Cost Evaluation of Black Steel Pipe and Galvanized Pipe When Using a Nitrogen Generator

Andy L. Kaempfer

Business Development Manager

Potter Electric Signal Company, LLC

1609 Park 370 Place

St. Louis, MO 63042

(800) 325-3936

www.pottersignal.com

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Abstract

Internal corrosion of dry and pre-action systems has been widely documented as a cause of sprinkler system failures. These failures cost owners millions of dollars a year in sprinkler system repairs and can result in loses by way of property damage, or production downtime. Typically, most dry and pre-action sprinkler systems use compressed air as a supervisory gas in these systems but it's becoming more common to see compressed nitrogen as a method to reduce corrosion and mitigate the issues caused by internal corrosion. The overall effectiveness of nitrogen in both black iron and galvanized pipe has been well documented as a method of controlling corrosion. This study will analyze the cost savings of using black iron pipe with a nitrogen generator as compared to galvanized pipe and the traditional air compressor.

Introduction

The benefits of using nitrogen gas over compressed air in dry and pre-action systems as a means of controlling corrosion as well as ice plugs in freezer applications has been well published. Nitrogen is an inert diatomic molecule that's key attribute is its inability to react with metals. However, the initial cost of the nitrogen system can be seen as a limiting factor in an owner's ability to install a comprehensive corrosion mitigation plan in a new sprinkler system. This study will evaluate actual cost difference between a black steel system with a nitrogen generator and galvanized steel with an air compressor. We will also examine some exceptions that FM has made to the use of black steel over galvanized in closed type sprinkler systems as well NFPA's reduction of C factor that was made in NFPA 13 – 2013. Some of these code changes and exceptions may allow some designs to move from using a galvanized pipe to black steel to reduce cost. Some of that cost savings can be used to improve the compressed gas supply to nitrogen creating a less expensive, more robust sprinkler system that will have an extended service life with less corrosion.

System Design & Requirements

In this examination a typical dry system installation in an Assisted Living Facility located in the Midwest will be evaluated. The particular project consists of two attic dry systems that are of the same design and capacity. Some general notes to consider:

1. Design and installation to comply with NFPA 13 – 2013 requirements and city fire department.
2. All pipe 2” and smaller to be Sch. 40 with threaded or groove ends for use with threaded or groove type fittings.
3. All pipe 2 ½” and larger to be Sch. 10 with grooved ends for use with groove type fittings.
4. All hangars to comply with NFPA 13 requirements.
5. All materials are to be new and UL Listed where applicable.
6. Dry system capacity is approximately 425 gallons each with a total of 850 gallons.
7. Supervisory pressure is assumed at 40PSI.

While examining cost the material considered was identical with the exception of those items that could change from black steel to galvanized steel. All grooved fittings, short tees, caps, short 90°, short 45°, etc. were priced through standard national US distributors and an average taken. Hangars, braces and screws remained constant across both pricing segments and Potter Nitrogen Equipment was used as the basis of design.

Nitrogen Generator Selection

When selecting a nitrogen generator there are several factors to consider. The first is the maximum total system capacity of all sprinkler systems to be served by the nitrogen generator. Second, determine the volume of the largest sprinkler system that will be served by this nitrogen generator. Lastly, the supervisory nitrogen pressure that the generator will need to maintain within each sprinkler system. With this information it is possible to determine the demands of the nitrogen generator and select a unit with enough capacity to serve the needs of the facility.

One technique used to control the cost of applying nitrogen to dry and pre-action systems is a “plant nitrogen” approach. This means using one nitrogen generator to serve all the sprinkler systems within a facility. It is important to take into consideration any additional volume you may add by means of nitrogen supply lines. Sometimes plant layout does not make it feasible to approach the project with the “plant nitrogen” approach. In that case, multiple nitrogen generators may be required. In this examination a single nitrogen generator for both sprinkler systems will be used.

Pressure within the piping array is another important aspect of selecting a nitrogen generator. Pressure and volume are directly proportionate to one another and that means that as pressure increases so does the volume, volume of gas in this case. Another technique used to keep cost down is using the lowest possible pressure in the sprinkler system. Pre-action systems using a pre-action valve only need supervisory pressure of about 8-15 PSI. Differential valves rely on an Air Pressure Settings table that utilize the maximum water pressure the valve may incur and provide a minimum and maximum air pressure that will keep the clapper closed. The closer the valve can be set to the minimum air pressure the less volume the nitrogen generator has to produce.

The last and most important thing to consider with regards to application is the sprinkler system(s) leak rate. The lower the sprinkler system leak rate, the longer the life expectancy of the nitrogen generator and the smaller the unit can be sized. NFPA 13 allowable leak rate for new sprinkler systems is 1.5 PSI loss over 24 hours. NFPA 25 allows for a 3 PSI loss over a 2 hour period. The larger existing leak rate will increase the demand for nitrogen and increase the size of the nitrogen generator, resulting is more cost. Fixing the sprinkler system leaks can lower the cost of the overall project.

Nitrogen Generator Unit Example

In this scenario a Potter Nitrogen Generator will be the basis for the design and will supply nitrogen to the two attic dry systems. Noting the largest single riser of 425 gallons and a total system capacity of 850 gallons at 40 PSI results in a model selection of the Potter NGP-500D.

Nitrogen Generators are deployed using their by-pass mechanism to pump the sprinkler up to pressure within the NFPA allotted 30 minutes using compressed air. Then utilize a purge system to allow for evacuation of the compressed air and replacement utilizing 98% or higher nitrogen. When the sprinkler system reaches 98% purity the generator maintains the pressure by consistently delivering 98% nitrogen as the makeup gas. Since there is two sprinkler systems for two Potter Purge Valves (Model NGP-SPV) will be required.

This brings estimated total equipment cost of the Potter Nitrogen Generator and the two purge valves to $12,000 for the application of compressed nitrogen source. This does not take into additional piping material or labor for wiring and installation.

Conclusion and Discussion

The systems examined in this scenario are a small scale comparison. Larger projects such as multi-level parking garages, freezer storage facilities or large scale data center facilities typically contain much larger sprinkler systems. Economies of scale will influence the cost savings. It is expected to see even greater savings by using black steel pipe and a nitrogen generator over galvanized pipe and compressed air in larger applications. In this study the costs break down looks like this:

A 425 gallon dry sprinkler system constructed of **galvanized** components as defined in system requirements - $38,276.91. The scenario requires two of these per our project bringing our total to $76,553.82. This accounts for material cost alone. Fabrication, loose materials, couplings, dry valve, checks valve, seismic hangers, etc. No labor is included in these numbers, strictly material. See Table 1.

Table 1. Estimated galvanized sprinkler systems with air compressor cost.

Galvanized Material Cost	$ 76,553.82
Air Compressor Equipment	$ 1,150.00
Total Cost	***$ 77,703.82***

A 425 gallon dry sprinkler system constructed of **black steel** components as defined in system requirements - $30,556.49. The scenario requires two of these per our project bringing our total to $61,112.98. This accounts for material cost alone. Fabrication, loose materials, couplings, dry valve, checks valve, seismic hangers, etc. No labor is included in these numbers, strictly material. See Table 2.

Table 2. Estimated black steel sprinkler systems with nitrogen generator equipment cost.

Black Steel Material Cost	$ 61,112.98
Nitrogen Generator Equipment	$ 12,000.00
Total Cost	***$ 73,112.98***

In this application, the galvanized sprinkler system costs $15,440 more than an equivalent black steel system. Even with the addition of the nitrogen generator equipment, the black steel system is $4,590 less than the galvanized system with an air compressor.

However, what isn't evident by the cost comparison is life expectancy increase by using nitrogen as a supervisory gas. In Josh Tihen's white paper titled "Corrosion Inhibition Using Nitrogen" he successfully performed experiments proving the effectiveness of nitrogen by reducing corrosion rates in both black steel and galvanized whether or not trapped water is present. Tihen states, "The corrosion reduction potential ranges from 48% to 91% when compared to compressed air". Furthermore, according to Tihen, "The metal losses under every condition were lower when using black steel when compared to galvanized steel". The net result of Tihen's study indicates that average life expectancy increase of 5.3 times. For a comparison of the life of the two different systems above see Table 3.

Table 3. Life expectancy comparisons of fire sprinkler system designs.

Estimated Galvanized System Life under Compressed Air	10 years
Estimated Black Steel System Life under Nitrogen	53 years

The two different approaches to corrosion control show a significant advantage by using nitrogen as the supervisory gas. Assuming an average life of 10 years for a new dry system, a comparable new dry system under nitrogen will net 43 more years before repair or replacement is required.

In an effort to provide a more robust system capable of withstanding high corrosion rates many designers and engineers have used FM Global Property Loss Prevention Data Sheets "Installation Guidelines for Automatic Sprinklers 2-0", specifically section 2.5.2.5 Protection of Sprinkler System Piping. FM clearly states in the *Exception: "Black steel pipe can be used in dry-pipe sprinkler systems equipped with closed-type sprinklers if the piping is filled with an inert gas".* Furthermore, the NFPA has reduced the C Factor of galvanized pipe to 100 in revision of NFPA 13 – 2013. This eliminates any benefit the designer would see in hydraulics performance by the previously higher C factor.

The conclusion is black steel coupled with an inert gas such nitrogen out performs any other combination for both cost and reliability. By reviewing Table 1 and Table 2 there is a clear cost savings in moving from the use of galvanized pipe and compressed air to black steel and nitrogen gas by means of a nitrogen generator. In doing so you not only reduce overall cost but install a fire sprinkler system that has on average a 5.3 times life expectancy. Clearly, nitrogen can be a cost effective measure.

Sources

Tihen (2013). *Corrosion Inhibition of Dry and Pre-Action Fire Suppression Systems Using Nitrogen Gas.* St. Louis, MO Potter Electric Signal Co., LLC

National Fire Protection Agency. 2013. NFPA 13: Standard for Installation of Sprinkler Systems. International Codes and Standards. Quincy, Mass., pgs. 13-25.

FM Global. 2014. FM Global Property Loss Prevention Data Sheets 2-0. Factory Mutual Insurance Company. Johnston, RI., pgs. 72-73