# Vapor Tales

## Protecting Pipelines Using Vapor Phase Corrosion Inhibitors

By Jim Holden, Julie Holmquist and Eric Uutala

A recent study from the U.S. Department of Transportation found that between 2006-2010, almost a fourth of significant onshore hazardous liquid pipeline incidents were caused by corrosion, along with a fifth of significant gas transmission pipeline incidents. According to "The State of the National Pipeline Infrastructure," released by the Pipeline and Hazardous Materials Safety Administration (PHMSA), 4 percent of significant distribution system incidents during 2008-2010 were blamed on corrosion.

These statistics only begin to highlight the importance of protecting gas and oil pipelines from the corrosion failures that can result in expensive repairs, pipeline failure or even loss of life.

### Inevitable Problem

Pipeline corrosion is inevitable and immediate. The question is how long it will take before the corrosion will eat away enough of the piping to cause a problem. Many factors play into the equation of whether a pipeline will have corrosion problems in five, 10 or 20 years. This depends on the corrosiveness of the pipeline fluid, the thickness of the pipe and the level of corrosion protection.

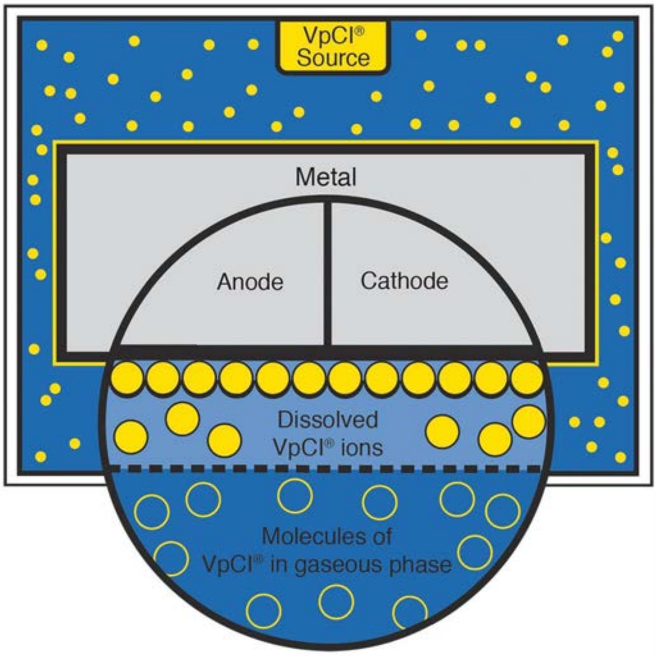
An excellent method for fighting costly corrosion issues and encouraging the longest possible service life is the use of Vapor phase Corrosion Inhibitors (VpCIs). VpCIs are able to perform beyond traditional methods of corrosion protection because of their ability to work effectively in the liquid phase, vapor phase and at the sensitive liquid-vapor interface. They are also adaptable to multiple application methods including fogging, painting, hydro-testing, injection under insulation, injection into flow streams and more.

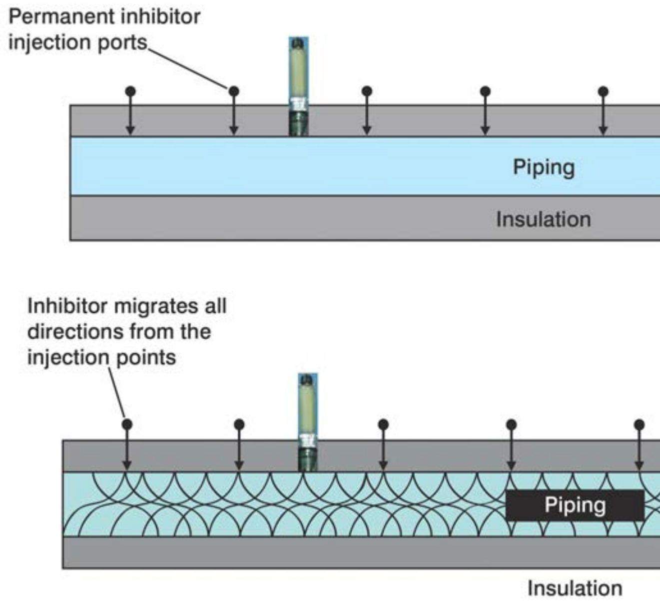
VpCI technology works by emitting a vapor from the VpCI source, whether applied in a powder, liquid or other form. When this vapor reaches a metal surface, it condenses and adsorbs — or forms a monomolecular protective layer — on the metal surface. This layer is highly hydrophobic and protects the metal from the attack of corrosive agents like moisture. It also neutralizes the electrical surface potential of the metal so that oxygen cannot interact with the metal to create a corrosion initiation site. An added benefit is that many VpCI applications have a self-replenishing capability, where new VpCI ions flow in to replace others that might be knocked away by scratching or marring of a protected surface. In the case of coatings, these VpCIs inhibit corrosion from creeping from areas of coating damage to the surrounding metal.

### Pipeline Issues: Construction, Post-Construction, Operation

Corrosion precautions must be taken even prior to pipeline construction. While PHMSA requires that steel piping installations in the U.S. be externally coated for corrosion inhibition and also protected cathodically, internal protection can fall by the wayside.

Manufacturers may face problems simply getting the piping to the field without internal rust. Historically, pipe internals have been protected with heavy, wax based coatings, if they are treated at all. While these coatings can work, they need to be coated on all metal surfaces to be effective. Further, they are difficult to remove, when the pipe system gets commissioned. Conversely, VpCIs disperse and coat all internal metallic surfaces with a monomolecular protective layer. VpCI in powder or liquid form can be applied by fogging and left inside the pipes




until they are installed.

After a pipe is installed below or above ground, it is flushed and hydro-tested for leaks. This is normally done with untreated water, leaving the pipe in a damp condition that can lead to rusting. In this case, VpCIs can be incorporated directly into the hydro-testing water (whether salt or fresh) so that the pipe internals are protected during and after the hydro-testing process.

Once a pipe is in operation with fluids running through it, the main concern becomes top of the line corrosion. Less corrosion will occur in areas of the pipe where the fluids are flowing, but the void space at the top of the pipe is left vulnerable to a mixture of moisture, air and corrosive gases that encourage corrosion. Though some pipelines may use no corrosion control at all, even traditional contact corrosion protection is limited because it is carried through the fluid and can only protect surfaces in direct contact with the fluid in the pipe. In contrast, VpCIs have the flexibility of working in the vapor phase as well as the liquid phase. They can also provide protection to the critical liquid-vapor interface where it is difficult to provide continuous corrosion protection.

Another corrosion trouble spot is pipeline crossings, where pipes run through an extra casing that is intended to allow better pipe access but that tends to promote corrosion in the annular space between the internal and outer pipe. VpCI filling can be used to enhance the effect of cathodic protection in this situation and even reduce its need.

A pipeline rupture at any of these locations could be disastrous in terms of public safety alone. Add to this the potential costs of replacement, downtime and environmental cleanup, and then investment in corrosion inhibitors produces a significant return on investment.

## Facility Issues: Equipment, CUI, Storage Tanks

Pipelines cannot function without periodic pumping stations and production facilities located along their route. These structures face corrosion problems common for many industrial facilities. Pumping stations operate with standard equipment such as pumps, turbines and motors. Equipment like this can experience external corrosion where paint is chipped off or never existed or where corrosive elements exist within a lubricating system. Corrosion in these locations poses serious loss through increased downtime and maintenance costs. Many of the same issues can occur at production facilities, and they also stand to benefit from the many available forms of VpCI protection, such as coatings, additives and powders.

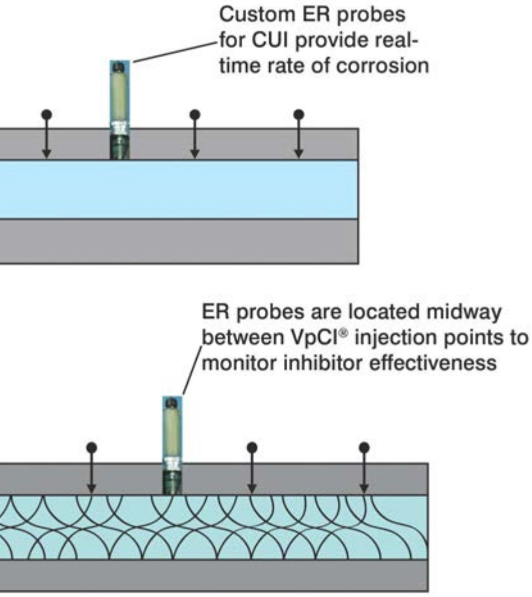
Another significant problem in the petrochemical industry is corrosion under insulation (CUI). Plants often contain pipes carrying extremely high or low temperature fluids, and these pipes must be insulated for the safety of plant personnel. Unfortunately, this is a corrosion-promoting trap, where moisture easily finds its way below the insulation's surface to start the corrosion process. The insulation in turn hides what is happening, making corrosion difficult to detect. As another testament to the flexibility of VpCI application, this situation can be treated by injecting VpCI right through the insulation and installing a corrosion detection system to monitor the pipe's condition.

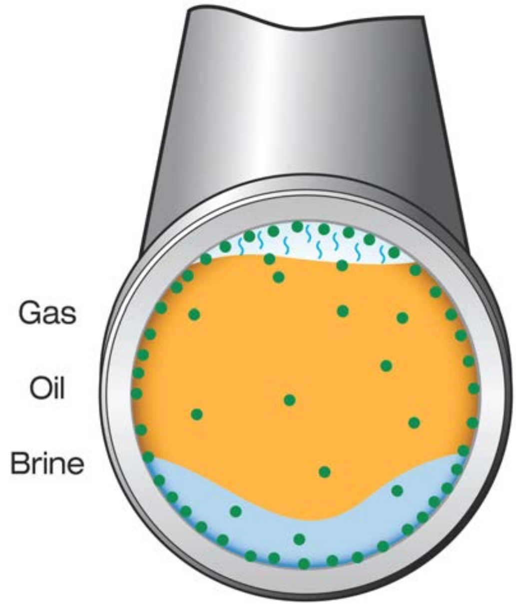
Oil and gas processing facilities naturally contain many storage tanks, which can be at risk for corrosion on tank bottoms. Though cathodic protection can be used and a corrosion rate monitoring system installed beneath the unseen storage tank floor, this method has limitations. Injecting VpCI slurry in the space below tank bottoms provides enhanced protection as its vapor is allowed to spread out and protect surfaces that cathodic protection cannot reach.

## Conclusion

While corrosion in gas and oil pipelines and facilities is an inevitable threat, it is also very treatable. VpCI technology offers superior protection adaptable to many pipeline features, protecting areas not reached by traditional corrosion inhibitors and supplying more continuous protection where cathodic protection fails.

When weighing protection costs vs. benefits, it is important to consider that the total cost of pipeline failure is several magnitudes higher than the cost of prevention. Included in the costs of failure are unplanned downtime, labor costs for replacing the failed pipe or equipment and environmental contamination costs. When these liabilities come into play, and when considering that VpCI protection of an entire plant can cost less than traditional protection of one component, the use of VpCI protection becomes very attractive and logical.




Pipeline section showing active VpCI® protection in the interface, liquid phose, and vapor phase.

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