Critical Application Steps with Two-Part Epoxies

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Agenda

• Product Overview
• Storage
• Safety
• Surface Preparation
• Mixing
• Application
• Quality Control
• Epoxies and HDD Applications
High Build Epoxies

- 185° to 205° Operating Temperature
- 100% Solids (no solvents)
- 2 component system (3 parts base / 1 part cure)
- Used for girth weld protection, valves & fittings and repair
- Supplied in Brush Grade Kits (liters or pounds), Spray Grade Material and Cartridge Guns (repairs)
- Various cure rates available
Storage

- Product should be stored at temperatures between 40°F and 105°F
- Do not store epoxy in direct sunlight on ROW
- DO NOT ALLOW to FREEZE
- Shelf life of 2-3 years when stored as specified
- Must ALWAYS check shelf life dates prior to application
Safety

READ MSDS sheet
Applicators should wear a mask with the proper cartridge (NIOSH Approved) to protect against the amine (cure side) vapors in high preheat and spray applications

Small percentage of the population are allergic to the amine vapors and other materials in 2PE. (rash)

Wear splash proof chemical safety glasses and rubber gloves during installation

Spilled cure or material remaining in cure containers can be neutralized by mixing with base material
Keys to a Successful Epoxy Installation:

- **Proper Surface Preparation** – **Critical**

- **Understanding the role of Temperatures** - **Critical**
  - Material Temperature
  - Surface Temperature
  - Ambient Temperature
Primary objective of surface preparation is to provide maximum coating adhesion

Proper Surface Preparation will:
1. Remove any loose/rust material from the surface
2. Increase the surface area
3. Impart an anchor pattern
Surface Preparation - Moisture Removal

- Remove moisture before sandblasting.
- **Flash Rust** – when blasted surface has been exposed to water or vapor (rain, dew point, high humidity)
  - To avoid flash rusting do not reheat the surface after blasting. (<105°F)
- **Examples of heat sources are infra-red heaters, induction coils or propane torches.**
Induction Coil Preheat

- Uniform heating across width & around circumference of joint
- Controlled & repeatable heating process
- Penetrating heat for lasting effect
- Imparts no surface residues
- Quicker heating times
- Extensive track record on thousands of projects
Propane Torch Preheat

No weed burners
Surface Preparation
Air Compressor Blotter Test

- ASTM D 4285
- White, absorbent paper placed on a hard surface
- Run for 1 minute – look for moisture / oil
- Done once per shift
Surface Preparation

• Most 2PE require an abrasive blast surface to Near-White Metal (SSPC-SP10, NACE 2, Sa 2 ½) or better.
• Blast profile should be 2.5 - 5 mils

Near-White Surface Prep
Testex Tape w/ micrometer
NACE 2 / SSPC SP10

2.5 - 5 mil anchor profile

No visible contaminants, mil scale, rust, oxides, coating, etc.

Random staining limited to no more than 5% of each unit area (3” x 3”)

Random staining may consist of light shadows slight streaks, minor discolorations.
A number of products will result in a 2.5 - 5 mil sharp angular anchor profile:

G-25 Steel Grit
16 Grit Aluminum Oxide
Black Beauty 1240
EnviroGrit – recycled glass

PLAY SAND IS NOT ACCEPTABLE!
Contains contaminants & silica
Silicosis = “No Bueno”

Certified Grit
Sieve tested, no oil or hydrocarbon contamination
Surface Preparation

“Little Bully” Blaster
Surface Preparation

- Power tool cleaning with wire brush (SSPC SP3) **NOT ACCEPTABLE**

Use of MBX Metal Blaster is acceptable, imparts 2.5 – 3 mil profile
Surface Preparation Comparison

Power wire brush (SP3) vs. Near white metal surface prep (SP10)

• Significant decrease in adhesion, impact resistance, CD values and rust creepage.

Surface Preparation

- Mainline coating must be cleaned and abraded.
- Knock shine off existing coating
- Don’t blast through existing coating.
Surface Preparation – Ambient Conditions

- Substrate Temperature 50° – 200°F
- Substrate Temperature 5°F above the Dew Point
- Relative Humidity <85%
Mixing Two Part Epoxies

Most two part epoxies are supplied in two separate containers:

- Large Container – Base
- Small Container - Cure

Containers will be color coded to prevent mixing different kit sizes.
Mixing Two Part Epoxies

- Empty all cure from container to ensure proper 3:1 ratio is achieved.
- The use of a paint stick or rubber spatula can help you to remove all cure contents.

Neutralize cure container by mixing in base material.
Mixing Two Part Epoxies

Mixing Choices:

– Hand
– Mechanical Mixer (Drill)
– Pneumatic Dispenser
– Plural Component Spray
– Plural Component Dispenser
Mixing Two Part Epoxies

By Hand
- Use a clean, sturdy stirring stick
- Make sure to mix material on the sides and bottom
- Approximate Mixing Time: 4 minutes
Mixing Two Part Epoxies

Mechanical Mixer

• Use a clean mixer
• Ensure that the mixer is neither too large or too small.
  – Too large and it will whip in a lot of air into the epoxy
  – Too small and it may take too long to mix or it may not mix the epoxy fully
• Watch the speed of the drill, if you have too high of a speed it will cause a vortex to form in the epoxy which will beat air into the epoxy. The use of a variable speed drill is essential.
• Sides and bottom
• Metal mixing paddles
• Approximate Mixing Time: 1 minute
Mixing Two Part Epoxies

- Be sure to mix all of the materials together. Ensure that you reach the bottom corners of the pail and to scrape the material off the wall of the container.

- Most 2PE have a white base and dark cure. A properly mixed batch will result in a homogeneous color with no streaks.

- Neutralize the cure containers.

- Larger kits = more volume = less pot life.
Mixing Two Part Epoxies

• Do not mix epoxy on top of the pipe. Straight cure is corrosive and any spilled material will need to be properly removed from the pipe.

Do Not Allow “Road-Side” Chemistry!

• Cure heavy - will react too quickly and become brittle once it has kicked over
• Cure light - may never react fully and will not provide proper corrosion protection
Epoxy Application: Pneumatic Spray

- 1.0 liter cartridges
- 90 second application
- Automated Mixing
- Zero waste in pails
- **Material preheat is critical**
Epoxy Application: Plural Component Spray

Typical Plural Component Spray Equipment

Other items (not identified) include hoses, filters, pressure regulators and gauges

** Minimum two 2.5kW heaters on Base-side and one 2.5kW on Hardener-side
Epoxy Application: Plural Component Spray
Mixing Two Part Epoxies
Dispensing Equipment

• **Pneumatic dispenser provides the following key benefits:**
  - Precise volumes dispensed per joint
  - Eliminates hand mixing time / errors
  - Eliminates component container waste
Epoxy Application: Automated Liquid Application

CRC-Evans PIH technicians specialize in a wide range of field joint coating systems, often working with large-diameter pipe spanning diverse terrains and climates.
Semi-Automated Epoxy Application
Epoxy Application: Automated Liquid Application

Pre-heat – Induction Coil and Generator
Surface Prep – Automated Grit Blast
Application – Automated Epoxy Application
How fast does the epoxy set up???
Numerous liquid coating systems on the market: standard cure, fast cure, cold weather cure, moisture tolerant, etc.

Must be aware of all temperatures and the relationship to cure times:

- Material Temperature
- Pipe Temperature
- Ambient Temperature
Material Temperatures
(determines pot life)

• **Warm / Hot Material**
  – Can dramatically reduce the pot life
  – 5° to 10°F increase in material temp = 50% decrease in pot life

• **Cool / Cold Material**
  – Will be difficult to mix
  – Difficult to obtain a proper blend
  – Will be thicker and harder to spread

• **Larger kits = more volume = shorter pot life**
Pipe Temperatures (determines cure time)

- **Surface temperature is too hot:**
  - Epoxy may become runny and difficult to build thickness
  - Epoxy sets up too quickly leading to streaks, clumps, icicles

- **Pipe surface temperature is too cool:**
  - Epoxy may not wet out fully into the steel and could affect adhesion
  - Epoxy may be hard to spread out leading to an extra thick coating that is out of spec and wasted material
• Do not stage epoxy on top of the pipe that has been sitting in the sun. Heat from the pipe transfers to the material containers which accelerates the cure.
Temperature Effects On Application

Ambient Temperatures
(affects material & surface temps)

• **Warm / Hot Weather**
  – Speed up pot life and cure times

• **Cool / Cold Weather**
  – At 50°F most epoxies cure very slow
  – Recoat project example: Cold ambient / warm material temp / 55F pipe temp
Thixotropy - time dependent shear thinning property

Materials that are thick or viscous under static conditions will flow (become thin, less viscous) over time when shaken, agitated, sheared or otherwise stressed (time dependent viscosity).

Epoxies – allows the installer to build thickness over the welds, prevents drips, runs and icicles at the bottom of the pipe
Cold ambient temperatures do not limit epoxy applications.
Increased substrate temperatures = faster cures

Should this be done??
Pipe Temperatures

- Faster cures can be achieved by pre-heating the steel pipe surface.
  - If you are pre-heating with a propane torch, preheat should be done before grit blasting.
  - If you plan on heating after the blast, ensure that the steel is over 40°C (105°F) or you will get flash rust.

- Each manufacturer will have a target pre-heat temperatures.

- Excessive preheat (off-gassing of solvents) which can lead to pinholes in coating.
Pipe, material and ambient temperatures are always changing on the ROW and you need to make adjustments!
Other Application Issues

• **Hydrostatic testing to verify pipe integrity**
  
  – If you exceed 100% or more of the specified minimum yield strength (SMYS), you can exceed the flexibility of the coating resulting in cracks.
  
  – Check tensile and elongation of the two part epoxy.

• **Flexibility on bore applications**

• **Be aware of coatings thickness** – to thick can result in cracking
QUALITY CONTROL
SSPC VIS-1 surface prep comparison chart

Near white metal surface prep
QUALITY CONTROL

PosiTector DPM (Dew Point Meter)

- Ambient Temperature
- Surface Temperature
- Dew Point > 3°C (5°F) above the dew point.

Sling Hygrometer
QC – Surface Prep

Measuring Surface Profile – Testex Tape (multiple locations!)
QC – Surface Prep

Elcometer – Measure & Record Blast Profile

- Usually every 25th weld
- 3 readings in random quadrants
- Any changes to the equipment, operator or media

2.5 – 5 mils
QUALITY CONTROL

Measuring Wet Film Thickness
QUALITY CONTROL

PosiTector – Measuring DFT
Durometer – Measuring Shore D Hardness

- Tests the epoxy for % of cure
- Can be used to determine if the coating is hard enough for backfill (>70 Shore D)
- Needle sticks out 100 mils @ 0 Shore D
- At 100 Shore D, needle sticks out 0 mils
- Can cause jeeps if the coating is too thin to measure.

- Make sure that coating is thicker than expected penetration (>60 mils, “button” @ 12 o’clock over existing ML coating)
- “Button” temperature (50°F – 77°F)

- Shore D = 70-80
- 20 mil coating is not cured
- Needle penetrates coating, hits steel = Shore D of 80
Quality Control

Adhesion Testing

DeFelsko PosiTest

Typical Values 2,000 – 3,000 PSI

Lengthy Test – 24 hours for dolly glue to cure
Quality Control

Adhesion Tester

Dollies & Cutting Tool
Holiday Detection (3)
SP0 490
FBE ML coatings
125V/mil

NACE SP 0188
< 20 mils wet sponge
21-40 mils = 3K
41-55 mils = 4K
56-80 mils = 6K

NACE RP 0274
\[ V = K \sqrt{T} \]
Where:
K = 1250
T = coating thickness in mils

Higher Voltages
SP 0188 @ 30 mils = 3K / RP 0274 @ 30 mils = 7K Volts Watch ML coating
Coating Logs

Installers need to take ownership of the application
Cold Weather Question
Coating Logs

- Date & Time
- Girth weld number or location description
- Coating brand / Model number
- Batch Information (QC Number) Expiration Date
- Pre-Heat Temp
- Blast Media Used
- Anchor Profile
- Substrate Temp
- Ambient Temp
- Dew Point
- Max / Min dry film coating thickness reading
- Name of installer(s)
- Digital pictures
Coatings are only as good as the installation.

- Install Guides
- Install Videos
- On-site tech support
- Applicator Certification
  - Applicators must have the knowledge, skills and ability to apply the product
Epoxy FJC / HDD Installations
§ 192.461. External Protective Coatings

(a) Each external protective coating, whether conductive or insulating, applied for the purpose of external corrosion control must -
(1) Be applied on a properly prepared surface;
(2) Have sufficient adhesion to the metal surface to effectively resist under film migration of moisture;
(3) Be sufficiently ductile to resist cracking;
(4) Have sufficient strength to resist damage due to handling and soil stress; and
(5) Have properties compatible with any supplemental cathodic protection.

(b) Each external protective coating which is an electrically insulating type must also have low moisture absorption and high electrical resistance.

(c) Each external protective coating must be inspected just prior to lowering the pipe into the ditch and backfilling, and any damage detrimental to effective corrosion control must be repaired.

(d) Each external protective coating must be protected from damage resulting from adverse ditch conditions or damage from supporting blocks.

(e) If coated pipe is installed by boring, driving, or other similar method, precautions must be taken to minimize damage to the coating during installation.
Typical Field Joint Coatings for HDD Applications
HDD Coating Tests

- Adhesion
- Abrasion
- Gouge
- Impact
- Hardness
- CP Compatibility

Gouge Test Results
Typical Results for HDD Applications (Field Joint)
• Raised girth weld experiences maximum abrasion, gouge and impact forces
• Performance data is not pulled from the girth weld location.
• Difficult to build consistent epoxy thickness over the girth weld
• Impossible to pull a wet film thickness over the girth weld
• Difficult to read a dry film thickness on the girth weld
• Trying to increase epoxy thickness (60+ mils) over the girth weld results in cracking.

The corrosion coating at the location that will see the most abuse (girth weld) is based on a visual guess.
Weld bead protection is critical for a successful HDD project
Field Applied Composite ARO

Tri-directional, fiberglass cloth, pre-impregnated with a moisture cured PU resin

Excellent abrasion, impact and gouge resistance

Activated by fresh or salt water

Fast cure times (~ 30 minutes)

Non-hazardous

Extremely easy field installation

Application over various corrosion coatings.

Non-shielding

Used for girth welds or as a ML ARO
• Corrosion system can be a 2-part epoxy or heat shrink sleeve
Composite Installation

Activating the PU resin as material is being applied
Composite Installation

Thickness dependent on HDD conditions
Compression film is used to compress all of the layers.
Composite ARO Installation

Perforation tool used to puncture the compression film which allows the CO$_2$ gas and water to escape
Composite ARO Installation

Cure times are approximately 30 minutes
Fracture Toughness

7. FRACTURE TOUGHNESS-STRENGTH

- Metals and Polymers: Yield Strength
- Ceramics and Glasses: Compressive Strength
- Composites: Tensile Strength

Guidelines for Safe Design

ENGINEERING COMPOSITES

Epoxies

Composites

20-60X Greater
Results after HDD Application
Results after HDD Application

30” OD Pipe – shale conditions, damage to ML ARO
Results after HDD Application

If you are using a plant applied ARO for an HDD, you should consider a field applied ARO for the area that will experience the most damage.

“Precautions Must Be Taken”
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