Heat-Shrinkable Sleeve Technology
Bob Buchanan Seal For Life Ind.

From corrosion coating basics to installed system inspection

AUCSC
Appalachian Underground Corrosion Short Course
Pipelines

Oil & Gas Pipelines

High Temperature Pipelines

Water Pipelines

Insulated Pipelines

Offshore Pipelines
Understanding Corrosion

- Steel is formed from Iron Ore and Energy
- With energy, steel may be returned to being iron ore - corrosion
Corrosion Basics

- Anode (pipe or other metallic structure)
- Cathode (pipe)
- Electrolyte (soil)
- External Circuit

- All 4 components creates a potential difference between the Anode and Cathode
- Removing any 1 of the components from the cell halts the corrosion process
- Break the circuit with a good coating as example
Underground Pipeline Coatings

• 1st line of defense against corrosion
• Must be properly specified based on constructability and pipeline operation
• Must be properly applied - big part of that is applicator training and final inspection
# What’s Important

- Specification / Product Selection
- Surface Preparation
- Proper Application
- Inspection & Testing
Prevent corrosion

Coatings need to have

• high electrical resistance
• low permeability to hydrogen and oxygen
• mechanical strength
• chemical stability
Heat-Shrinkable Sleeve System

- Sleeves consist of a backing and adhesive
- The backing needs to be cross-linked in order to be heat shrinkable
- The adhesive has several functions:
  - corrosion protection, shear resistance, long term adhesion to the steel, bond to the coating…
- Design of the backing and adhesive dictates performance at operating temperature
Heat-Shrinkable Sleeve System

Cross-linked backing

Must be compatible with the mainline coating

Optional epoxy primer

Adhesive bonds to cutback and coating

Pre-attached or separate closure
Irradiation Cross-linking

- High energy electrons are used to strike the molecules at the C-H bond
- The hydrogen atom is set free leaving the parent carbon atom as a “free radical”
- At adjacent sites, the free radicals use their energy to form a chemical bond
- This bond is called a cross-link
Polyolefin Cross-linking

Polyolefin (before)

Irradiation processing

Cross-linked Polyolefin (after)
Properties of Cross-linked Backings

- Imparts Elastic Memory
- Increases Tensile Strength
- Increases Impact Resistance
- Increases Abrasion Resistance
- Increases Insulation Value
Adhesives
Adhesive Functions

- Primary corrosion protection in 2-layer systems
- Develop a physical anchor to the substrate
- Provide shear force resistance
- Minimize cathodic disbondment
- Bond the sleeve to the mainline coating
Adhesive Choice Considerations

- Surface prep and pre-heat requirements
- Adhesion to cutback and adjacent coating
- Cathodic disbondment resistance requirements
- Soil stress resistance due to pipe movement and vertical soil shear
- Environmental conditions during construction
- Properties at operating temperature through service life
Adhesive Technologies

- Mastic Adhesives
  - Low pre-heat requirements
  - Forgiving on surface prep
  - Excellent water resistance
  - Excellent CD resistance

- Hot-Melt Adhesives
  - High shear resistance
  - Resistant to high ambient temperatures
  - Higher pipeline operating temperature
  - 3-Layer coating compatible
Selecting the sleeve

- Pipe operating temperature
- Pipe coating type
- Cutback distance
- Outside pipe diameter
- Adverse soil conditions
- Pipe laying method
- Climate conditions
- Recommended pipe preparation
- Mechanical resistance class
Wraparound 2- or 3-Layer Sleeve

- Installation directly on cleaned and dried pipe surface
- Compatible with standard mill-applied coatings
- Epoxy primer for 3-layer only

- Heat-shrinkable backing
- Hot melt/mastic layer
- Primer if used
Coating of Fittings & Bends

Heat Shrink Tape

• Highly flexible, hand installed tape
• Minimal inventory
Tubular Heat Shrink Sleeves

Two-layer coating for pipes with ambient operating temperature up to 30°C (86°F)

- Only handbrush or wirebrush required
- No closure patch, easy to install
- High impact strength and penetration resistance
- Thermal indicator (TPS)
Shrink Sleeves for Casing Ends and Flanges

- Fiberglass reinforced: mechanical strength, high impact strength, high penetration resistance
- Convenient wraparound design
- High shrink ratio (65%)
Special Applications

Three-layer coating for horizontal or directional drilling

- Extremely high shear and peel strength
- Fiber-reinforced sleeve, excellent abrasion resistance
- No 'curing time' - just cool and use immediately
- Superior cathodic disbondment
- Simple installation without special tools
Sleeve System
Required Properties & Characteristics

• Resistance to impact, abrasion, penetration
• Must be flexible
• Good adhesion to the substrate
• Resistance to environmental conditions
• Resistance to cathodic disbondment
• Remain functional under operating conditions
What is important to install?

- Suitable surface preparation
- Use of the proper tools
- Primer application (if used)
- Achieve the correct pre-heat
- Sleeve centered on the cutback
- Correct overlap to the coating
- Closure properly installed
- Correct procedure for shrinking
- Visual Inspection
- Field Peel Test
- Holiday Detection
Material and Tools for Proper Installation
Surface Preparation

- Chamfer 3LPE edges to minimum 45 degrees.
- No Chamfer required for FBE
- Clean and dry surface prepared to minimum St3 – ISO 8501:1
- Sand or Grit blasting possible
- Coating abraded at the sleeve overlap area with sand paper or grinderto achieve proper bonding of the sleeve
Surface Preparation

- The primary objective of surface preparation is to provide maximum coating adhesion.
- The actual mechanism of surface preparation is threefold:
  - Remove any loose material from the surface.
  - Increase the surface area.
  - Impart an anchor pattern.
# Surface Preparation Standards

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<th>NACE</th>
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<tr>
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<td>Sa2</td>
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<td>Power Wire Brush</td>
<td>ST3</td>
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<tr>
<td>Hand Wire Brush</td>
<td>ST2</td>
<td>SP2</td>
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Cleaning Blasting & Abrasion
Pre-heating

- Mastics – 150°F (65°C)
- Hot Melts – 200°F (90°C)
- OD pipe < 12”, one torch required
- OD >12”, two torches recommended
- Verify temperature with contact proble thermometer
Surface Pre-Heating

- Pre-heating with induction coils or propane torches
- Removes moisture from steel substrate (prior to surface prep)
- Pre-heats substrate to a specified temperature to melt and "Wet-Out" adhesives
- Oxidizes coating surface to aid bonding
Centralize the Sleeve and Install the Closure
Shrink the Sleeve / Visual Inspection

- Start shrinking at the center and complete to the edges
- Both installers shall shrink to the same side, then to the other side
- Check if the adhesive oozed to both edges on the entire circumference
Heat-Shrinkable Sleeve Installation
Heat-Shrink Sleeve Field Installation
Finishing the Installation

• Roll sleeve surface and the overlapping sleeve/sleeve region where an air channel can be formed in order to remove entrapped air.
Rolling the sleeve
Post installation inspection
Holiday Detection & Adhesion Testing
Contact
Bob Buchanan

bob.buchanan@sealforlife.com
416 577 0136