Advanced Weathering Field Trials
ArmorGel™ Anticorrosion Gel

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Abstract – Loss of containment due to leaks caused by external corrosion of steel components in applications such as Corrosion under Insulation (CUI) and Corrosion under Fireproofing (CUF),
Cryogenic (Cold Service) and general moisture prone components has significant cost implications for process plants. As a result, piping fixtures, vessels, tanks, valves and other equipment often require expensive inspection, repairs, replacements and overdesign. Asides the detrimental environmental impacts of a leak, lost time due to production losses adversely impact operational profits. The external corrosion of steel piping and process equipment results from moisture trapped on the surface of steel under insulation or fireproofing, condensation buildup from process temperature and natural elements (rain, snow, humidity etc.). This has been a perennial problem in process facilities for many decades. Traditional solutions such as surface painting have proven ineffective with associated cost running into billions of dollars globally. Surface paint/resin often disbands and disintegrates over time making the system susceptible to CUI/CUF. Conventional coatings are unable to effectively keeping moisture out and are thus shown to be ineffective prevention or mitigation solutions in CUI and CUF, cold service applications.

Forced continued Exposure of Carbon Steel to Ultraviolet rays, water, and elements to mimic extreme field conditions which propagate external corrosion for Cold service, CUI, CUF applications was conducted for more than one year in a non-controlled environment using ArmorGel™ as an anti-corrosion agent. Results are presented herein.

Note: Performance claims made in this report are based on experience and field tests. Corrosion protection results may vary.

Fig1Corrosion paint failure & CUI Damage on a Steam piping

I. INTRODUCTION- NEXT GENERATION COATING

ArmorGel™ premium anti-corrosion gels provide advanced and superior CUI and CUF prevention and mitigation by creating a protective shield. This prevents moisture (electrolyte) and gases from initiating a corrosion reaction in affected metal components. No surface moisture – No external Corrosion. Period!

Our superior non-drying surface coating technology prevents the initiation of galvanic, alkaline and chloride corrosion in process equipment and facilities, thereby extending their mechanical integrity. ArmorGel™ premium anti-corrosion coating gel may also prevent related damage mechanism types on the pipe external surfaces such as crevice corrosion, general atmospheric corrosion, and oxidation and chloride stress corrosion cracking. The technology promotes asset integrity and plant safety while reducing losses associated with unsafe operations, lost production and downtime.

II. AFFECTED MATERIAL

Affected Material Type: Carbon steel, low alloy steels, 300S Series SS, and duplex stainless steels systems.
A traditional and common solution to CUI /CUF is pipe paint coating is designed to adhere to the surface and so, prevent moisture buildup hence corrosion. The problem is they don't always adhere and over time, they disband, flake-off and decompose. In the process, they blister and cause localized moisture pots. This results in corrosion.

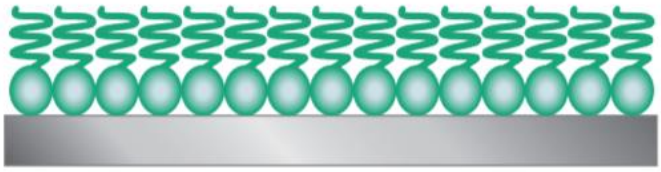

Fig2 Protective shield 50 – 200 angstroms deep prevents moisture and gases from reacting with metal components

III. SUPERIOR ENGINEERING

ArmorGel™ premium anti-corrosion gels are specially engineered to withstand critical CUI and CUF causative conditions such as:

A. All externally insulated and Fireproofed Systems and those in intermittent service or operate between:

- *10°F (–12°C) and 350°F (175°C) for carbon and low alloy steel.*
- *140ºF (60°C) and 400ºF (205°C) for austenitic stainless steels and duplex stainless steels.*

B. Environments that provide airborne contaminants such as chlorides (marine environments, cooling tower drift) or SO2 (stack emissions) can accelerate corrosion and Plants located in areas with high annual rainfall or warmer, marine

C. Cyclic thermal operation or intermittent service and equipment that operate below the water dew point which create condense water on the metal surface thus providing a wet environment.

D. Insulating materials that hold moisture (wick) and contaminants that may be leached out of the insulation, such as chlorides.

E. Cold Service Systems prone to condensation.

The general application areas are as follows: External Corrosion, Cold service piping CUI and CUF in Process Piping,

Pressure Vessels, Tanks, Control Valves, Pressure Safety Valves, Pipe Fittings, Flanges, Hangers, Shoes & Racks Assemblies), Inspection Pots, Bolts, Nipples & Plugs, Caulking etc.

IV. TEST METHOD

TEST START DATE: 2018/01/08 TEST END DATE: 2019/02/11

1. A sample of ArmorGel™ was obtained from a current production batch (Production Batch - 94736). About 2-3 mm thick of the gel was applied to an 8" Carbon Steel pipe section. The upper end of the pipe nipple was left free of ArmorGel™. There was no special preparation of the pipe nipple prior to this corrosion test to emulate real application and weathering conditions.
2. The pipe nipple was then placed outside exposed to the elements – rain water, high temperature and high humidity (zip code 32254 - North Florida). The pipe section was installed vertically on a plastic spacer to isolate it from the concrete pad. Periodic pictures were taken of the pipe nipple and observations noted.

3. The pipe section was cleaned by hand, wiping the ArmorGel™ from the nipple with a paper towel. Pictures were taken of the nipple with the ArmorGel™ removed.

4. The nipple was then further cleaned with a soapy towel and additional pictures taken

V. TEST OBSERVATIONS / RESULTS

2018/01/08 – Start of Test.

2018/01/11 – Minor external corrosion in form of (0.5mm mill scale) was observed on the section of both the top and bottom of the pipe. Very minor spotted pattern corrosion (<0.1mm mill scale) were noted on the section of the pipe end.

2018/05/11 - The uncoated section at the top of the pipe nipple is showing signs of substantial corrosion (>1mm). The balance of the pipe nipple continues unchanged.

2018/11/09 – The pipe appears unchanged from the previous observation. Significant debris has accumulated on the outside of the corroded area of the pipe.

2019/02/11 – End of test. Visual Inspections show no substantial change in the external corrosion in pipe section from the previous observation noted.

2019/02/12 – The pipe section with ArmorGel™ applied was wiped clean with a dry soft cotton patch. No solvent was used in the cleaning. The anti-corrosion gel retained its physical properties (color, viscosity, and texture). And no corrosion was observed in the area upon wipe off.

2019/02/12 - The pipe was cleaned with a soapy towel to further inspect for external Corrosion. No indication of any form of external Corrosion was observed.

Data from install test confirmed ArmorGel™ reached all design criteria with respect to protecting a section of pipe when exposed to external corrosion agents to mimic application instance for general external corrosion, CUI, CUF and Cold service moisture buildups for over one year.

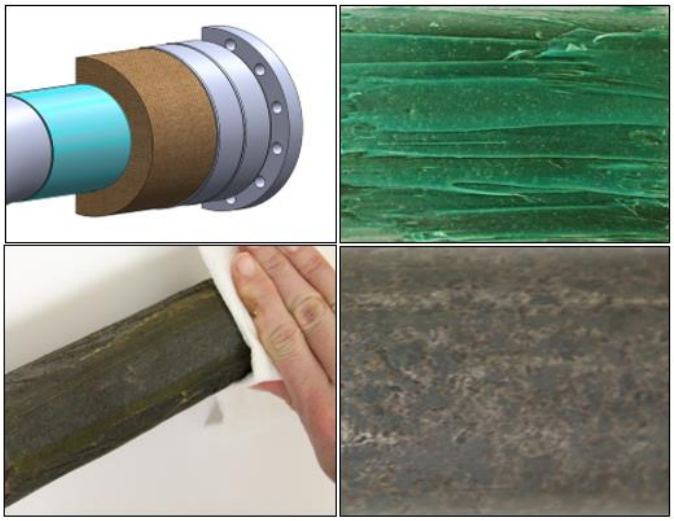

Fig3 Application and Visual Inspection Results. Zero indications of corrosion reactions.

VI. APPLICATION -SUSCEPTIBLE PLANT LOCATIONS

General areas: Areas downwind of cooling towers exposed to cooling tower mist, Areas of protrusions (i.e. transitions) through the jacketing at manways, nozzles, & other components, Areas of protrusions through insulation for systems operating at or below ambient, or in cold service, Areas where insulation jacketing is damaged or missing, Areas where caulking is missing or hardened on insulation jacketing, Areas where the jacketing system is bulged or stained, Areas where banding on jacketing is missing, Areas where thickness monitoring plugs are missing, Areas where vibration has caused damage to the insulation jacketing, Areas exposed to steam vents, Areas exposed to process spills,…

Fig 4 CUI Damage on a Storage Tank

…the ingress of moisture, or acid vapors, Areas exposed to deluge systems, Areas insulated solely for personnel protection, Areas under the insulation with deteriorated coatings or wraps, Areas with leaking steam tracing, Pipe and flanges on pressure safety valves, Systems that operate intermittently above 250 °F

(120 °C), Systems operating below the atmospheric dew point, Systems that cycle through the atmospheric dew point, Ice-to-air interfaces on insulated systems that continually freeze and thaw.

Piping: Dead-legs, vents, and drains, Pipe hangers and supports, Valves and fittings, Bolted on pipe shoes, Steam-tracing/electric-tracing tubing penetrations, Termination of insulation at flanges and other piping components, Carbon/low alloy steel flanges, bolting, and other components in high alloy piping, Jacketing seams on the top of horizontal piping, Termination of insulation on vertical piping, Areas where smaller branch connections intersect larger diameter lines, Low points in piping with breaches in the insulation, Close proximity to water (e.g. wharf) and/or ground (e.g. increased absorption), Wet due to flooding or submerging into water, Damage due to foot traffic

Pressure Vessels: Support rings below damaged or inadequately caulked insulation on vertical heads/bottom zones, Stiffening rings on insulated vessels/columns in vacuum service, Insulated zone at skirt weld, Insulated leg supports on small vessels, Ladder and platform attachments, Termination of insulation at nozzles and saddles, Fireproofed skirts (CUF), Anchor bolts (CUF), Bottom of horizontal vessels (i.e. lower third to half of vessel), Irregular shapes that result in complex insulation installations (e.g. davit arm supports, lifting lugs, body flanges, etc.)

Tanks & Spheres: Area above chime, Stairway tread attachments, Insulation support rings, Fireproofed legs on spheres (CUF), Insulation penetrations such as nozzles, brackets, etc. on shell and roof.

References:
API583: Corrosion under Insulation and Fireproofing-RP.
CTCE1000 External Coating System Selection Criteria.
CTSE1000 Application of External Coatings.
CTGG1000 Coatings Document Use Guideline.
INSC1000 Requirements for Cold Service Insulation Material.
INIC1000 Cold Insulation Installation Details.
INSC2000 Installation of Cold Service Insulation Systems.
INEG1000 Insulation Design Guide.
INTG1000 Insulation Inspection Checklist.

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