POTTER CORROSION SOLUTIONS
The Symbol of Protection

Corrosion in Fire Sprinkler Systems

Jeff Merwin
Director of Business Development
Fire Sprinkler Monitoring / OEM Controls
jeffm@pottersignal.com
800-325-3936

Overview

Å Objectives

- ï Discuss the problems corrosion causes in fire sprinkler systems
- ï Discuss life expectancy of fire sprinkler systems
- ï Identify the causes of corrosion
- ï Current state of corrosion technology
- ï Mitigation: when / where to apply
- ï Evaluate the economic impact decisions regarding corrosion has on fire sprinkler systems

Overview

- Why do we care about corrosion in fire sprinkler systems?
- Codes require them
- **COST!!**
  - American Fire Sprinkler Association, AFSA
    - New construction $1-$2 / ft^2
    - Retrofits $2-$3 / ft^2
  - 100K ft^2 (9300m^3) = $100K-$200K new construction
  - 50K ft^2 (4650m^3) = $100K-$150K retrofits

Safety

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)

Issues

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

Issues

What is the life expectancy of a fire sprinkler system?

Classes of Corrosion

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.

VdS Inspected. Approved. Safe.

Classes of Corrosion

Wet Systems

- Fontana
- **Class I**

- Indianapolis
- **Class II**

- Wisconsin
- **Class III**

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Classes of Corrosion

Dry Systems

- Cincinnati
- **Class I**

- Minneapolis
- **Class II**

- Illinois
- **Class III**

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VdS Survey

Results Summary

System Type	Class I	Class II	Class III	
Wet Systems	65%	**32%**	**3%**	In **25** years, 35% have significant corrosion issues
Dry and Pre-Action Systems	27%	**51%**	**22%**	In only **12½** years, 73% have significant corrosion issues

What is the life expectancy of a fire sprinkler system?

Types of Corrosion

There are 2 main types of corrosion in FSS

1) Generalized Corrosion (Rust)

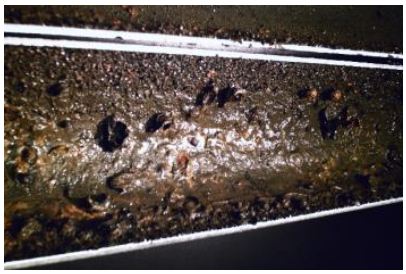
2) Microbiologically Influenced Corrosion (MIC)

Generalized

MIC

MIC in FSS

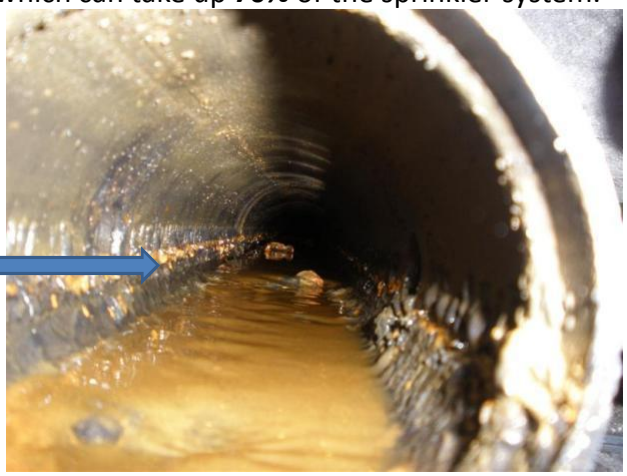
FM Global study found 40% of corrosion was influenced by MIC and 60% of corrosion was generalized corrosion.



Wet Systems

The number one enemy of a wet system is **TRAPPED AIR,** which can take up **70%** of the sprinkler system.

Corrosion Air Water Interface Line



Wet Systems

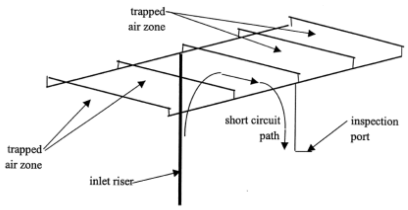
Trapped Air Causes:

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

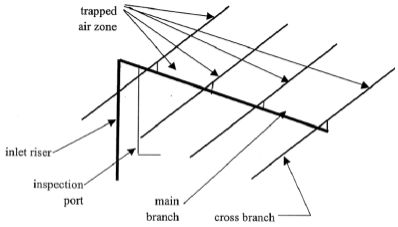
Why Is Trapped Air a Problem:

- System Design!

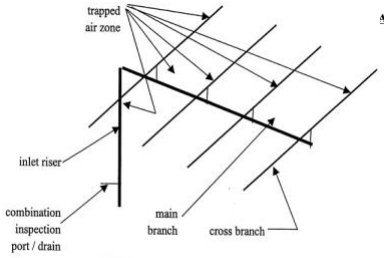
Wet Systems



TYPICAL GRID SYSTEM INSTALLATION

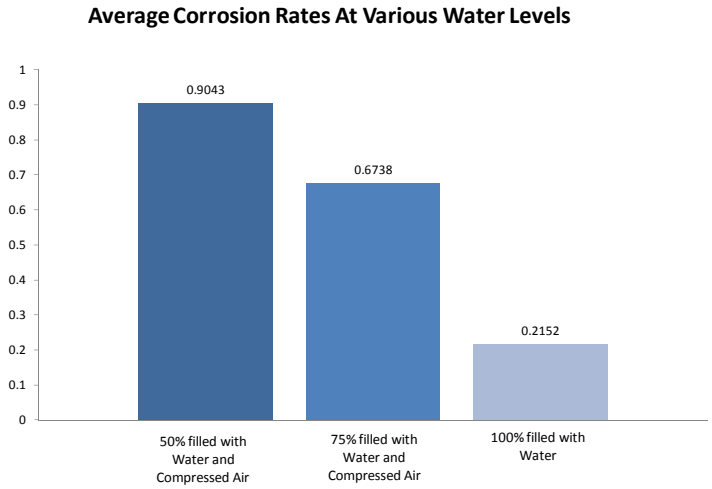


AL DEAD END TREE SYSTEM



TYPICAL DEAD END TREE SYSTEM
WITH COMBINATION INSPECTION / DRAIN PORT

Research



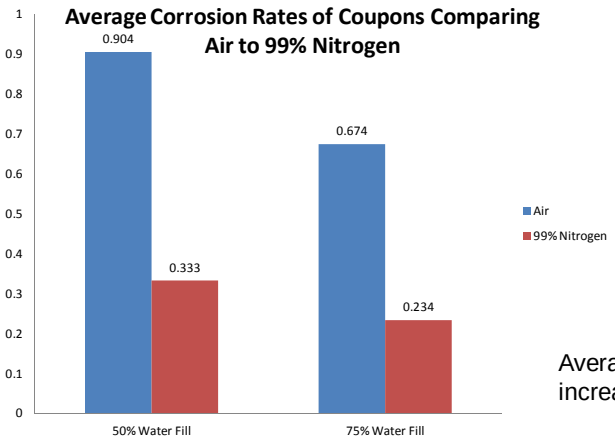
Wet System Inerting

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!

Research

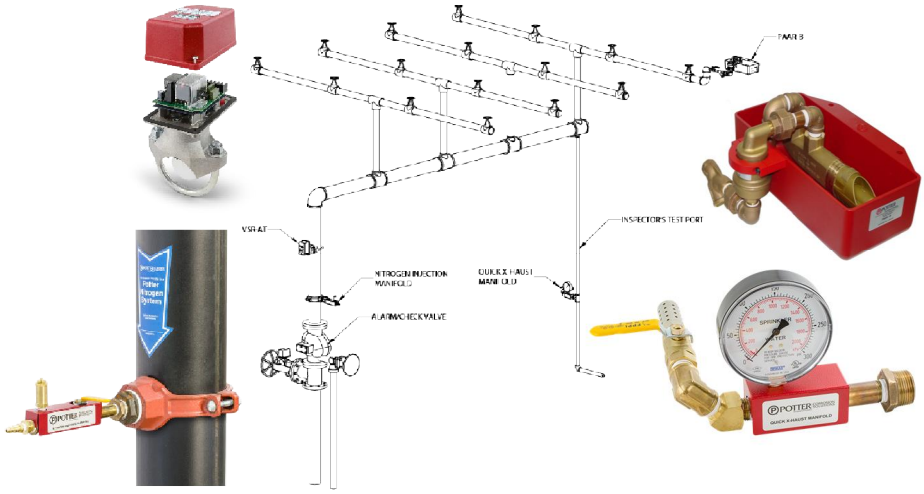
Wet System Inerting Testing



Average life expectancy increase up to **2.8X**

Wet System Inerting

How do I purge Oxygen From A Wet System?



Dry and Pre-action

*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

Nitrogen Tests

Corrosion Comparison Tests
(0.010” Leak Diameter)

Nitrogen Tests

Compressed Air **98% Nitrogen**

After 20 months

Nitrogen Tests

Corrosion Coupon Testing Manifold

After 12 Months

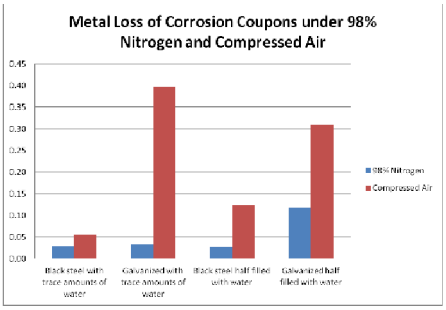
Steel Coupon
Compressed Air

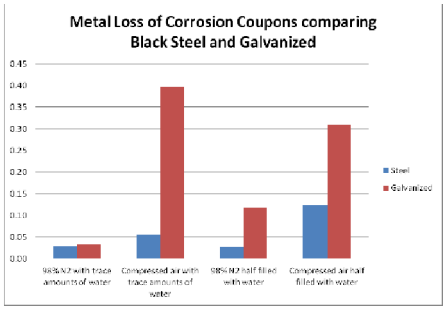
Steel Coupon
98% Nitrogen

Galvanized Coupon
Compressed Air

Galvanized Coupon
98% Nitrogen

Nitrogen Tests





Water	Metal	98% Nitrogen Inhibition Effectiveness (% Protection)	Life Expectancy Multiplier
Trace	Steel	45.4%	1.8
Trace	Galvanized	91.8%	12.2
Half Full	Steel	78.6%	4.6
Half Full	Galvanized	61.6%	2.6
Average		**69.4%**	**5.3**

Localized Corrosion

Localized Corrosion = Quick Failures

Galvanized Schedule 40 after only 3 1/2 years

Galvanized Schedule 10 after only 18 months

Nitrogen Use

Installation Guidelines for Automatic Sprinklers 2-0
FM Global Property Loss Prevention Data Sheets

2.5.2.5 Protection of Sprinkler System Piping

See Data Sheet 7-14, *Protection for Flammable Liquid/Flammable Gas Processing Equipment*, for installation guidelines for sprinkler system piping in areas subject to potential explosion hazards. Do not hang anything, including conduit, cable trays, air piping, speakers, and signs, from 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.

Galvanized Pipe

Table 23.4.4.7.1 Hazen–Williams *C* Values

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

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

No Hydraulic Advantage

23.4.2.1 Friction Loss Formula.

23.4.2.1.1 Pipe friction losses shall be determined on the basis of the Hazen–Williams formula, as follows:

$$p = \frac{4.52Q^{1.85}}{C^{1.85}d^{4.87}}$$

where:
p = frictional resistance (psi/ft of pipe)
Q = flow (gpm)
C = friction loss coefficient
d = actual internal diameter of pipe (in.)

Source: NFPA 13, 2013

Wet Systems

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.

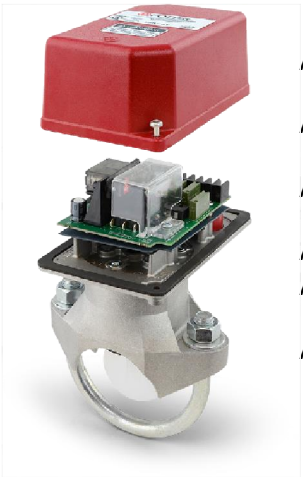
PAV

PAAR-B

The **Only** UL-Listed and FM approved air vents for fire sprinkler branch lines.

Wet Systems

Keeping the System Free of Oxygen



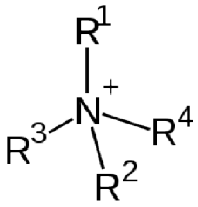
- Remotely test without flowing new water into systems
- Reduces corrosion – no new oxygen when testing
- Conserves water – contributes to LEED's Section 3.1 & 3.2
- Preserves chemical treatments
- No environmental concerns over sprinkler water discharge
- Initiate test using key switch or Fire Alarm Panel

Wet Systems

- **Pipe-Shield™** is a patented biostatic environmentally friendly corrosion inhibitor.
- Specifically developed to protect wet and dry fire sprinkler systems from MIC and oxygen corrosion.
- Is a cationic (+) polymer that is attracted to the anionic (-) oxygen layer on the surface of the iron. This attraction creates an effective wall which blocks the penetration of oxygen free radicals and formation of MIC bacterium.
- Designed for metallic systems ONLY.
- Reduced Pressure Backflow Preventer often required.
- Does not require replenishment like a toxic biocide.

20 month exposure test

No Pipe-Shield | Pipe-Shield



Quaternary amine

Nitrogen

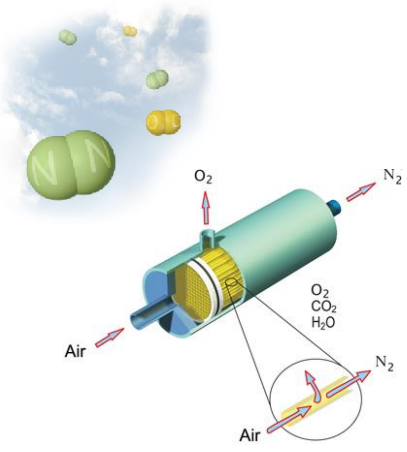
Replace the Oxygen with Nitrogen.

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 Generator

Nitrogen generators provide reliable, on-site nitrogen production.

NGP-250

NGP-1750

Nitrogen Generators

Purging Process – Getting Air Out

- Initial system fill with air
- Nitrogen level monitoring
- Stops purging when nitrogen levels reach target.
- BMS connectivity and notification
- Advance Purging ï Designed for drying and freezer applications, reducing moisture and ice build-up.
- Manual options also available

INS-PV

INS-RA

NGP-SPV

Nitrogen Generators

Economic Impact

- Use black steel instead of galvanized piping
  - Saves roughly **30%** on sprinkler piping
- Save existing systems from additional corrosion
- Use a lower supervisory pressure
  - Smaller compressor
  - Smaller membrane
  - Less expensive system
- Feed more than one system
  - "Plant Nitrogen"
  - Economies of scale

Parking garage installation

Nitrogen Generator

Nitrogen: Cure all??

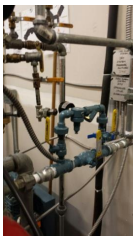
- Eliminates most oxygen in wet and dry systems
  - Slows corrosion
  - Disrupts MIC environments
- Further decreases dew point

Corrosion Monitoring

Every corrosion mitigation plan should include a monitoring program.

Corrosion Monitoring Station

Installation Variations



Wet Inerting

Recommendations

Wet Systems

- Design systems to vent trapped air
- Minimize fresh water ingress
- Test the water
- Wet inert the system prior to filling
  - Or, use a corrosion inhibitor (steel systems)
- Implement a corrosion monitoring program

Recommendations

Dry Systems

- Use nitrogen over compressed air
- Use black steel over galvanized
- Use a corrosion inhibitor
- Use lower supervisory pressure
- Implement a corrosion monitoring program

Questions?

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