POTTER | CORROSION SOLUTIONS
The Symbol of Protection

Corrosion in Fire Sprinkler Systems

Increasing Your Liability, Increasing Your Costs, and Shortening System Life

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Overview

- Objectives
  - Discuss the problems corrosion causes in fire sprinkler systems
  - Discuss life expectancy of fire sprinkler systems
  - Identify the causes of corrosion
  - Current state of corrosion technology
  - Mitigation: when / where to apply
  - 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!!** (Installation and Repair)
  - American Fire Sprinkler Association, AFSA
    - New construction \$1-\$2 / ft^2
    - Retrofits \$2-\$3 / ft^2
  - 100K ft^2 (9300m^2) = \$100K-\$200K new construction
  - 50K ft^2 (4650m^2) = \$100K-\$150K retrofits
  - Pinholes \$800 - \$1200 to as high as \$5000

System Basics

- What are the types of fire sprinkler systems?
  - Wet Systems: pressurized water throughout
  - Dry Systems: pressurized gas holds water at riser
  - Others: Pre-action, deluge, mist, foam, chemical…
- What is the purpose of a fire sprinkler system?
  - To permit occupants to exit structure
  - To control / extinguish a fire at the location where the fire is active

System Basics

- How does it control / extinguish a fire?
  - Heat from the fire opens a sprinkler, water flows through piping and out of the open sprinkler
  - Only those sprinklers impacted by fire open
- Is it that simple?
  - Usually…

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
- Loss of property
- Loss of production
- Total system replacements
- Temporary shutdowns, often unplanned
- Limits effectiveness of fire sprinkler design
- 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.

Wet Systems

- Fontana
- **Class I**

- Indianapolis
- **Class II**

- Wisconsin
- **Class III**

Dry Systems

- Cincinnati
- **Class I**

- Minneapolis
- **Class II**

- Illinois
- **Class III**

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?

VdS Inspected. Approved. Safe.

Types of Corrosion

There are 2 main types of corrosion in FSS

1) Generalized Corrosion (Rust)

2) Microbiologically Influenced Corrosion (MIC)

Generalized

MIC

NFPA Code

NFPA 13

24.1.5.1 Water supplies and environmental conditions shall be evaluated for the existence of microbes and conditions that contribute to microbiologically influenced corrosion (MIC). Where conditions are found that contribute to MIC, the owner(s) shall notify the sprinkler system installer and a plan shall be developed to treat the system…

NFPA 25

14.2.1.3 Tubercules or slime, if found, shall be tested for indications of microbiologically influenced corrosion (MIC).

NFPA®

MIC in FSS

FM Global study found 10-30% of corrosion was influenced by MIC and 70-90% of corrosion was generalized (oxygen) corrosion.

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

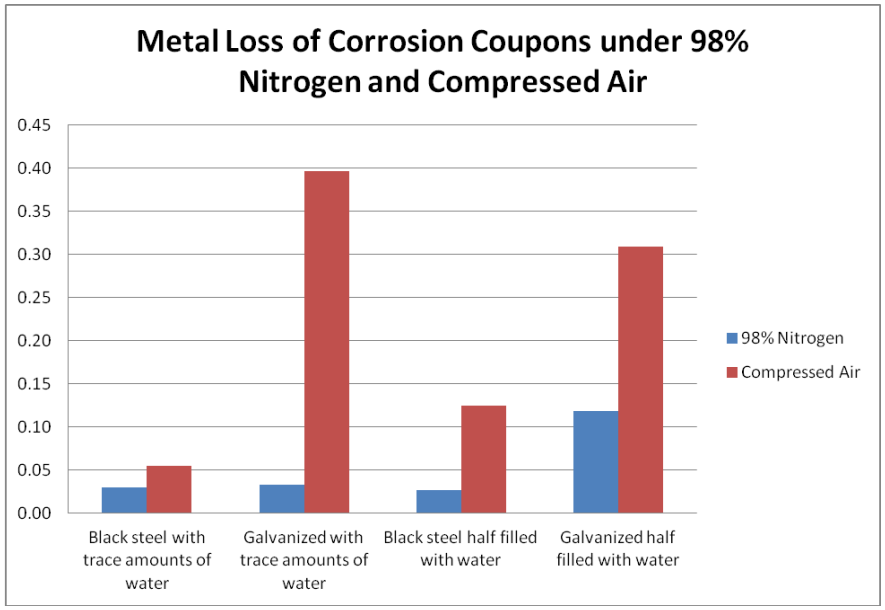
Steel Coupon
Compressed Air

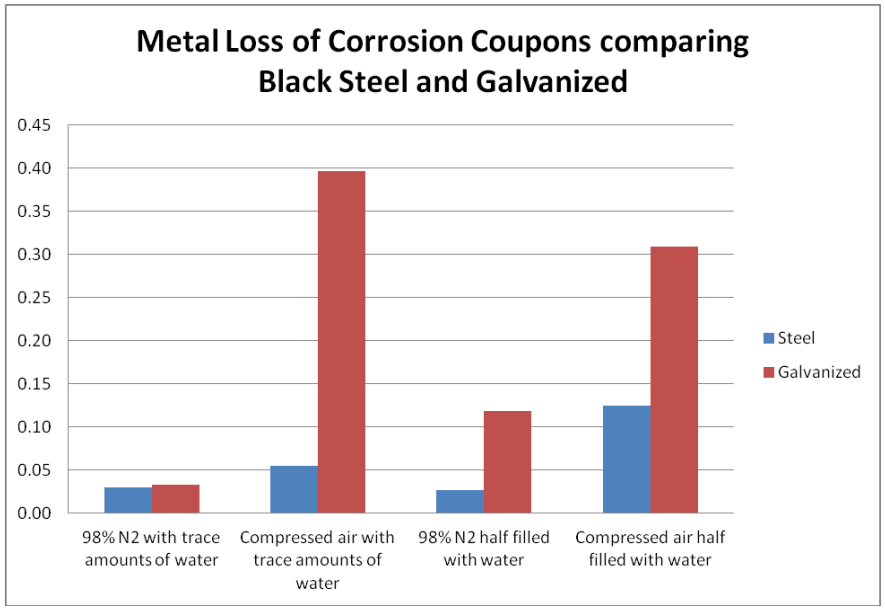
Steel Coupon
98% Nitrogen

Galvanized Coupon
Compressed Air

Galvanized Coupon
98% Nitrogen

Nitrogen Tests





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Life Expectancy Multiplier = 5.3

Localized Corrosion

Localized Corrosion = Quick Failures

Galvanized Schedule 40 after
only 3 1/2 years

Galvanized Schedule 10 after
only 18 months

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

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.

Generate it on-site!

Source: NFPA 13, 2013

Nitrogen

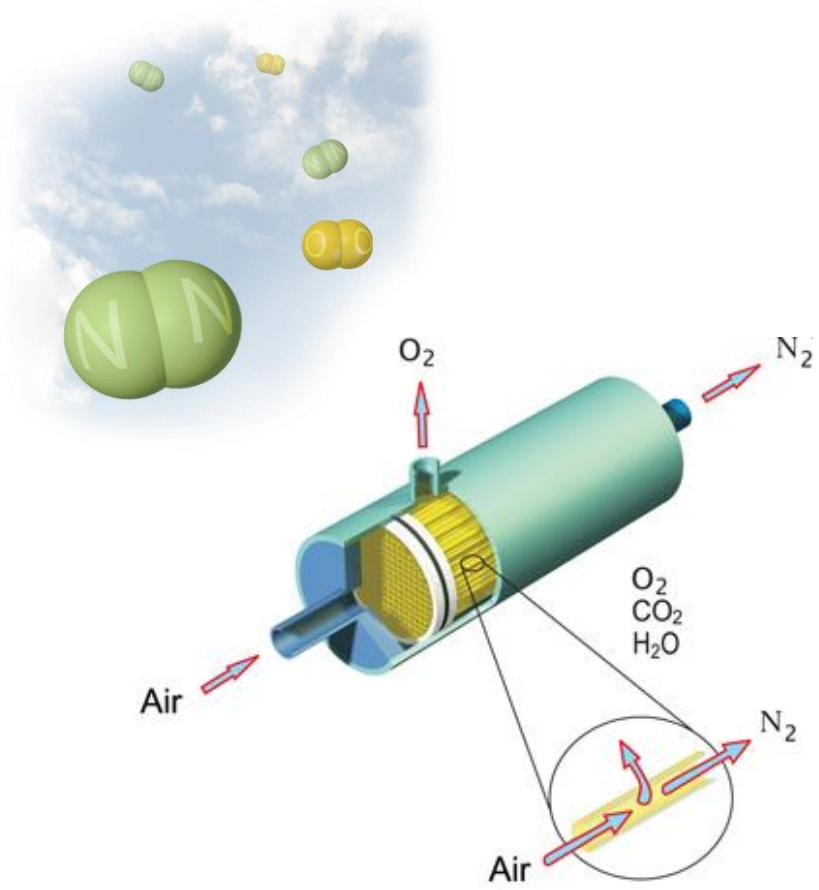
Replace the Oxygen with Nitrogen.

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 that 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

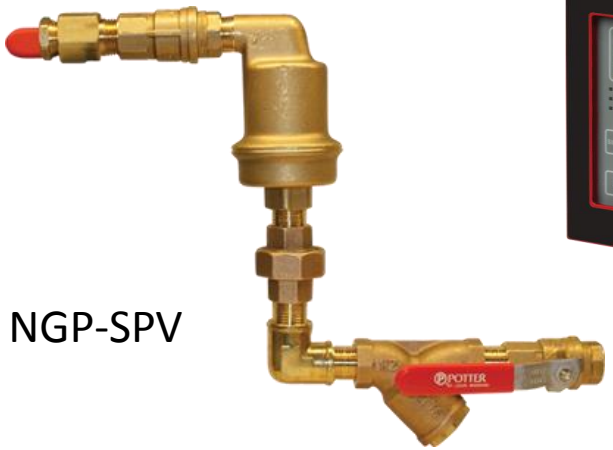
Nitrogen Generators

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 – Designed for drying and freezer applications, reducing moisture and ice build-up.
- Manual options also available

INS-PV

INS-RA

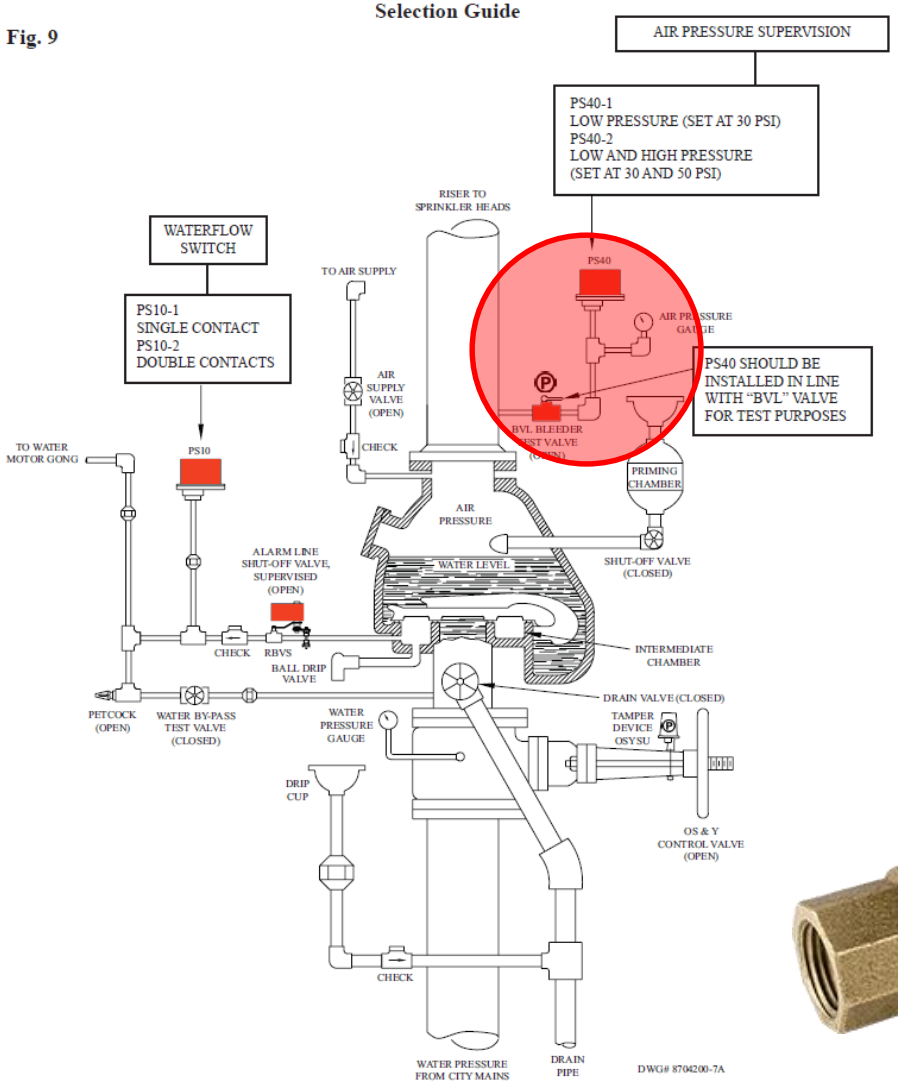


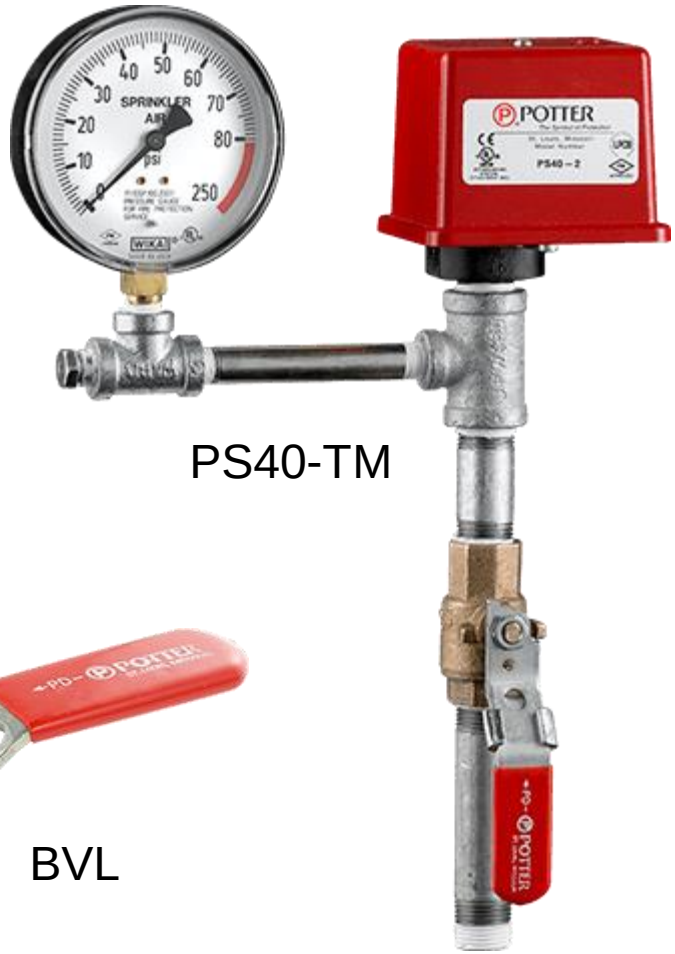
NGP-SPV

Dry System Testing

Dry Pipe System Waterflow And Air Supervisory Switch Selection Guide

Fig. 9





PS40-TM

BVL

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

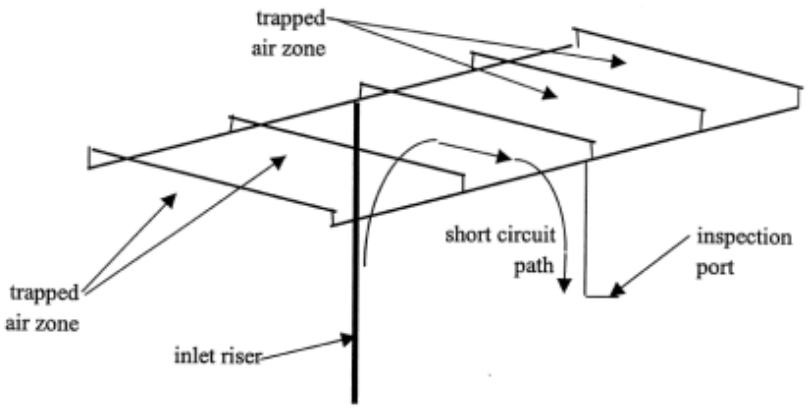
Trapped Air Causes:

- Increased Generalized Corrosion
- Supplies **99%** of the oxygen for corrosion
- Better MIC environment
- Unnecessary False Flow Alarms

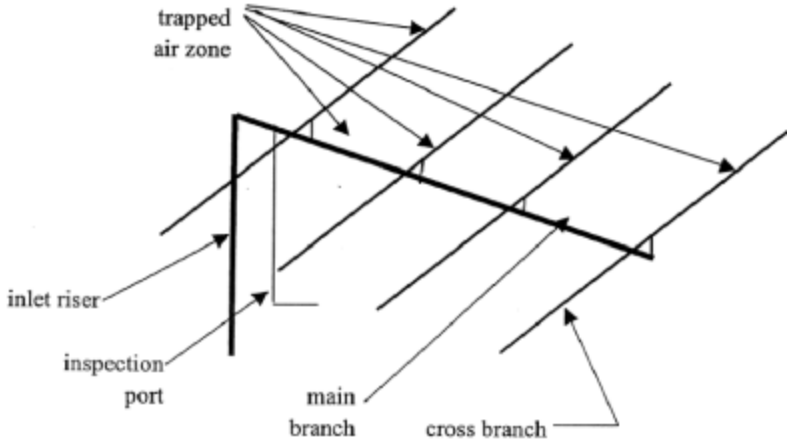
Why Is Trapped Air a Problem:

- System Design!

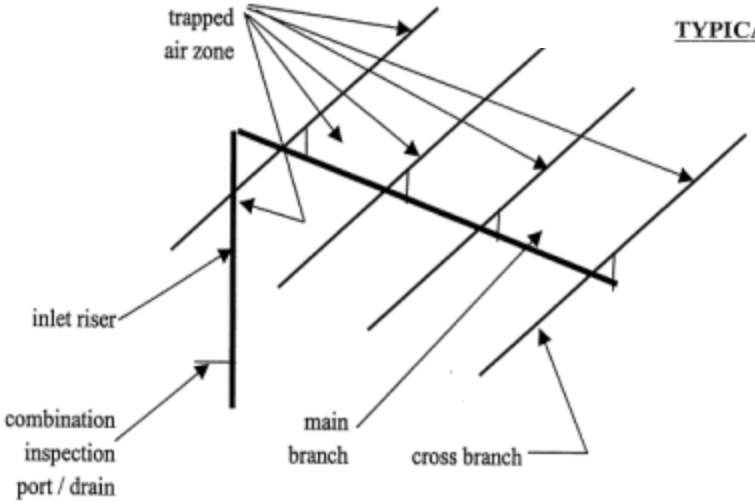
Wet Systems



TYPICAL GRID SYSTEM INSTALLATION



TYPICAL DEAD END TREE SYSTEM



TYPICAL DEAD END TREE SYSTEM
WITH COMBINATION INSPECTION / DRAIN PORT

Corrosion Technical Report

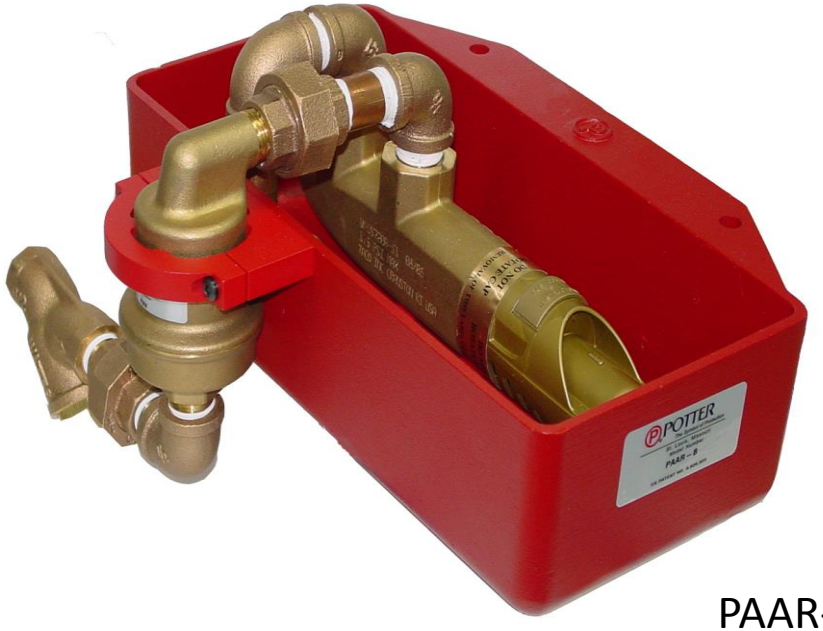
6.3 – WET PIPE SYSTEMS

Minimizing air pockets in wet pipe system is recommended. An air release valve which is capable of venting trapped air in the pipe can mitigate this kind of corrosion

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



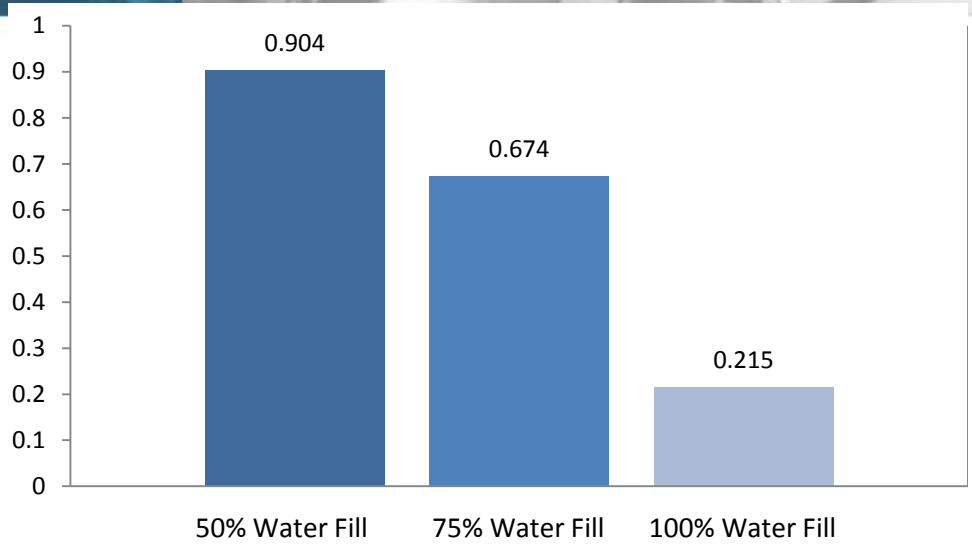
PAAR-B

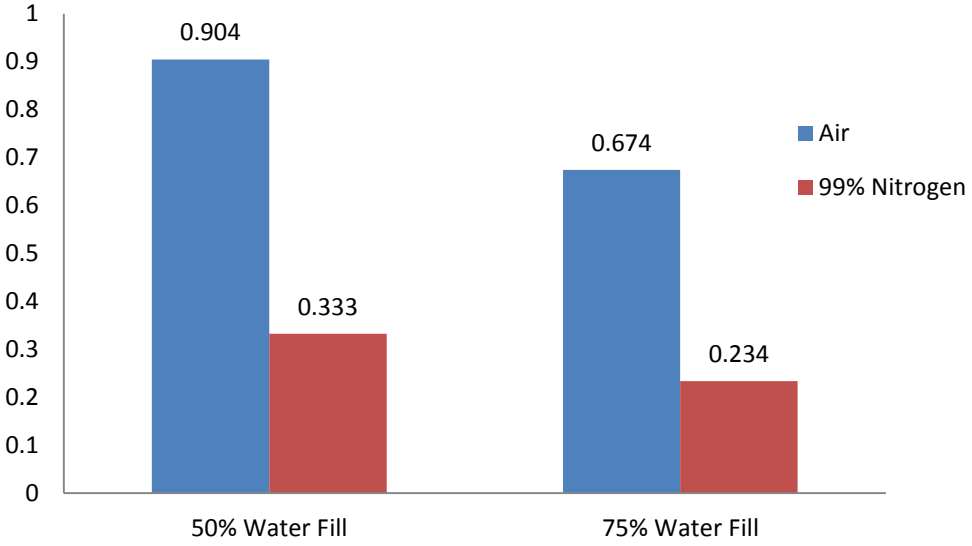
The **Only** UL-Listed and FM approved air vents for fire sprinkler branch lines.

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

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On average, with systems with 99.9% nitrogen pockets increases the life expectancy of a wet fire sprinkler system up to

2.8X

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

Cost Evaluation Using Nitrogen

Assisted living facility

Two, 425 gallon dry systems @ 40 psi

No labor, materials and equipment only

Nitrogen

- 1 nitrogen generator + purge valves
- Black steel pipe, Schedule 10
- Steel fittings

Item	Cost
Black Steel + Fittings	$61,122.98
N2 Generator Equipment	$12,000.00
Total Cost	**$73,112.98**

Estimated life 53 years

Compressed Air

- 1 air compressor
- Galvanized pipe, Schedule 10
- Galvanized fittings

Item	Cost
Galvanized Pipe + Fittings	$76,553.82
Compressor Equipment	$1,150.00
Total Cost	**$77,703.82**

Estimated life 10 years

Dry Systems

- Use nitrogen over compressed air
- Use black steel over galvanized
- Use lower supervisory pressure
- Limit addition of new water
- Implement a corrosion monitoring program

Wet Systems

- Design systems to vent trapped air
- Pre-fill with nitrogen gas
- Minimize fresh water ingress
- Test the water
- Implement a corrosion monitoring program

Keys for Tomorrow

- Identify expenditures on leak repairs
- Develop budgets for addressing existing systems
- Establish requirements for corrosion preventions in new systems
- Ally with fire sprinkler contractors experienced in fighting corrosion in fire sprinkler systems
- Look at long term cost benefits

Applications

- Parking structures
- Data centers
- Dormitory attic systems
- Sports stadiums
- Loading docks
- Laboratories
- Document archives
- Freezer systems

Questions?

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