Corrosion in Fire Sprinkler Systems

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The biggest concern is that corrosion can cause a sprinkler system to fail.

50% Blockage
(California, 5 year old system)

Failed Sprinkler Head
(Illinois, 12 year old system)
Corrosion produces many issues in the fire sprinkler market

- Pinhole leaks
- Limits effectiveness of fire sprinkler design
- Loss of property
- Loss of production
- Temporary shutdowns, often unplanned
- Total system replacements
- Personal injury
What is the life expectancy of a fire sprinkler system?
VdS 20-year long survey of corrosion in sprinkler systems:

Class I - Little damage is found, the pipe array should just be flushed.

Class II - Medium damage is found, so that some but not all pipes show increased damage, those pipes must be replaced.

Class III - Considerable corrosion and deposits the complete pipe array or parts of it must be replaced.
Classes of Corrosion

Wet Systems

- Fontana
- Class I
- Indianapolis
- Class II
- Wisconsin
- Class III
Classes of Corrosion

Dry Systems

- Cincinnati
  - Class I

- Minneapolis
  - Class II

- Illinois
  - Class III
### Results Summary

<table>
<thead>
<tr>
<th>System Type</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Systems</td>
<td>65%</td>
<td>32%</td>
<td>3%</td>
<td>In <strong>25</strong> years, 35% have significant corrosion issues</td>
</tr>
<tr>
<td>Dry and Pre-Action Systems</td>
<td>27%</td>
<td>51%</td>
<td>22%</td>
<td>In only <strong>12(\frac{1}{2})</strong> years, 73% have significant corrosion issues</td>
</tr>
</tbody>
</table>

**What is the life expectancy of a fire sprinkler system?**
There are 2 main types of corrosion in FSS

1) Generalized Corrosion (Rust)
2) Microbiologically Influenced Corrosion (MIC)
Generalized Corrosion, also known as rust, requires 3 things:

1) Water
2) Iron
3) Oxygen
FM Global study found 10-30% of corrosion was influenced by MIC and 70-90% of corrosion was generalized (oxygen) corrosion.
The largest concern for corrosion is related to oxygen.

How do we eliminate oxygen in the fire protection system?
Corrosion flourishes in Dry and Pre-action systems because air compressors supply an unlimited supply of oxygen and water.

Trapped water from hydrostatic testing, combined with humid air supplied constantly by the air compressor creates a perfect storm.
Replace the Oxygen with Nitrogen.

Nitrogen is an INERT gas.

It does not react with metals. Thus, no oxidation or rust occurs!

The earth’s atmosphere is 78% nitrogen and 21% oxygen.

Strip the oxygen from air and leave pure nitrogen!
Nitrogen Tests

Compressed Air

98% Nitrogen

After 20 months
Nitrogen Tests

On average, using 98% Nitrogen gas over compressed air increases the life expectancy of a dry fire sprinkler system up to 5.3X.
Results of Study

Table 6.1 Corrosion rates (CR) of galvanized and carbon steel coupons based on weight loss measurements.

<table>
<thead>
<tr>
<th>Exposure Time (Month)</th>
<th>Corrosion Rate (MPY)</th>
<th>Galvanized Steel</th>
<th>Carbon Steel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N2 STDev HA STDev</td>
<td>N2 STDev HA STDev</td>
</tr>
<tr>
<td>2</td>
<td>0.54 0.27 1.15 0.06 2.14</td>
<td>0.11 0.02 5.60 1.59 50.91</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.44 0.25 0.70 0.04 1.59</td>
<td>0.13 0.02 5.90 0.65 45.38</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>0.25 0.10 0.29 0.03 1.16</td>
<td>0.14 0.02 5.90 0.57 42.14</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>0.29 0.13 0.37 0.04 1.28</td>
<td>0.14 0.01 2.96 0.77 21.14</td>
<td></td>
</tr>
</tbody>
</table>

N2: Nitrogen, 0.2 l/min, 40 psi
HA: House Air, 0.2 l/min, 40 psi
Galvanized is not effective.

**Metal Loss of Corrosion Coupons comparing Black Steel and Galvanized**

- **Galvanized Schedule 10 after only 18 months**
- **Galvanized Schedule 40 after only 3.5 years**
### Table 23.4.4.7.1 Hazen–Williams C Values

<table>
<thead>
<tr>
<th>Pipe or Tube</th>
<th>C Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unlined cast or ductile iron</td>
<td>100</td>
</tr>
<tr>
<td>Black steel (dry systems including preaction)</td>
<td>100</td>
</tr>
<tr>
<td>Black steel (wet systems including deluge)</td>
<td>120</td>
</tr>
<tr>
<td>Galvanized steel (dry systems including preaction)</td>
<td>100</td>
</tr>
<tr>
<td>Galvanized steel (wet systems including deluge)</td>
<td>120</td>
</tr>
<tr>
<td>Plastic (listed) all</td>
<td>150</td>
</tr>
<tr>
<td>Cement-lined cast- or ductile iron</td>
<td>140</td>
</tr>
<tr>
<td>Copper tube or stainless steel</td>
<td>150</td>
</tr>
<tr>
<td>Asbestos cement</td>
<td>140</td>
</tr>
<tr>
<td>Concrete</td>
<td>140</td>
</tr>
</tbody>
</table>

*The authority having jurisdiction is permitted to allow other C values.

**Note:** Galvanized pipe offers no hydraulic advantage.
Nitrogen generators provide on-site reliable nitrogen production.

- Meet NFPA 13, 30 minute fill time requirements
- Easy installation
- Sized to meet the needs of systems
- Cost effective
- Low maintenance
- Dependable
Key Economic Impacts

Use of black steel instead of galvanized piping saves roughly 30% on sprinkler piping and fittings

- Decreases unexpected maintenance costs
- Increases useable life of sprinkler systems by over 5 fold
TRAPPED AIR supplies 99% of all the oxygen needed for corrosion in the sprinkler system.
Wet Systems

Trapped Air Causes:

• Increased Generalized Corrosion
• Better MIC environment
• Unnecessary False Flow Alarms

Why Is Trapped Air a Problem?
Wet Systems

System Design!
Automatic Air Vents

**NFPA 13 7.1.5 Air Venting**

- A single air vent with a connection conforming to 8.16.6 shall be provided on each wet pipe system utilizing metallic pipe.

**NFPA 13 8.16.6 Air Venting**

- The vent required by 7.1.5 shall be located near a high point in the system to allow air to be removed from that portion of the system by one of the following methods:
  - Manual valve, minimum ½” size
  - **Automatic Air Vent**
  - Other approved means
Removing Trapped Oxygen

Automatic Air Vents AUTOMATICALLY vent the trapped air in the wet fire sprinkler system. This eliminates the corrosion oxygen trapped in the line.
Trapped Air:

• In many sprinkler systems, it is unrealistic to remove all trapped air cost effectively.

• How can you remove more trapped air (oxygen)?

• Pre-fill the wet system with Nitrogen before filling with water – Wet Inerting!
Wet System Inerting Testing

Average Corrosion Rates of Coupons Comparing Air to 99% Nitrogen

On average, with systems with 99.9% nitrogen pockets increases the life expectancy of a wet fire sprinkler system up to **2.8X**
How do I purge Oxygen From A Wet System?
This affects the entire industry

In 2007-2011 fires where sprinklers operated, they were effective in 96% of the cases. The graph below is based on the other 4% in which the sprinkler was ineffective.
• QUESTIONS?