Viscous Elastic Coatings

How solid coatings with fluid properties can eliminate typical coating rehabilitation problems in the field

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Some phenomena we face when rehabilitating coatings in the field:

1. Salt and osmosis (due to water permeability)
2. Microbiological Induced Corrosion (MIC).
3. Improper surface preparation.
5. Cathodic protection conflicts
1. Salt & osmosis

The presence of salt, for instance NaCl solved in water, plays an important role in the corrosion mechanism:

Salt attracts water....
Due to a difference in salt concentration, water is able to create a pressure behind the coating if:

- Most coatings is not impervious to moisture (electro-endosmosis)
- Most coatings do not have perfect adhesion (undercreep)
2. MIC (SRB’s)

- Responsible for almost 50% of the corrosion problems!
- Sulphate is reduced to sulphide.
- Hydrogen sulphide is very corrosive to ferrous metals and further reacts with dissolved iron to form an iron sulphide film over the metal substrate.
3. Surface preparation...

Contamination remaining in corroded area of steel after sand or grit blasting.
4. Some examples of application failures...

- Applications failures due to non skilled labor and difficult to apply
- Coatings (PU spray coating)
- Curing time of liquids (epoxies)
- Bad pre-heating (heat shrink sleeves)
- Air inclusion (heat shrink sleeves)
- Under tensioning (butyl rubber tapes)
5. Cathodic protection

Bad = Permeable coating that shields (shrink sleeves)
Acceptable = Permeable coating that does not shield (epoxy)
Perfect = Impervious coatings
Some examples of typical coating failures in the field...
Disbondment

Causes

- Bad surface preparation
- Volume change
- Penetration of moisture (non impermeable character).
Bad adhesion

Causes

- No good contact due to irregular surface of steel.
- No wetting properties of the coating.
- Penetration of moisture
Biological Failure

Cause

- Biodegradation of coating by bacteria of fungi.
  Sulphate ---> Sulphide.
Blistering

Causes

- Osmosis
- Soluble pigments in primer
Osmosis

Causes

- Permeable to moisture, salt
- Bad surface preparation.
Other examples

MIC with sleeve

Disbondment with polyester.
Generally coatings tend to fail amongst others due to:

- Microbiological Induced Corrosion.
- Improper surface preparation.
- Adhesion problems (can be application or material problem)
- Permeability to moisture (salt & osmosis).
- Volume changes
- Application failures (curing times, overspray, air inclusion et cetera).
- Damage of the coating.
- Bad combination with Cathodic Protection
How to eliminate coating failures in the field:

- **MIC**: design a coating not sensitive to MIC.
- **Bad surface preparation**: design a coating that does not need accurate surface preparation.
- **Adhesion**: design a coating with an immediate and remaining adhesion.
- **Permeability**: design a coating that is impermeable to water and water vapor (no osmosis).
- **Volume changes**: design an amorphous coating with adhesion based on Van Der Waals bond and low surface tension.
- **Application failures**: design a coating that anyone can apply.
- **Damages**: design a coating that is self healing.
- **CP**: design a coating with permanent adhesion and impervious to moisture and oxygen.
What is a viscous elastic coating

- A-polar polyolefin polymer > **Impervious to moisture**
- 100% inert material > no reactive groups or free radicals > **stable over decades**.
- Amorphous : not cross linked > **wetting properties of a fluid**
- Pressure sensitive adhesive > solid in rest, **flow under pressure**.
- Inner Wrap and Outer Wrap > mechanical protection **separated** from corrosion prevention.
About viscous elasticity

- Non elastic solids: concrete
- Elastic solids: rubber
- Elastic solids: viscous-elastic solid coating
- Elastic fluids: viscous-elastic fluid coating
- Fluids: oil/water
Rheology: $G'$ and $G''$

Concrete rubber | VE solid | VE fluid | motor oil | water

Solid
$G' > G''$

Fluid
$G'' > G'$

$G'$ is the **storage modulus** (storing energy) > solid behavior

$G''$ is the **loss modulus** (loss of energy) > fluid behavior
Viscous-elastic solid

- $G' > G''$, after a certain strain, $G'' > G'$.
- During application the material will show flow-under-pressure:
- Advantage: no dripping behavior.

Switching from solid to fluid
Viscous elastic solid versus viscous elastic fluid...

SOLID

No dripping behavior

FLUID

Dripping behavior
Properties of a viscous elastic coating

- Intimate contact with surface.
- Initial adhesion by so called Van Der Waals Forces.
- Self healing characteristics
- There is no loss of contact and the valleys are filled.
Further characteristics...

- Cohesive fracture: **MATERIAL REMAINS ON THE PIPE.**
- 100% impermeable to moisture and gases: **NO OSMOSIS.**
- Inert formulation: **NO AGING.**
- Amorphous fluid behavior: **SELF HEALING.**
- Adhesion to all substrates: **NO INTENSIVE SURFACE PREPARATION.**
- Wetting characteristics: **EXTREME LOW CD.**
Why a **solid viscous elastic coating**?

- Solid material: No dripping behavior and unequal coating thickness.
- Solid material: Low creep values.
- Solid material: Good resistance to shear.
- Solid material: Melting point, stable at high temperatures.
How Viscous Elastic Coatings overcome typical field coating rehabilitation problems...
NO osmosis

- Impermeable for water: no osmosis.
- Hence no disbondment.

Extreme low cathodic disbondment after 30 days. Original Ø 6.4 mm hole did NOT grow in diameter...
NO adhesion problems

- Adhesion without primer
- Adhesion to all materials even PE, PP.
- Permanent adhesion over decades: no disbondment.
- No curing, no cracking.
- Cohesive fracture: when peeled off material is left on pipe.
- Very low cathodic disbondment values.

Tape coating delamination

- Adhesion only with primer
- No immediate adhesion to materials like PE factory coating
- No permanent adhesion: disbondment.
- Wrinkling, Delamination.
- No cohesion fracture but adhesive failure
- High cathodic disbondment values.

VEC cohesive fracture
No MIC problems

- Impermeable for water and oxygen. No life for anaerobe bacteria.
- No nitrogen components in the coating.
- No permeability for ionic species from soil e.g. nitrate, nitrite, ammonium.
- No water available and ions are insoluble in the a-polar material.
- Material is slightly basic : PH8 which is unfavourable for SRB’s.
NO application failures

- Minimal ST-2 surface preparation
- No priming.
- No risk for holidays.
- No repair at site.
- Cut and Paste
NO surface preparation problems

Blasting pipe to SA 2-1/2 is advised but not obligatory. Surface can be minimum ST-2.
Tested by international acknowledged labs

- Viscous elastic coatings have been tested by many overseas laboratories and oil and gas companies: it is proven technology!
Excellent resistance to shear!
Diverse easy applications: Cut and Paste!
Viscous Elastic Coatings
Smart self healing coating technology....