Backflow Prevention in Nitrogen Gas Supervised Fire Protection Systems – Is there a requirement and/or need for it?

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The increased popularity of nitrogen generators for supervision of dry and preaction fire protection systems has raised questions with regard to the interpretation of the requirement that systems treated with corrosion inhibitors, be furnished with backflow preventers. In order to avoid confusion or the distribution of misinformation, the distinct differences between chemical corrosion inhibition (for which backflow prevention is required) and inhibition of corrosion by displacing oxygen with nitrogen (for which backflow prevention is not required), are discussed below.

Nitrogen generators separate the nitrogen from the air via membrane separation, which is simply a filtration process. This is a safe, nonchemical process that effectively separates the gasses within air, and therefore results in capturing pure, food quality nitrogen at low pressure. The nitrogen is then stored in a receiver tank, similar to an air tank under an air compressor, and then distributed from there to whatever the application may be.

Historically, air compressors have been used to supply pressurized supervisory air to dry or preaction systems. Compressed air is used as a supervisory gas to fill the sprinkler system piping in place of water to either prevent freezing and pipe damage, or to minimize the risk for water spillage in sensitive areas (i.e. data centers, museums, electronic manufacturing facilities etc). If and when a fire erupts, air pressure is relieved from within the fire protection system, and water is allowed to fill the sprinkler piping to flow to the open sprinkler head, putting out the fire.

An ever-present problem with supervisory compressed air is that it contains 20.9% oxygen - the driving force behind internal corrosion of steel sprinkler pipe. Most dry and preaction systems retain some residual water after hydrotesting and/or periodic flow testing. This residual water in combination with the oxygen in the supervisory compressed air then form an ideal electrochemical cell leading to corrosion of the steel piping from the inside out. The same phenomenon occurs in wet systems due to the presence of dissolved oxygen in the sprinkler water. However, the important difference is that corrosion in wet systems is self-limiting in the sense that the dissolved oxygen is consumed very quickly by the electrochemical corrosion reactions and corrosion is effectively arrested from that point forward (if the wet system is water-solid without pockets of trapped air).

Conversely, in dry and preaction systems the supervisory compressed air is an inexhaustible source of oxygen and therefore the corrosion will continue indefinitely as long as residual water is simultaneously in contact with both the supervisory compressed air and the steel pipe surface. By replacing compressed air with inert nitrogen, the driving force (oxygen) for the electrochemical reaction is removed and corrosion is inhibited as long as the purity of the nitrogen is maintained above approximately 98%.

This technique is sometimes referred to as corrosion inhibition, but differs greatly from chemical inhibition that is sometimes employed in wet sprinkler systems. Chemical corrosion inhibition relies on the principle that a chemical, which reacts with the metal surface, is added to the sprinkler water. Due to the chemical reaction, a protective, adherent, barrier layer of corrosion product is formed on the metal surface. In the same manner as a layer of paint, this layer of corrosion product deposits then effectively slows down or "inhibits" the corrosion reaction. It differs from inhibition by means of nitrogen in the sense that potentially toxic or environmentally unfriendly chemicals are added to the sprinkler water, which can contaminate the drinking water supply if backflow is allowed to occur. It is for this reason that backflow preventers are required for sprinkler systems using chemical inhibition, also referred to as chemical corrosion inhibitors.

In contrast, nitrogen gas is a completely inert, environmentally friendly, and harmless gas. The air we breathe typically contains 79% nitrogen, 20.9% oxygen and .1% helium, & argon (also an inert gas like nitrogen). The maximum solubility of nitrogen in water at room temperature is approximately 0.018 ppm, (which is about half the solubility of oxygen in water) and completely harmless to humans and animals drinking the water (i.e. the water we drink, contains Nitrogen). See the "Solubility of nitrogen in water" chart on page 3.

NFPA has recommended the use of "Supervisory Air or Nitrogen" for a long time and FM Global also recommends the use of supervisory nitrogen as an effective means to mitigate dry and preaction sprinkler pipe corrosion. The Fire Protection Industry has gravitated towards nitrogen generation technology because the systems provide a solution that is green, which won't negatively affect the environment or city water. Nitrogen is not a chemical corrosion inhibitor (i.e. a solution) that needs to be continually flushed into the sprinkler pipe and therefore Nitrogen does not require the installation of a RPZ backflow preventer. Nitrogen generation technology simply filters out the oxygen through a mechanical process and provides pressure to the fire protection system just as an air compressor would. Nitrogen also helps prevent sulfur smells, bacteria, and other harmful components that could negatively affect the city water supply.

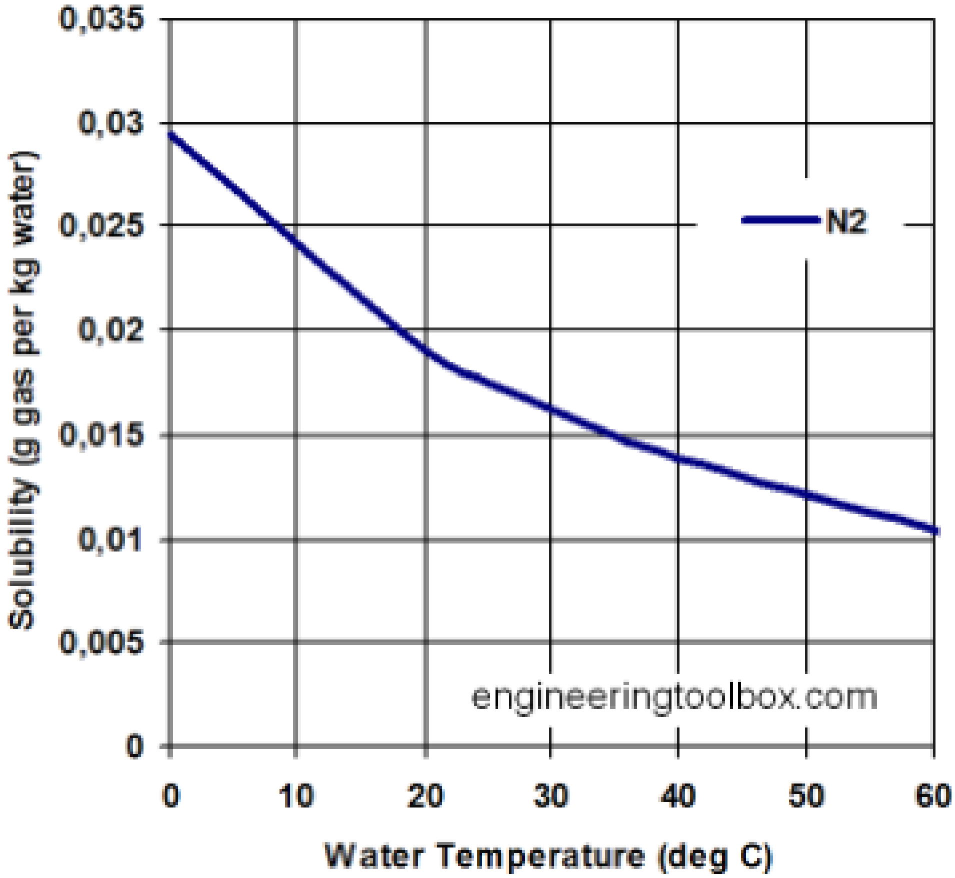

Figure 1. Solubility of nitrogen in water[1]

[1] http://www.engineeringtoolbox.com/gases-solubility-water-d_1148.html