POOL & HOT TUB ALLIANCE

May 2021

FACT SHEET

Alkalinity

Brought to you by the PHTA Recreational Water Quality Committee (RWQC)

I. INTRODUCTION

This fact sheet discusses alkalinity, its relationship to water balance for pools and spas, and how it is measured and controlled.

II. SUMMARY OF CHARACTERISTICS

- Carbonate alkalinity is the portion of the alkalinity coming from bicarbonate and the much smaller amount of carbonate in the pool or spa water. It affects calcium carbonate ($CaCO_3$) saturation index or LSI (Langelier Saturation Index) in the water.
- Total alkalinity is a measure of the amount of bicarbonate, the much smaller amount of carbonate, and in stabilized pools, the amount of cyanurate ions. It is a measure of the pH buffering capacity of water; that is, the ability of water to resist a pH change.
- Carbonate and total alkalinity are generally expressed in terms of the equivalent concentration of $CaCO_3$ in ppm.
- **Total alkalinity is a key parameter in the maintenance of water balance.** When total alkalinity is properly adjusted, pH, swimmer comfort, sanitizer efficacy, water balance, and clarity are more easily maintained.
- At excessively high carbonate alkalinity there will be a tendency for the pH of the water to drift upward, due to the rapid escape of carbon dioxide from the water into the air.

III. GENERAL DESCRIPTION

The recommended total alkalinity level in pool or spa water provides buffering so that pH does not swing in and out of the proper range in response to sanitizer addition, bather load or other factors. With too little total alkalinity there will not be enough buffering and the pH may quickly drift out of the proper range. The maintenance of $CaCO_3$ concentration within the recommended range reduces the tendency of pool and spa water to scale or etch surfaces. The ANSI/APSP/ICC-11 2019 *American National Standard for Water Quality in Public Pools and Spas* by the Pool & Hot Tub Alliance states that total alkalinity shall be maintained between a minimum of 60 ppm and a maximum of 180 ppm as $CaCO_3$. Ideally, total alkalinity should be maintained between 80 and 100 ppm as $CaCO_3$ where electrolytic chlorine generators, calcium hypochlorite, lithium hypochlorite, and sodium hypochlorite are used, because these sanitizers cause the pH to rise. Where sodium dichlor, trichlor, chlorine gas and bromine are used, the ideal range is between 100 and 120 ppm as $CaCO_3$, because these sanitizers will cause the pH to drift downwards. Polyhexamethylene biguanide (PHMB)

sanitizer efficacy in controlling bacteria is unaffected by total alkalinity changes and the sanitizer does not impact total alkalinity, but still it is important to maintain total alkalinity in biguanide treated pools to maintain water balance and clarity in pools. The total alkalinity in biguanide pools has a recommended range of 80 to 150 ppm.

IV. APPLICATION

Total alkalinity is most often measured using test kits or test strips. Carbonate alkalinity is calculated from total alkalinity, cyanuric acid (CYA) and pH (see calculation below). Carbonate alkalinity should always be used when calculating LSI. Total alkalinity of pool or spa water should be corrected before adjusting pH or sanitizer levels.

To reduce total alkalinity, acid is added to the water. Approximately 2.1 pounds of sodium bisulfate (94%) or 1.6 pints of muriatic acid (31%) will reduce the total alkalinity of 10,000 gallons of water by 10 ppm.

Sodium bicarbonate is used to increase total alkalinity. Approximately 1.5 pounds of sodium bicarbonate (100%) will raise the total alkalinity of 10,000 gallons of water by 10 ppm.

Calculating Carbonate Alkalinity:

Dichlor and trichlor sanitizers release CYA which serves to stabilize the chlorine sanitizer. CYA stabilizer may be added separately as well. The cyanurate system is a weak buffer and will contribute to the total alkalinity concentration.

The approximate carbonate alkalinity is often calculated by subtracting one-third (1/3) of the CYA concentration in ppm from the total alkalinity concentration in ppm as $CaCO_3$. A more accurate calculation of carbonate alkalinity is given below:

1. Measure the pH.
2. Measure total alkalinity (Measured TA).
3. Measure CYA concentration. If the CYA is 90 ppm or greater, it may be necessary to dilute the pool water sample with tap water to get an accurate reading.
4. Multiply the Cyanuric Acid Correction Factor in Table 1, based on the pH of the water, by CYA concentration to adjust the CYA.
5. Subtract the adjusted CYA from the total alkalinity to get the carbonate alkalinity.
6. Formula: Measured TA – (CYA x Cyanuric Acid Correction Factor) = Carbonate Alkalinity

Table 1: Cyanuric Acid Correction Factor

pH	Factor
7.0	0.23
7.2	0.27
7.4	0.31
7.6	0.33
7.8	0.35
8.0	0.36

Example:

pH is 7.4. Total Alkalinity measurement (Measured TA) is 110 ppm. Cyanuric Acid level is 100 ppm.
Cyanuric Acid Correction factor at pH 7.4 is 0.31. (From Table 1)

Using the formula:

110 ppm – (100 ppm x 0.31) = 110 ppm – 31 ppm = 79 ppm carbonate alkalinity

V. PRECAUTIONS

Follow all label directions regarding safe storage and handling of any chemical products.

VI. REFERENCES

1. ANSI/APSP/ICC-11 2019 *American National Standard for Water Quality in Public Pools and Spas*, Pool and Hot Tub Alliance, 2019
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3. Wojtowicz, J.A. "Treatment of Swimming Pools, Spas, and Hot Tubs," Kirk – *Othmer Encyclopedia of Chemical Technology*, Fourth Edition, Vol. 25, John Wiley and Sons, Inc., New York, NY, pp 569-594, 1998
4. Wojtowicz, J.A. "The Carbonate System in Swimming Pool Water," *Journal of the Swimming Pool and Spa Industry*, 3(1)(2001):54-59, 2001
5. RWQC "Water Balance Indexes" Fact Sheet, Pool & Hot Tub Alliance, 2017, https://www.phta.org/pub/?id=0944F15C-1866-DAAC-99FB-94B844527165