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

Markus Bieber, *Cortec Corp., St. Paul, Minnesota, USA*

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 phase corrosion inhibitor (VCI) technology to be incorporated into temporary coatings that 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 VCI 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.

Vapor phase corrosion inhibitors (VCIs) are a corrosion inhibitor technology that is comprised of very small particles that are attracted to a metal substrate. They come in various formulations that 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 that provide protection in ferrous, nonferrous, or multi-metal applications. Other variables include the amount of vapor phase compared to contact phase inhibitors.

How VCIs Work in a Coating

VCIs are formulated into a coating through a complex development process that 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. VCIs work by adsorbing onto the metal surface in a nonreactive attractive capacity; in other words, they are attracted to the metal through the particle charge.[1]

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.[2-3] This is illustrated in Figures 1 and 2.

Types of Coating Systems That 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 that 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.

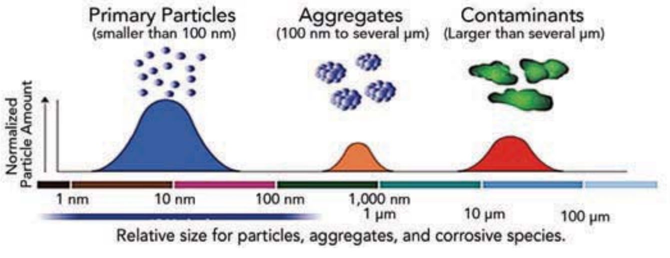

FIGURE 1 VCIs provide more complete coverage and protection of a surface than traditional inhibitor systems.[4]

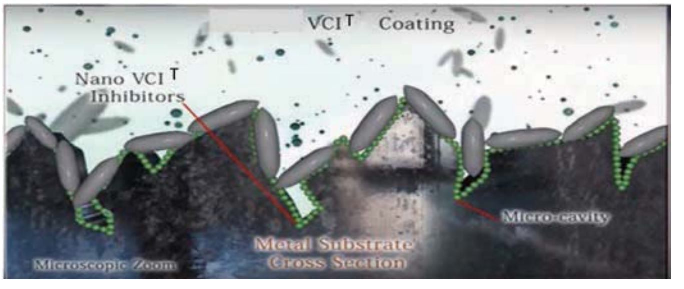

FIGURE 2 The larger platelets are representative of traditional inhibitors that are unable to fill the micro-crevices, leaving gaps where corrosion can start and/or grow.[5]

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 nontoxic, 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 to 20%), sprayed or brushed onto the coated surface, and allowed to dwell for a period of 5 to 15 minutes. The coating is then removed using a hot water wash (120 to 180 °F [49 to 82 °C]).

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% sodium chloride (NaCl) salt fog chamber with continuous exposure. ASTM D1748 tests products in a 120 °F, 95% relative humidity chamber with continuous exposure.

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

ASTM B117 ASTM B117

350 h Without VCI (A) | 50 h Without VCI (B) | 400 h With VCI (A) | >400 h With VCI (A)

FIGURE 3 Salt spray testing for solvent-borne wax coating without and with VCIs.

ASTM C1748 ASTM C1748

3,170 h Without VCI (A) | 1,100 h Without VCI (B) | >3,170 h With VCI (A) | >3,170 h With VCI (A)

FIGURE 4 Humidity testing for solvent-borne wax coating without and with VCIs.

A Solvent-borne coating without VCI | B Solvent-borne coating without VCI | C Waterborne coating with VCI

FIGURE 5 Salt spray (ASTM B117) testing for various systems (600 h).

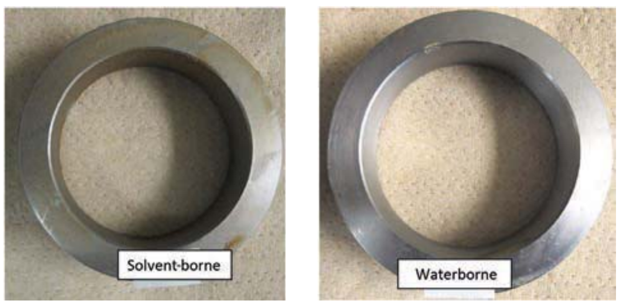

FIGURE 6 Humidity testing for solvent-borne wax coating and waterborne wax coating with VCIs (768 h).

FIGURE 7 Construction grader.

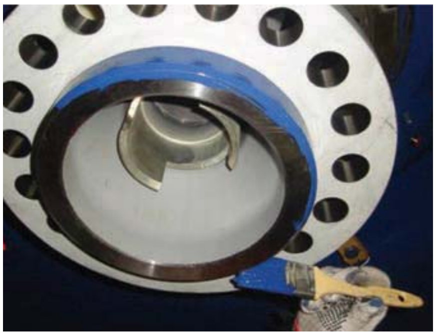

FIGURE 8 Industrial equipment.

This testing shows that waterborne systems can compete with solvent-borne systems through the use of VCIs (Figure 5 and 6). However, there are some distinct advantages for using a waterborne system, which include:

- More environmentally friendly
- Lower volatile organic compounds (VOCs)
- Easier cleanup

Case History 1

Problem

A manufacturer of large construction graders (Figure 7) needed an effective alternative to prevent corrosion on its products. There were several disadvantages to the heavy wax-type product it was using. First, it did not always work if the equipment was stored outdoors for extended periods of time before shipping. Second, 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.

Application

The manufacturer sprayed the VCI-containing coating and solvent in a 3:1 ratio on the equipment, which resulted in DFTs between 0.8 and 1 mil (20 to 25 µm). 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.

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

Case History 2

Problem

A manufacturer of industrial equipment (Figure 8) was struggling with protecting critically machined surfaces from corrosion and damage during transport. Due to the nature of the equipment, it was not able to deal with a spray application of a coating nor washing it down for removal.

Application

The manufacturer brush-applied the waterborne VCI-containing coating onto the equipment, which resulted in DFTs between 2 to 10 mils (50 to 250 µm). The equipment was transported to the final destination where the coating was removed by simply peeling it off.

Conclusions

There is a need in the marketplace for environmentally friendly, low VOC, removable coatings that can be applied at a thin film thickness (1 mil) that provide adequate corrosion protection and yet can still be easily removed. Compared to permanent coatings where removal requires blasting or the use of heavy-duty solvents, or thick heavy barrier-type wax coatings that 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 article shows, through research, that systems enhanced with VCIs 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 solvent-borne systems, while at the same time being more environmentally friendly, easier to clean up, and lower in VOCs.

References

1. Y.I. Kuznetsov, et al., "Inhibiting Action and Absorption of Beta-Aminoketones on Metals," *Zasshchita Metallov* 32, 5 (1996): pp. 528-533.
2. C.W.Lea, FUCHS Lubricants, 2003 National Corrosion Service.
3. S. Prabhu, "Temporary Corrosion Protection during Storage, Transportation and Handling" (2016).
4. B. Bavarian, B.A. Miksic, "Influence of Crystalline Structure and Particle Size of Vapor Corrosion Inhibitor Powders on Their Inhibiting Effectiveness," CORROSION 2016 Research Symposium, Vancouver, BC, Canada.
5. B.A. Miksic, "Use of Vapor Phase Inhibitors for Corrosion Protection of Metal Products," CORROSION/83, paper no. 308 (Houston, TX: NACE International,1983)
6. ASTM B117-16, "Standard Practice for Operating Salt Spray (Fog) Apparatus" (West Conshohocken, PA: ASTM International, 2010).
7. ASTM D1748-10, "Standard Test Method for Rust Protection by Metal Preservatives in the Humidity Cabinet" (West Conshohocken, PA: ASTM, 2010).

This article is based on CORROSION 2018 paper no. 10566, presented in Phoenix, Arizona, USA.

MARKUS BIEBER is the director of sales—High Performance Coatings & Additives at Cortec Corp., St. Paul, Minnesota, USA, email: mbieber@cortecvci.com. He has spent more than 20 years in product and sales management in the coatings industry, with a focus on providing customers with value-added coating solutions. He is a member of NACE International. MP