

A Novel Methodology for Addressing Corrosion Under Insulation (CUI) Utilizing Corrosion Inhibitor Impregnated Self-Amalgamating Silicone Based Tape

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ABSTRACT

Corrosion under insulation (CUI) is regarded as one of the largest corrosion threats across the oil, gas and petro-chemical sectors. CUI is a condition which results in aggressive localized corrosion in carbon and low alloy steel. This form of corrosion occurs when water is absorbed by or collected in the insulation. The equipment begins to corrode as it is exposed to water and oxygen. CUI is common in refineries, process plants, midstream and downstream, where equipment operates at higher temperatures.

The Inhibitor Fusion Tape is a silicone based self-amalgamating tape that is impregnated with corrosion inhibitors that were specifically designed to combat CUI. The Tape provides a physical barrier between the steel substrate and insulation medium and can transfer corrosion inhibitor to the underlying metal surface in the event of any water ingress or sweating of the line. Finally, the Tape is translucent to allow ease of inspection and as the Tape has no glues/resins/primers for adhesion, the tape is easily removed for inspection cycles leaving no adhesive residue behind.

This paper will provide various case studies and showcase a diversified overview. The Tape has also been tested and passed ISO 19277 for protective coating systems under insulation according to modified ISO 19277¹

Key words: CUI, corrosion under insulation, volatile corrosion inhibitor, VCI, SCI, ZIF, corrosion management, integrity

INTRODUCTION

Integrity management of corrosion under insulation (CUI) has historically and continues to be one of the biggest corrosion related challenges within the oil & gas, maritime, chemical and petrochemical industries.² Corrosion of piping, associated flanges, pressure vessels and structural components from CUI is a commonly found phenomenon and if left undetected or not stringently managed can result in catastrophic leaks or explosions, equipment failure and periods of prolonged downtime due to repair or replacement. It is estimated around 40% to 60% of an operator's pipeline maintenance budget is a result of CUI.³

Methods to try and control CUI risks have been to adopt conventional coatings such as epoxies, thermal sprayed aluminum (TSA) etc., along with a robust insulation system, such as conventional rock wool with metal cladding or newer technologies such as open or closed cell insulation, as well as UV cured glass reinforced plastic (GRP) or glass fiber reinforced plastic (GFRP).^{2,3}

Further enhancements in new monitoring systems can help with monitoring and detection and having robust maintenance processes and procedures can all attribute to minimizing the threat and risks from CUI. However, the first line of defense is trying to create the physical barrier between the metal substrate and the insulation medium.

Insulation

Various failure mechanisms exist on the outer cladding of the insulation such as, mechanical impact damage of the insulation, organic damage such as sealants breaking down due to UV, age, or missing seals.²

Where defects are found, a water path typically occurs and can lead to the insulation "holding" the water. Closed cell insulation will typically hold the water at the equipment surface where it can often find low points and attack at 6 o'clock positions. For open cell insulation systems, the water will typically soak the insulation and will result in heat loss from the operating pipeline or equipment. This results in cycles of evaporation and condensation, which over time, the water, heat, and contaminants will degrade the coating system. When this occurs, carbon steel systems will typically see pinhole or catastrophic rupture, where stainless steel will typically see a stress cracking or localized pits to the substrate. It is also worth noting that water can travel along long pathways from the damaged entry point, resulting in undetected failures.²

Coating

Coating failures, which can lead to holidays within the coating, can occur as a result of many factors such as: mechanical and ageing damage, cissing or contaminants, cratering, where solvent or surface chlorides, pinholes within the coating creating pathways for moisture and contaminants entering, coating damage due to the skill set of the applicator such as overcoating or undercoating potentially creating rash corrosion. Trying to create factory conditions in the field is a difficult task and trying to achieve an industrial blast cleaning⁴ or a near white blast cleaning profile⁵ in harsh environmental conditions is all known issues relating to coating failures. Environmental impact can play a large part in the CUI system breakdown as many assets are located coastal or offshore resulting in harsh climatic conditions. An example of CUI damage is shown below in Figure 1.



Figure 1: CUI example

This paper presents the results of various live field trials with the Tape and ISO 19277 testing.

Inhibitor Fused Tape

The Tape is based on self-fusing silicone tapes that were developed in the 1950s for US military applications. Various versions of self-fusing silicone tape are commercially available with typical application temperatures in the range of -40° to 200° C. The new Tape is an extension of that technology wherein corrosion inhibitors have been compounded into the Tape. It combines corrosion inhibitors with the specific properties of a self-fusing polymer for easy, cold application.

The Tape was specifically manufactured and designed for 3 main areas of protection:

1. CUI - to provide a physical barrier whilst also allowing for a robust but quick and easy use.
2. Scab Repairs/Remedial works – by minimizing blasting, entire work order/processes can be eliminated, such as: reducing hot work down to cold work perimetry, eliminating blasting on live lines (BOLL), reducing hazards and costs, eliminating heavy equipment such as blasting equipment, hoses, gauntlets, air purification tests, compressors, generators and so on. Thereby, also eradicating coating equipment. Inspectors can also use the Tape to a great effect during integrity inspections works and complete repairs following an NDT inspection. This could drastically reduce workflows: reporting and entire work party management flows and saving multiple crews visiting the same jobsite to perform remedial works.
3. Flanges – both fixed and rotating.

The main attributes/features of the tape can be summarized as follows:

- Provide protection by a soluble and contact corrosion inhibitor.
- Capacity to conform / mold when wrapped around/onto complex shapes.
- Bond to itself Instantaneous and remains non-tacky to the touch.
- Cold, easy and quick application process.
- No residue remains when the tape is removed.
- Wind, sunlight UV, oxygen, and seawater resistance.
- No heat/equipment required.

- Based on silicone elastomer.
- Good mechanical and puncture resistance. Can also be repaired with ease.
- At 15+ years of corrosion protection, to fall in line with planned Inspections.

Field Trial(s) Conducted in Central Europe

Two separate trial locations were utilized for conducting simple atmospheric corrosion protection case studies for the Tape. Asset 1, as seen in Figure 2, is a large refinery close to the climatic North Sea region., The refinery processes and stores multiple products petrochemical products.



Figure 2: Central European Refinery

Various pipelines operating at around 100°C were chosen for the trial. Multiple, randomly selected areas were scraped back to bare metal and non-destructive testing (NDT) was conducted on the chosen area(s) to determine remaining line wall thickness. The results were recorded for monitoring purposes, as shown in Figure 3.