

Corrosion under Insulation (CUI) – Differences in Gel Coating Technology

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Corrosion under insulation (CUI) of steel operating equipment and piping is recognized as an important problem in the ammonia refrigeration, chilled water, chemical, and petroleum industries. A systems approach to CUI includes the correct material selection and design of the jacketing, insulation, and coating. This approach will help prevent CUI, but many corrosion engineers would agree that electrolytes will eventually find their way into even the best system. Selecting the right coating is extremely important, as the coating is the last line of defense for keeping the electrolyte from the metal surface and preventing corrosion.

Historically, many different types of products have been used to prevent CUI. One of the most common is the use of a synthetic fabric impregnated with petroleum jelly that is spiral wrapped around bare piping prior to the installation of the insulation. Known as “grease tapes”, these products do not typically offer long-term performance and can add to the overall insulation system cost by requiring insulation with a larger inside diameter to cover the tape. These tapes are inexpensive and fairly easy to apply but do not provide long term performance. See Picture # 1.

There are numerous paints and coatings available using silicon and epoxy technologies. Some are available on new pipe. Some require multiple coatings. When used in retrofit applications, they require a degree of surface preparation of the existing pipe that adds significant cost and time to project completion. Although more effective than grease tapes, paints and epoxies must be installed with great care to prevent damage to the surface and in retrofit applications often require the system itself to be shut-down,

Gel type pipe coatings have gained in popularity over the last few years in the food process industry due to their high quality performance and ease of application.

Ease of Application

Surface preparation when applying gel coatings on existing piping is generally limited to removal of loose scale or rust using a wire brush. Paints and epoxies typically require removal of all scale and rust down to bare metal.

Gel coatings are typically applied by hand since only as much gel should be applied as can be covered with insulation in the same day. The gels are applied at 25-30 mil thickness. One manufacturer offers stainless steel trowels in the most common pipe sizes that are calibrated to meter the proper amount of gel onto the pipe surface. Gels can also be applied using a brush or for bigger pipes and vessels may also be sprayed. See Pictures 2, 3, and 4 for examples of these application techniques.

The remainder of this paper will focus on these systems. Pipe gel coatings can generally be split into two categories; Reactive Gel (RG) technology and Synthetic Petroleum Hydrocarbons with Thickeners (SPHT). There are significant differences in these types of products. They are not the same type of technology, they do not have the same performance characteristics, and they have not been put through the same rigorous testing and field application trials. RG and SPHT products have significant differences. They are made using different technologies. Their performance characteristics are different; and their performance histories, laboratory testing and field application trials are significantly different.

Technology

- Synthetic Petroleum Hydrocarbon with Thickeners(SPHT)

- Synthetic Petroleum Hydrocarbons are typically used as gear and chain grease type lubricants. They are not commonly used as a CUI coating.
- Reactive Gels (RG) are specially formulated and patented anti-corrosion products that are primarily designed to be used in Corrosion under Insulation (CUI) applications. RG products have the ability to form a mineralization layer as an integral part of the surface of the pipe. This prevents undercutting where moisture can get under the coating and begin the corrosion process.

Performance Characteristics – A CUI coating needs to have various properties in order to be successful at mitigating corrosion. A few basic characteristics of a good CUI coating are thermal stability, the ability to resist water wash off, and the ability to protect the substrate from corrosion.

- Thermal Stability - Synthetic Petroleum Hydrocarbon with Thickeners versus Reactive Gels
 - An independent lab tested both types of products at 240°F.¹
 - This test was conducted on cold rolled steel (CRS) panels with the product applied at 25-27 mils thick (within the manufacturers recommended application thickness range). The pictures taken after 24 hours at 240°F show the degradation of the Synthetic Petroleum Hydrocarbon with Thickeners (Pictures #5& #6) while the Reactive Gel was shown to have little to no change in physical appearance.
- Water Wash Off Resistance - Synthetic Petroleum Hydrocarbon with Thickeners versus Reactive Gels
 - Synthetic Petroleum Hydrocarbon with Thickeners can be cleaned up using dishwashing liquid and water.
 - Reactive Gels are formulated to resist moisture/water and are designed to be cleaned up with a citrus based cleaner.
- Specific Gravity - the ratio of the density of a substance to the density of a standard, usually water for a liquid or solid.
 - Water = 1.00
 - Typical Synthetic Petroleum Hydrocarbon with Thickeners = 0.85 – 0.95.
 - Typical Reactive Gel = 0.98 – 1.08
 - Because the SPHT product has a much lower specific gravity than RG, it will be much less resistant to water-wash off.
- Anti-Corrosion Testing
 - ASTM B-117 is the most effective test in assessing the laboratory performance of anti-corrosion coatings and is used by corrosion engineers world-wide to compare product performance.
 - An independent lab tested both RG and SPHT side by side at a thickness of 25 – 27 mils with an “X” scribe for 504 hours.² You can see the results in pictures #7, #8, and #9. An “X” is commonly added to this type of test to show resistance (or lack of resistance) to edge undercutting.
 - Actual Field Performance of Gel Products
 - Synthetic Petroleum Hydrocarbon with Thickeners
 - A leading manufacturer of the Synthetic Petroleum Hydrocarbon with Thickeners says that the corrosion properties have been previously verified

be exposing a pipe to the Florida coastal elements for one month, and no corrosion formed (Picture #10)

- SPHT products have no documented record of long term success in mitigating corrosion in general and specifically CUI.
- Reactive Gels
 - Reactive Gel has been tested in a salt water immersion test where pipes were coated, covered with fiberglass insulation, and submerged in 5% aerated salt water for 2 years (Picture #11, #12, #13, #14). As can be seen in the photos, the pipe area coated with Reactive Gel was corrosion-free.
 - In addition RG technology has 40 years of performance history in stopping corrosion in the auto industry and on U.S. Navy vessels in high corrosive environments. RG Technology has over 10 years of specific experience in mitigating CUI in the Food and Beverage Industry as well as the Oil Industry on the Alaskan North Slope.

Conclusion

Lab testing shows that there is a significant difference between Reactive Gel technology and Synthetic Petroleum Hydrocarbons with Thickeners in thermal stability, resistance to water wash off, and anti-corrosion properties. In addition, Reactive Gel technology has significantly longer field experience in various applications and significant direct experience in Corrosion under Insulation applications.

In ammonia refrigeration and other very low temperature applications, where system integrity and worker safety are important considerations, engineers will need to closely evaluate the above factors in choosing the proper gel technology to use.

Picture 1



Pipe with Grease Tape after 10 Years



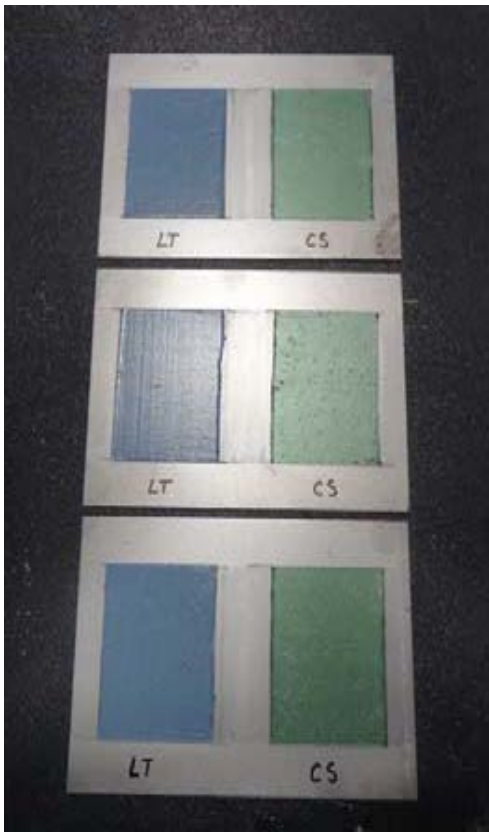
Picture 2- Typical Gel Hand Application



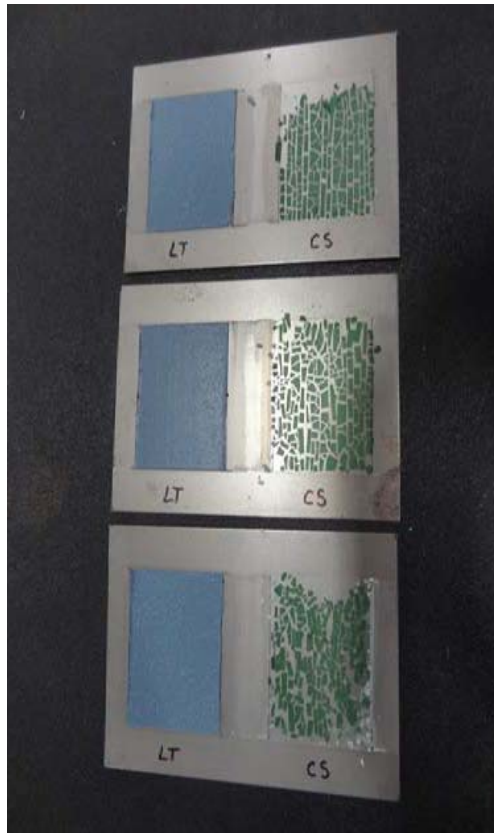
Picture 3- Using Calibrated Trowel to Apply Gel



Picture 4- Gel Being Spray Applied

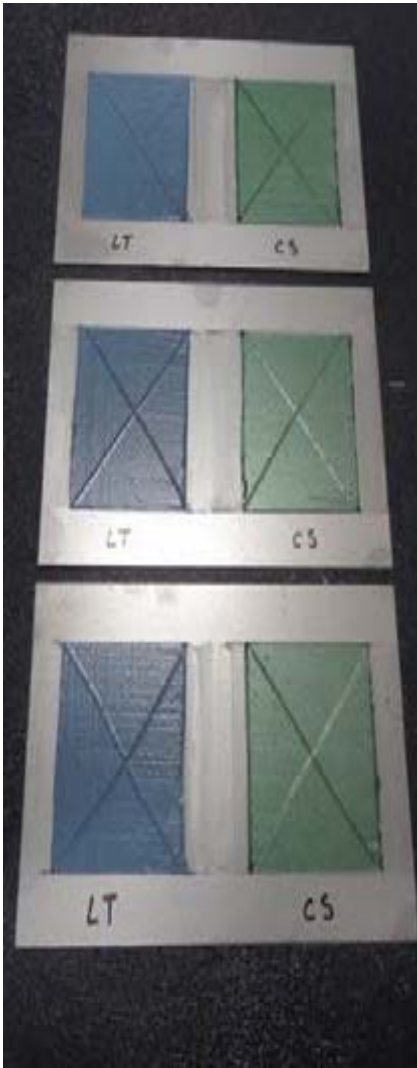


Picture 5-Heat Age Test Panels, Pre-Exposure



Picture 6-Test Panels after 24 Hours of Exposure at 240°F

Picture 7



Pre-Exposure

Picture 8



Post-Exposure

Picture 9



Post Exposure – After Coating Removal

504 Hour Salt Spray Test Panels

Picture #10



Pipe treated with Petroleum Hydrocarbons with Thickeners on one end. Then exposed to the Florida costal elements for one month

Picture #11



Reactive Gel Applied to Pipe

Picture #12



Reactive Gel coated pipes in 5% salt water

Picture #13



Pipe & insulation after 2 years

Picture #14



2 year test pipe after Reactive Gel is cleaned off

References

1. Intertek Report No.: 101276703GRR-001c, September 27th, 2013
2. Intertek Report No.: 101276703GRR-001b, September 27th, 2013