GW
SPRINKLER SYSTEM
WATER QUALITY RECOMMENDATION

The durability and operational reliability of any automatic sprinkler system is highly dependent on its design for purpose and continued external and **internal** maintenance & testing.
The real thread and “silent killer” of a pressurized wet sprinkler system is normally invisible to the eye, as it is located inside the pipe work. It is the **highly complex** interaction between chemical, physical and biological elements in – and in contact with, the sprinkler water.

Depending on the amount of these elements present (single and in combination), the water pressure and the temperature, - the environment in the sprinkler system, or parts of the sprinkler system, can vary from **acidic** (sour), over **neutral** to **alkaline** (basic).

The following elements are considered important for determining and predicting the actual state of the sprinkler water quality – and the potential long- and short term **corrosion** or **scale forming** in the sprinkler system:

Element	**Description**	**Effects**
pH	The pH is a measurement of the acidity, or alkalinity, of a water.	If a water’s pH is below 7.0, it is said to be acidic, and **corrosion** rates can increase. If a water’s pH is above 7.0, it is said to be alkaline in nature, and calcium carbonate and iron compounds are less soluble, which can lead to **formation of scale**. With increasing amounts of acid gases (hydrogen sulfide and carbon dioxide) the pH of the water will decrease. Understanding their effect on pH will help us to understand and predict their impact on the corrosivity of the water.
TDS	Total Dissolved Solids	The materials (specifically, ions) dissolved within water are known as the total dissolved solids, or TDS. TDS is anything else than pure H_2O in water, that one cannot see.
Conduc-tivity	The resistance to electrical flow	The resistance to electrical flow (resistivity) is a function of the number of ions dissolved in the water. Lower resistivity (higher conductivity) results in the potential for higher corrosion rates. The lower the resistivity, the higher the conductivity, and the higher the concentration of ions; the higher the resistivity, the lower the conductivity, and the lower the concentration of ions. This property aids in predicting the corrosivity of the water and is an important property in the identification of water sources. It is directly related to the total dissolved solids (TDS) and serves as a good check/balance test for the water analysis’ accuracy.
Total hardness	Mineral content in the water	The total hardness of water is the sum of 1) **Carbonate hardness** (i.e. Carbonate, CO_3 + Bicarbonate, HCO_3) and 2) **Non-carbonate hardness** (typically silicate, chlorate, sulfate).
Alkalinity	Robustness to change in pH	Is closely related to water hardness and is a meassure of how well the water solution can absorb acidic inputs without significantly changing its pH value. High alkalinity gives high robustness against acidic exposure.
O_2	Dissolved oxygen	Dissolved oxygen contributes significantly to the corrosivity of a water. It acts as a catalyst in the corrosion reaction of hydrogen sulfide and/or carbon dioxide on metallic equipment. Furthermore, dissolved oxygen can react with hydrogen sulfide and result in the formation of elemental sulfur. Oxygen can react with soluble iron present in sweet production systems and result in the formation of iron oxide. Any of these solids can result in plugging problems. Oxygen also facilitates the growth of aerobic bacteria.

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Element	Description	Effects
CO_2	Dissolved carbon dioxide	Dissolved carbon dioxide influences the pH, the corrosivity and the calcium carbonate scaling tendencies of a water.
H_2S	Sulfide	Hydrogen sulfide will also affect the pH and the corrosivity of a water. Hydrogen sulfide may be naturally occurring or may be the result of sulfate reducing bacterial activity. The corrosion product of hydrogen sulfide corrosion of ferrous materials is iron sulfide – which is a very efficient plugging agent. Furthermore, depending on the concentration of the H_2S and the pressure of the system, hydrogen sulfide can also crack certain metallic substances.
Bacterial population	MIC Microbiologically Influenced Corrosion	The presence of bacteria can result in accelerated corrosion and/or plugging problems in filters. Many techniques are available for enumeration. However, it should be noted that bacteria can result in souring an otherwise sweet system, can produce organic acids and can exist in “microenvironments” under deposits present in systems.
Cations	Positively charged ions	In a completed water analysis, the milli-equivalents of cations must balance to the milli-equivalents of anions. In other words, all anions are matched up with cations. How these cations and anions “pair-up” is related to their reactivity, solubility, and availability within the water.
Ca^{++}	Calcium	This ion is of major importance due to its ability to combine with bicarbonate, carbonate or sulfate ions and precipitate mineral scales, adherent and/or suspended.
Fe^{++}	Iron	Many times, its presence signifies active corrosion. Iron counts are often utilized in “sweet” systems (systems not containing hydrogen sulfide) to monitor and semi-quantify corrosion rates. In “sour” systems, the iron will be present as a form of iron sulfide and is often responsible for plugging issues within pipe equipment. Iron sulfide is almost always an indicator of corrosion, bacterial activity, or incompatible mixtures of water.
Mn^{++}	Manganese	Manganese is an alloying material utilized in the steel milling process; therefore, its presence can be an indicator of active corrosion of metallic components. When analyzed, trends can be developed to enable the engineer to evaluate active corrosion, or evaluate the effectiveness of a corrosion inhibitor program. The manganese levels are generally analyzed in conjunction with total iron counts and are usually 1/100th of the iron level when originating from the metallic materials.
Anions	Negatively charged ions	In a completed water analysis, the milli-equivalents of cations must balance to the milli-equivalents of anions. In other words, all anions are matched up with cations. How these cations and anions “pair-up” is related to their reactivity, solubility, and availability within the water.
Cl^{-}	Chloride	It is also a major constituent of fresh waters. Usually the concern with chlorides is that with increasing chlorides comes increasing conductivity and thus, increased corrosion.
CO_3 HCO_3	Carbonate Bicarbonate	These ions are important because they are the natural buffer for the water. These ions will influence the pH of a water, and the pH of the water will define which ion, or if both ions, are present in a water sample. Bicarbonates are present in waters with pH’s ranging from 4.5 – 8.2. Above 8.2, carbonates can also be present. These ions can combine with cations to form insoluble mineral scales. Most carbonate scales are soluble in hydrochloric acid.

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Element	**Description**	**Effects**
SO_4	Sulfate	The sulfate ion is important because of its ability to react with calcium, barium and/or strontium to form acid insoluble scales. This also serves as a nutrient for sulfate reducing bacteria (SRBs).

The optimum water quality for a pressurized wet sprinkler system is characterized by the following parameters:

- Non-corrosive
- Non-scale forming
- Balanced / Saturated
- Stable
- Biological and bacterial (**MIC**) neutral *)
- Colorless & odourless

The following element specifications will support the above parameters – and are recommended for wet sprinkler installations involving GW automatic sprinkler heads – and water mist nozzles:

Element	Required	Recommended
Water	Fresh – equivalent of potable supply.	
pH	7 - 9	8,5 - 9
TDS, ppm (mg/l as $CaCO_3$)	100 – 500	100 - 300
Conductivity, µS/cm	~ TDS / 0,7	140 - 430
Total hardness, ppm as $CaCO_3$	80 – 600	90 - 400
Dissolved O_2 (ppm)	< 0,1	< 0,04
Dissolved CO_2 (mg/l)	< 20	
Chloride, ppm	< 50	
Free chlorine	0	
Iron (Fe) + Manganese (Mn), mg/l	< 0,35	
Sulphate, mg/l	< 50	

Distilled, demineralized, de-ionized or reverse osmosis water (typically “soft” water) should not be used without adjustment of the pH / alkalinity / water hardness in accordance with above values.

*) For further information and guidance on inspection and maintenance in general – and specifically **MIC** (Microbiologically Influenced Corrosion), it is recommended to consult relevant internet sites, e.g. http://xlcatlin.com/insurance/insurance-coverage/property-risk-engineering/gaps-guidelines,

Document: GAP 12.0.2 - Inspection, testing and maintenance of water based fire sprinkler systems.
Document: GAP 12.0.2 A - Summary of minimum inspections, test and maintenance frequencies.
Document: GAP 12.0.3 - Microbiologically Influenced Corrosion in sprinkler systems.

Complete water supply microbial analysis should be conducted semiannually on each system.
Water samples should be taken from system riser main drains and at a system remote connection point.
Similar testing should also be completed at the all fire pump reservoirs and tanks if applicable.
Positive results will require repeating the sterilization process.

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