White Paper

Setting the Record Straight - MIC vs. Oxygen Corrosion
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The goal of Dry Pipe Nitrogen Inerting (DPNI) in dry and preaction fire sprinkler systems is to first purge the oxygen rich air from the piping and second to eliminate the future introduction of oxygen gas into the system piping. The goal is NOT to prevent all forms of corrosion. Evidence from field sampling of failed fire sprinkler piping indicates that the vast majority of corrosion related leaks are caused by oxygen while bacteria in fire sprinkler systems result in less than 5% of the leaks that occur. Each type of corrosion exhibits characteristic metal loss patterns.

Figure 1: Microbiologically Influenced Corrosion (MIC) Pit (left) vs. Oxygen Corrosion Pit (right)

The most fundamental exercise associated with any problem solving initiative is to first clearly understand and define the problem. Such is the case with corrosion problems in dry and preaction fire sprinkler systems. The reason that dry and preaction fire sprinkler systems develop corrosion related leaks is as follows:

1. Water gets trapped in the piping from hydrostatic testing, trip testing or condensate from the air compressor – corrosion cannot occur without liquid water
2. The air compressor provides what is essentially an unlimited supply of oxygen gas (21% of the air) to the piping network
3. Oxygen gas very quickly dissolves into the water at the air/water interface
4. Dissolved oxygen in the water reacts with the iron or zinc at the pipe wall adjacent to the air/water interface – this reaction takes place in minutes
5. The oxygen corrosion reaction produces two (2) results:
    a. Pit in the pipe wall where metal is removed
    b. Corrosion by-product deposit containing iron or zinc

<u>Bacteria in Fire Sprinkler Systems</u>

As we assist clients in understanding and mitigating risk associated with corrosion in fire sprinkler systems one of the routine services that we perform is to dissect and analyze through-the-wall leaks that have occurred on sprinkler piping. We analyze and inspect 300-500 pipe samples per year from fire sprinkler installations that are experiencing leaks. We also perform several hundred MIC/Deposit tests per year. Here is what we find:

- Bacteria can be found in every fire sprinkler system
- When microbes are not found in a particular fire sprinkler water sample it can almost always be traced to poor sample handling and preparation
- The most common type of bacteria found in fire sprinkler systems utilize iron as part of their metabolism
- There are always several different types of bacteria in the fire sprinkler systems as a mixed consortia living symbiotically, i.e. they support each other
- There is absolutely **no correlation** between the number of bacteria in a fire sprinkler system and the number of leaks that the system experiences
- There is a **direct correlation** between the frequency of oxygen rich air introduction to a fire sprinkler system and the number of leaks that occur in dry and preaction fire sprinkler systems
- Eliminating the introduction of oxygen rich air to the dry or preaction fire sprinkler system by nitrogen inerting will always produce predictable results:
    - Cleaner piping by elimination of iron and zinc oxide by-product deposits
    - Fewer deposits always means that there will be fewer bacteria
    - No oxygen, no leaks - dramatic reduction in the number of corrosion related leaks

Figure 2: Galvanized Main Subjected to Oxygen Corrosion in Dry Pipe System

<u>Monitoring Corrosion Activity</u>

In a recent article published in the September issue of Fire Protection Contractor Magazine it is suggested that “chemically treated FPS are simply and inexpensively tested for corrosion by testing waters in the FPS for oxygen, MRM, iron and residual treatment chemical.” As a chemist, I would like to understand the protocol for measuring FPS in-situ oxygen and iron.

First, it is virtually impossible to accurately measure the amount of dissolved oxygen in a water sample that is captured from fire sprinkler system piping. In order to get an accurate measurement, the water must be collected without exposing it to the air. Exposure of the water sample to the air even for a few seconds during sample collection would result in an immediate increase of the dissolved oxygen content in the water. This contaminated sample would no longer be representative of the conditions that exist with trapped water within the piping.

Second, it is also impossible to capture a sample of iron from the fire sprinkler system that could accurately indicate the rate of corrosion. Iron oxide is completely insoluble in water at neutral pH. In order to measure the iron content in a collected water sample it must first be acidified to make the iron measurable. It is quite impossible to correlate iron measurements in a sample of water from the system to the level of corrosion in the system.

We agree that corrosion coupons are inappropriate for detecting corrosion in dry and preaction fire sprinkler systems. In most cases, coupons cannot be placed where the corrosion would be worst and they pose an obstruction risk that is unacceptable. The NFPA Installation Standard does not allow for the placement of obstructions in fire sprinkler piping. As such, we recommend in-line corrosion detectors[1] that are equipped with a thin walled design (see Figure) that provides for the following:

1. Placement of the detector at a point in the system where corrosion is most likely – for example in dry and preaction systems the supply main where water might pool is a good location
2. Pitting corrosion of the thin wall in the in-line detector will cause the detector to activate, as such this device is highly representative of the worst case of corrosion in the system
3. The in-line corrosion detection device is "real time" with immediate detection of elevated corrosion in the system

Figure 3: ECS In-Line Corrosion Detector (ILD) and ILD cut-away of thin wall section

The Use of Chemical Treatments

We believe that recommending the use of chemical treatments to control oxygen and bacteria in fire sprinkler system piping is profoundly flawed in its logic.

First, chemical oxygen scavengers are not persistent within the piping system. They are immediately consumed by the chemical reaction with any dissolved oxygen in the water. This means that more oxygen scavenger would have to be added on a regular recurring basis each time the system was tested or opened to atmosphere.

Second, the 2013 Edition of NFPA 13[2] does not allow for the random introduction of any chemicals to fire sprinkler systems that cannot document complete compatibility with all of the fire sprinkler system components, gaskets, seats, fittings, etc. There are no suppliers that can provide that data.

Third, it is environmentally inappropriate to discharge fire sprinkler waters into sewers or to the surface when they contain residual chemicals. Further, any chemical products that claim to "kill microbes" must be registered with the federal government as a biocide for use in this particular industry. There are no registered biocides for the fire protection industry.

Finally, even if all of the microbes within a dry or preaction fire sprinkler system are killed, the rate of corrosion related failures **will not decline** unless oxygen is kept out of the system as well.

FM Global now has a product approval standard for nitrogen generator use within the fire protection industry[3]. The refinements that have occurred in designing, installing and deploying DPNI technology have yielded a robust system that can completely control the corrosion in dry and preaction fire sprinkler systems without using potentially hazardous and incompatible chemicals.

References

[1] ECS In-Line Corrosion Detector, http://ecscorrosion.com/product/ecs-in-line-corrosion-detector/

[2] NFPA 13, The Standard for the Installation of Sprinkler Systems, 2013 Edition, Section 24.1.5.3

[3] Approval Standard for Nitrogen Generators, Factory Mutual Class Number 1035

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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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