New Water-Based Amine Technology for Epoxy Application Over Green Concrete

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Current Epoxy Floor Application

Concrete Pour

Wait 28 Days

Prime Floor and Topcoat

Shot Blast
What If…

Concrete Pour → Wait 28 Days → Shot Blast → Prime Floor and Topcoat

- Concrete Pour
- Wait 28 Days
- Shot Blast
- Prime Floor and Topcoat
Overview

• Background
• The New Water-Based Amine Technology
• Evaluation as a Concrete Curing Compound
• Evaluation as a Green Concrete Primer
• Top-Coat and Re-Coat Test Results
• Questions
Background

• Market Trend: Faster Return to Service
• Millions of Tons of Concrete Placed/Year
• Estimated 5MMlb/Year of Concrete Curing Compounds, Sealers and Primers Applied
• Typical Epoxy Systems Are Not Stable/Do Not Wet/Do Not Adhere to Green Concrete
Typical Epoxy System over Green Concrete
Typical Epoxy System over Green Concrete

Blister

De-lamination
So What Would Make a Good Epoxy Curing Agent For Green Concrete?

- Compatible with Water
- Compatible with High Alkalinity
- Deep Penetration Into the Green Concrete
- Excellent Adhesion to Green Concrete
- Pass ASTM C156-98 for Water Retention for Use as Concrete Curing Compound
- Compatible with Various Top-Coat Technologies
- Easily Mixed, Diluted, Applied, and Cleaned From Tools
The Result: New Water-Based Amine Curing Agent Technology

• Patent Pending, Unique Molecular Structure Designed for Use Over Green Concrete
• Curing Agent Based on Novel Air Products Proprietary Amine Technology
# New Water-Based Amine - Properties

<table>
<thead>
<tr>
<th>Physical Form</th>
<th>Liquid Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>Amber with Greenish Tinge</td>
</tr>
<tr>
<td>Solids</td>
<td>50 % in Water</td>
</tr>
<tr>
<td>Viscosity @ 25°C, cP</td>
<td>400 – 1,000</td>
</tr>
<tr>
<td>AHEW</td>
<td>240</td>
</tr>
<tr>
<td>Recommended Use Level</td>
<td>120-130</td>
</tr>
</tbody>
</table>
New Water-Based Amine - Characteristics

- No Benzyl Alcohol
- Zero VOC
- Low Odor
- No Acid
- Visible End of Pot Life
- Very Low Viscosity
- Low % Solids Dilution

- Good Penetration of Concrete Surfaces
- High Bond Strength to Concrete
- No Carbamation
- Excellent Inter-Coat Adhesion with Epoxy and Polyurethane Systems
Evaluation as a Concrete Curing Compound by CTL
Evaluation as a Concrete Curing Compound by CTL

- 40% Solids Formulation
  - Diluted Epoxy Resin* 95 gms
  - New Curing Agent 120 gms
  - Water 173 gms
- Application Rate/Method: 200 ft²/gal, Brush Applied

*80:20 Blend of 190 EEW Resin and Epodil 746 Diluent
Evaluation as a Concrete Curing Compound by CTL

Results

Avg. Water Loss of Coated Samples: 0.53 kg/m²

Avg. Water Loss of Control Samples: 3.84 kg/m²
Evaluation as a Green Concrete Primer by CTL
Green Concrete Adhesion Test
CTL Protocol

• Two Concrete Formulations Were Evaluated

<table>
<thead>
<tr>
<th>Concrete Formulation 1 *</th>
<th>Concrete Formulation 2 **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement</td>
<td>470 lbs</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>100 lbs</td>
</tr>
<tr>
<td>Fine Agg.</td>
<td>1420 lbs</td>
</tr>
<tr>
<td>Coarse Agg.</td>
<td>1850 lbs</td>
</tr>
<tr>
<td>Water</td>
<td>30.8 gal</td>
</tr>
</tbody>
</table>

W/C ratio = 0.45

W/C ratio = 0.60
Green Concrete Adhesion Test

CTL Protocol

• Concrete Slabs Poured into Forms with Bottom Plastic Liner
• Slab Finished by
  • Steel Trowel *
  • Broom Finish **
  • Mild Shot Blast After Three Days**
• Slabs Cure 24 Hours, Forms Removed, Sides Sealed, 40 % Solid Epoxy Formulation Applied (Application in 3 Days for Shot Blast Finish)
• Bond Strength to Concrete Slab Determined
Green Concrete Adhesion Test
CTL Protocol

Brush Application of Primer

Coring

Bond Pull off Test
Bond Strength Test After 7 Days of Epoxy Cure

- Steel Trowel
- Broom
- Shot Blast
Mode of Failure After 7 Days of Epoxy Cure

<table>
<thead>
<tr>
<th>Method</th>
<th>Concrete Paste</th>
<th>Concrete / Epoxy Interface</th>
<th>Cohesive Epoxy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Trowel</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Broom</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Shot Blast</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
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</tbody>
</table>
Bond Strength Test After 30 Days of Epoxy Cure

![Bar chart showing bond strength test results after 30 days of epoxy cure.](chart.png)
Mode of Failure After 30 Days of Epoxy Cure

[Bar chart showing the mode of failure for different surfaces and interfaces after 30 days of epoxy cure.]

- Concrete
- Paste
- Concrete / Epoxy Interface
- Cohesive Epoxy
Evaluation as a Green Concrete Primer
Observations / Conclusions

• New Waterborne Epoxy Primer Shows Excellent Adhesion to 24 Hour Concrete
• Bond Strength of Coated Concrete Improves with Time as the Concrete Completes its Cure
• Application of the New Primer Improved Overall Bond Strength Compared to the Concrete Control
• Surface Finish on Concrete and Concrete Formulation May Have a Significant Impact on Adhesive Performance
Top Coat Adhesion and Re-Coat Test Results by APCI
Top-Coat and Re-Coat Test Results by APCI

• Slab Preparation
  – 80 lb Bag of Quikrete® Concrete Mix and 1 gal of Water
  – 2 X 2 ft Slab with 2” Thickness, Steel Trowel Surface Finish
• 40% Solids Primer Formulation
  Diluted Epoxy Resin* 100 g
  New Curing Agent 126 g
  Water 181.5 g
• Application Rate: 200ft²/gal
• Application Time: Eight Hours after Pouring the Slab

* 80:20 Blend of 190 EEW Resin and Epodil 746 Diluent
Top-Coat And Re-Coat Test Results by APCI

• Two Commercial Topcoats
  – Two-part 100% Solids Epoxy
  – Two-part 80% Solids SB Polyurethane

• Application Time:
  – After 14 hours, 24 hours, 5 days, 7 days, 14 days and 28 days from the Time of Primer Application
  – Allow to Cure for Seven Days

• Adhesion Test
  – Elcometer Test Method
Top-Coat Application
Bond Strength Results

[Bar chart showing bond strength over time for Epoxy and Polyurethane]

Bond Strength, psi

Application Time:
- 14 hrs
- 1 day
- 5 days
- 7 days
- 14 days
- 28 days

Epoxy (Green) vs Polyurethane (Blue)
Epoxy Top-Coat Application

Failure Mode

<table>
<thead>
<tr>
<th>%Failure</th>
<th>14 Hrs</th>
<th>1 Day</th>
<th>5 Day</th>
<th>7 Day</th>
<th>14 Day</th>
<th>28 Day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>0%</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
</tr>
<tr>
<td>Adhesive</td>
<td>0%</td>
<td>14%</td>
<td>20%</td>
<td>30%</td>
<td>40%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Epoxy Top Coat

After 14 hours

After 24 hours

After 7 Days
Polyurethane Top-Coat Application

Failure Mode

% Failure

Concrete | Adhesive

14 Hrs | 1 Day | 5 Day | 7 Day | 14 Day | 28 Day
Polyurethane Top Coat

After 24 hours

After 5 days

After 7 days
Top-Coat Application Observations/Conclusions

• The Re-Coat Window for the New Curing Agent Primed Surface is Very Wide; Tested from 14 hours to 28 days
• Both Epoxy and Polyurethane Topcoats Showed Excellent Adhesion to the Primed Surface
• If Surface is Still Damp, Wait Before Applying the PU System, Otherwise Gassing May Occur
• Most Failure Occurred within Concrete with Bond Values Ranging from 200 to 350 psi
New Water-Based Amine Technology for Epoxy Application over Green Concrete

- Best Penetration and Adhesion of any System Tested over Green Concrete
- Only Epoxy System that Passes ASTM C156-98
- Over 200,000 ft² in Service with Over 50,000 ft² in Service for Over 1 Year
Questions???
tell me more
www.airproducts.com