SPA VS POOL CHEMISTRY

A spa is not a small swimming pool. Reactions happen faster in warmer water, placing even more dependence on the need to maintain sanitizer levels

By the Recreational Water & Air Quality Committee (RWAQC)

SWIMMING POOLS AND hot tubs offer distinct aquatic experiences with one of the primary differentiators being the water temperature. As outlined in Section 3.1 in the ANSI/APSP/ICC-11 2019 American National Standard for Water Quality in Public Pools and Spas, pools are typically maintained at between 78 to 82 degrees Fahrenheit. These temperatures allow for a refreshing escape on warm days, providing a cool and invigorating environment for recreational activities. On the other hand, hot tubs have a maximum temperature of 104 degrees Fahrenheit, as they are designed to be a warm oasis, offering a soothing and relaxing experience. Recognizing the significance of temperature differences in aquatic environments is crucial as it affects sanitation, water balance, and overall enjoyment for patrons.

Chemists have long studied kinetics to understand how it influences chemical reactions. The Arrhenius equation, formulated by Swedish chemist Svante Arrhenius over 100 years ago, provides the mathematical expression that describes the temperature dependence of reaction rates. Applying these principles to the pool and hot tub water, which exhibit a temperature difference of approximately 18 degrees Fahrenheit, reveals that reactions in a hot tub will occur at a rate approximately twice as fast.

With the understanding that reactions unfold more rapidly in the warmer environment of a hot tub, the role of sanitizers becomes even more critical in maintaining water quality. The elevated temperature not only influences the chemical reactions but also increases the microbial activity which includes reproduction, toxin production and infectivity.

The impact of temperature on microbes depends on the type of microbe. Temperature has a significant impact on the bacteria that cause Recreational Water Illnesses (RWIs). But in the hot water of hot tubs, the growth rate on infective potential of Pseudomonas aeruginosa and Legionella pneumophila are increased. The infective units of Cryptosporidium (oocysts), Giardia (cysts) and viruses are not impacted by the temperatures encountered, as these are dormant until ingested and germinate in the gastrointestinal (GI) tract.

Regardless of what sanitizer, chlorine

or bromine based, is being used in the water, the corresponding hypohalous acid (i.e. hypochlorous acid (HOCl) or hypobromous acid (HOBr)) is being generated as it does the sanitizing. The sanitizers are consumed or depleted, and disinfection by-products (DBPs) are formed, more rapidly at higher temperatures (see Sections 5.2 & 5.3 in the APSP-11 Standard). This means that the sanitizer will have more frequent interactions with organic material (e.g. sweat, body oils, sunscreen, lotions, environmental debris and bacteria). This heightened interaction amplifies the likelihood of the formation of DBPs, which, if not managed properly, can compromise water quality, lead to unpleasant odors, and pose potential health concerns for users. Therefore, diligent monitoring and maintenance of sanitizer levels, coupled with effective water circulation and filtration systems, are paramount to ensuring a safe and enjoyable environment.

Now that we have briefly discussed the interactions between a sanitizer's effectiveness and organic material in the pool environment, the topic of how temperature impacts the solubility of calcium carbonate scale needs to be discussed. Calcium carbonate scale is a white, chalky solid that tends to accumulate on pool surfaces, plumbing systems, and heater coils. Unlike other salts, like your common table salt, i.e., sodium chloride, as temperature increases, the solubility of calcium carbonate decreases. This is demonstrated by using the saturation index and changing the temperature factor of a balanced water to higher temperatures; the water will become more scale forming (see PHTA Water Balance Indexes Fact Sheet, 2017). Compounding the challenges faced by pool and spa owners, scale can provide a surface for organic contaminants to adhere to, allowing for an environment suitable for the growth of bacteria and other microorganisms. Regular monitoring, along with adjustments to maintain optimal water quality parameters, is essential for preventing scale formation and ensuring the longevity and efficiency of equipment.

POOL AND SPA WATER TESTING – TEMPERATURE EFFECTS

Chemical reactions of reagents for testing pool water are affected by temperature just like the reaction in the water. But is it significant to affect the result of the test? Most water test reagents react very quickly. If a chlorine DPD reaction in pool water is complete in one second at about 80 degrees Fahrenheit, then in a spa at 104 degrees Fahrenheit, the reaction should take about half a second. Compared with the time it takes to perform the test, this is an insignificant difference because the reaction is complete at both water temperatures. This is true of most of the reactions in most pool and spa water testing. Another thing to note is that the sample water temperature can change while setting up and running the test. A spa water sample when transferred to small testing vials or comparators may cool down significantly. This means the testing temperature of spa water is often close to ambient temperatures. Most manufacturers recommend testing between 50 degrees Fahrenheit and 90 degrees Fahrenheit — however, the best advice is to follow the instructions from the manufacturers.

One reaction which does not occur quickly is the reaction with combined chlorine. Combined chlorine includes monochloramine, dichloramine, trichloramine and a variety of organic amines, which are all disinfection by-products. These DBPs may take 30 seconds or more to react with the test reagent. Manufacturers may recommend waiting 30 seconds before taking a total chlorine reading.

Cyanuric acid testing does have a known temperature affect. High temperatures, above 90 degrees Fahrenheit, can result in readings as much as 15 ppm low. The ideal temperature is about 75 degrees Fahrenheit. Again, moderating the water temperature before testing is suggested.

Portable electrochemical sensors and probes can be subject to temperature interferences. Many pH and salt testers have built in temperature compensation. Read the instruction manual to see if your probe is temperature compensated. If they are not, moderate the water temperature before testing. ORP probes typically do not have a significant temperature interference. Again, check the user's manual.

CONCLUSION

Every pool and hot tub owner, maintenance technician, and operator is advised to gain an understanding of the water chemistry at work in any recreational body of water — and water temperature is a critical detail to examine.

Water quality degrades faster in hotter water, placing even more dependence on the need to maintain sanitizer levels. Water testing results can vary based on temperature, and pool scale behaves differently in a steaming hot tub than it does in a refreshing pool. Understanding the temperature dependence of chemical reaction rates can support the ongoing maintenance of a clean and safe hot tub. Strict adherence to manufacturer testing instructions is crucial, as well as knowledge of industry-accepted standards such as the APSP-11 2019 American National Standard for Water Quality in Public Pools and Spas.

Tip: An automated chemical controller can maintain a residual of sanitizer as needed (as referenced in this article regarding level of sanitizer).

Additional information: For more information, see the PHTA Fact Sheets on Water Balance Indexes and Common Interferences in Pool and Spa Water Testing, which are available on the PHTA website at https://www.phta.org/standards-and-codes/fact-sheets/water-quality/ ~

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