Optimizing Remediation with Advanced Wax Tape Systems

How does data-driven selection enhance wax tape performance across varying environments?

SUPERIOR CORROSION CONTROL
SCC
WAX WRAP

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Overview

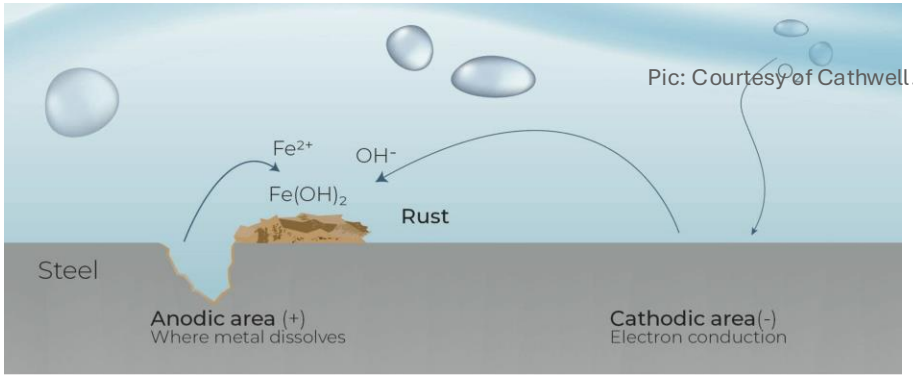
Protective Coatings

- What makes a Coating Successful in preventing external corrosion?
- Coating Remediation
- Factors in Choosing Liquid VS Tapes
- Application Comparison, Inspection
- How to choose the tape?
  - Wax Tape and Wraps, Viscous-Elastic
  - Industry Standards
  - Data and effectiveness of Tapes
  - Outerwraps
  - Case Study Photos, Questions

Corrosion

Protective Coatings

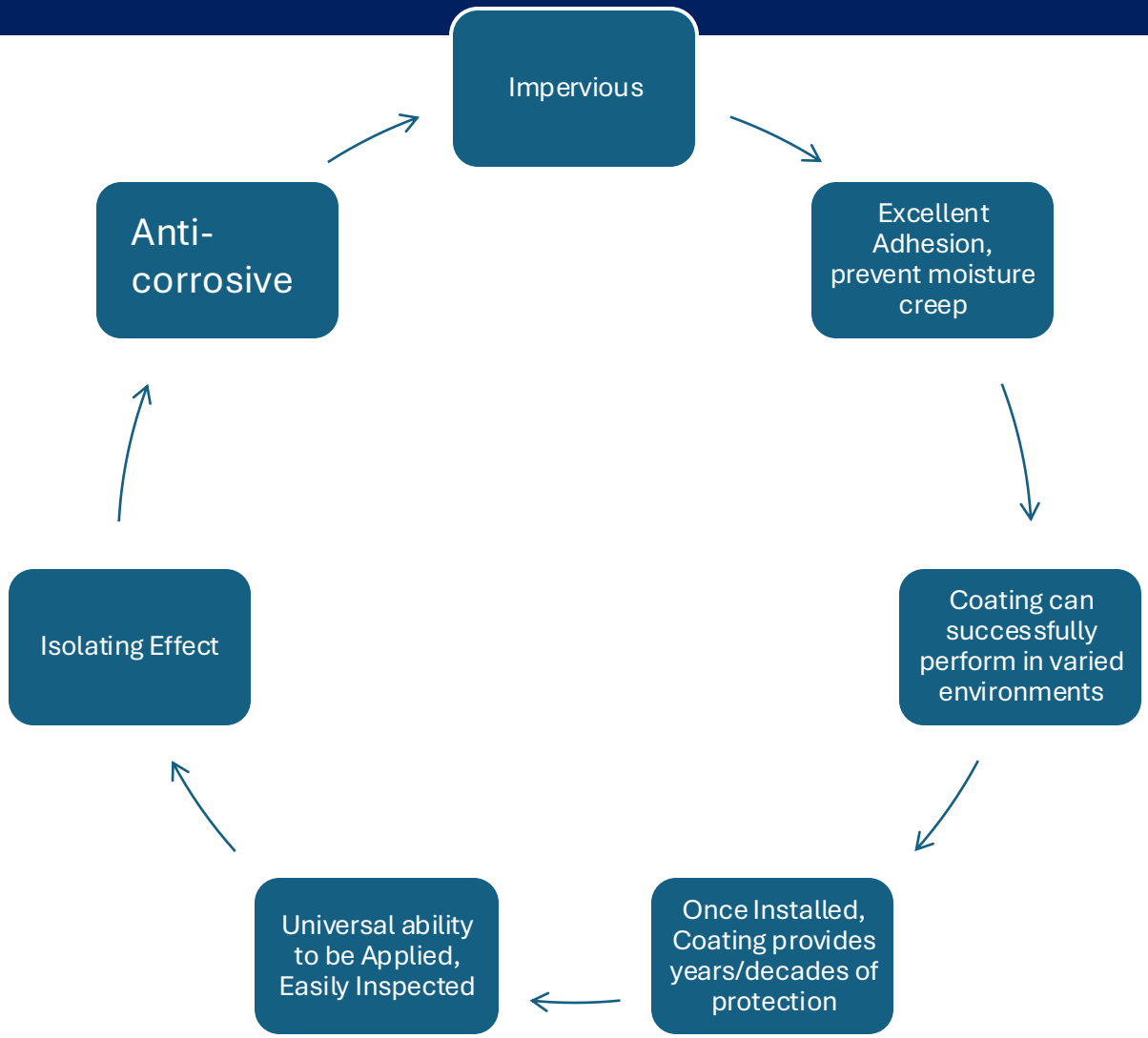
Corrosion is the chemical or electrochemical reaction between a metal and the contaminates in its' environment that results in rust and deterioration. This is due to metal trying to "go back" to its' natural, most stable state.



In fundamental terms, corrosion is the natural degradation of a metal caused by electrochemical reactions with its surrounding environment.

What makes a coating successful?

PROTECTIVE BARRIER: for protecting the underlying surface from external factors that cause corrosion; such as Moisture, Oxygen, Salts, Galvanic Corrosion, Current and other environmental elements.



What makes a coating successful-Application Specification

Liquid VS Tapes, there are different application methods, properties, and suitability for various situations.

EVERY Successful application of a Coating System consists of…

- Proper Surface Prep
- Proper Material Selection
- Specification
- Application Guide
- Inspection Technique

Factors for Choosing Liquids VS Tapes

Crevice Corrosion

- Tapes were introduced over 100 years ago to conform to areas with a risk of crevice corrosion.
- Areas where there is a void to fill
- Areas where surface prep is hard to achieve on irregular shapes or A consistent layer of Liquid applied coating cannot be achieved

Factors for Choosing Liquid-applied VS Protective Coating tapes Surface Prep

Although Liquid applied coatings are the preferred method, these type of coatings whether spray or brush-applied are Surface Preparation Critical: Thorough surface preparation is crucial for proper adhesion and performance. Inadequate preparation can lead to coating failure and trapped moisture.

  - **Surface Preparation Requirements:** What preparation is achievable in the field, is there a blasting hazard? This will impact the suitability of different methods.

- **Application constraints and weather elements in Environment :** Liquid-applied can be sensitive to environmental conditions like temperature and humidity, requiring specific conditions for proper curing.
- **Liquid-Applied:** Over 80%

Liquid coatings are notoriously sensitive to surface profile and cleanliness (SSP-SP 10/NACE No. 2) whereas many tapes are designed for "marginal" surfaces (SSP-SP 2 or 3)

Strengths in Liquid Applied

Liquid Application: epoxies, polyurethanes, are applied directly to the prepared pipe surface via brush, roller, or spray.

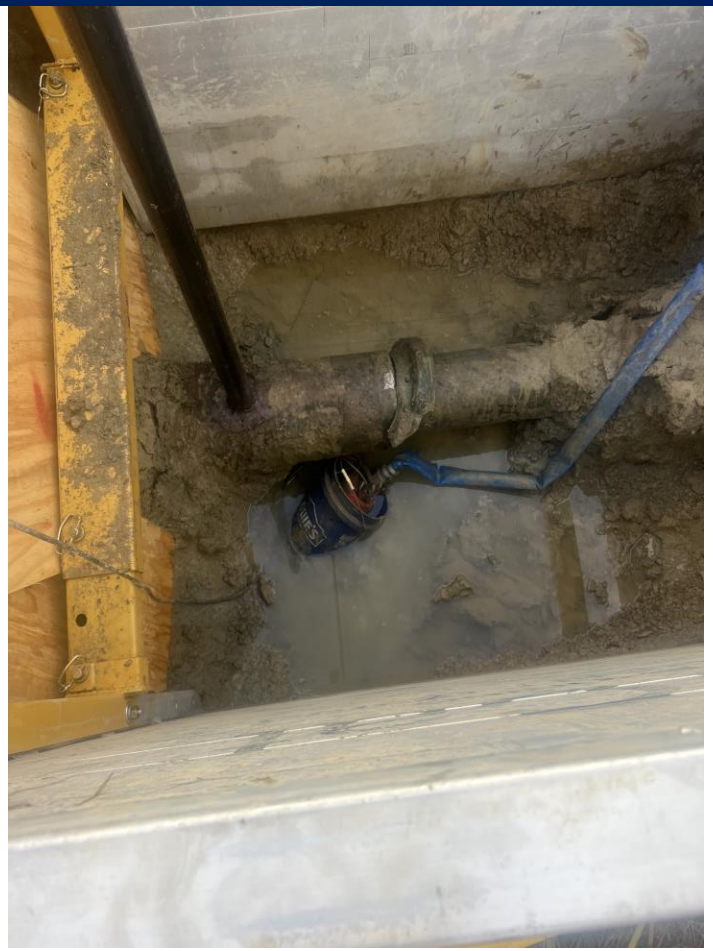
Liquid-Applied: Although they Rely on mechanical anchors. They cure to form a continuous, bonded layer that restricts corrosion risk with its complete adhesion in a consistent manner making the difficulty of surface prep worth it.

Use the **Field-Applied Liquid Coatings** for Weld Joints and External Repair and Rehabilitation of Buried Steel Pipelines NACE SP0105-2024 for min. performance requirements

- Strong, Durable Bonds
- Formulations are available for wide temp range
- High-Build + ARO Ability
- Non-Shielding
- When Cured, Resistant to Water, Chemicals
- Tight Barrier

Factors for Choosing Liquid-Applied coating VS Protective Coating Tapes

- **Operating Conditions:** Pipeline Temperature, pressure, and the transported substance will influence your choice
- **Elements and Environment:** Temps, Weather, soil, Wind and surface contamination
- **Cure-Time:** Liquid coatings require time to cure fully before the pipeline can be returned to service. Pot Life restrictions.
- **Long-Term Performance and Cost:** Consider the expected lifespan of the repair and the overall cost, including material, labor, and potential future maintenance.
- **Inspection Challenges:** If the pipe needs to be accessed periodically for inspection, be sure to choose a tape that is easily removed.



Factors for Choosing Liquid-Applied coating VS Protective Coating Tapes

- Contaminated surface risk
- Incompatible coating, won't adhere to old coating
- Irregular shaped surface at risk for CREVICE CORROSION
- Extreme Environments, Tropical, moisture, salts
- Limited number of knowledgeable coating applicators
- Sweating Pipes, Prescence of water
- Multiple materials (steel, concrete, HDPE)

Tape Applications Vary

Tapes are typically applied spirally around the pipeline at either a 1inch overlapor a 50-55% Overlap.

Did you know? The 2024 NACE/AMPP specifications spells out 50% overlap for an air to soil transition using wax tape. Some require a primer to enhance moisture displacement and adhesion, while others require an outerwrap to reinforce the technology of the protective qualities of the wrap and prevent impact damage. They come in various materials.

Environmental Challenges:

The Wheat State Landscape

Kansas is an agricultural powerhouse. Soils near farming operations often have high concentrations of **sulfates, nitrates, and ammonia** from fertilizers and livestock runoff. These chemicals are highly aggressive to standard thin-film coatings.

Wax-based tape systems should prove to you they are **chemically inert**. They Should provide an impermeable barrier that is unaffected by agricultural chemicals and soil organics.

TESTING: ASTME96
TESTING: ASTMB117

Environmental Challenges:

The Kansas Landscape

Field remediation in the Midwest often happens in humid or damp conditions where achieving a "White Metal" blast (SP-10) is nearly impossible without flash rusting.
Wax Tape Systems are surface-tolerant, Only requiring a Wire Brush Clean (**SSPC SP-2 or SP-3**), and the primer actually "wets out" the remaining tightly adhered rust, displacing moisture and oxygen at the substrate level.

This is a game-changer for Kansas technicians working in less-than-ideal field conditions.

Environmental Challenges:

The Kansas Landscape

The "Salt State" Factor
Kansas is one of the top salt producers in the U.S., and road salt use is heavy. This leads to high chloride concentrations in the soil, which dramatically lowers soil resistivity and accelerates electrochemical corrosion.

Unlike liquid coatings that can develop "holidays" or pinholes during application, wax-based systems provide a high-build, **void-free encapsulation**. The dielectric strength of the wax prevents the flow of corrosion currents even in the most aggressive, low-resistivity (high-salt) soils.

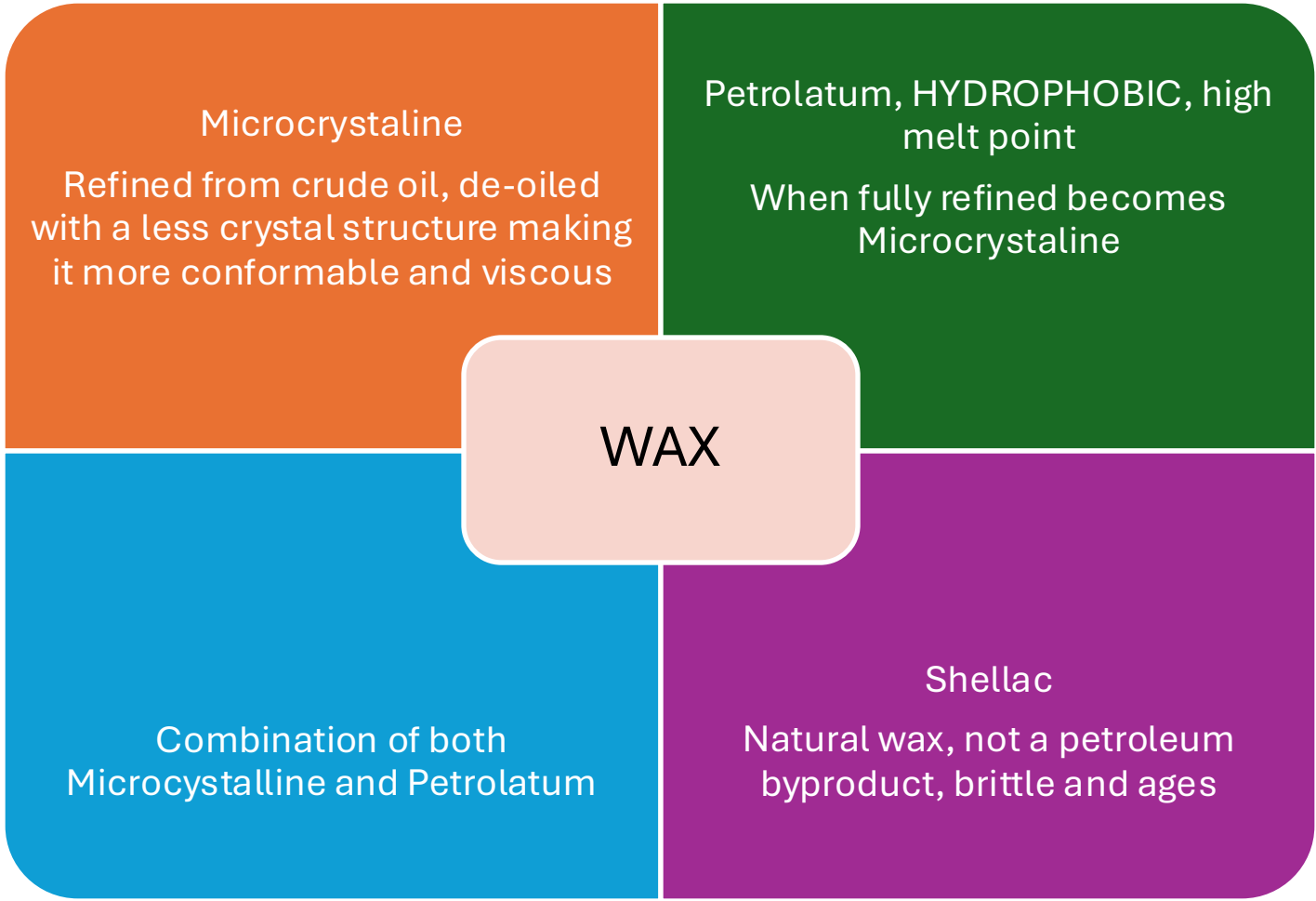
TESTING: ASTM B117

Expectations of a Protective Coating Tape

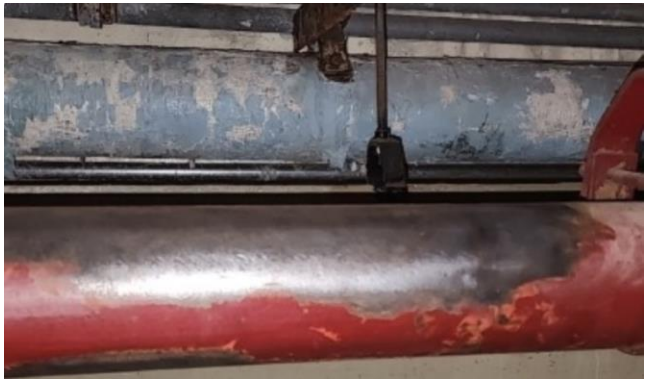
- Minimal Surface Prep
- Inert Material
- Reduces Human Error with easier application
- Should be High Salts and Chemical Resistance
- UV Resistant
- Fills minor pits and voids, conformable
- Can be applied where moisture is present(wax tape)
- Compatible with most/all old coating
- No cure time required
- Mastics and putty

Wax Tapes, Petrolatum, Wax Wraps

All Wax Petroleum Tapes are not created equal, each tape has a unique formulation



Wax Tapes-minimal surface prep-SP2



Loose rust, mill scale, old coating, and dirt shall be removed by hand-tool cleaning in accordance with SSPC-SP 2. Wet surfaces shall be wiped until they are as dry as possible. If ice is present, it shall be removed by heating the pipelines and valves.

Surface preparation shall be visually inspected before application of the wax-based tape coating system.

Wax Tapes, Petrolatum, Wax Wraps

Petroleum-based compound impregnated into a non-woven synthetic carrier tape that provides indefinite external corrosion protection.

2-Part System: Consisting of Primer, Wrap, and depending on application could require a 3rd step Outerwrap

Wax Tapes, Petrolatum, Wax Wraps

Industry Standards NACE/AMPP using Wax Tape as example SP0375-24

AMPP NACE SP 00375-2024

EXCERPTED FROM AMPP.ORG Wax Based Tape Coating Systems: Specifies Below Ground

Properties	Physical Requirements	Test Method
Primer		
Congeal Point	57 °C (135 °F) min.	ASTM D938
Flash Point	66 °C (150 °F) min.	ASTM D92
Specific Gravity at 25 °C (77 °F)	0.85 to 1.25	ASTM D70
Cone Penetration at 25 °C (77 °F)	74 to 250 dmm	ASTM D937
Dielectric Strength	4 V/µm (100 V/mil) min.	ASTM D149
Tape		
Congeal Point of Saturant	63 °C (145 °F) min.	ASTM D938
Flash Point of Saturant	60 °C (140 °F) min.	ASTM D92
Thickness	1,000 µm (40 mil) min.	ASTM D1000
Dielectric Strength	6.7 V/µm (170 V/mil) min.	ASTM D149
Cone penetration of saturant at 25 °C (77 °F); 102 g weight, 5 seconds	61 dmm min to 170 dmm max.	ASTM D937
Breaking Strength	32N/cm	ASTM D1000
Water vapor transmission rate	0.10 g/(h-m²) max	ASTM E96 Procedure A
Cathodic disbondment	20 mm max radius	ASTM G8 or NACE TM0115
Profiling Mastic		
Percent Solids	100%	ASTM D2369
Specific Gravity	1.6 to 1.3	ASTM D70

ASTM D127 The congeal point of a liquid is comparable to the melting point of a solid

congeal point: highest temp at which liquid solidifies

Astm D937: Determines Hardness or firmness of wax when probed. The depth in which the cone sinks is measured in tenth of a mm. Higher number, the softer the wax

ASTM Testing

"American Society for Testing and Materials", ASTM is a developer of international voluntary consensus standards.

ASTM standards are developed by committees of relevant industry professionals who meet regularly in an open and transparent process to deliver standards, test methods, specifications, guides, and practices.

Third Party Testing Firms hired to test products according to these standards

Check Manufacturer data according to these standards

ASTM Testing-Chemical, UV and Salts

ASTM B117

Test Results:

Salt Spray (ASTM B117) – 1000 hours of exposure
Dates of Testing: 12/23/12 – 2/3/12
Panel 11: No visible effect
Panel 12: No visible effect
Panel 13: No visible effect

Ultraviolet Exposure (QUV) (ASTM G53) – 1000 hours of exposure
Dates of Testing: 12/23/12 – 2/3/12
Panel 14: Some very slight discoloration (yellowing); no visible material degradation
Panel 15: Some very slight discoloration (yellowing); no visible material degradation
Panel 16: Some very slight discoloration (yellowing); no visible material degradation

Chemical Resistance (ASTM G20) – 30 days
Dates of Testing: 12/23/12 – 2/3/12

Vapor Phase

Reagent / Effect	Hydrochloric Acid, 5%	Nitric Acid, 10%	Sodium Chloride, 10%	Sodium Hydroxide, 10%	Lime Water, Saturated
Blistering	None	None	None	None	None
Chalking	None	None	None	None	None
Discoloration	None	None	None	None	None
Swelling	None	None	None	None	None
Loss of Adhesion	None	None	None	None	None
Delamination	None	None	None	None	None

ASTM D149 Dielectric Strength Testing Example

Example: Standard Test Method-ASTM D149

Measures Dielectric Strength of an electrical insulating material.

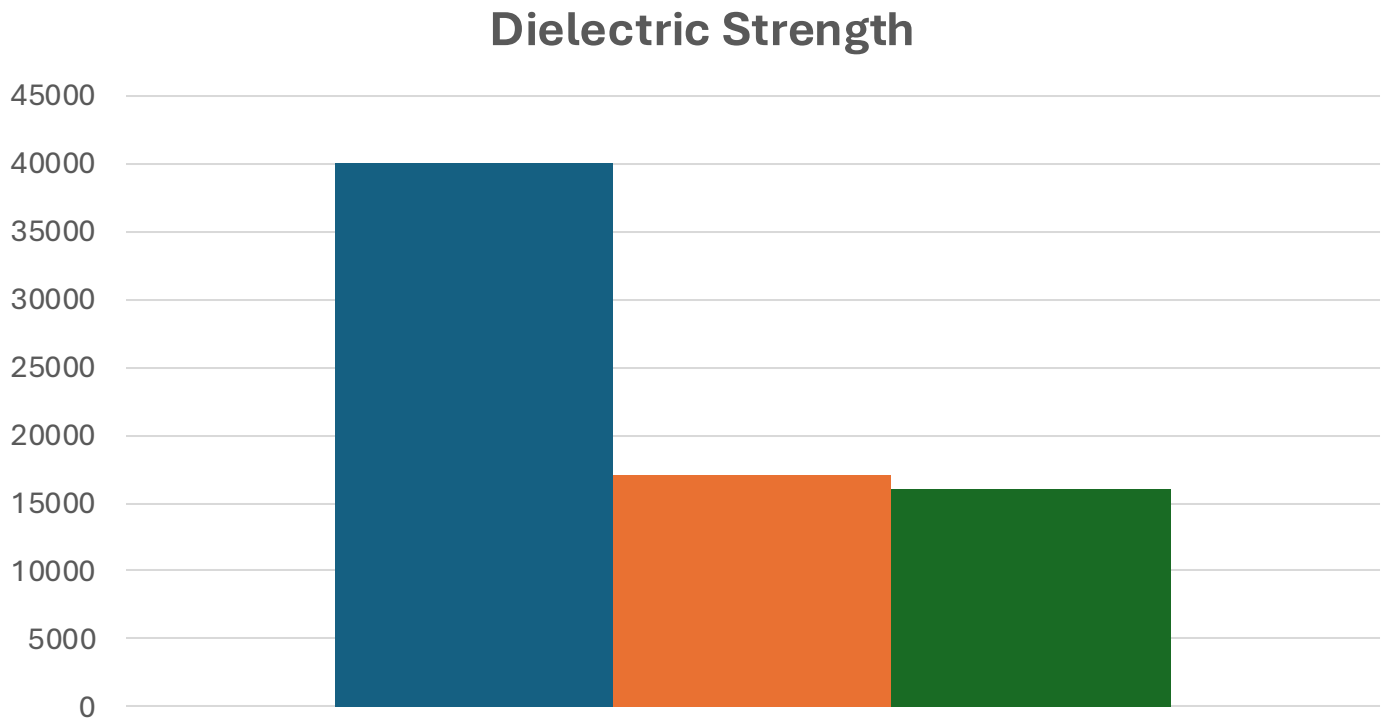
Lab # 14030525

TEST METHOD	DESCRIPTION		RESULTS
ASTM D149	Dielectric Strength per SAE AS8660: ½ inch hemispherical electrodes 500 volts/second rate of rise, 50% R.H. @ thickness of fabric		
	Run #1	21.38 kV	48 mil gap
	Breakdown voltage		445 volt/mil
	Run #2	12.27 kV	32 mil gap
	Breakdown voltage		383 volts/mil
	Run #3	16.08 kV	44 mil gap
	Breakdown voltage		365 volts/mil
	Run #4	14.98 kV	39 mil gap
	Breakdown voltage		384 volts/mil
	Run #5	17.70 kV	40 mil gap
	Breakdown voltage		443 volts/mil
	Breakdown Voltage Average		404 volts/mil

DIELECTRIC STRENGTH ASTM Testing-D149

- Demonstrates coatings' ability to withstand an applied voltage without breakdown.
- Isolating Aspect
- The Higher- The Better, Good Insulating Material has High Dielectric Strength while typically having low thermal conductivity(transfer heat)
- Dielectric Strength increases with thickness of tape coating
- Dielectric Strength decreases with higher operating temp, water present and other factors

Dielectric Strength Comparison Leading Tapes



Dielectric Strength Foreign Line Crossings

Why Dielectric Strength Matters at Crossings
Foreign lines (power, other pipelines) create electrical "interference." Without a high-dielectric barrier, current "jumps" from one pipe to another.

Where current leaves your pipe, you can get **instant metal loss**. A crossing with poor coating can fail in months, not years.

The coating is your "Electrical Insulator." Even a tiny pinhole (holiday) at a crossing is a massive vulnerability.

Breaking Strength VS Elongation

When the applicator "pulls" the tape during application, they are applying **Stress**, and the tape responding with **Strain** (Elongation).
Breaking Strength:

Elongation (106%): This is the "Distance." It tells you how far that "pull" will actually take you before the material fails.

Advantages of Higher Elongation
Energy Absorption: When the ground and pipe shifts, a high-strength/low-elongation tape will simply snap. Higher Elongation tapes will "absorb" that movement by elongating. It uses that range to stay sealed while the soil moves around it.

Higher elongation also shows better conformability around irregular shapes, preventing crevice corrosion

Temp Restrictions

Flashpoint	Melt Point
507°F	176.72°F
538°F	179.24°F
424.4	167.9°F
525.2	184°F
507°F	Non-Melting
538°F	260°F

Cathodic Disbondment Testing Example

10-day test is a more aggressive, accelerated test.

10 days at 3.5 volts.

The 10-day test at 3.5v increases the amount of chlorine produced, making the environment more aggressive.

Cathodic Disbondment Testing Example

Electrolyte: Deionized water with the addition of 1 mass % of sodium chloride, sodium sulfate and sodium carbonate

Test duration: 10 days **Voltage:** -3.5V, impressed current **Temperature:** 21°C
Start Date: 11/24/2010 **End Date:** 12/4/2010 **Immersion Depth:** 8"

Results:	164A	164B	164C
Initial holiday diameter (in)	0.25	0.25	0.25
Initial holiday area (in^2)	0.049	0.049	0.049
Final disbonded diameter (in)	0.25	0.25	0.25
Final unsealed area (in^2)	0.049	0.049	0.049
Net disbonded area (in^2)	0	0	0
Disbonded ECD (in)	0	0	0
Classification Group:	A	A	A

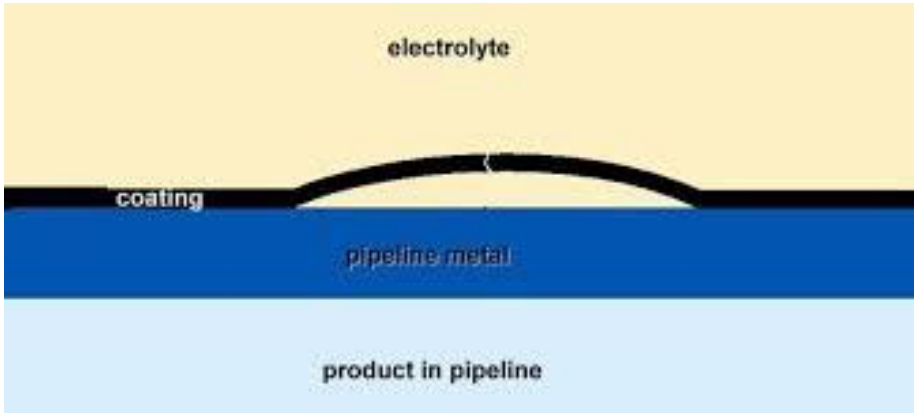
ECD=equivalent circle diameter

Visual Inspection:	164A	164B	164C
Color:	No visible change	No visible change	No visible change
Unintentional holidays:	None	None	None
Blisters:	None	None	None
Cracking:	None	None	None
Adhering deposits:	None	None	None

Advancements made in Wax Wraps produce 3rd party tested Zero Cathodic disbondment The continuity and consistency of the advanced Primer contributes to the Zero Cathodic disbanding.

ASTM CD Testing-Cathodic Dispondment

Consequences of Cathodic Disbondment decrease the lifespan of a Pipeline, Accelerate Corrosion, Weak Integrity on Pipeline=Leaks and Spills



Cathodic disbondment on a pipeline can cause localized corrosion underneath the protective coating, leading to potential leaks, environmental contamination, and even catastrophic pipeline failures, as the coating loses adhesion to the metal substrate, exposing the pipe to corrosive elements despite the presence of cathodic protection.

Cathodic Disbondment Testing Example-30 Day

Coating ID: **High Temperature Tape**

Laboratory ID: **13-655.2157**

Electrolyte: Deionized water with the addition of 1 mass % of sodium chloride, sodium sulfate and sodium carbonate

Test duration: 30 days **Voltage:** -1.5V **Temperature:** 21°C
Start Date: 4/8/13 **End Date:** 5/8/13 **Immersion Depth:** 14.5"

Results:	**Pipe #1**	**Pipe #2**	**Pipe #3**
Initial holiday diameter (in)	0.25	0.25	0.25
Initial holiday area (in^2)	0.049	0.049	0.049
Upper Holiday	**Pipe #1**	**Pipe #2**	**Pipe #3**
Final disbonded diameter (in)	0.25	0.25	0.25
Final unsealed area (in^2)	0.049	0.049	0.049
Net disbonded area (in^2)	None[1]	None[1]	None[1]
Disbonded ECD (in)	0	0	0

Water Transmission Rate Data-Impervious?

Results:

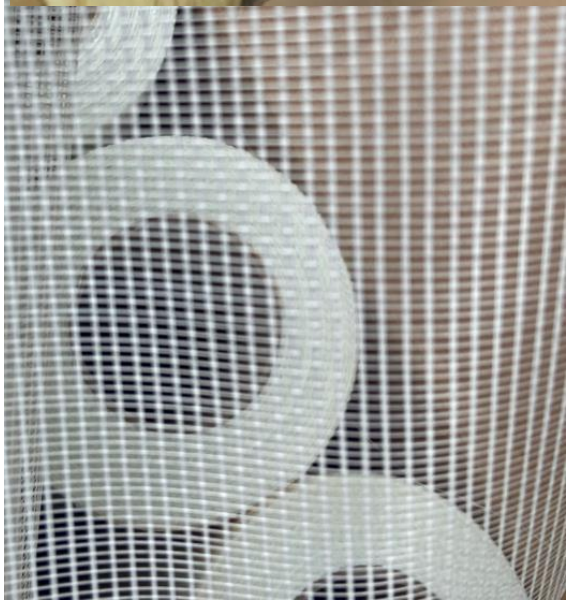
Average Thickness: 1.7mm

Average Water Vapor Transmission:	0.0020	grains/hour*foot^2
Average Permeance:	0.0042	inch pound
Average Permeability:	0.00028	perm inch

Protection of Tape Systems in Soil Stress

Some applications you will want to consider a Heavy Duty Outerwrap

- Large diameter
- Exposed areas
- impact risk
- Pipe Supports
- Pipespans
- Extreme Environments
- Rocky Backfill, Additional mechanical protection
- Sacrificial, ARO, HDD



Protection of Tape Systems in Soil Stress

- Tapes can sometimes "creep" or wrinkle in high-plasticity clay soils.
  - A fiber urethane wrap creates a rigid outer shell. The soil "slides" against the smooth urethane shell rather than "grabbing" the tape and pulling it off the pipe.
- In high-traffic areas or facilities where tools might be dropped or equipment might bump the asset:
  - It serves as a "shield" against mechanical impact that would otherwise crack a brittle liquid epoxy.

Outerwraps should show chemical resistance

Chemical Resistance ASTM D 543, Test period 2 months at 73°F (23°C)

Solution Tested	Product Result
Sulfuric Acid 50%	No Change
Hydrochloric Acid 50%	No Change
Sodium Hydroxide Solution 20%	No Change
Gasoline	No Change
Toluene	No Change
Xylene	No Change
Mineral Spirits	No Change
Distilled Water	No Change

Available on request:

Tensile Strength, ASTM D3039

Shear Strength, ASTM D5379

Flexural Strength, ASTM D790

Lap Shear, ASTM D5868

Protecting your Coating-Sacrificial Wrap

If the remediation involves pulling a pipe through a bore hole, a standard tape or even a liquid epoxy will likely be "stripped" or gouged by rocks and debris.

The Tech: The fiber reinforcement provides the **tensile strength** to withstand the pull-force, while the urethane provides the **impact resistance**.

Heavyweight Bout: Liquid ARO vs. Fiber Urethane Wrap as ARO

This is the choice most remediation projects face. One is a **field-applied liquid** (usually a reinforced epoxy or urethane), and the other is a **pre-impregnated fiber mesh** that cures with water or moisture.

Liquid ARO (e.g., Dual-Layer Epoxy)
What it is: A highly "filled" liquid coating (containing ceramic or glass flakes) applied at 40-60+ mils.
Best For: Automated applications or large, **smooth** surface areas where a spray or "plural component" pump can be used.
It creates a monolithic, chemical bond with the base layer.
The Flaw: It is still "brittle" compared to a wrap. If the pipe flexes or takes a massive hit, a liquid ARO can crack. Pot Life, Cure Time can effect High Build and protection

Liquid ARO vs. Fiber Urethane Wrap as ARO

Fiber Urethane Wrap ARO (e.g., GRP or "Outerwrap")

- **What it is:** A woven fiberglass or polyester mesh saturated with moisture-cured polyurethane resin.
- **Best For: HDD (Boring)** and complex shapes (flanges, bends).
- **The Tech:** The fibers provide **tensile strength**—the wrap acts like a "straitjacket" for the pipe. It handles impact by distributing the energy across the weave.
- Application is manual and can be labor-intensive.

ARO Liquid VS Tapes

Metric	Liquid ARO	Fiber Urethane Wrap
Gouge Resistance	Good (Hardness-based)	**Superior** (Tensile-based)
Impact Resistance	Moderate (can shatter)	**High** (absorbs energy)
Ease of Application	Easy (if spraying)	Difficult (requires manual tension)
Profile / Thickness	Thinner (40–80 mils)	Thicker (varies by # of wraps)
Primary Failure	Cracking / Delamination	"Tenting" or poor tension / voids

Inspection

A Holiday in coating refers to a discontinuity , defect or area of insufficient coating on the pipeline surface https://doi.org/10.5006/NACE_SP0188-2024 Provides Holiday Detection guidelines

Most Wax Tapes and Wraps are tested according to their thickness, between 10000-15000V

Visual Test with annual inspections are easier

Tapes: Shielding VS Non-Shielding

49 CFR Part 192 regulates, The pipe must be protected against external corrosion by a non-shielding coating. For protective coating tapes, the key to this compatibility usually lies in the open-weave structure of the integrated fabric. This design in some tapes allows for the free passage of moisture and electrical currents should underlying coating underneath disbond.

A non-shielding Tape AND a non-shielding OUTERWRAP ensures a continuous path for the protective cathodic protection currents to reach the steel substrate. This unimpeded flow of current mitigates corrosion in any areas that may become exposed over time, a fundamental requirement for coatings used in conjunction with CP systems under federal regulations (49 CFR Part 192,)

Tape Application Photos

Highly Conformable for Flanges

Mechanical Joint with Mastic and Primer

Mechanical Joint with Conformable Wax Wrap

Tapes and Mastics in combination can be used to fill voids

Straight Pipe Exposed to Extreme Heat

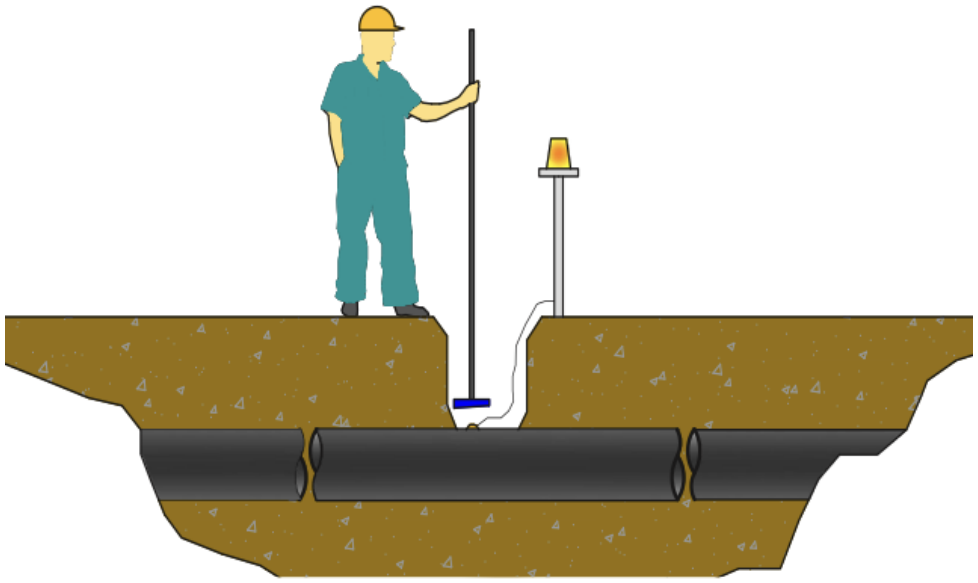
Tapes are ideal for Transitions from below to above

Tapes can be better suited for Bridgespans, creek crossing

Gas line in a tunnel of Wastewater plant where several different liquid applied coating did not hold up

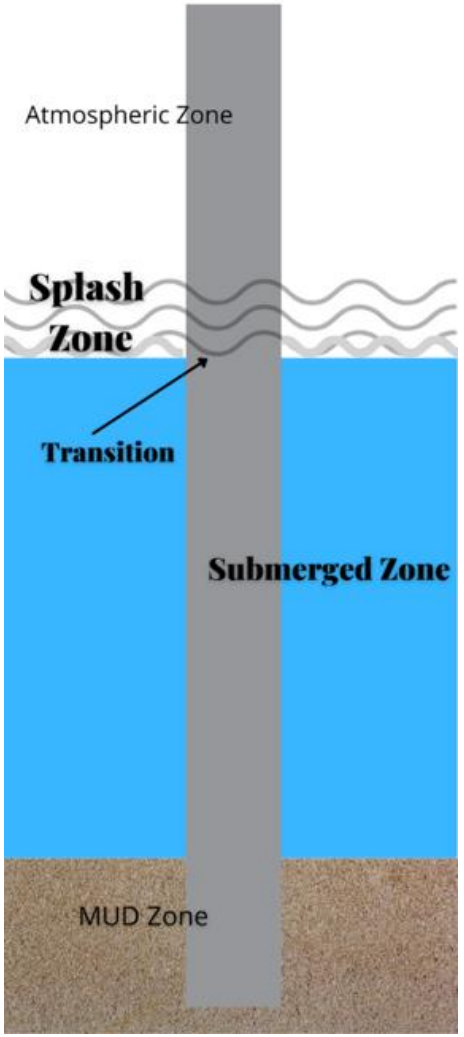
Tapes and Mastics in combination can be used to fill voids

Tape Patches can make it easier to repair coating where the same coating technology is applied as a patch with no cure time

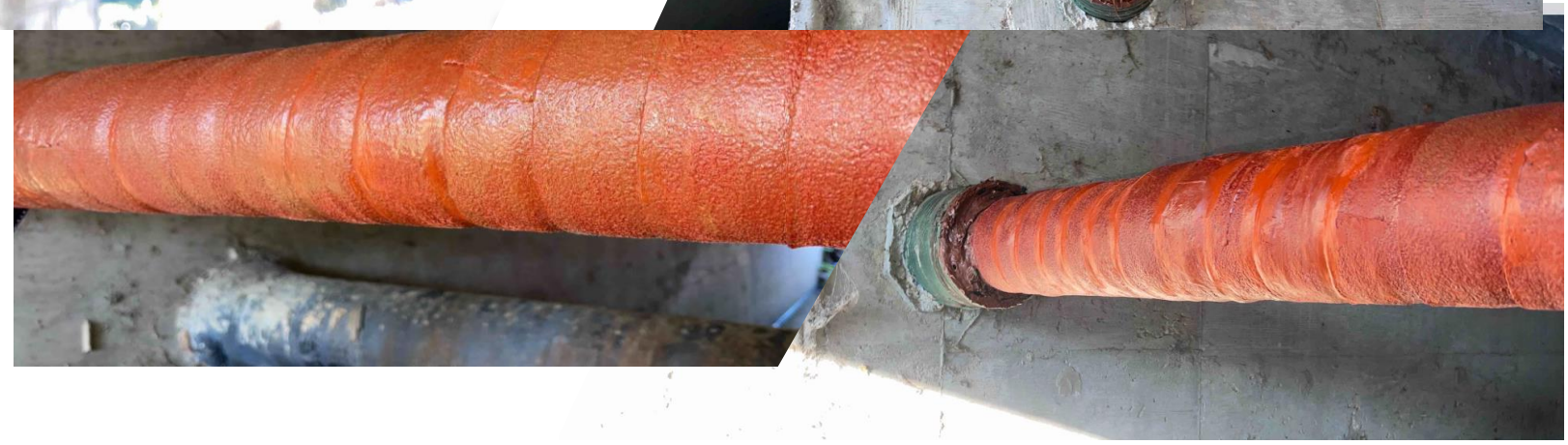


Tape Patches can make it easier to repair coating where the same coating technology is applied as a patch with no cure time

Tapes are better suited for Columns and Piles



Bridge Span, Tropical environment



Thank you, Any Questions?

Advanced High Performance Wax Tapes expand the application use in compared liquid-applied coatings in Kansas environments.

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