Ice Plug Prevention in Dry and Pre-action Sprinkler Systems

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"It makes no difference if the weather is frigid or fiery – ice plugs can occur at any time of the year."[1] Dry and pre-action fire protection system ice plugs are commonplace in attic and roof spaces, parking garages, outdoor canopies and garden centers, as well as freezer systems. Examinations of existing freezer systems conducted by Factory Mutual found that ice plugs were present in more than 50% of those inspected.[2] When a system freezes, ice plugs obstruct the flow of water to sprinklers – impairing a system and often times resulting in its failure in the event of a fire. To safeguard against ice plugs in a dry or pre-action fire protection system, a primary objective is maintaining supervisory pressure with a dry, inert gas such as Nitrogen, which has an extremely low dew point.

How does Nitrogen supervision inhibit ice plugs within sprinkler piping?

Accumulation of condensate leads to ice plugs in dry and pre-action fire protection systems. Put simply by FM Global Senior Engineer, Antonio Braga, *"The more air that you pump into the system, the more moisture you're adding and the greater the chance for the formation of ice plugs".*[1] If the dew point of the supervisory compressed air within the sprinkler piping is greater than the temperature of the piping or facility itself, then condensation will occur and the piping may eventually freeze. Nitrogen is an inert gas with an inherently low dew point, especially if provided by a Nitrogen Generator employing Pressure Swing Adsorption (PSA) technology. PSA technology ensures a true -40° to -70°F dew point and ultra-low humidity discharge conditions within the sprinkler piping. Since in the majority of cases, the temperature of the sprinkler piping is greater than -40°F, moisture is not tolerated by supervisory Nitrogen and the fire protection system is void of any ice plugs. An increasing amount of new and pre-existing facilities have turned to Nitrogen by installing a Nitrogen Generation System, which provides an infinite supply and requires very little maintenance. Also, Nitrogen Generators include AutoPurge Systems, which allow for the constant introduction of very minute amounts of Nitrogen into a fire protection system. Over time, the cyclic venting of Nitrogen through a fire protection system dries out small areas of residual water and displaces Oxygen – a method which also inhibits corrosion within the piping. Computational Fluid Dynamics (CFD) modeling has proven this to be the most effective way to ensure that high purity Nitrogen reaches all branches within a fire protection system, thereby inhibiting moisture accumulation and the potential for ice plugs throughout the entire system.

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[1] FM Global. (2000). Record. *The Magazine of Property Conservation*, 16.
[2] FM Global. (2007). Property Loss Prevention Data Sheets. *Refrigerated Storage,* 15.

Alternatives to Nitrogen Supervision

An air compressor alone provides very little protection against moisture accumulation or corrosion within sprinkler piping. Compressed air, containing 20.9% Oxygen, exits the air compressor between 180° and 220°F and enters the sprinkler piping through the air maintenance device(s). As the warm air quickly cools to ambient temperature, moisture collects on the low temperature pipes and ice plugs may form within the sprinkler piping. An improved method is to pair an air compressor with a regenerative desiccant dryer. Typically, these configurations supply down to a -20°F dew point, offering better protection against moisture accumulation. However, since compressed air is not an inherently dry gas, it is imperative to properly maintain the air compressor and regenerative desiccant dryer in order to consistently achieve a -20°F dew point. The desiccant material within the dryer should be changed at least every 18 months. Failure to do so will result in an *increased* dew point and place extra strain on the air compressor motor and/or pump. As the desiccant material weakens, the dew point of the supervisory compressed air may rise above the temperature of the piping (freezer system temperatures may be -40°F), allowing moisture to accumulate and thereby compromising the integrity of the fire protection system with subsequent ice plugs. In addition, regardless of whether a regenerative desiccant dryer is present, compressed air constantly introduces 20.9% Oxygen - *the key ingredient in corrosion* - into the fire protection system.

Conclusion

Dry and pre-action fire protection systems are vulnerable to the accumulation of condensate – *and ensuing ice plugs* - as a result of inadequate sloping, failure to drain a system correctly, improper maintenance and lack of testing. However, even a well-designed fire protection system can collect moisture and potentially malfunction due to freezing. Taking proactive measures such as utilizing supervisory Nitrogen, draining all water after testing or false trips, and regularly inspecting the sprinkler piping will inhibit the occurrence of ice plugs. The ultimate goal is to install a fire protection system that effectively controls a fire in its earliest stages. Educate your customer and do not let an ice plug compromise the efforts you've taken to save lives.