Corrosion in Fire Sprinkler Systems
• Objectives
  – Discuss the problems corrosion causes in fire sprinkler systems
  – Identify the causes of corrosion
  – Take an in-depth look at the current state of corrosion technology
  – Evaluate the economic impact that corrosion has on fire sprinkler systems
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 fire sprinkler design
- Personal injury
What is the life expectancy of a fire sprinkler system?
VdS 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.
- Cincinnati
- Dry system
- Class I
- Minneapolis
- Dry system
- Class II
- Illinois
- Dry system branch line
- Class III
Dry systems after being installed for 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
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.
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.
Corrosion requires 3 things:

1) Water
2) Iron
3) Oxygen

If eliminate one, you stop corrosion.
Replace the Oxygen with Nitrogen.

Nitrogen is an INERT gas.

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

After 20 months – Compressed Air
Nitrogen Tests

After 20 months – 98% Nitrogen
Nitrogen Tests

After 20 months

98% Nitrogen

Compressed Air

After 20 months
Corrosion Coupon Testing Manifold
After 12 Months

Steel Coupon
Compressed Air

Steel Coupon
98% Nitrogen

Galvanized Coupon
Compressed Air

Galvanized Coupon
98% Nitrogen
Metal Loss of Corrosion Coupons under 98% Nitrogen and Compressed Air

- Black steel with trace amounts of water
- Galvanized with trace amounts of water
- Black steel half filled with water
- Galvanized half filled with water

Comparison between 98% Nitrogen and Compressed Air.
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.
Nitrogen Tests

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

- 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><strong>Black steel (dry systems including preaction)</strong></td>
<td>100</td>
</tr>
<tr>
<td>Black steel (wet systems including deluge)</td>
<td>120</td>
</tr>
<tr>
<td><strong>Galvanized steel (dry systems including preaction)</strong></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

**Galvanized Pipe**

No Hydraulic Advantage
Nitrogen Use

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.

Source: NFPA 13, 2013
“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 Generator

- Nitrogen Cabinet
- Dryer
- AMD
- Air Compressor
- Nitrogen Storage Tank (98%+ N₂)
The nitrogen membrane is the “heart” of the nitrogen generator.
Sizing a Nitrogen Generator

- Largest riser size
- Supervisory pressure
- Total system capacity
Design with Nitrogen in mind

- Use black steel over galvanized – save 30% on average of sprinkler piping
- Use a lower supervisory pressure – smaller compressor needed
- Feed more than one system – “Plant Nitrogen”
Dry Systems

- Use nitrogen over compressed air
- Use black steel over galvanized
- Implement a corrosion monitoring program
Questions?

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