Corrosion in Fire Sprinkler Systems

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

50% Blockage  
(California, 5 year old system)

Failed Sprinkler Head  
(Illinois, 12 year old system)
Corrosion is known to produce many problems in the fire sprinkler market

- Pinhole leaks
- Temporary shutdowns
- Loss of property
- Loss of production
- Total system replacements
- Reduces effectiveness of design
- 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.
- Fontana
- Wet system
- Class I
- Indianapolis
- Wet system
- Class II
- Hartford
- Wet system
- Class III
Evaluated wet pipe systems after 25 years:

65% - Class I
32% - Class II
3% - Class III

Over $\frac{1}{3}$ of systems have significant corrosion issues
- Cincinnati
- Dry system
- Class I
- Minneapolis
- Dry system
- Class II
- Illinois
- Dry system branch line
- Class III
Evaluated dry systems at 12½ years:

- 27% - Class I
- 51% - Class II
- 22% - Class III

73% of dry systems have significant corrosion issues.
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

Generalized Corrosion Cell (Rust reaction)
The term Microbiologically influenced corrosion (MIC) is used to designate corrosion due to the presence and activities of bacteria.

The three main type of bacteria are
• Acid Producing Bacteria (APB)
• Sulfur Reducing Bacteria (SRB)
• Iron related bacteria (IRB)
FM Global study found 40% of corrosion was influenced by MIC and 60% of corrosion was generalized corrosion.
The number one enemy of a wet system is **TRAPPED AIR**, which can take up **70%** of the sprinkler system.
Trapped Air Causes:

- Increased Generalized Corrosion
- Better MIC environment
- Unnecessary False Flow Alarms
Why is trapped air a problem now?

System Design.
TYPICAL GRID SYSTEM INSTALLATION
FIG 1

TYPICAL DEAD END TREE SYSTEM WITH COMBINATION INSPECTION / DRAIN PORT
FIG 4
Removing Trapped Oxygen

Air Vents automatically vent the trapped air in the wet fire sprinkler system. This eliminates the corrosion oxygen trapped in the line.
Corrosion flourishes in Dry and Pre-action systems because they are NEVER 100% DRY.

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

Typical “Dry” System
Replace the Oxygen with Nitrogen.

Nitrogen is an INERT gas.

It does not react with metals. Thus, no oxidation or rust occurs!
After 20 months – Compressed Air
After 20 months – 98% Nitrogen
Compressed Air

98% Nitrogen

After 20 months
Metal Loss of Corrosion Coupons under 98% Nitrogen and Compressed Air
<table>
<thead>
<tr>
<th>Water</th>
<th>Metal</th>
<th>98% Nitrogen Inhibition Effectiveness (% Protection)</th>
<th>Life Expectancy Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>69.35%</td>
<td>5.33</td>
<td></td>
</tr>
</tbody>
</table>
Metal Loss of Corrosion Coupons comparing Black Steel and Galvanized

- 98% N2 with trace amounts of water
- Compressed air with trace amounts of water
- 98% N2 half filled with water
- Compressed air half filled with water

Legend:
- Steel
- Galvanized
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.

Source: NFPA 13, 2013

No Hydraulic Advantage
FM Global Property Loss Prevention Data Sheets

Installation Guidelines for Automatic Sprinklers 2-0

2.5.2.5 Protection of Sprinkler System Piping

Use internally galvanized, stainless steel, or similar corrosion-resistant pipe in all new dry-pipe, pre-action, refrigerated-area, deluge, and exposure-protection sprinkler systems. Do not use galvanized pipe in areas where the ambient temperature could exceed 130°F (54°C) unless the pipe is specifically FM Approved for use in such conditions.

Exception: Black steel pipe can be used in dry-pipe sprinkler systems equipped with closed-type sprinklers if the piping system is filled with an inert gas.
How do you supply nitrogen to a fire sprinkler system?

7.2.6.8 Nitrogen or Other Approved Gas.

7.2.6.8.1* Where nitrogen or other approved gas is used, the supply shall be from a reliable source.

7.2.6.8.2 Where stored nitrogen or other approved gas is used, the gas shall be introduced through a pressure regulator and shall be in accordance with 7.2.6.6.

7.2.6.8.3 A low pressure alarm shall be provided on gas storage containers to notify the need for refilling.
“Reliable Source”

The trick to this is removing that 21\% oxygen from the fire sprinkler piping and replacing it with pure nitrogen.

The earth’s atmosphere is 78\% nitrogen and 21\% oxygen.
Nitrogen generators provide on-site reliable nitrogen production.
The nitrogen membrane is the “heart” of the nitrogen generator.
Air Compressor

Dryer

Nitrogen Cabinet

AMD

Nitrogen Storage Tank (98%+ N₂)
Dry Systems

• Use nitrogen over compressed air
• Use black steel over galvanized