr>
<td>Hot tire marking</td>
<td>No marking</td>
</tr>
</tbody>
</table>
## Side by Side Comparison

<table>
<thead>
<tr>
<th>Property</th>
<th>Traditional Aspartate</th>
<th>Next Generation Aspartate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry time</strong></td>
<td>4 hours</td>
<td>4 hours</td>
</tr>
<tr>
<td><strong>Working Time / Potlife</strong></td>
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<td>10-15 minutes 40 minutes</td>
</tr>
<tr>
<td><strong>Taber</strong></td>
<td>60 mg loss</td>
<td>80 mg loss</td>
</tr>
<tr>
<td><strong>Weathering QUV-A 2000 hours</strong></td>
<td>~98% retention</td>
<td>~90% retention</td>
</tr>
<tr>
<td><strong>Tensile</strong></td>
<td>~5000 psi</td>
<td>~3500 psi</td>
</tr>
<tr>
<td><strong>Elongation</strong></td>
<td>~5%</td>
<td>~3%</td>
</tr>
<tr>
<td><strong>Hot tire marking</strong></td>
<td>No marking</td>
<td>No marking</td>
</tr>
</tbody>
</table>
Final Points

• Proven performance

• High throughput

• More robust Gen II
Acknowledgements

Ahren Olsen
Kurt Best
Thomas Baeker
QUESTIONS?

Mike Jeffries
Mike.Jeffries@Bayer.com
412-777-4950
Polyaspartics for Flooring and Concrete Coatings
Floor Coating Market

Professionally applied high-performance floor coatings market

- Heavy Duty 75%
- Light Duty 15%
- Decorative 10%

Source: P.D. Lovett & Co., Skiest, Industry Experts
Case History – Disney WWS Stadium

Disney Wide World of Sports Stadium - Orlando, FL

Contractor: Shield Co.

- 125,000 square feet
- Disney holds all their sites to Title 10 compliance
- Required a flexible concrete coating with low- to zero-VOC
- Architectural and Facilities Engineering preferred this smart solution for VOC compliance as well as proven long term durability
- 3-coat system with a 2K moisture-resistant epoxy primer and two coats of polyaspartic
Ave Maria University – Naples, FL

Architect: Cannon Design

General Contractor: Suffolk and Kraft

- Initial project was spec’d in marble but proved to be too costly
- 70,000 square feet to be coated
- A durable, low-VOC, and ADA-compliant floor coating system with the look of aged leather was desired
- Decorative ChemTone Acid stain was applied, followed by zero-VOC clear polyaspartic topcoat
- Very fast cure allowed trades back in the area quickly
Case History – Beau Catcher Tunnel

Beau Catcher Tunnel: Asheville, NC

- 12 mils white polyaspartic top coat
- Aromatic polyurea liner
- Completed in 1996
- Remains in service
Gen II – Hot Tire Resistance

Concrete Sample
• Acid Etched
• Room Temp

Tire Preparation
• Wet Sample
  • Soaked in 140°F, 2 hrs
• Dry Sample
  • Baked at 140°F, 2 hrs

Tire Type
• High Performance – P
• Normal - C
Gen II – Hot Tire Resistance

Clamped Setup
- 250 psi

Wet Sample
Dry Sample
Duration – 2 hrs
Hot Tire Testing - Results

Control - Before

Control - After

Next Gen - After