White Paper

Nitrogen Inerting Vs. Chemical Corrosion Treatment in Water-Based Fire Sprinkler Systems

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By Jeffrey T. Kochelek

Engineered Corrosion Solutions

Complete Corrosion Control.

Engineered Corrosion Solutions, LLC
11336 Lackland Road
St. Louis, MO 63146
314-432-1377
ecscorrosion.com

ECS Engineered Corrosion Solutions
ecscorrosion.com

In 2008 the state-of-the-art method for corrosion control in water-based fire sprinkler systems was to employ chemical injection systems to "chemically treat" the water. The widespread belief within the fire protection industry was that corrosive deterioration and leaks in sprinkler piping were caused by the bacteria that were found in all fire sprinkler systems. Microbiologically Influenced Corrosion (MIC) which describes the action of microorganisms to stimulate corrosion was thought to be the primary cause for pin-hole leaks.

In 2008 Engineered Corrosion Solutions published a break-through article that identified dissolved oxygen in sprinkler water as the primary cause of corrosion in water-based fire sprinkler systems[1]. The work identified MIC as a very minor contributor to the corrosion that was occurring.

Chemical Treatment for Corrosion Control

For chemical corrosion inhibitors to perform effectively the inhibitor must form a barrier on the surface of the metal that is being corroded to prevent the reaction between the corrosive gas in the water and the metal. Most chemical corrosion inhibitors that are used to protect black steel metal are "film forming" amine-based products. These type chemicals move from the bulk water to the water/pipe interface to form a semi-stable film on the metal. When water containing a dissolved corrosive gas like oxygen, hydrogen sulfide or carbon dioxide comes in contact with the metal, the film prevents the chemical corrosion reaction.

Problems with Chemical Treatments in Fire Sprinkler Systems

1. Backflow contamination of municipal drinking water

Almost every jurisdiction in the US will require an upgrade of the fire sprinkler system backflow prevention device from a simple double check type back flow to a much more expensive reduced pressure zone (RPZ) type back flow[2]. Authorities Having Jurisdiction (AHJ) throughout the country generally will not accept the risk or liability of introducing ANY chemical into the drinking water. Arguing about how safe the chemical is for human consumption is irrelevant to the AHJ regarding their requirement for an RPZ. If the sprinkler water is treated with a chemical, the backflow preventer will have to be upgraded. When there is a non-chemical solution like nitrogen inerting available, it is much safer and less expensive to go with the nitrogen.

2. Discharging chemically treated water from sprinklers creates environmental issues

Regardless of claims of "green" chemistry or biodegradability, fire sprinkler water that has been chemically treated must be handled differently that water that has not been chemically treated. It makes sense to consider the fact that if the chemical corrosion inhibitor is forming a film on solid surfaces, then it is probably forming a film on the gills of the marine life that comes in contact with the

chemically treated water. Every chemical that is used to prevent corrosion is toxic to marine life. The level of toxicity may vary from chemical to chemical, but they are all toxic.

3. Chemical compatibility with fire sprinkler system components – gaskets

The 2013 Edition of NFPA 13 and all subsequent editions require that any chemical that is introduced to fire sprinkler water must have documented evidence of compatibility with ALL system components[3]. The components that are at most risk are the elastomers that are used in valves, sprinklers and couplings. Many chemical corrosion inhibitors cause degradation or swelling of the Buna-N, EPDM, natural rubber and Teflon elastomers that are used in fire sprinkler system components. A certified laboratory must do the testing and provide the necessary compatibility data before a chemical can be used to treat fire sprinkler water.

4. Exposure to chemically treated water for first responders

The last thing in the world that a fire fighter needs to think about is the safety of the water that is being discharged for a sprinkler system. Can the chemical treatment cause burns to the skin or damage to the eyes? When it comes to fighting a fire it is ridiculous to even discuss the possible need for flushing of the eyes or skin. All chemicals require a Material Safety Data Sheet (MSDS) for a reason, because there needs to be a protocol for what to do if there is unintended human exposure to the chemical. When there is a non-chemical solution like nitrogen inerting available, it is much safer to go with the nitrogen.

5. Performance of the chemical treatment in a fire sprinkler system

NACE (formerly known as the National Association of Corrosion Engineers) creates all of the standards for testing to verify the efficacy of chemical corrosion inhibitors in a variety of different environments. For example, the testing for a corrosion inhibitor that can stand up to an oil well with a 500°F bottom hole temperature would be very different from a test designed to evaluate corrosion inhibitors used in HVAC cooling water. There is NOT currently a standard NACE test for corrosion inhibitors that are proposed for use in water-based fire sprinkler systems. Performance testing of a corrosion inhibitor by the company manufacturing the chemical creates a significant conflict of interest.

6. Difficult to get the chemical corrosion inhibitor to all of the piping

Chemical corrosion inhibitors work best in systems where the water is flowing. By injecting the corrosion inhibitor into the flowing stream, it mixes and disperses throughout the water. When the water containing corrosion inhibitor contacts any solid surface, the inhibitor molecule adheres to that surface to form the protective film. Generally, corrosion inhibitor treatments in flowing water can be done at very low dosages below 500 parts per million (0.05%).

Fire sprinkler systems are closed, stagnant pressure vessels. They only flow water when they are being filled, when they are tested or when they are responding to a fire event. Otherwise the water lies stagnant within the piping. Forming and maintaining a persistent film is difficult within a stagnant vessel because it is hard to get the chemically treated water to contact all of the metal surfaces. Further, any time a wet pipe system is drained, the chemical treatment needs to be reapplied. Retreatments can significantly increase the maintenance cost.

Nitrogen Inerting to Remove Oxygen Gas

1. Nitrogen inerting is NOT a chemical treatment

Nitrogen gas is inert. At the temperatures and pressures of a water-based fire sprinkler system, nitrogen exhibits extremely low reactivity with other substances. Nitrogen gas is used in beer, wines and coffee to preserve the freshness. Nitrogen inerting of tanks, equipment and vessels is described in several documents as a way to displace an unwanted gas[4,5,6]. In this case nitrogen inerting is used to displace oxygen from the fire sprinkler system piping to prevent the reaction of oxygen with steel or galvanized steel piping.

2. Nitrogen gas is abundant, inexpensive and simple to deploy

Performing nitrogen inerting on wet pipe fire sprinkler systems can be done in a couple of hours. Nitrogen gas displaces the air from the empty piping and the system is filled with water as per the normal operations. In dry and preaction fire sprinkler systems, nitrogen generators extract nitrogen gas from the air and use it for pressure maintenance in place of a standard air compressor.

3. Dry Pipe Nitrogen Inerting (DPNI) and Wet Pipe Nitrogen Inerting (WPNI) are proven effective

The first nitrogen generator was installed on a dry pipe fire sprinkler system in 2009. There has been ten (10) years of successful use on dry and preaction fire sprinkler systems to prevent corrosion. The first large scale WPNI project was done in 2010. Thousands of wet pipe systems have been inerted in the past nine (9) years using nitrogen gas to displace oxygen rich air before filling with water. Corrosion and leaks can be completely stopped by inerting. The rate of industry and government acceptance is accelerating.

4. FM Global has a standard[7] for nitrogen generators for use in dry and preaction fire sprinkler systems

FM Standard 1035 describes the critical performance standards for any nitrogen generator that will be used for pressure maintenance in dry and preaction fire sprinkler systems.

5. The US Government[8,9] requires nitrogen generators on all dry and preaction fire sprinkler systems

The US Department of Defense fire code requires the use of a nitrogen generator for pressure maintenance on all dry and preaction fire sprinkler systems (UFC 3-600-01). The US General Services Administration fire code requires the use of a nitrogen generator for pressure maintenance on all dry pipes fire sprinkler systems (PBS-P100).

Conclusion

In 2010 there were three (3) companies selling chemical corrosion inhibitors for corrosion control in water-based fire sprinkler systems – fpsCMI (CI-100), Potter (Pipe Shield) and Huguenot (ProGuard). For the reasons listed above, the industry and government have moved away from the use of chemical corrosion inhibitors and toward the use of safe, effective, inexpensive nitrogen inerting for the control of corrosion in water-based fire sprinkler systems. Today there is only one (1) company that recommends the use of chemical corrosion inhibitors in water-based fire sprinkler systems the other two (2) recommend nitrogen inerting. Note that fpsCMI was purchased by Engineered Corrosion Solutions in 2013.

References

[1] **"Microbiologically Influenced Corrosion (MIC) is NOT the Primary Cause of Corrosion in Fire Sprinkler Systems"** – Sprinkler Age Magazine October 2009

[2] **California Water District UPC 2018 Edition 603.5.14.2 Chemicals** – requiring Reduced Pressure (RP) back flow preventer when chemical antifreeze, corrosion inhibitor or other chemical is added to the fire sprinkler system.

[3] **2013 Edition of NFPA 13 24.1.5.3 Chemical Compatibility** – when listed biocides or corrosion inhibitors are used, they shall be compatible with system components.

[4] **"Properly Purge and Inert Storage Vessels"** – AICHe February 2001

[5] **FM Global Property Loss Prevention Data Sheet 7-59 September 1977** – Inerting and Purging of Tanks, Process Vessels and Equipment

[6] **Inerting in the Chemical Industry** (Handbook) – The Linde Group 2008

[7] **FM Global Approval Standard 1035** – Approval Standard for Nitrogen Generators December 2014

[8] **US Department of Defense UFC 3-600-01** April 2018 pgs. 94-95

[9] **US General Services Administration PBS-P100** April 2017 pgs. 230-232

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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.

For complete information about the entire line of corrosion management products and services and the complete list of downloads of White Papers, FAQs, installation schematics and product spec sheets please visit the Engineered Corrosion Solutions website at ecscorrosion.com or contact us at (314) 432-1377 and one of our engineers will assist in personally answering any of your questions.

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