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Removable Coatings for up to One Year Service Life in the Oil and Gas Market

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Abstract

The oil and gas industry has a tremendous need for the protection of assets during shipment and storage. Newer advances have allowed the use of the vapor corrosion inhibitor technology to be incorporated into temporary coatings which are designed to provide corrosion protection in extreme environments, yet still be easily removable compared to the older traditional wax type coatings made from hydrocarbons. By incorporating the vapor corrosion inhibitor technology into these temporary coatings, it allows the use of thinner film thicknesses and less reliance on a thick barrier to keep contaminants away from the surface.[1, 2]

Keywords: protection, corrosion, inhibitor, temporary, coatings

Technology Background

Types of VCIs

VCIs are a corrosion inhibitor technology which is comprised of very small particles which are attracted to a metal substrate. They come in various formulations which are dependent on the type of system they will be used in, for example films, oils, coatings, cleaners, etc. There are also a variety of formulations which provide protection in ferrous, non-ferrous or multi-metal applications. Other variables include the amount of vapor phase compared to contact phase inhibitors.

How Vapor Corrosion Inhibitors (VCIs) work in a coating

VCIs are formulated into a coating thru a complex development process which involves determining chemical compatibility of the VCIs with the other components of the coating such as the resin, solvents, pigments and other additives used for a variety of reasons.

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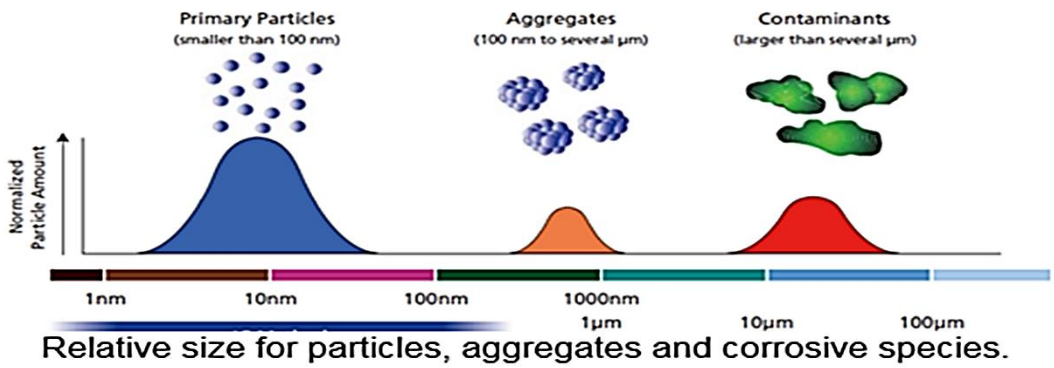
VCIs work by adsorbing onto the metal surface in a non-reactive attractive capacity, in other words, they are attracted to the metal through the particle charge[3]

How VCIs compare to traditional inhibitors

Traditional inhibitor systems use inorganic metal particles such as zincs, chromates, aluminum and others. Additionally, traditional inhibitor systems often rely on thick barriers to prevent moisture and oxygen from getting to the substrate. VCIs compare with traditional inhibitor systems by using smaller particles as well as relying not only on contact inhibition but also vapor phase inhibition, providing more complete coverage and protection of the surface. This can be illustrated as follows:



[4]

Figure 1

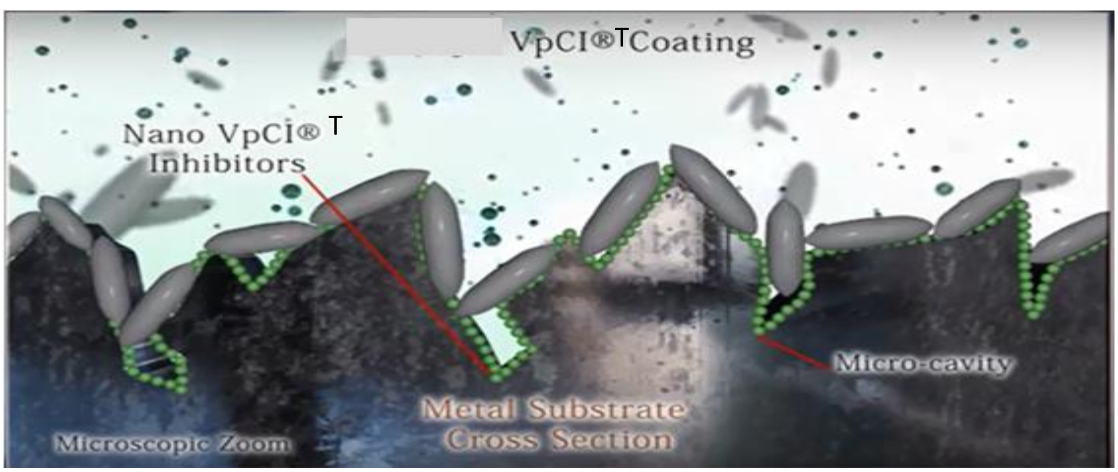


Figure 2

The larger platelets are representative of traditional inhibitors which are unable to fill the micro-crevices, leaving gaps where corrosion can start and/or grow.[5]

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What type of coating systems can use VCIs

VCIs can be used with most coating systems. There are many variations of VCIs and the key is to choose the correct VCI for the corresponding coating system by checking compatibility, effectiveness and processability. Compatibility is determined using bench ladder tests which will use various concentrations of VCIs and various versions of VCIs to determine if there is phase separation, gelling or particle generation. Typically this is done visually and the formulating chemist will determine if the results are acceptable.

The environmental advantages of VCIs over traditional inhibitors

Traditional inhibitors containing heavy metals, nitrites or secondary amines or banned materials such as Dicyclohexylammonium Nitrite are becoming increasingly more regulated and often are no longer allowed to be used due to the negative impact they have on the environment and carcinogenic effects on workers exposed to them. The environmental advantages of using VCIs are that they are non-toxic, do not contain heavy metals, and have no adverse effect due to their low usage concentrations. VCIs have long been used in other products such as polyethylene films, foams, powders and liquids to provide a vapor phase of corrosion protection without impacting the environment.

Removal of Temporary Coatings

Removal of temporary coatings can be done using environmentally friendly alkaline cleaners. These cleaners are typically diluted in water at a relatively low concentration (2-20%), sprayed or brushed onto the coated surface and allowed to dwell for a period of 5-15 minutes. The coating is then removed using a hot water wash (120F- 180F).

Experiments

These studies examine the effectiveness of various types of corrosion inhibitors in solvent and waterborne removable coatings, based on salt fog results, (ASTM B117[6]) and humidity results (ASTM D1748[7]). ASTM B117 tests products in a 5% NaCl salt fog chamber with continuous exposure. ASTM D1748 tests products in a 120F, 95% relative humidity chamber with continuous exposure.

Each coating was applied on cold rolled steel (CRS) panels (SAE 1010) obtained from an industry supplier of test panels. The panels provided are pre-cleaned test panels which are ready to use without any additional surface preparation required. In some case, coatings were applied to actual parts provided by customers. Dry film thicknesses (DFTs) were according to mfg's recommendations (Figure 3, 4, 5 & 6).

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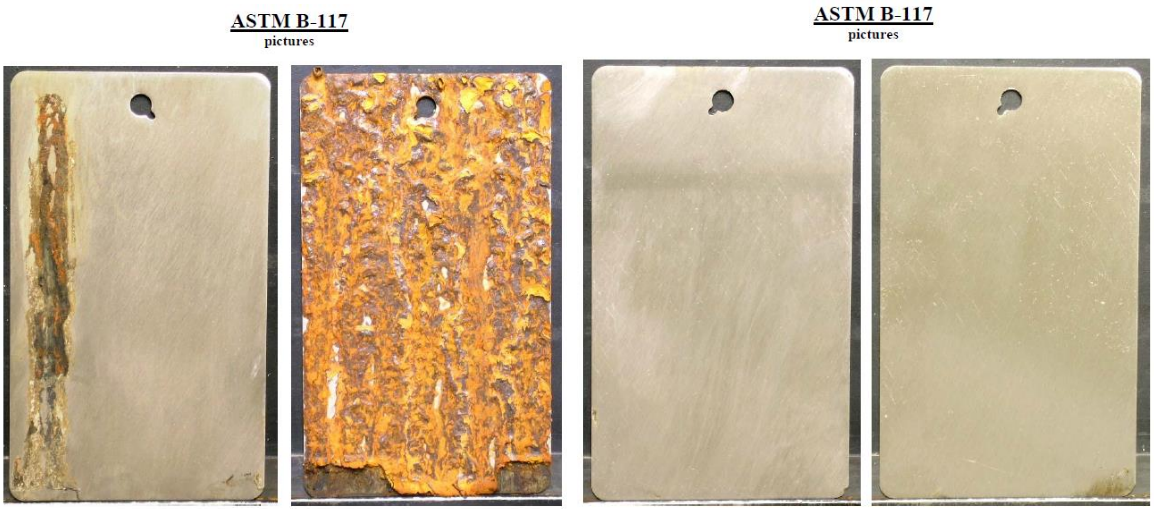
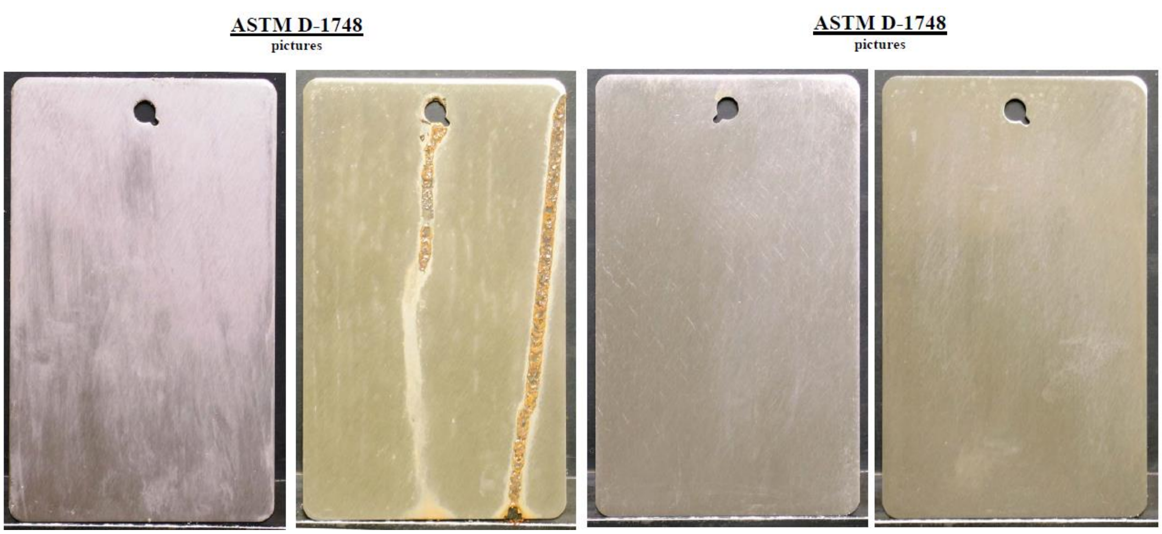
Salt Spray Testing for solventborne wax coating with and without VCI inhibitors



350 Hours	50 Hours	400 Hours	> 400 Hours
Without VCI(A)	Without VCI(B)	With VCI(A)	With VCI(B)

Figure 3

Humidity Testing for solventborne wax coating without and with VCI inhibitors



3170 Hours	1100 Hours	>3170 Hours	> 3170 Hours
Without VCI(A)	Without VCI(B)	With VCI(A)	With VCI(B)

Figure 4

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Salt Spray(ASTM B117) Testing for Various Systems(600 hrs)

A	B	C
Solventborne Coating without VCI	Solventborne Coating With VCI	Waterborne Coating With VCI

Figure 5

Humidity Testing for solventborne wax coating and waterborne wax coating with VCI inhibitors(768 hours)

Figure 6

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This testing shows that waterborne systems can compete with solventborne systems thru the use of VCI inhibitors (Figure 5 & 6). However, there are some distinct advantages of using a waterborne system which include:

- More Environmentally friendly
- Lower VOCs
- Easier cleanup

Case History 1

PROBLEM

A manufacturer of large construction graders (Figure 7 & 8) needed an effective alternative to prevent corrosion on their products. There were several disadvantages to the Heavy Wax type product they were using. First, it did not always work if the equipment was stored outdoors for extended periods of time before shipping. Secondly, it left a greasy and slippery film on the graders, which made it difficult to climb into them for moving and shipping. Finally, the product was hard to remove and had to be disposed of as hazardous waste.


Figure 7 – Construction Grader

APPLICATION

The manufacturer sprayed the VCI containing coating and solvent in a 3:1 ratio on the equipment, which resulted in dry coat thicknesses between 0.8 and 1 mil (20-25microns). Then the machines were transported by rail to the seaports. A few of the graders were placed in containers, but the majority were left uncovered.


Figure 8 – Construction Grader

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The VCI containing coating at 1mil (25 microns) outperformed the traditional wax type coating at 3 mil (75 microns). The manufacturer also found VCI containing coating easier to spray, free of offensive odors and much easier to remove. After two years of export shipments they had experienced no corrosion problems when using the thinner film VCI containing coating.

Case History 2

PROBLEM
A manufacturer of industrial equipment (Figure 9 & 10) was struggling with protecting critically machined surfaces from corrosion and damage during transport. Due to the nature of the equipment, they were not able to deal with a spray application of a coating nor washing it down for removal.

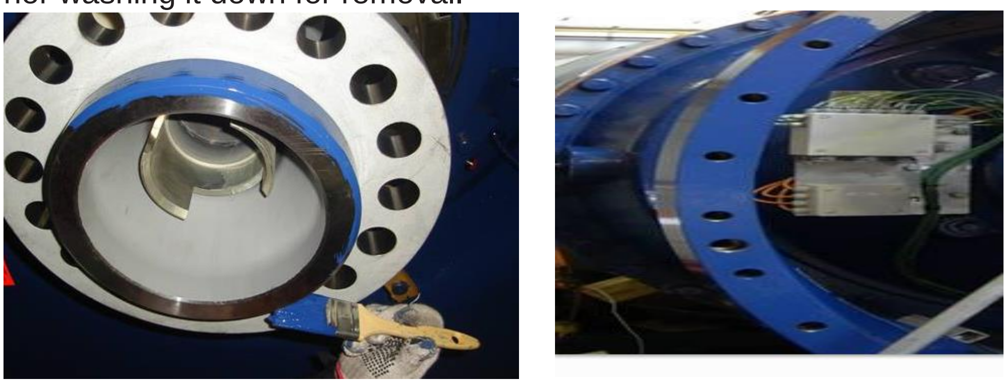

Figure 9 - Industrial Equipment

APPLICATION
The manufacturer brush applied the waterborne VCI containing coating onto the equipment, which resulted in dry coat thicknesses between 2-10 mil (50- 250 microns). The equipment was transport to the final destination where the coating was removed by simply peeling it off.

Figure 10 – Industrial Equipment

Conclusion

There is a need in the market place, for environmentally friendly, low VOC, removable coatings that can be applied at a thin film thickness (1.0 mils) which provide adequate corrosion protection and yet can still be easily removed. Compared to permanent

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coatings where removal requires blasting or the use of heavy duty solvents, or thick heavy barrier type wax coatings which are difficult to remove and dispose of, many removable thin film coatings with VCI technology can be easily removed using an alkaline solution and high pressure water.

In offshore oil and gas applications where the preservation of critical spare parts, or structures in a very severe environment is critical, these coatings can save customers from costly downtime of their equipment.

This paper shows, through research, that systems enhanced with VCI inhibitors can greatly improve the corrosion resistance of both solvent and waterborne coatings. In addition, waterborne coatings with VCI inhibitors can compete from a performance aspect with solventborne systems, while at the same time being more environmentally friendly, easier to cleanup and lower in VOCs.

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