Inhibiting sprinkler pipe corrosion with nitrogen generation technology

As more facilities experience corrosion related failures, the demand for nitrogen generators continues to grow. It has never been as important as it is now to understand the key components and features that make up a reliable nitrogen generator.

The use of nitrogen to inhibit corrosion in dry and preaction fire protection systems is no longer an 'experimental' solution. In fact, its use is growing exponentially across the globe. Traditionally, compressed air has been utilized as the source for maintaining supervisory pressure within dry and preaction fire protection systems. However, oxygen makes up approximately 20.9% of compressed air and its presence is the driving force behind sprinkler pipe corrosion. Due to the constant availability of oxygen in the compressed air, any part of the sprinkler piping containing residual water originating from hydrotesting, flow testing, and/or accumulation of condensate from humid air, is highly vulnerable to electrochemical corrosion.

To better understand the effects of compressed air and nitrogen on sprinkler pipe corrosion, South-Tek Systems initiated the Fire Protection Industry's first and longest running exposure testing program. Both schedule 10 black and galvanized steel sections were subjected to a supervisory gas comprised of either compressed air, 95% or 98% nitrogen gas. Recent results of samples pulled after 2,893 days (approximately 7.9 years) showed that when exposed to supervisory gas of 98% nitrogen, the corrosion penetration rate in black steel pipe was approximately 67% less than it was when exposed to compressed air. By extrapolating the corrosion penetration rate, the projected black steel pipe service life extends from approximately 19 years to more than 60 years. In galvanized pipe, 98% nitrogen gas reduced the corrosion penetration rate by approximately 94% and extended the projected service life from approximately 9 years to more than 150 years.

The effect of 98% nitrogen gas supervision in real world installations

▼ Tubercle build-up on a cross-section of sprinkler pipe removed from a dry pipe system.

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demonstrate the same success as those provided by multiple clinical tests. Thousands of examples across North America are currently proving that the nitrogen generator's future in the industry is bright. Property owners and facility managers are looking for viable and cost effective measures to minimize the ongoing cost of sprinkler pipe replacement. This, in addition to 3rd party certifications such as FM Standard 1035, UL 508A ICP, and CE, are what's driving the Industry's acceptance and wide-spread use.

With the majority of nitrogen generators being installed into pre-existing facilities, of which most have experienced corrosion related failures, a large emphasis has been placed on designing a unit that is "plug and play". Meaning, with little modification to the existing fire protection system, a nitrogen generator can be integrated and commissioned in short time. To follow is a description of the key components you need to know before specifying or procuring your first nitrogen generator. These components include a feed air compressor, refrigerant air dryer, nitrogen generator, nitrogen receiver tank, automatic gas purging device, and nitrogen purity sensor.

Compressed Air Source

The term nitrogen generator can be misleading, in that a nitrogen generator is not creating nitrogen, but simply separating nitrogen molecules from the air we breathe. This is an intricate process since nitrogen molecules are very minute. Thus, an experienced manufacturer places a great amount of emphasis on such design considerations as the air flow patterns, air temperature, filtration, operating & delivery pressures, and purity versus volume to ensure the nitrogen generator can reach its full potential lifecycle. In addition to the air compressor, a refrigerant air dryer is vital to ensuring that the majority of moisture is removed from the feed air before it enters the nitrogen separation unit.

Nitrogen Generator/Separation Unit

There are two main technologies used in fire protection to separate nitrogen molecules; Membrane and Pressure Swing Adsorption (PSA). Membrane systems utilize a filtration process where air passes through hollow fibers at roughly 125 psi. This process forces oxygen, water vapor and other impurities out of the membrane, leaving only the nitrogen molecules to remain. PSA systems utilize an adsorption process, by which the compressed air passes through pressure vessels called sieve beds, which are filled with Carbon Molecular Sieve (CMS). Under pressure, the CMS material adsorbs oxygen, water vapor and other impurities from the feed air, allowing the nitrogen to pass through and into the fire protection system. In a properly designed and maintained nitrogen generator, membranes can last approximately 8-13 years, while the more efficient PSA systems last 20-25+ years before needing a low cost renourishment.

Automatic Gas Purging Device

Every dry or preaction system has at one point been at atmospheric pressure or initially filled with compressed air, making it imperative that the oxygen is depleted from the system. Therefore, an automatic gas purging device or AutoPurge System is installed at a remote section of the sprinkler piping network to displace the oxygen. As Fick's Law of Diffusion demonstrates, upon introduction to the fire protection system (typically near the valve), nitrogen will immediately begin to evenly distribute and typically within two weeks, the nitrogen purity concentration will reach 98% or greater throughout the piping network.

The AutoPurge System contains an engineered calibrated orifice similar to the one located within an air maintenance device. In essence, an AutoPurge System creates a minute purge so that fresh nitrogen can constantly cycle throughout the fire protection system. This is the key to maintaining 98% or greater purity at all times.

Image courtesy of South Tek Systems

▲ The N_2-Blast® FPS-650 Nitrogen Generator supervises up to 650 Gallons or 2,460 Liters of total sprinkler capacity.

Nitrogen Purity Monitoring

There are two types of technology available to confirm that 98%+ nitrogen purity has been achieved within the system. The least expensive option is a hand-held nitrogen purity sensor. This is a battery-operated device that manually connects to each AutoPurge System to provide a purity reading within a few seconds. The other, more permanent option, is the PowerSaver Manifold. This device is mounted to the wall, includes a touch-screen interface, and connects to each AutoPurge System to constantly monitor the nitrogen purity levels within each fire protection system. The PowerSaver Manifold samples the nitrogen purity within each zone of the fire protection system once per day. If the

Image courtesy of South Tek Systems

◀ Photograph represents a typical installation of a complete nitrogen generation system. Components from left to right include: The air compressor, refrigerant dryer, nitrogen generator, nitrogen receiver tank and PowerSaver Manifold.

purity within a zone is 98% or greater, the purge coming from the AutoPurge System is capped for 24 hours until the next sampling period. However, if the purity is less than 98%, the purge remains open until it is sampled again 24 hours later. Real-time purities, graphical trending and zone history are accessible on the interface and stored on the removable SD card. Dry contacts and analog outputs come readily available for connection to the building monitoring panel. Additionally, remote monitoring capabilities are provided via ethernet connection, allowing remote access to the PowerSaver Manifold from a computer, tablet or smartphone.

Preventing Sprinkler Pipe Ice Plugs

Up until this point, we have only discussed the benefits of nitrogen related to inhibiting sprinkler pipe corrosion. However, an equally important benefit to employing a nitrogen generator is that the extremely low dew point of 98% nitrogen gas prevents moisture build-up, and consequently, ice plugs, from occurring within the sprinkler piping. Ice plugs are commonplace in cold storage, freezer applications and/or regions that are subjected to temperatures lower than the dew point of the feed air going into the sprinkler piping.

Historically, air compressors have been paired with regenerative desiccant dryers to lower the dew point of the feed air. However, since compressed air is not an inherently dry gas, the air compressor and dryer should be constantly monitored and maintained in order to consistently achieve a dew point lower than the temperature of the sprinkler piping.

A nitrogen generator utilizing PSA technology ensures a true -40˚ to -56˚ Celsius dew point and ultra-low humidity discharge conditions within the sprinkler piping. Since in the vast majority of cases, the temperature of the sprinkler piping is greater than -40˚ Celsius, moisture is not tolerated with supervisory nitrogen and the fire protection system is void of any ice plugs.

Conclusion

Internal corrosion of sprinkler systems is one of the foremost issues facing the Fire Protection Industry. It leads to costly and extensive pipe repairs that can shut down or delay production in a manufacturing setting, cause catastrophic property and equipment damage in facilities such as data centers or museums, reduce usable space in garage and warehouse settings, and force relocation of tenants or patients in residential and hospital settings. More importantly, internal corrosion can cause sprinkler head blockage, reduce flow rates, and render fire protection systems completely inoperable in the event of a fire.

Integrating a nitrogen generator that provides 98%+ nitrogen purity will effectively inhibit Electrochemical, Galvanic, and Microbiologically Influenced Corrosion (MIC), significantly extend the sprinkler pipe service life, and provide years of trouble-free operation.

With that said, why isn't every facility worldwide not already using nitrogen generation technology? The answer is quite simple, education. It is up to the manufacturers, distributors, engineers and installers to continue to spread awareness about the benefits of nitrogen generation systems. Companies like South-Tek Systems provide a multitude of online and hands-on education and training opportunities, including system design, sales/estimating, installation and maintenance procedures. Contact your local representative today to learn more.

Checklist for a complete Nitrogen Generation System

Feed Air Compressor and Refrigerant Air Dryer Package

- Complete filtration package including particulate and coalescing filters
- Air receiver tank with automatic tank drain

Nitrogen Generator

- Outputs a minimum of 98% nitrogen purity
- FM Approved (per Standard 1035)
- CE Approved
- UL 508A Industrial Control Panel (ICP) Listed
- Included with a nitrogen receiver tank

AutoPurge System/Automatic Gas Purging Device

- One required per system/zone
- Tunable device based on FPS capacity
- Pneumatic device, should not require a power connection
- Provides outlet connection for monitoring nitrogen purity

Nitrogen Purity Monitoring

- At minimum, a hand-held purity analyzer should be provided for manual monitoring
- For automatic, remote, and continuous purity monitoring, a PowerSaver Manifold™ should be provided

For more information, go to www.southteksystems.com