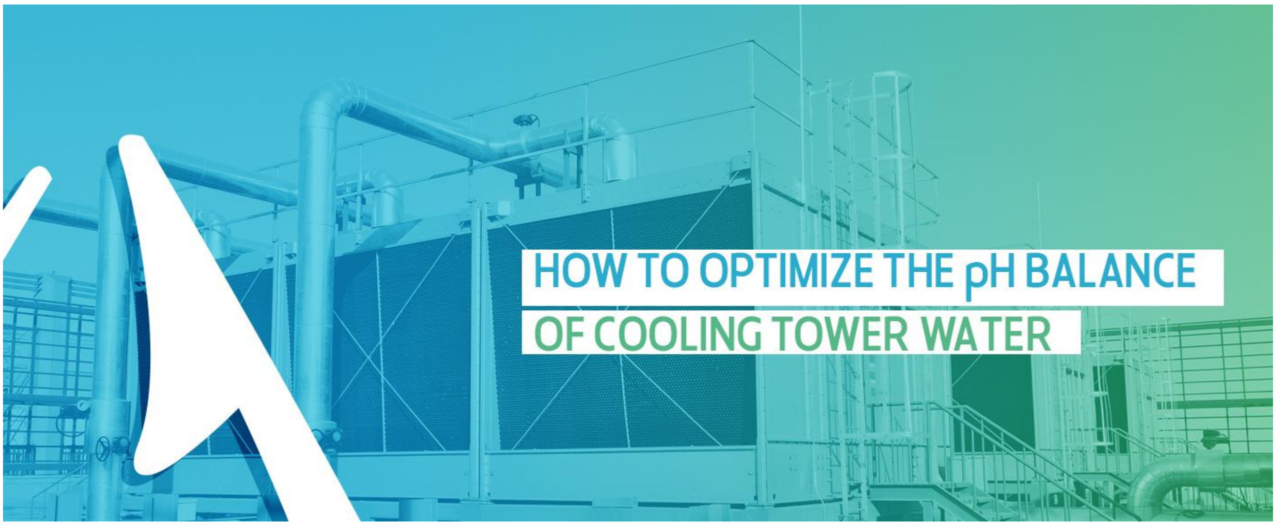
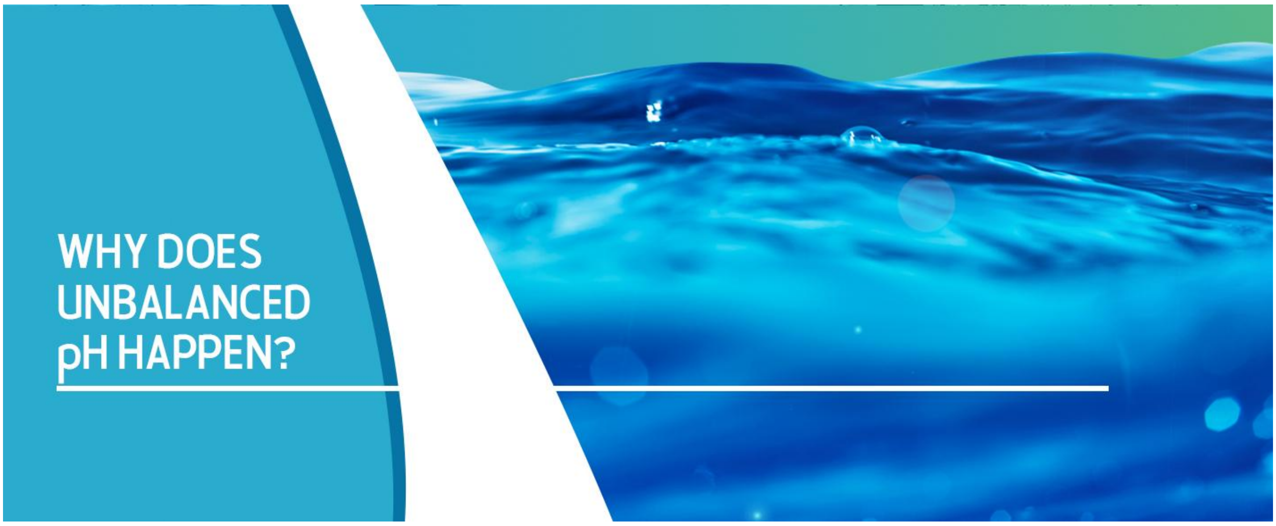
How to Optimize the pH Balance of Cooling Tower Water



So many businesses rely on cooling towers to perform vital services such as air conditioning, manufacturing and electric power generation. But cooling towers also pose several challenges in their upkeep. Chemical control of the water in the cooling tower is critical to your cooling system and the tower's integrity.

Poor pH balance could result in expensive damage or contamination to your system. It can accelerate corrosion and reduce the longevity of your cooling tower and the connected systems. Understanding why cooling towers are a prime source of contamination and how to correct problems will help you preserve your system and protect it from harm.

What Causes Unbalanced pH?



The chemical property known as pH, or "power of hydrogen," refers to the balance of hydronium ($H3O+$) or hydrogen ($H+$) and hydroxide ($OH–$) in an aqueous solution — in this case, your process water. It determines how acidic or basic the water is. The more alkaline — more basic — a solution is, the more hydroxide it contains and the higher its pH. The more acidic the solution is, the more hydronium it contains and the lower its pH.

The pH scale is a logarithmic scale. For every 1 increase in pH, the alkalinity increases by a factor of 10. The neutral pH of pure water is 7. Measurements below 7 correspond to acidic solutions. Stronger acids have lower pH values.

Imbalances in cooling tower pH occur because the water is not pure — it is composed of more than just oxygen and hydrogen. Most process water contains significant concentrations of dissolved minerals, which tend to change the pH of the tower water, often significantly. These minerals can collect and cause scale to form on the cooling tower's internal surfaces.

In cooling towers, the main mineral accumulation is calcium carbonate. This product forms as a result of reactions with calcium, heat and bicarbonate. Calcium carbonate tends to increase the pH of the water, making it more alkaline. Acids like ascorbic acid, hydrochloric acid and sulfuric acid can be used to combat the rise in pH, but they can damage the cooling tower if it contains certain materials.

The allowable pH ranges for different cooling towers vary. The material the tower is made from determines the ideal pH of the water as well as possible treatments against scale and corrosion. Galvanized steel's optimum pH ranges from 6.5 to 9, but type 316 stainless steel has a broader pH range, from 6.5 to 9.5.

Iron, likewise, is highly soluble in water, and therefore subject to corrosion, at a pH between about 9 and 11.5. However, even when a facility maintains pH in the desired ranges, issues can still often develop in the absence of inhibitor treatments.

Other properties of the water, such as conductivity, hardness and alkalinity, also have different target values depending on the tower's material because of potential reactions between the metal and minerals in the water.

Which Water Treatments Work and Which Cause Complications?

Water treatment options are not universal for all cooling towers. For example, while using acids to neutralize alkaline water in cooling towers is an option, this may not always be the best course of action.

In one example cited by Power Magazine, when the standard method of reducing alkalinity involved adding sulfuric acid, the carbonate in the water turned into carbon dioxide. To complement the treatment, experts also treated the water with sodium dichromate, which created toxic hexavalent chromium.

Since then, acid treatments have diminished in popularity, replaced by chemical treatment programs. Alkaline phosphates with anodic and cathodic scale inhibitors are often effective. Polymer treatments are also increasing in popularity. We recommend that your facility always get a customized tower water treatment plan for the best results.

Why Is It Important to Optimize the pH Balance of Cooling Tower Water?

Maintaining balanced pH levels for your tower is critical for preventing scale and corrosion. The ideal pH values depend on the metal the cooling tower is made from, since solubility at specified pH ranges tends to differ for different metals. If you have doubts about the proper pH levels for your tower water, ask your water treatment company for recommendations.

A pH between 6.5 and 7.5 is generally considered the ideal range for reducing scale formation, though some non-acid treatments for scale prevention can increase the cooling tower pH range up to 8.5. The pH also depends on the cycles of concentration (COC). Operating at higher COC allows the tower water to have a higher pH, even up to 10.

Even when your facility maintains the proper pH levels for preventing scale, other problems may arise. For instance, chlorine does not kill microbes as effectively in water more alkaline than a pH of 7.5. For tower water containing microbial life, chlorine may not be the best treatment option, especially if the water has a high pH. Other options are more effective at high pH values — chlorine dioxide, for instance, works well regardless of the pH of the water.

One means of protecting against corrosion in towers made of stainless steel, copper or steel is increasing the pH to 8.5 or above. Raising the COC allows the carbonate concentration in the water to increase, boosting the alkalinity. Though higher alkalinity levels can cause scale formation, they prevent corrosion in certain types of metals and also inhibit bacterial growth.

When the pH deviates from the prescribed range, several undesirable effects may occur:

White rust: If the pH rises above 8.3 and the water contains a high concentration of carbonate ions, cooling towers made of galvanized steel can develop white rust.
Aluminum corrosion: With pH values above 8, the chance of aluminum corrosion in a cooling tower increases. The likelihood of corrosion is even higher at pH values above 8.4.
Iron corrosion: With pH values between 7.5 and 8, iron and iron alloys in the cooling tower can experience corrosion.
Corrosion from pollutants: Open towers in urban areas have a particular problem with corrosion. The water in the tower comes into contact with the same gases that cause acid rain. These gases reduce the pH of the water and make it more corrosive. Monitoring for corrosion with weighted coupons and balancing the pH of the water can mitigate the effects of having an open cooling tower in a pollution-prone area.
While these problems pose challenges for your facility, they can be controlled and corrected. With careful monitoring and control of the water chemistry, you can balance pH while reducing the chances of corrosion and scale.

What You Can Do to Balance Tower Water pH

Maintaining the ideal pH balance in tower water is a continual process that requires constant vigilance and control. Following all these steps will help ensure the proper pH balance for your facility:

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