Nitrogen: A *Total* Solution to Corrosion in Dry and Preaction Systems?

Mother Nature has the task of reducing compounds down to their primary constitutes, and this is accomplished very effectively. Corrosion of fire sprinkler systems is inevitable. One of the challenges faced by the fire sprinkler industry is to minimize this process. This article seeks to explain that there is not a single total solution to corrosion control in fire sprinkler systems. Instead, our industry must battle corrosion on several different fronts.

For good reason, nitrogen use has gained popularity in the past few years as a replacement for air in dry and preaction systems. A primary reason is that pure nitrogen systems eliminate the nearly 21% oxygen[1] present in the air we breathe thus limiting the oxygen available for the corrosion process. Nitrogen charged dry systems protect many mission critical areas, cold storage warehouses, and areas containing irreplaceable historical assets. It is a logical decision to employ nitrogen in these situations. Nitrogen has been used with success in many dry pipe and preaction systems, however, it is **not** the ***total*** solution for controlling corrosion in dry and preaction systems. Keep in mind that Mother Nature is very effective in accomplishing her job.

While the use of nitrogen is one tool in the mitigation of some types of corrosion in fire sprinkler systems, this article will explain that is not a panacea for all of the corrosive forces present in sprinkler systems. There are other factors to consider for optimum corrosion protection in dry and preaction fire sprinkler systems.

MIC Bacteria – A Double Threat

Recent history has shown that MIC corrosion is a reality and its presence is increasing in fire sprinkler systems. There are many factors that contribute to this increase in MIC corrosion, and a variety of articles thoroughly discuss this subject. The presence of MIC in fire sprinkler systems must be addressed.

There are two categories of MIC bacteria:

Aerobic: Bacteria that need air (oxygen) to survive.

Anaerobic: Bacteria that do not need air (oxygen) to survive.

Nitrogen systems control the growth of aerobic bacteria due to reduced levels of oxygen in fire sprinkler systems. By eliminating most of the oxygen necessary for them to grow, corrosive damage is greatly reduced. However, it is important to understand that reduced oxygen levels do not control the growth of **anaerobic** bacteria and some bacteria strains actually increase their growth rates at lower than normal oxygen levels.

---

[1] http://www.physicalgeography.net/fundamentals/7a.html, atmospheric composition.

Two main types of anaerobic bacteria are responsible for most of the MIC corrosion damage to fire sprinkler systems:

1. Acid Producing Bacteria (APB) are bacteria that live only in anaerobic conditions and produce a number of organic acids including, acetate, lactate, propionate and butyrate based acids. These acids corrode steel, iron, galvanized, copper, and bronze components of fire sprinkler systems. If oxygen were present, these APB would not be able to ferment significant amounts of acid. Acid Producing Bacteria are also found living in conjunction with the other type of common anaerobic bacteria which cause corrosion in fire sprinkler systems, known as SRB or Sulfate Reducing Bacteria. Acetate, a by-product of APB, is a nutrient for sulfate reducing bacteria and actually enhances its growth.

2. Sulfate Reducing Bacteria (SRB) are bacteria that live without air (oxygen) and derive their energy by reducing sulfates to sulfides. In simplified terms, the sulfides, which are formed by the SRB actions, react with hydrogen to form H_2S gas and iron sulfide from the iron in fire sprinkler piping[2]. The H_2S gas, when dissolved in water, forms sulfuric acid. The sulfuric acid produced directly corrodes fire protection systems. The iron sulfide is the main cause for the "black water" present in fire sprinkler systems, and the "bad smell" that comes from H_2S gas is produced by the sulfate reducing bacteria. Sulfate Reducing Bacteria have even been found to live without water, using the hydrogen available from the metal's surface[3].

The oil and gas industry has been plagued by anaerobic MIC corrosion for years. Obviously, there is no air or oxygen present in oil and gas wells, pipelines, or refinery operations. They are all essentially anaerobic conditions.

Nitrogen and Water?

Four things must be present to initiate and propagate a corrosion cell:

1. Anode (the metal which corrodes)
2. Cathode
3. Electrical path between the anode and cathode
4. Electrolyte to transfer chemical ions[4]

Water is usually the electrolyte within fire sprinkler systems. Dry and preaction systems eliminate the majority of the water by their design. Charging these systems

---

[2] http://wiki.biomine.skelleftea.se/wiki/index.php/Sulfate_reducing_bacteria, Hydro-metallurgy, sulfate reducing bacteria .

[3] Environmental Microbe-metal Interactions By Derek R. Lovley
Published by ASM Press, 2000 ISBN 1555811957, 9781555811952

[4] "An Introduction to Corrosion", Earl Pye Ph.D, PE, CCS Control Systems, Inc, Wildmar, CA TEL: 800-now-CCS-1

with nitrogen helps eliminate more water by its desiccating or drying action. These factors help minimize or eliminate oxygen corrosion. However, eliminating all of the water within a nitrogen system is almost impossible because even dry and preaction systems still contain micro-droplets of water. There is a point of diminishing returns in trying to eliminate all water within a fire sprinkler system. System testing, as required by code, exposes systems to water periodically. Corrosion cells (most are small) still exist and promote the chance for corrosion.

Oxygen concentrations are much higher in air (which is about 21% oxygen) than in water, which is a tiny fraction of 1 percent oxygen[5], or 10,000 ppm (parts / million). However, concentrations as low as >10 / billion have been found to cause oxygen pitting corrosion[6]. Any water left in a dry or preaction system enhances localized pitting corrosion from oxygen.

Water contains nutrients and organic matter that MIC bacteria use as food to perform their corrosive behavior. As the majority of the water evaporates in nitrogen systems, these small amounts of water left behind become concentrated with nutrients and organic matter. These concentrated food sources promote localized MIC bacteria growth that increases corrosion rates in that specific area.

Dynamic Biostatic Corrosion Inhibitors

It has been established that increasing nitrogen concentrations in sprinkler systems is one tool for corrosion control in dry and preaction systems. It helps control corrosion by reducing oxygen, some MIC bacteria, and water in these systems. However, nitrogen use alone only addresses a part of the problem. What can be done about those corrosion processes that nitrogen does not address, such as localized corrosion? Another tool is needed to combat this type of corrosion activity.

Dynamic Biostatic Corrosion Inhibitors are that tool. Dynamic Biostatic Corrosion Inhibitors do not treat the water; they actually treat the pipe. They are perfect for using in dry and preaction systems because the inhibitor actually coats by molecular bonding to the wall of the pipe and system components with a one molecule thick coating. This monomolecular coat does not let reactive oxygen or MIC bacteria penetrate to the surface of the pipe. It is effective for both air and nitrogen charged systems. Dynamic Biostatic Corrosion Inhibitors can be introduced into the system when pressure testing the dry and preaction system with water. Once coated, it protects the pipe without the need for water in the system. After the pressure testing, the dry and preaction systems can be returned to normal service, and the pipe remains coated. While nitrogen reduces the corrosion potential, the Dynamic Biostatic Corrosion Inhibitor keeps the remaining oxygen and MIC bacteria from attacking the pipe.

---

[5] "Water on the Web", http://waterontheweb.org/under/waterquality/oxygen.html, 2008

[6] Department of Energy, SR Instrumentation Engineering Group Report, Jeff T. Collins, Advanced Photon Source Experimental Facilities, Division SR Instrumentation Engineering Group, November 30, 2000

In Conclusion

Mother Nature is relentlessly attacking dry and preaction fire sprinkler Systems day and night. It is a formidable challenge to mitigate all corrosive forces in these circumstances. Nitrogen is an effective tool, but used alone it fails to treat all corrosive processes. Using Dynamic Biostatic Corrosion Inhibitors mitigates MIC and oxygen corrosion by coating the piping and system components, protecting these systems even when charged with nitrogen. When designing your next dry and preaction systems, use a Dynamic Biostatic Corrosion Inhibitor in conjunction with nitrogen to provide the maximum corrosion protection.

A good team against corrosion in dry and preaction systems is Potter Electric's patent pending Dynamic Biostatic Corrosion Inhibitor, *Potter Pipe-Shield* (Stock # 1119105) in combination with Potter Electric's *Supervised Nitrogen System* (Stock # 1119710). Using this team will provide a one-two punch against the corrosive forces present in sprinkler systems today.

Author: Doug Chartier, Corrosion Product Manager, Potter Corrosion Solutions, Potter Electric Signal Company, Telephone: 1-800-325-3936, Cell Phone: 314-853-6983, 1609 Park 370 Place, Hazelwood, MO 63042

Date: 11/19/2008
Word Count: 1375
Lines: 164

Doug Chartier's Bio:

DOUG CHARTIER is the Corrosion Product Manager for Potter Corrosion Solutions a division of Potter Electric Signal Company. He is the co-author of various patents, is a "hands-on" field chemist, and has been involved with MIC for 25 years plus. He was recently awarded two U.S. Patents on an environmentally friendly biostatic coating "FPS MIC Remediation & Mitigation Methods and Apparatus", #6,517,617 & #6,841,125 and currently applying for another patent on an advanced formulation. He is a member of the National Fire Protection Association (NFPA), National Association of Corrosion Engineers (NACE), Society of Petroleum Engineers (SPE) and the American Chemical Society (ACS). His work on MIC is widely published. He may be contacted at 314.853.6983 or dougc@pottersignal.com .

.