White Paper

Chemical Corrosion Inhibitors - Six Reasons Why They Should Not Be Used in Water Based Fire Sprinkler Systems
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Introduction

As the installed water based fire sprinklers in the US continue to age, many systems begin to experience pinhole leaks caused by corrosion on the internal surfaces of the piping. The current state-of-the-art[1] research regarding corrosion in fire sprinkler systems suggests that the primary cause for these corrosion related failures is dissolved oxygen in the water. Although microbiologically influenced corrosion (MIC) can be a contributing factor, there is strong empirical evidence gathered by two independent firms[2] who have investigated actual fire sprinkler pipe failures which indicates that MIC accounts for less than 15% of the corrosion related failures. Oxygen corrosion accounts for the vast majority of corrosion related pipe failures.

In other industries, e.g. industrial process water treatment and oil and gas production, it is common to use water dispersible "filming amine" type chemical corrosion inhibitors to control oxygen corrosion in fresh water flowing environments. This approach achieves corrosion control through continuous low dosage injection of the inhibitor into the flowing stream of water. A thin inhibitor film protects the metal surface by forming a barrier which inhibits the action of oxygen on the metal. Any rupture or breach of the inhibitor layer on the metal surface is "repaired" by maintaining a threshold level of chemical in the water stream. As the inhibitor moves past the breach, new molecules are attracted to the exposed metal surface to repair the film.

The standard list of chemical corrosion inhibitors that provide excellent corrosion control in fresh water flowing environments have a much more difficult task in controlling corrosion in water based fire sprinkler systems. The following discussion proposes six reasons to consider before putting chemical corrosion inhibitors into a fire sprinkler system.

Reason No.1: Backflow Device Upgrade Required

In the US, the vast majority of water based fire sprinkler systems are connected to the local municipal water supply. The point of connection is typically equipped with some form of backflow prevention device that prevents possible cross contamination of the municipal water supply with fire sprinkler system water. In many jurisdictions, the use of **any chemical additive** to the fire sprinkler water will require a default upgrade of the backflow prevention device from a double-check type device to the more sophisticated and costly reduced pressure zone (RPZ) type device. Authorities Having Jurisdiction (AHJs) are acting in the best interest of the public to require this modification given the fact that many of the chemical corrosion inhibitors that are being applied in the field utilize the standard list of amine, alkyl amine or quaternary amine chemistries that are inexpensive and widely available for other industrial uses. At typical use concentrations, most of these type chemicals are toxic and the focus on backflow prevention is rightfully elevated to a top priority.

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Upgrading a backflow prevention device can be a very expensive proposition especially for those property owners located in climates where winter temperatures require burying the connections in underground vaults. The cost for labor and materials required to perform the upgrade can be very significant.

Reason No.2: Risks Managing Toxic Chemicals

Each time a wet pipe fire sprinkler system is taken out of service to allow for work to be performed on the system, the chemically treated water must be **discharged**. This means that fire sprinkler water that has been chemically treated is drained onto the ground, into a storm sewer, into a private waste water treatment facility or into a municipal waste treatment facility. The recommended treatment dosage for several of the chemical corrosion inhibitors being used today range from 5000 parts per million (0.5%) up to 10,000 parts per million (1.0%).

Claims of low toxicity, biodegradability or “green” chemistry are usually not backed up by the chemical supplier with documented rigorous scientific verification of the low toxicity claims. However, even if the chemical corrosion inhibitors do degrade over time, several key questions must be considered relative to degradation or deactivation:

- Under what conditions will the chemical degrade, e.g. exposure to sunlight?
- How long does degradation of the treated fire sprinkler water take?
- What chemical products are left after the chemical degrades?
- Would the local municipality allow for surface discharge of the treated fire sprinkler water if they knew it was to be discharged?
- If the water is to be discharged to the municipal sewer, what are the limits of concentration for the chemical in the discharge water that will be acceptable by the waste water handling entity?

In most cases these questions have never been properly addressed. Building owners and fire sprinkler contractors may be liable for the unintended consequences. As the construction industry moves toward lower impact, greener approaches, the use of “chemicals” in fire sprinkler systems would appear to be contrary to those overarching objectives.

Reason No.3: Expense of the Chemical Injection System

Providers of chemical corrosion inhibitors for fire sprinkler systems invariably require fairly complicated and expensive chemical injection systems to apply and maintain the chemical treatment. Chemical injection systems provide the following functions:

- Metered chemical delivery pump tied to the fire sprinkler system flow switch

- Chemical injection line and injection port into the fire sprinkler system riser
- Reservoir and spill containment for the chemical corrosion inhibitor
- Low chemical reservoir level alarm

Several of the chemical injection systems purport to “automatically” add the necessary chemical to treat any new water that enters the fire sprinkler system. However, fire sprinkler system flow switches DO NOT measure water flow rate, they simply indicate that water flow is occurring. In the standard design, flow switch activation results in new chemical corrosion inhibitor being added to the incoming water. Because flow rate is never really known, the exact dosage of chemical in the system is never really known. If the system is filled quickly it may end up under treated while a system that is filled slowly may end up over treated. After a system is filled, it is not uncommon to find that the inhibitor concentration can be different from one portion of the piping to another depending on where the water sample is captured. In the end the expensive metered delivery of chemical is going into a water stream of unknown volume. At best it can be described as a glorified “batch” treatment.

Reason No.4: Effectiveness of the Chemical in Controlling Corrosion

Formerly known as the **N**ational **A**ssociation of **C**orrosion **E**ngineers, NACE International is the leader in the corrosion engineering and science community and is recognized around the world as the premier authority for corrosion control solutions. NACE International has never prepared a standardized protocol for testing and applying chemical corrosion inhibitors in fire sprinkler applications. Most other industries develop highly sophisticated testing protocols to evaluate chemical corrosion inhibitors for their specific application. Within the fire sprinkler industry, there is no standard methodology, established by NACE or any other organization, for testing and comparing the overall efficacy of chemicals that are being used in the industry. At this point, suppliers are not required to prove that the proposed chemical corrosion inhibitor actually works in fire sprinkler systems.

From a corrosion control perspective, the standard wet pipe fire sprinkler system can be best described as “a long, narrow, stagnant pipeline containing varying levels of iron solids that periodically and regularly receives a fresh supply of oxygen as the corrosive gas.” This type system is difficult to treat for the following reasons:

- Insuring an even distribution of enough chemical to all of the exposed piping
- Choosing and maintaining the proper chemical dosage in the system
- Loss of chemical to solids that are trapped within the piping
- Treating new water that is added to the system
- Measuring the amount of chemical in the system

When it comes to water based fire sprinkler systems, the greatest risk for the owner and fire sprinkler contractor may be in assuming that the chemical corrosion inhibitor that has been injected into the fire sprinkler water is actually controlling corrosion. Unfortunately, if it takes 10 years for the “treated” system to fail, at which point it becomes apparent that the corrosion inhibitor did not do the job; the company that supplied the inhibitor may be long gone. The list of excuses as to why the chemical treatment failed could be endless.

Reason No.5: Compatibility Risks of the Chemical with Fire Sprinkler System Components

Before any chemical is proposed for incorporation in a water based fire sprinkler system, it must be tested for possible compatibility issues with the fire sprinkler components. Will the chemical cause the components to degrade or lose performance prematurely? Unfortunately, to this point chemicals have been indiscriminately added to fire sprinkler systems with no regard for the potential affect on the following components:

- Metal components – mild steel, galvanized steel, brass, copper
- Plastics – CPVC
- Elastomeric components in valves and sprinklers – Buna-N, natural rubber, Teflon
- Elastomeric gaskets in couplings – EPDM

In a worst case scenario after years of chemical exposure all of the gaskets might require replacement or the sprinklers themselves might start leaking. This is not to say it is inevitable, but the complete lack of compatibility data for chemical corrosion inhibitors poses significant liability risks for building owners and fire sprinkler contractors. At the very least, the fire sprinkler industry should require that all chemical corrosion inhibitors and interior pipeline coatings provide a time-aged compatibility matrix versus all of the most common fire sprinkler system components. Once again an industry standard for performance and comparison is sorely needed to ensure that the chemical treatment is not doing more harm than good.

Reason No.6 – Risks to Emergency Response Personnel and Property

What is the exposure risk of chemically treated fire sprinkler water for emergency fire response personnel? Is it okay to spray the chemically treated fire sprinkler water on your skin or in your eyes? What is the risk? What if the chemical treatment in the fire sprinkler water is accidently overdosed by the automatic chemical injection system? Is the exposure risk increased? At this point, none of the current chemical providers have answered these questions in enough detail to instill confidence.

One other consideration that can come into play regarding chemical corrosion inhibitors in fire sprinkler waters is the sensitivity of the property being protected by the fire sprinkler system. For example, there may be significant reluctance on the part of the proprietors in cultural resource settings to use any chemical additives that might permanently damage artifacts and other priceless antiquities. The same might be true in areas where sensitive manufacturing environments are being protected.

Once again, there is no standard for testing and performance and the liability seems to land again on the shoulders of the building owners and fire sprinkler contractors.

An Alternative Solution

All of the reasons that have been explored in this article pose real, quantifiable risks associated with using chemical corrosion inhibitors in water based fire sprinkler systems. It seems that one of the overarching assumptions tied to the use of chemicals for corrosion control is that the corrosive specie, in this case oxygen, is an unavoidable component of the system that is being treated. Quite the contrary is true. The amount of oxygen that is available for corrosion can be reduced dramatically by displacing the air with nitrogen gas so that the oxygen in the air cannot react with the piping.

Nitrogen inerting of the fire sprinkler piping by filling and purging with nitrogen gas may be the simplest, safest, most compatible remedy for controlling oxygen corrosion in water based fire sprinkler systems. Nitrogen gas is readily available, it is non-toxic and corrosion can be completely controlled under the inerted environment that is created when nitrogen gas is used to purge these systems of oxygen. When it comes to fire sprinkler systems, the more you understand corrosion, the more you appreciate nitrogen as the complete solution.

References

[1] "MIC is NOT the Primary Cause of Corrosion in Fire Sprinkler Systems" by Jeffrey Kochelek, ***Sprinkler Age Magazine***, October 2009.

[2] Internal results compiled for failed fire sprinkler pipe analyses over several years – internal research by Engineered Corrosion Solutions, LLC and discussions of evidence from FM Global.

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Engineered Corrosion Solutions, LLC is a corrosion management consulting firm that offers fire sprinkler system assessment and analysis coupled with design services and a full suite of corrosion management strategies that include equipment and integrated devices for controlling corrosion in water-based wet, dry, and preaction fire sprinkler systems. We understand the science of corrosion in fire sprinkler systems in a complete variety of different settings from parking structures to warehouses to clean rooms to data centers.

Engineered Corrosion Solutions, LLC offers proprietary dry pipe nitrogen inerting technology (DPNI) and wet pipe nitrogen inerting technology (WPNI), which includes the ECS Protector Nitrogen Generator, Pre-Engineered Skid Mounted Nitrogen Generator, Gas Analyzers, SMART Dry Vent, Two (2) Wet Pipe Nitrogen Inerting Vents and the industry's first real time in-situ corrosion monitoring device the ECS In-Line Corrosion Detector. Finally, we offer the first comprehensive remote corrosion monitoring system that provides live validation of the corrosion control strategy that is in place within your facility.

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