In the sample on the left, vapor corrosion inhibitor protects the metal below the surface of the water as well as the metal in the void space above the water. By contrast, no corrosion protection is used in the water or void space of the sample on the right.

Working with Suppliers to MINIMIZE CORROSION Between Manufacturing and Installation

An appropriate protection plan based on the expected corrosion threat should be adopted.

By Julie Holmquist and John Wulterkens, Cortec Corp.

Heat exchangers, boilers and other water-contacted vessels are integral parts of many industrial plants. Often, when people think of protecting these components from corrosion, their minds fast-forward to corrosion issues that occur after the equipment is installed. Corrosion protection prior to installation can be just as important, however, especially in situations where the equipment will experience prolonged storage or outdoor exposure.

Corrosion that occurs before installation can have a negative impact for both the manufacturer and the end user. Corroded equipment either will need to be repaired or replaced to avoid future clogging and malfunctions. If the equipment is corroded when it arrives at its destination, responsibility to correct the problem likely will fall on the manufacturer. This can lead to delays for the end user and possible tension between the two parties. If corrosion occurs during storage at the processor's facility, the end user will have to absorb labor-time and material costs to remedy the problem.

Industrial facilities can avoid both scenarios and begin operations corrosion-free by working with their suppliers to ensure proper protection is implemented from the start.

Evaluating the Level of Corrosion Risk

Before implementing a corrosion plan, the end user should evaluate the nature and the potential for corrosion by asking the following questions:

- Will the vessel be hydrotested, either at the manufacturing or installation site?
- Where and how long will the vessel be stored?
- What will shipping conditions be like?

The risk for corrosion is heightened any time the equipment is exposed to moisture, fluctuating temperatures, high humidity, sea spray and other corrosive elements. This can occur when equipment is hydrotested, transported overseas, shipped through winter conditions or tropical climates, or stored outside and subject to changing ambient conditions. The longer the equipment remains in these conditions, the greater the risk. An appropriate protection plan based on the expected corrosion threat can be adopted depending on the risks identified.

Minimizing Corrosion from Hydrostatic Testing

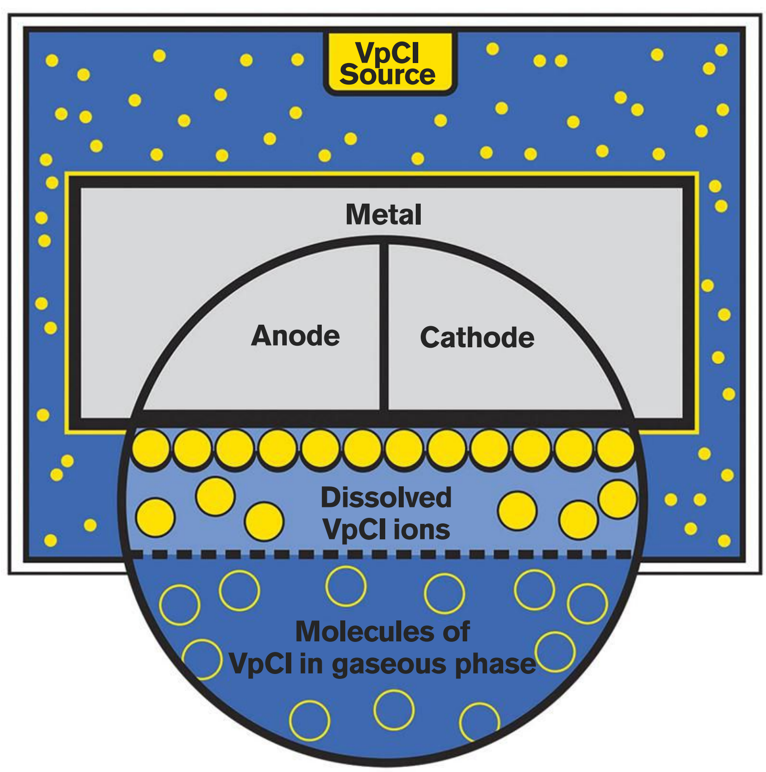
Vessels like boilers, heat exchangers and related piping — those that are designed to hold fluids — must be hydrostatically tested to check for leaks. This may be done at either the manufacturing or installation stage — or both. Hydrotesting introduces moisture into the system as an unfortunate side effect. This increases the potential for corrosion during and after hydrotesting, especially from any water that may not be fully drained out.

Corrosion inhibitors such as an amine-carboxylate-based material can be used to mitigate the potential for corrosion due to hydrotesting. Such materials may contain a mixture of film-forming contact and vapor corrosion inhibitors (VCIs). Materials with a dual protection mechanism can help inhibit corrosion to the metal surfaces directly in contact with the hydrotest water as well as any voids or air pockets above the surface of the water. The inhibitor forms a thin film that persists after the hydrotest water is drained.

Providing Void-Space Protection

Depending on the degree of protection required, vapor corrosion inhibitors like those found in certain hydrotesting additives also can be used to protect void-space internals. These can be used whether or not a hydrotest additive has been used.

In these applications, protection can



Vapor corrosion inhibitor technology releases vapors that disperse throughout the equipment to be protected and fill void spaces. The corrosion protection materials form a protective molecular layer on metal surfaces inside the enclosure.

A vapor corrosion inhibitor packaged in a water-soluble pouch provides dry internal protection to boilers. Such materials typically can be left to dissolve inside the boiler when it is refilled.

be accomplished either by fogging internal void spaces with waterborne vapor corrosion inhibitors or by inserting pouches of vapor corrosion inhibitors in powder form. To be effective, the entire vessel must be enclosed to keep the vapor corrosion inhibitors from dispersing into the external atmosphere. The inhibitors readily vaporize and spread out until they fill an enclosed space, conditioning the environment with corrosion inhibitors. The corrosion inhibitor molecules adsorb, or "stick," to the metal surfaces to form a protective molecular layer that interferes with normal corrosion processes.

When it is time to install the equipment, this vapor mechanism simplifies removal. Opening the previously enclosed area allows the vapor corrosion inhibitors to leave the surface of their own accord when the space is no longer enclosed.

To apply, one option is to fog vapor corrosion inhibitors lightly into void spaces via a waterborne carrier. To improve the circulation and reach of the corrosion inhibitors, especially when dealing with piping, a fan sometimes is placed at the other end of the void. This helps promote airflow and helps draw the corrosion inhibitor through. After fogging, as with the pouches, all openings should be capped. The user should always confirm the compatibility of the system with the waterborne vapor corrosion inhibitor. But, in many cases, the chemistry is compatible and does not need to be flushed before commissioning.

Vapor corrosion inhibitor powders provide a means of dry protection. In this case, the breathable or water-soluble vapor corrosion inhibitor pouches are placed inside the equipment and close the openings. The number of pouches is dosed based on the volume of the void space being protected. The type of pouch used depends on the types of metals involved. Some vapor corrosion inhibitors are designed only for protecting steel, making them appropriate for boilers. Other materials provide protection for yellow metals, making them suitable for heat exchangers and related piping systems that may contain copper components or brass valves. To simplify removal, users sometimes tie the pouches onto a string and thread them through the internals or piping. When the protection period has ended, all that is needed is to pull out the string of pouches — no further removal required.

Some vapor corrosion inhibitors packaged specifically for boiler protection are supplied in water-soluble pouches. To apply these materials, the water-soluble packaging should be slit open to allow the vapor corrosion inhibitor molecules to vaporize and condition the environment. Often, when the protection period has ended, and the boiler goes online, this type of pouch can be left inside the boiler. As the boiler fills with water, the water-soluble pouch dissolves, and any remaining vapor corrosion inhibitors circulate throughout the boiler for additional protection.

Protecting Equipment Externals

Protecting the outside of boilers and heat exchangers also is important, especially if the components will be stored outdoors or transported through harsh environments. In these cases, vapor corrosion inhibitor film provides a physical barrier from the elements in addition to forming a molecular corrosion-inhibiting layer on the metal surface.

The strength, thickness and other characteristics of the film such as ultraviolet protection should be selected based on the severity of the conditions. The film can be shrink-wrapped to fit the contours of the equipment. Shrink wrapping also serves a second purpose of creating an enclosed space for vapor corrosion inhibitor protection.

Vapor corrosion inhibitors in breathable pouches are designed to protect both ferrous and yellow metals. They can be installed and removed by tying them onto a string before placing them inside the equipment.

Examples of Equipment Preservation

One example of vapor corrosion inhibitors protection in action comes from a private turbine plant in Russia. Corrosion was causing damage after hydrotesting on heat exchange internals. Another issue was the expense of the metal packaging used to protect the equipment during an aggressive shipment stage. The problems were solved by implementing a vapor corrosion inhibitor hydrotesting additive and shrink-wrapping the equipment with vapor corrosion inhibitors UV-resistant film.

Another situation used a slightly different method of protection for newly manufactured heat recovery steam generator tube bundles in the Middle East. Again, the internals needed protection, and a vapor corrosion inhibitor additive was used during hydrotesting. The system was subsequently drained and air dried. For additional protection, a vapor corrosion inhibitor powder was fogged into the coil bundles. This provided a low maintenance protection system and provided an alternative to more costly methods of protection.

As these examples show, there are multiple ways to use and combine vapor corrosion inhibitor protection methods. The level and type of protection should be decided based on the expected environments and duration in those environments. **PC**

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