Relative Humidity, Dew Point, and Pressure Dew Point - How They Relate to Corrosion in Dry Pipe and Pre-Action Sprinkler Piping

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Dry air prevents the process of oxidation from occurring by controlling the pressure dew point of the air to -26°C (-14.8°F) or lower. By removing water molecules (moisture) from the air, the electrolyte required to complete the process of oxidation is eliminated and corrosion cannot occur. Science technology has proven through experimental testing the effects of RH on the corrosion of iron and steel. Numerous tests have been conducted and the results have been reported through numerous associations such as CAGI, the British Museum, and many dryer manufacturers.

In experimental testing The British Museum conducted controlled tests on iron and steel samples. Pitting was hardly observed on the foils exposed at 33% RH or below after exposure for one year. The findings indicate that keeping iron at RH levels below 35% can significantly slow metal deterioration (*Wang, 2007*).

Critical RH (Relative Humidity)

The combined effect of the physical and chemical properties of a metal surface means that there is a “critical” relative humidity above which the corrosion rate “becomes rapid.” The actual value depends upon the nature and composition of the surface. Clean iron in pure air does not corrode until the air is practically saturated. However, if the air contains contaminants or pollutants, (even a trace (0.01%) of sulphur dioxide), the critical relative humidity drops to 70%. It is generally accepted that when RH is below 35-45%, no corrosion occurs. When RH is above 45%, corrosion can occur at an exponential rate the higher the RH is and when other contaminants are added to the environment, corrosion occurs at an even faster rate.

As a matter of scientific fact, a pressure dew point lower than the ambient temperature will avoid condensation in the compressed air piping system. But this is not enough to prevent corrosion. Depending on the pipe material, corrosion may start if the relative humidity in the air system is above 50%. Based on these facts, a relation between the ambient temperature and the pressure dew point required to avoid corrosion can be established.

The area below the dotted line represents a relative humidity lower than 50%, for example, for an ambient temperature of 25°C (77°F) a pressure dew point of 13°C (55.4°F) or lower is enough to prevent corrosion.

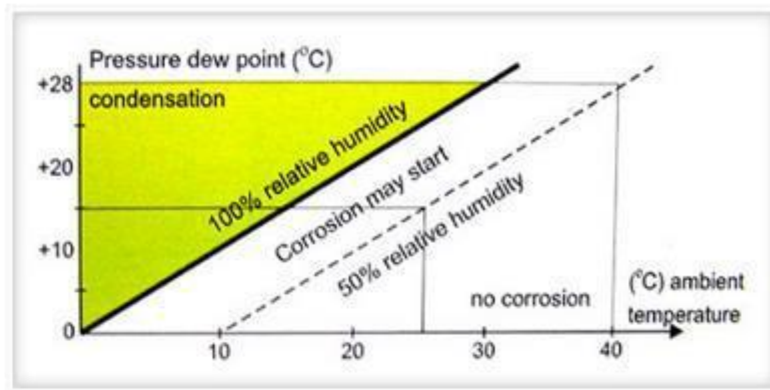

Figure 1.

The typical rate of corrosion for Ferrous Metals (Iron, Steel, etc.) can be shown graphically as follows:

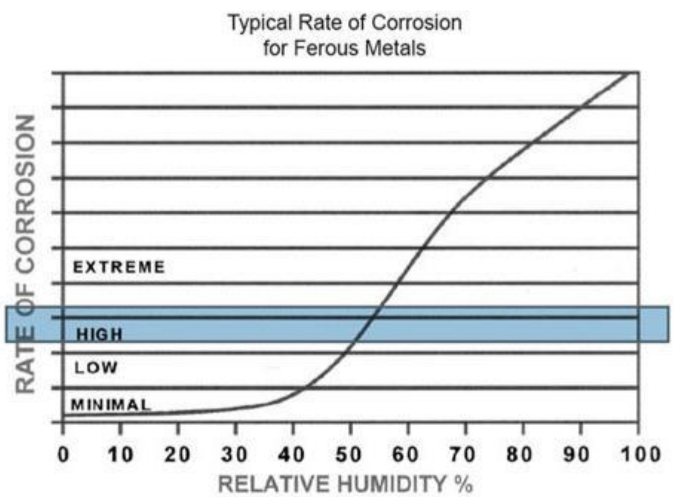

Figure 2.

Figure 2. graphically shows when RH reaches approximately 45%, the corrosion rate increases exponentially and when below 40% RH, minimal corrosion occurs.

Dew point is the temperature at which the moisture in a gas will condense. More specifically, it is the temperature at which the vapor pressure of a gas equals the saturated vapor pressure. As it relates to a dry pipe or pre-action sprinkler piping system, the gas in question has typically been air.

As the dew point of air is reduced, its ability to take in moisture is increased. The difference between dew point and relative humidity as a measurement of moisture in air is that relative humidity changes as the air temperature changes, but the dew point stays constant with temperature changes. Dew point is a measurement of actual water content. Relative humidity changes with temperature, even with the same amount of moisture in the air, because the density of air changes with temperature.

Generally speaking, compression increases dew point, and expansion (i.e. de-compression) lowers dew point. For this reason, the phrase pressure dew point (PDP) is commonly used. This term usually refers to the dew point of the compressed air at full line pressure. Conversely the phrase atmospheric dew point refers to what the dew point would be if fully depressurized to atmospheric conditions. Correspondingly it is sufficient to say that maintaining a pressure dew point below -26°C (14.8°F) will minimize compressed air piping system corrosion (Parker Hannifin, 2010).

In the Food and Pharmaceutical industry where air is in direct or indirect contact with equipment, ingredients, packaging, or finished products, a -40°F pressure dew point (PDP) is recommended. This is primarily driven by the fact that a PDP of -26°C or (-14.8°F) will not only virtually stop corrosion, it will also inhibit the growth of micro-organisms (Parker Hannifin, 2010).

The following table 3. shows Dew Point at atmospheric pressure, Relative Humidity (RH) at 70°F and Pressure Dew Point (DP) at 40 PSIG equivalents:

Dew Point °F / °C	RH (Relative Humidity) @ 70°F (21.1°C)	PDP (Pressure Dew Point) @ 40 PSIG) °F / °C
68 / 20	93.5	98.6 / 37
50 / 10	42.9	78.8 / 26
32 / 0	24.4	59 / 15
14 / -10	10.4	35.6 / 2
-4 / -20	4.3	15.8 / -9
-22 / -30	1.52	-4 / -20
-40 / -40	0.516	-23.8 / -31

Table 3.

Summary: For dry pipe and pre-action sprinkler pipe corrosion to be minimized, the target pressure dew point dryness of -26°C (-14.8°F) should be utilized. The supply compressed gas (air) needs to be treated to obtain a -40°F dew point when it enters the piping system to maintain a pressure dew point of -26°C (-14.8°F). This pressure dew point will provide the highest level of corrosion protection to the piping system.

References

1. Wang, Quanyu, The British Museum Technical Research Bulletin, Volume 1, 2007. Article: *Effects of Relative Humidity on the Corrosion of Iron: An Experimental View;* From: *www.britishmuseum.org*, Last viewed: July 31st, 2018.

2. Parker Hannifin, Ltd., Article: *High quality compressed air for the food industry*; From: *www.dominickhunter.com*, Last viewed: July 31st, 2018.