

## **What is MIC?**

MIC, is the acronym for Microbiologically Influenced Corrosion. Simply stated, it is corrosion accelerated by microorganisms.

### **A Brief Explanation of How MIC Works**

Corrosion is a deterioration or change in state of matter. Rusting or oxidation can occur without microorganisms present however, microorganisms can accelerate the corrosion process. Corrosion involves the "electrolytic" transfer of ions. This process is much the same as the transfer of ions during the discharge of a battery.

Microorganisms don't "eat" the pipe, but they do form colonies and multiply. As part of their multiplication process, these microorganisms set up very complex chemical, electrical, and biological processes to grow and protect "the colony." Figure 1 is a simplification of how microorganisms contribute to and accelerate the corrosion process.

### **A Brief History**

Microbiologists and corrosion experts have known about MIC for decades. Historically, the biggest problems have occurred in heated, closed loop systems. The power utility industry recognized these problem years ago and has established extensive water treatment programs and procedures to reduce or eliminate the effect of microbiologically influenced corrosion.

MIC in fire protection systems, however, is a relatively new phenomenon. In the mid-1980s, a sharp rise in MIC incidences was reported in the Pacific Southwest, notably in Texas, New Mexico, and Arizona (areas with warm climates).

Today, the presence of MIC has been verified throughout the United States; from California to New Jersey and from Illinois to Texas. MIC has also been verified in various countries throughout the world.

Since 1990, there has been a dramatic rise in the number of corrosion leaks in sprinkler systems less than ten years old. Some systems have experienced corrosion leaks in less than two years in both steel and galvanized piping systems!

### **Why Is MIC on the Increase in Fire Protection Systems?**

The most commonly asked question is, "if MIC has been around for decades (and longer), why is there an increase in the number of reported incidences in fire protection systems?"

### **There are five primary reasons for the increase in MIC reported in fire protection systems.**

#### **1. Changes in Material**

From the inception of the automatic sprinkler systems in the late 1800s until the mid-1970s, nearly all U.S. sprinkler systems used Schedule 40 (thick wall) steel piping manufactured in the United States. Starting in the mid-1970s, foreign pipe was used in many systems. In the 1980s, Schedule 10 and Schedule 5 (thin wall piping) was introduced in fire protection systems. Through the 1970s, the average life of a fire protection system was about 50 years. Some systems remained serviceable after 75 years. Failures for systems less than 25 years old were very rare. Prior to the late 1980s, most galvanized sprinkler pipe was hot dipped rather than electroplated.

Recent investigations by this writer on sprinkler systems ranging in age from three years old to 50 years old have shown a wide variance in MIC activity. Scientific testing has shown promising patterns in determining which sprinkler systems may be more susceptible to MIC corrosion. Spectrographic metallurgical analysis (determination of the elements present in the base metal) was conducted on a limited sampling of piping both with and without extensive MIC present. Initial results indicated that higher carbon steels (> 0.8% carbon) are more subject to MIC corrosion. Also, the results suggest that higher sulfur steels (> 0.008% sulfur) may be more subject to MIC corrosion. Other elements such as manganese do not show any pattern relative to MIC development. It should be noted that the sampling was limited and additional study is needed.

From existing data base information and the samples studied, there is also some evidence to suggest that electroplated piping may accelerate MIC activity. It appears that the microorganisms can set up a "reverse galvanic" process and take advantage of the ionic structure in place from the plating process.

While ASTM standards address the structural performance of sprinkler piping, there are no specific requirements or recommendations for identification or limitation of elements in fire protection piping.

## 2. The Number of Sprinkler Systems in Service

We simply have more sprinkler systems than ever. Current codes require automatic sprinklers in nearly every commercial and industrial business. Some jurisdictions require apartments and homes to have automatic sprinkler systems.

## 3. Changes in the Way We Disinfect Our Water

In the 1970s, Trihalomethanes (THM) were identified as cancer causing compounds. THMs occur as a by-product of a reaction between chlorine and naturally occurring organics in water. In the early 1980s, the EPA set new standards for the level of THMs in the water. Again, in the mid-1990s, the EPA substantially reduced the allowable particles per million (ppm) of THMs in drinking water. The end result was a change in the way that water suppliers disinfect the water. Because the disinfection process is less rigorous, more of the microorganisms (or bugs) survive the water treatment process. Once trapped inside a dead end fire protection system, these microorganisms are free to grow. The more bugs, potentially the more corrosion. Although microbiologists agree that problems exist, the mechanisms and treatments of microorganisms in sprinkler systems are widely debated.

## 4. Expanded Awareness of the MIC Problems

With the rise of the information age, more people are aware of the problem and reporting it as MIC, and not "just another pinhole leak."

## 5. Increased Maintenance Activity

Twenty plus years ago the average sprinkler system was rarely drained. In today's fast-paced society, changes are common. Areas are rearranged and remodeled more frequently, which requires re-piping the sprinkler system and necessitates draining the system. Each draining of the system introduces fresh nutrients and oxygen to the system. Also, routine testing and maintenance activity increased on most sprinkler systems during the last quarter of the century. Recently, NFPA has reduced the recommended testing frequency because of the reliability of monitored fire protection systems and in recognition of increased MIC activity.

## **What Can Be Done to Prevent or Reduce MIC in Fire Protection Systems?**

1. For new systems, flush the piping (both underground and overhead) to remove oils and debris. These materials are "food" to microorganisms. Proper flushing should include a detergent to remove oil from the system. Water alone won't remove the oil. Nearly every other piping system requires thorough flushing of the system to remove dirt and oil prior to placing the system in service. This includes chilled water lines, refrigeration lines, process steam or water lines, etc. Sprinkler systems have unique flushing challenges. While most other piping systems are re-circulating, automatic sprinkler systems are "dead end" systems. Although more difficult, these systems can be properly flushed if the designer and installer pre-plan for accessible filling and drainage of all parts of the system. "Tree" systems (which are increasingly less common) will be hard to thoroughly flush due to their inherent design.

2. Test systems only to minimum requirements. (NFPA requires quarterly testing of fire protection systems.) The less introduction of "new water" into the system, the fewer introductions of "new food" and "new oxygen."

3. Drain and refill the system as infrequently as possible. Modifications to the sprinkler systems should be pre-planned to maximize efforts and minimize the number of times the system must be taken out of service. The reason is the same as in Item 3 - limit new food and oxygen into the system.

4. Look for early warning signs of MIC such as pinhole leaks or weeping at joints. Consider internal visual inspections of the pipe. It is suggested that sprinkler systems have an internal inspection after two years

of service. If no abnormal corrosion activity is noted, the frequency should coincide with the sprinkler systems five year certification. (If you are in a known MIC prone area, see additional suggestions under Item 6.)

5. For new sprinkler systems in MIC prone areas, consider specifying thicker wall piping. The thicker the piping wall, the longer it will take for the corrosion to perforate the piping.

6. In MIC prone areas, consider periodic inspections for MIC. The most telling piece of evidence is the actual piping. Every MIC test should include the removal of a section of piping. However, it is extremely important that before draining the system, water test samples be taken and immediately shipped to a laboratory qualified to test for MIC microorganisms. Other tests to determine the physical make up of the metal pipe and accumulated interior deposits are also valuable in identifying the extent of the problem. Use a MIC protocol so that your results can be compared to the results of other companies. A sample MIC protocol is available from Marsh Risk Consulting.

Water tests are informative but not conclusive. Some level of microorganisms is present in all sprinkler systems. Therefore, just because microbes are present in the water doesn't mean you have a MIC problem. MIC can only be verified by a combination of internal inspection and scientific testing.

Caution: How samples are taken, when samples are taken, the number of samples taken, and where samples are shipped for analysis are critical issues. The cost of three water test samples and one deposit sample is about \$600 (including the report). Laboratories should have experience in testing for MIC in fire protection systems.

Testing of metallurgical properties may be an important factor in determining why your piping is susceptible. EMS (spectrographic) metallurgical analysis is readily available and inexpensive (about \$100).

X-ray defraction tests can also be performed to identify the compounds present in the deposits. The number of testing laboratories capable of performing X-ray defraction tests is limited and the cost is approximately \$500 per sample (including the report). These tests have been performed for the past several years on MIC samples but the results vary widely and no definitive pattern has yet been reported.

7. If MIC is confirmed in your system, contact a fire protection consultant knowledgeable about MIC and the options available to you. There are several procedures or chemicals that can effectively treat MIC. However the type of MIC and the severity of the corrosion can affect the type of chemicals and treatment. Some treatments are expensive. Often there are options that may result in lower overall costs.

## **Conclusion**

So, having said all of the above is MIC a myth or a cancer?

The answer is MIC is like a cancer. It is real and we know it exists. We have verified highly accelerated MIC corrosion in sprinkler systems. But, like a disease, not everyone is infected.

I believe the correct approach is the same as we use for our own physical health:

- We have periodic check-ups.
- We look for the early warning signs.
- If we detect a problem, we seek early treatment.

If we follow the same approach for MIC, we can give our sprinkler systems a long and healthy life.

## **ABOUT THE AUTHOR:**

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