Water Treatment Applications

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The direct cost of atmospheric corrosion in metals and alloys is an estimated $5 billion annually. The volatile corrosion inhibitor is one weapon for combatting such damage that has recently gained favor in the chemical processing industry.

Volatile corrosion inhibitors (VCIs) condition air or other gaseous environments with trace amounts of inhibitive material to achieve the protective effect. Classic methods of protection involve changing an alloy's composition, changing the environment, or using contact inhibitors. In some instances, these measures may prove impractical because of cost, limited accessibility, risk of contamination, or simply the inability to provide good protection.

VCIs can be used in applications such as air spaces above liquids, condensers, cooling towers and boilers during shutdown or standby, crude oil pipelines, closed-loop cooling systems, open loop cooling systems, brine systems, vessels and other equipment during storage, instrumentation, and control-room equipment.

Water Treatment Applications

In the water treatment industry, the newly developed treatment programs are ambiotic and show inhibition at cathodic and anodic sites. These treatment programs provide three levels of corrosion protection:

1. In the water phase.
2. At the water-air interface.
3. In the air (vapor) phase.

VpCIs are compatible with boiler water and cooling water treatment chemicals. They are used in operational, standby, and laid-up cooling towers as well as closed-loop systems.

VpCIs control corrosion in the multiple phase flow regimes found in oil and gas pipelines and other process equipment.

VpCI building blocks and additives for the water treatment and process industry provides a unique ability to protect in three phases. Incorporating these building blocks and additives into the different formulations used in these industries allows multi-phase, multi-metal protection (Figure 1). These building blocks can be incorporated into cooling tower, closed loop cooling systems, and boiler treatment programs.

BOILER SHUTDOWNS (SEASONAL/LONG-TERM LAY-UPS)

The traditional approach for dry lay-up involves two main processes:

1. Nitrogen gas blanketing.
2. The use of desiccants that must be maintained during the lay-up period and removed prior to boiler start-ups.

The traditional methods for wet lay-up involve:

- Use of oxygen scavengers.
- Alkaline chemicals for pH >10.
- Use of dispersants and/or antiscalants.
- Use of dicyclohexylammonium nitrite and diisobutylammonium sulfate.

These chemicals are the source of hydroxide ions and use neutralizing inhibitors to neutralize hydrogen ions in the environment. They become volatile only in contact with steam. Examples of neutralizing inhibitors are cyclohexylamine, diethylaminoethanol, morpholine, etc. These compounds are not considered VpCIs since, at use concentrations, they need steam to volatilize. The disadvantage of using silica gel or other desiccants is that once they are saturated with moisture (H_2O), they will release the moisture and create a corrosive environment. Desiccants do not protect against corrosion directly but they do eliminate moisture and pro-

vide indirect protection. Oxygen scavengers are not recommended for long-term protection. They neither prevent oxygen ingression nor protect surfaces out of contact with the solution. Moreover, these solutions must be replenished with time, requiring manpower to check levels periodically.

COOLING TOWER SHUTDOWNS (SEASONAL/LONG-TERM LAY-UPS)

The traditional approach to seasonal cooling tower lay-up includes wet lay-up (in places where the temperature does not drop below freezing) and dry lay-up.

Conventional seasonal lay-up programs often use an oil-based product that does not apply evenly. They can foul equipment, posing a tough challenge for disposal. This practice is environmentally unsound. Another problem with oil-based products is they react with rubbers in the system and with roof tars. Oil-based products are a good source of nutrients for various kinds of bacteria, including anaerobic bacteria. This situation promotes microbiological growth in the cooling tower system and bacterial corrosion.

The major shortcoming of conventional lay-up products is that they are strictly contact corrosion inhibitors—they can only protect the parts of the system that they contact. The overhead spaces, crevices, and other hard-to-reach spaces remain unprotected. These areas tend to corrode during downtime because they lack protection. For all of these reasons, a thorough cleaning of the system must be performed before returning the tower to normal usage.

The VpCI Difference

The new method for laying up boilers and cooling towers uses a unique blend of VpCI compounds and contact corrosion compounds in convenient water-soluble polyvinyl alcohol (PVA) bags. The application includes the following steps:

BOILER LAY-UP

Dry Lay-Up

1. After the boiler has cooled down and is safe to enter, the PVA bags are slit open and placed inside the boiler. One bag protects up to 1,000 gal (3,785 L) of void (135 ft^3 [3.8 m^3]) including the surface area of tubes.

2. Close the openings (manholes, etc.).

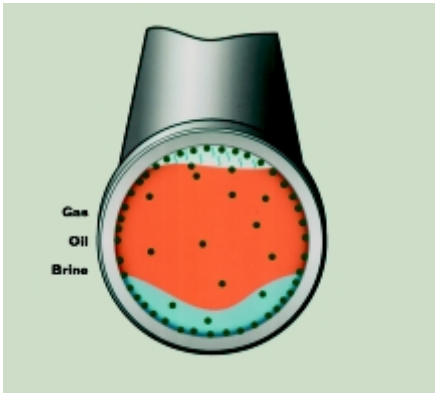
Wet Lay-Up

1. Dissolve VpCIs in water (after it is <60°C) and circulate the water for 4 to 5 h.

2. The boiler does not need to be filled completely to protect various void areas because of the migrating nature of the VpCIs.

The VpCIs will reach equilibrium in the void space and protect the metal in the system. These products' performance can be evaluated with corrosion coupons.

FIGURE 1



Pipeline section shows active VCI protection at the liquid phase, the vapor phase, and the interface.

COOLING TOWER LAY-UP

Cooling tower lay-up is also conveniently achieved with the help of VpCIs. The towers can be laid up in the following fashion with the help of specially formulated VpCIs in water-soluble PVA bags.

Flushing Lay-Up:

- Place bags into cooling water and circulate the water for 6 to 10 h.
- Drain the treated water and lay-up the tower.

Wet Lay-Up

- Place bags into cooling water and circulate the water for ~6 to 10 h.
- Lay-up the tower with the treated water.

One carton of VpCI water-soluble bags treats up to 1,000 gal of cooling water (or space). VpCIs are compatible with all nonoxidizing biocides. When using oxidizing biocides, it is necessary to be careful and keep the free chlorine levels in check (under 4 ppm) or use a higher concentration of VpCIs.

Advantages

VpCIs have the unique ability to control corrosion in a water treatment system. VpCIs distinguish themselves from conventional contact corrosion inhibitors since they provide:

- Protection in three phases: vapor phase, liquid phase, and liquid-vapor interface (Figure 1).
- Biodegradable and environmentally friendly solutions free of nitrites, phosphates, chromates, and heavy metals.
- Economical solutions for protecting cooling towers, closed-loop systems, and boilers during the interim period, seasonal lay-ups, or long-term lay-ups.
- Economical solutions for niche applications that require vapor phase protection.
- Protection in the presence of moisture and other corrosive environments by forming a corrosion-inhibiting monomolecular layer on the metal itself.
- Cost savings by eliminating the use of expensive cleaning chemicals.
- Increased worker safety and efficiency because of the nontoxic, nonhazardous nature of the products packaged in convenient water-soluble bags.
- Easy startups at the end of the lay-up period with no cleanup required.

Conclusion

VpCI solutions include building blocks (liquid and powder) for formulations, dry and wet layup for cooling towers and boilers, corrosion additives for closed-loop and open loop systems, fire sprinkler systems, antifreeze coolants, and much more.

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