Experimental Findings for the Sealing and Corrosion Inhibition Properties of Vappro VBCI Corro-Tape Using ASTM B117 Salt-Spray Chamber Test

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Abstract

Vappro VBCI Corro-Tape [1] is an anti-corrosion tough synthetic fabric impregnated with VBCI inhibitors and petrolatum compound. It contains a special high tacky adhesive fortified with Vappro VBCI anti-corrosion additives formulated to resist corrosion of metal piping systems above ground, fittings and joints on all pipes and electrical conduit systems. Vappro Corro-Tape is resistant to corrosive salt water, soil acids, alkalis and salts, common chemicals, chemical vapours and exposure to outdoor weathering and sunlight. It has excellent repellent water-repellent properties. To validate the above said properties, two pipes, a galvanized and a high carbon steel pipe surfaces were cleaned with Isopropyl alcohol to ensure that they are free of oil, grease and other contaminants. The center portion of the high carbon steel pipe was protected and insulated with Vappro VBCI Corro-Tape before both pipes were subjected to the ASTM B117 Salt-Spray Chamber [2] for 1000 hours. The degree or rate of corrosion was monitored and documented every fifty hours and the test was terminated after 1000 hours.

Introduction

Carbon steel is the most common pipe material used in the hydrocarbon processing industry, but the material's susceptibility to corrosion on pipelines continues to be a significant cause of leaks and issues that can lead to early replacements, unplanned outages, and incidents potentially resulting in loss of property and injury to workers.

The demand for Vappro VBCI Corro-Tape has seen a marked increase in recent years due the EU regulations on reduction emission of VOCs (volatile corrosion compounds) [3,4]. The said Directive 1999/13/EC aims to prevent or reduce the direct and indirect effects of emissions of volatile organic compounds (VOCs) on the environment and human health, by setting emission limits for such compounds and laying down operating conditions for installations using organic solvents.

Polyurethane and epoxy coatings used to protect pipelines contain such VOCs compound. Vappro VBCI Corro-Tape has been found to be a good alternative for the replacement for said coatings due to its unique property to combat corrosion of pipes against contaminants such as; moisture, oxygen, carbon dioxide, chlorides and sulfur compounds present in the atmosphere.

Vappro VBCI Corro-Tape is synthetic fibre tape impregnated with VBCI inhibitors and proprietary adhesive compound. It contains a very tacky adhesive to enhance its bonding strength to the pipes. The synthetic fiber tape displays excellent water displacement properties to keep rain water or condensate from seeping into it. Hence eliminating crevice corrosion and general corrosion on the pipe services. Vappro VBCI Corro-Tape is used extensively for protecting pipes against corrosion caused by brine and salt in the marine and offshore environments.

Pipelines are laid both above ground and underground, since Vappro VBCI Corro-Tape is used for protecting pipelines above ground, only corrosion found on pipelines above ground will be mentioned. There are different forms of corrosion commonly found in pipelines above ground such as; Uniform corrosion, Crevice Corrosion and Filiform Corrosion.

Uniform Corrosion [5,6,7,8] ensues at uniform rate over most of the surfaces throughout the pipe lengths. It is commonly found in pipelines that are not protected by surface coatings or inhibitors. A surface of rust in formed on the surface of the pipelines when exposed to corrosive environment such as marine environment (see picture1).

Crevice Corrosion [9,10,11] is a type of localized corrosion usually associated with stagnation of water in a micro-environmental level. Such stagnant micro-environments tend to occur in crevices in shielded areas such as gaskets, joints of pipelines, washers, insulation materials and surface deposits (see picture 2).

Whereas extreme localization corrosion such as filiform corrosion [12,13,14] is commonly experienced due to hostile marine local environment for pipelines above ground. Filiform corrosion or filamentary corrosion occurs under the protective paints or coatings due to poor surface preparation before the paint was applied on the surface It is also referred to as under-film corrosion (see picture 3).

Picture 1-Uniform Corrosion of Pipelines

Picture 2-Crevice Corrosion of Pipeline

Picture 3-Filiform Corrosion on the surface of a pipeline

Marine environment [16,17] consists of many contaminants such as chlorides, salts, sulfur dioxide, carbon dioxide, moisture resulting in severe corrosive atmosphere compared to inland environment. The relatively higher corrosive environment demands for better corrosion protection mechanisms. Coating is used as a primary corrosion protection of pipe lines. It is one of the effective insulating barriers between the pipe surfaces and the external corrosive atmosphere.

However, methods adopted to lay the pipeline may at times damage the coatings provided on external surfaces, hence, promoting localized corrosion and shorten its protection life-span. Vappro VBCI Corro-Tape [1] is used as an additional protective layer for the coated pipelines. It can also be used for protecting pipelines above ground without the physical coating on the surfaces of the pipe or can used as anti-corrosion tape over the coating of the pipe as additional layer of protection.

As pipelines are designed to last for many years, it of paramount importance to ensure that they are protected based on the intended period. The ASTM B117 [2] Salt Spray Test has been adopted to evaluate the sealing properties and the corrosion inhibition properties of Vappro VBCI Corro-Tape [1]. The details of said test are herein described below.

Test Procedure

Two pipes were used for salt spray chamber test.

A galvanized pipe without any anti-corrosion tape (Please refer to picture 4) and a high carbon steel pipe wrapped with Vappro VBCI Corro- Tape (Please refer to picture 5).

Both pipes were degreased and cleaned with Isopropyl Alcohol and the center portion of the high carbon pipe was wrapped with Vappro VBCI Corro-Tape. Then both were placed in the salt spray chamber.

Galvanized pipe without wrapping with Vappro VBCI Corro-Tape is used as a control blank trial. By means of a blank trial – that is, a trial structure without VCI auxiliary packing material – it is determined whether the conditions of the trial are sufficient to cause corrosion to appear on the unprotected test sample.

According to ASTM B117 [2], standard practice for salt spray chamber, 5% salt solution is used, and temperature of the chamber is set to 35°C.

Both Pipes were placed in the chamber for total 1000 hours.

Analysis Results

After 48 Hours in the chamber

Some white rust of was found on galvanized pipe. (Please refer to picture 6)
However, for the high carbon steel pipe, corrosion was observed on both sides of the pipe that were not protected by with Vappro VBCI Corro-Tape. (Please refer to picture 7)

After 100 hours in the chamber

More white rust was found on galvanized pipe. (Please refer to picture 8)
For the high carbon steel pipe, the exacerbation of corrosion was observed on both the unprotected sides. (Please refer to picture 9)

After 500 Hours in the chamber

Extensive white rusts were observed on the galvanized pipe. (Please refer to picture 10)
For the high carbon steel pipe wrapped with Vappro VCI Corro-Tape, 80% of the unprotected surface areas were corroded. (Please refer to picture 11)

After 1000 Hours in the chamber

Extensive severe white rusts were observed at the galvanized pipe. (Please refer to pictures 12) For pipe wrapped with Vappro VBCI Corro-Tape, 95% of the unprotected surface area were corroded. (Please refer to picture 13)

The salt spray test was terminated after 1000 hours

Vappro VBCI Corro-Tape was unwrapped from the center portion of the high carbon steel pipe and observed the protected surface area. (Pls refer to picture 14)

Observation

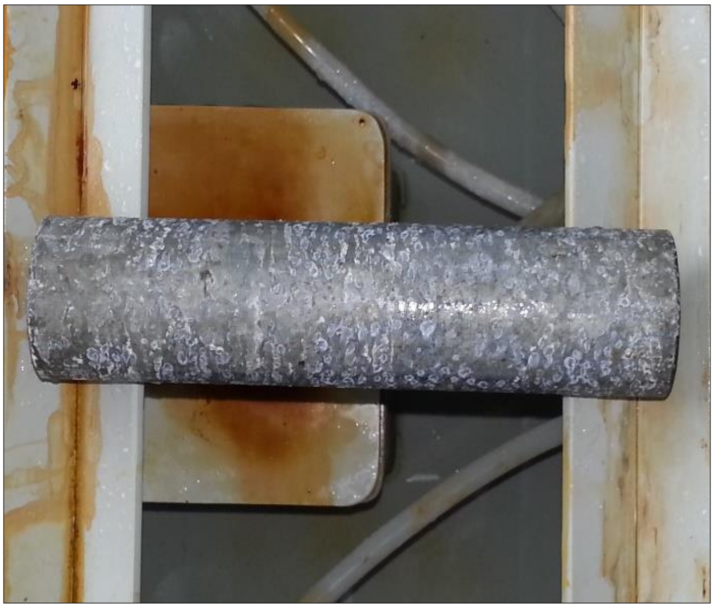
No sign of corrosion was observed on protected surface area wrapped with Vappro VBCI Corro-Tape. (Please refer to picture 15 and 16)

Picture (4) Galvanized pipe.

Picture (5) High Carbon Steel Pipe wrapped with Vappro VBCI Corro-Tape.

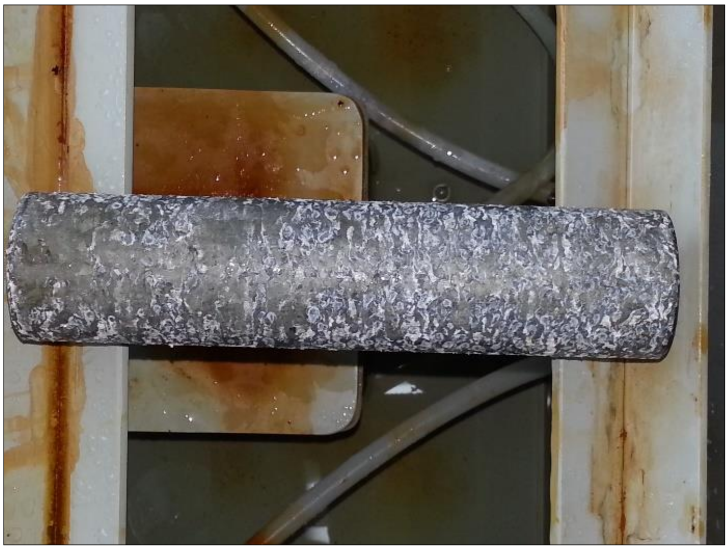
Picture (6) after 48 hours in the salt spray chamber.

Picture (7) after 48 hours in the salt spray chamber.



Picture (8) after 100 hours in the salt spray chamber spray chamber.

Picture (9) after 100 hours in the salt spray chamber



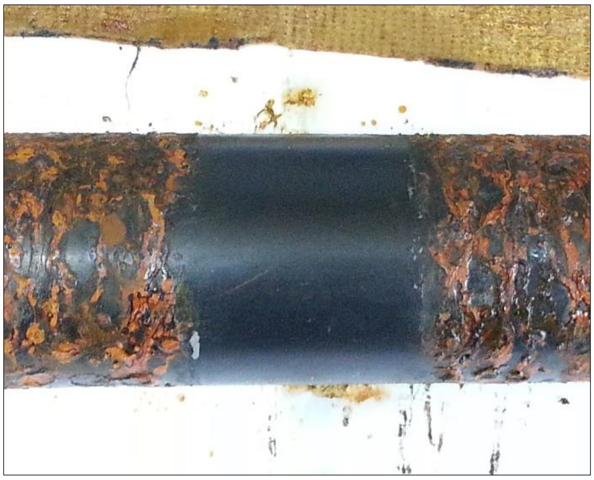
Picture (10) after 500 hours in the salt spray chamber.

Picture (11`) after 500 hours in the salt spray chamber.

Picture (12) after 1000 hours in the salt spray chamber.

Picture (13) after 1000 hours in the salt spray chamber

Picture (14) Vappro VCI Corro-Tape was unwrapped for observation



Picture (15)

Picture (16)

No sign of corrosion was observed on the protected surface area wrapped with Vappro VCI Corro-Tape.

Conclusion

After 1000 hours in the salt spray chamber, there was no sign of corrosion on the surface of the high carbon steel pipe sealed and protected by Vappro VBCI Corro-Tape. It was concluded that Vappro VBCI Corro-Tape displayed good sealing, water resistant properties and exhibited excellent corrosion inhibition properties.

Hence, Vappro VBCI Corro-Tape is an excellent product for protecting pipelines above ground against corrosion in harsh marine environment.

References

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https://www.vapprovbci.com

[2]ASTM B117, "Standard Practice for Operating Salt Spray (FOG) Apparatus.," *ASTM*

Stand., vol. 03, no. February, pp. 1–15, 2003.

[3] Summary of the Directive 1999/13/EC on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations (VOC Solvents Emissions Directive

[4] Directive 2004/42/EC of the European Parliament and of the Council of 21 April 2004 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in decorative paints and varnishes and vehicle refinishing products and amending Directive 1999/13/EC ("the Paints Directive") aims to prevent the negative environmental effects of emissions of volatile organic compounds (VOC) from decorative paints and vehicle refinishing products.

[5] Different Types of Corrosion: Uniform Corrosion or General Corrosion ...
www.corrosionclinic.com/types_of_corrosion/uniform_corrosion.htm
Uniform corrosion also refers to the corrosion that proceeds at approximately the same rate over the exposed metal surface. Cast irons and steels corrode uniformly when exposed to open atmospheres, soils and natural waters, leading to the rusty appearance

[6] Uniform Corrosion - NACE International
https://www.nace.org/Corrosion-Central/Corrosion-101/Uniform-Corrosion/
Uniform Corrosion. Uniform corrosion is characterized by corrosive attack roceeding evenly over the entire surface area, or a large fraction of the total area. General thinning takes place until failure. On the basis of tonnage wasted, this is the most important form of corrosion.

[7] What is Uniform Corrosion? - Definition from Corrosionpedia
https://www.corrosionpedia.com/definition/6542/uniform-corrosion
Uniform corrosion can render large amounts of material useless quite rapidly because the attack occurs across the entirety of the exposed surface. Although

[8] CORROSION TYPES CHAPTER 4 1) UNIFORM CORROSION
https://uomustansiriyah.edu.iq/media/lectures/5/5_2016_04_20!11_11_41_AM.pdf
specimens or failed equipment. There are eight forms of corrosion. 1)Uniform or General Corrosion. It is uniform thinning of a metal without any localized attack.

[9] Crevice Corrosion - NACE International
https://www.nace.org/Corrosion-Central/Corrosion-101/Crevice-Corrosion/

This advanced form of crevice corrosion is called 'pillowing'. The most common form is oxygen differential cell corrosion. This occurs because moisture has a lower oxygen content when it lies in acrevice than when it lies on a surface. The lower oxygen content in the crevice forms an anode at the metal surfac

[10] Different Types of Corrosion: Crevice Corrosion -Causes and ...
www.corrosionclinic.com/types_of_corrosion/crevice_corrosion.htm
Crevice Corrosion refers to the localized attack on a metal surface at, or immediately adjacent to, the gap or crevice between two joining surfaces. The gap or crevice can be formed between two metals or a metal and non-metallic material

[11] Crevice Corrosion
www.cdcorrosion.com/mode_corrosion/corrosion_crevice.htm
This form of attack is generally associated with the presence of small volumes of stagnant solution in occluded interstices, beneath deposits and seals, or i

[12] Filiform Corrosion - NACE International
https://www.nace.org/Corrosion-Central/Corrosion-101/Filiform-Corrosion/
A special form of crevice corrosion in which the aggressive chemistry build-up occurs under a protective film that has been breached. This type of corrosion

[13] Different Types of Corrosion: Filiform Corrosion or Underfilm Corrosion
www.corrosionclinic.com/...of_corrosion/filiform_corrosion_underfilm_corrosion.ht...
Filiform corrosion is a special form of corrosion that occurs under some thin coatings in the form of randomly distributed threadlike filaments. Filiform corrosion is also known as "underfilm Corrosion" or "filamentary corrosion". Filiform corrosion of a tin-coated stee

[14] Filiform Corrosion - an overview | ScienceDirect Topics
https://www.sciencedirect.com/topics/materials-science/filiform-corrosion
15.3.4 Filiform corrosion. As mentioned above, filiform corrosion is a particular form of crevicecorrosion. This type of corrosion typically occurs on coated surfaces when moisture or a corrosive solution penetrates through the defective coatings. It is caused by active galvanic cells across the metal surface.

[15] Chloride Penetration Profiles in Marine Environments
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The chlorides from the sea and the marine breeze are the main source of corrosion in marine environments. Their penetration into concrete occurs through

[16] Effects of Marine Environments on Stress Corrosion Cracking of ...
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Wet storage stain describes the white, generally powder-like substance which can form on the surface of a galvanized article. It can also create black spots on

[18] Prevention of white rust. - Tubecon
www.tubecon.co.za/en/technical-info/tubecon-wiki/prevention-of-white-rust.html
The white rust can be caused in a number of situations for example: through condensation in the stack of galvanised or pre-galvanised (Z275) steel tubes, coils

[19] White Rust Prevention & Cure-DongPengBoDa Steel Pipes Group
https://www.pipesteelchina.com/blog/news/121-en.html
Dec 29, 2016 - One of the commonly encountered problems
with galvanised coatings of all kinds is 'white rust' or 'white storage stain'. It is manifested as a

About the Authors

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Nelson Cheng PhD (honoris causa) is the founder and Chairman of Magna Group, consisting of Magna International, Magna F.E. Chemical Pte Ltd, Magna Chemical Canada Ltd, Magna Australia Pvt Ltd and Lupromax International Pte Ltd.
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Michael Schorr is a professor (Dr. honoris causa) at the Institute of Engineering, Universidad Autonoma de Baja California. He has a BSc in chemistry and an MSc in materials engineering from the Technion-Israel Institute of Technology. From 1986 to 2004, he was an editor of Corrosion Reviews. He is acquainted with the appreciation of VCI in industrial environments. In addition, M. Schorr was a corrosion consultant and professor in Israel, USA, Latin America, and Europe. He has published 410 scientific and technical articles on materials and corrosion.