CSS

Complete Sanitation System
Ozone/Salt Chlorinator

PROZONE
Ozone Water Purification Systems

Basic Pool Chemistry

The Table below summarizes the levels that are recommended by The Association of Pool and Spa Professionals (APSP). It is important to maintain these levels in order to prevent corrosion or scaling and to ensure maximum enjoyment of the pool. Test your water periodically. Take a water sample in to be professionally tested by a Pool and Spa Professional at least once a month. Be sure to tell your local Pool Store that you are using a Complete Sanitation System, Ozone/Salt Chlorine Generator Combination System.

pH	7.2 to 7.6
Alkalinity	80 – 120 ppm
TDS	< 1,000 Excluding Salt
Cyanuric Acid	30 – 70 ppm
Salt Levels	2500 to 3000 ppm
Free Chlorine	.5 to 1.5 ppm
Calcium Hardness	60 to 400 ppm
Metals	0 ppm
Nitrates / Phosphates	< 30 ppm

1 Basic Pool Chemistry Terminology

WATER BALANCE: The balance of your pool is critical to monitor even after you have installed your CSS System. Control of water quality in a pool with minimal chemical dosing and maximum disinfectant effectiveness is controlled by a variety of factors. The most important are defined here along with their impact on pool water quality and system effectiveness. These factors are: Chlorine, pH Value, Alkalinity, Hardness, Dissolved Solids and Temperature.

1.1 Chlorine Tests & Requirements

Free Chlorine: A 'free' Chlorine residual of 0.5ppm to 1.5ppm should be maintained at all times. This will vary only with respect to bathers in the pool, debris falling into the pool, and the pools overall temperature. These factors will affect the demand for chlorine and also the water balance and filtration effectiveness (refer to the equipment manufactures specifications with regard to the maximum chlorine level permissible).

This lower level of residual chlorine is possible because your Ozone system has the potential to oxidize and sanitize between 60% and 80% of all the contaminants in the pool's water. Free Chlorine provides a high level of sanitizing power and has no odor or irritating effects.

Testing for Chlorine - Testing for Chlorine levels is very important and should be performed regularly by the pool owner, as well as a pool water professional on a periodic basis.

Residual Water Test - The sample of water to be tested should be taken at arms depth away from the pool returns. This will avoid highly chlorinated water coming from the Chlorine Generator Cell, and ensures that the reading will be a true representation of the pool's residual chlorine levels.

Production Water Test – Testing for Chlorine production is performed by taking a sample directly at the pool return, which is water directly from the Salt Generator Cell, and should indicate a higher chlorine level than the residual test showed.

Combined Chlorine vs. Free Chlorine - Combined Chlorine, which includes Chloramines, is a molecule of Chlorine that has attached to a contaminant in the pool water. It remains bound together until it is either burned off through breakpoint chlorination (an unpleasant procedure) or Ozonation. Combined chlorines are most often associated with odors, eye irritation, and other unpleasant side effects of chlorination.

NOTE: The use of a chlorine generator still requires that water be balanced on a regular basis to ensure optimum performance.

1.2 pH Tests & Requirements

pH Level - pH is a measure of how 'acidic' the water is in the pool.
The pH scale runs from 0 to 14 and measure the acidity/alkalinity of the water. A pH value of 7 is neutral, a pH value below 7 is acidic and a pH value above 7 is alkaline. Water in the acidic range becomes increasingly corrosive as pH decreases from neutral (7) as it increases from neutral the water has an increasing tendency to scale.

In a pool, the optimum pH range is typically listed as 7.2 to 7.6, however, for maximum chlorine effectiveness the pH should be kept between 7.2 and 7.4. The reason for this is that chlorine effectiveness decreases rapidly between 7.6 and 8.0. As an example, at a pH of 7.2, approximately 80 percent of the chlorine generated will form hypochlorous acid, which is the active form of chlorine. At a pH of 8.0, only 20 percent of chlorine is in the active form-a reduction of 75 percent. Another way to look at this is that reducing pH from 8.0 to 7.2 increases its effectiveness by 300 percent, but also uses chlorine faster.

Problems related to pH

Low pH (acidic) < 7.2	High pH (basic) > 7.6
• Cloudy Water	• Cloudy Water
• Eye and Skin Irritation	• Eye and Skin Irritation
• Equipment Corrosion	• Reduce Chlorine Effectiveness
• Deteriorating Pool Surfaces	• Plugged Filtration System
• Staining & Etching	• Scale Formation
• Hair Loss	• Greater Risk of Algae
• Scale Removing	

The pH level also affects the ability of chlorine to sanitize pool water. The higher the pH, the lower the amount of hypochloric acid available to sanitize and oxidize the unwanted materials in the pool water (see table below).

Effect of pH on Chlorine Activity

Hypochlorous Acid Chlorine as HOC1 (Active)	pH	Hypochlorous Ion Chlorine as OC1 (Inactive)
90%	6.5	10%
73%	7.0	27%
66%	7.2	34%
45%	7.6	55%
21%	8.0	79%
10%	8.5	90%

Summary

Ideal Range is 7.2 to 7.4
Increasing pH from 7.2 = Decreasing Chlorine Available for Disinfection
Even small changes in pH result in fairly large decreases in chlorine available for disinfection. The pH value is the most important factor in determining chlorine effectiveness. High pH will decrease overall unit performance

Chart No. 2 - Lowering pH with Muriatic Acid
(If pH is over 7.6, add this amount of acid, then retest)

	GALLONS IN POOL						
pH	1,000	5,000	10,000	15,000	20,000	25,000	50,000
7.6-7.8	1 1/4 oz.	6 oz.	12 oz.	18 oz.	24 oz.	1 qt.	2 qts.
7.8-8.0	1 1/2 oz.	8 oz.	16 oz.	24 oz.	1 qt.	1 1/4 qts.	2 1/2 qts.
8.0-8.4	2 1/2 oz.	12 oz.	24 oz.	1 1/4 qts.	1 1/2 qts.	2 qts.	1 gal.
Over 8.4	3 oz.	16 oz.	1 qt.	1 1/4 qts.	2 qts.	2 1/2 qts.	1 1/4 gal.

The higher the pH, the less hypochlorous acid present and the less effective free chlorine becomes. At a pH of 7.2 about 66% of free chlorine is hypochlorous acid. At a pH of 7.8 only about 33% of free chlorine is hypochlorous acid, therefore pH control is essential for maintaining the effectiveness of chlorine as a disinfectant.
Total Alkalinity (TA):

1.3 Total Alkalinity (TA) Requirements

Alkalinity is a measure of alkaline salts dissolved in the water, such as Carbonates, Bicarbonates and Hydroxides, and their ability to resist change in the pH. From a practical standpoint, it determines how large the pH change will be when chlorine (which is acidic) or pH correction chemicals are added to the water.

If Total Alkalinity is low (less than 75 mg/L), additions of these chemicals may result in large changes in pH (sometimes referred to as pH bounce). Low alkalinity is often associated with green water, plaster etching and accelerated corrosion rates. Sodium bicarbonate is normally used to increase low alkalinity.

High Total Alkalinity (above 175 mg/L) can be lowered by the addition of Muriatic acid. When Total Alkalinity exceeds 200 mg/L pH adjustment can become very difficult (pH Lock).

When adjusted within the acceptable levels, TA acts as a pH buffer, resisting rapid changes to pH. The recommended TA level of your pool is from 80 to 120 ppm depending on the pool finish. A typical level is in the 80 ppm range.

Problems related to Total Alkalinity	
Low Total Alkalinity	Total High Alkalinity
• pH Fluctuation • Corrosion • Low pH • Skin & Eye Irritation	• Difficulty Adjusting pH • Cloudy Water • High pH

1.4 Calcium Hardness Requirements

Calcium hardness is a measure of the calcium content in the water and is not the same as Total Hardness. Calcium occurs naturally in water and its ideal range in for pools is 175-300 ppm. Because it is typically very difficult to adjust calcium levels in a pool, it determines adjustments in pH and alkalinity that compensate for the level in the pool (explained further below in the section on the Langelier Saturation Index).

A Calcium Hardness test is ignored frequently, but is very important for the proper maintenance of your pool.

The hardness of your pool water is very important in controlling scale and the corrosive effects of water. A low calcium level may cause pool water to become corrosive, even if the pH is within its recommended range.

A high calcium level may cause pool water to deposit scale even if the pH is within its recommended range. A telltale sign of this is a build up of calcium deposits inside your Chlorine Generator Cell

NOTE: If your hardness level is too high (generally over 500 ppm, depending on your region), you may need to drain your pool partially as there is no chemical to lower the hardness level. If you typically have high hardness levels due to the tap water in your area, you may need to add a Metal Sequestering Agent on a regular basis to rid the water of excess amounts of harsh minerals.

Problems Related to Calcium Hardness	
Low Calcium Hardness < 200 ppm	High Calcium Hardness > 500 ppm
Corrosive Water	Minimized Sanitizer Effectiveness
Etching of Plaster	Scale Formation
Pitting of Surfaces	Filter Calcification
Staining	Cloud Water
Skin & Eye Irritation	Skin & Eye
Foam	Minimized Sanitizer Effectiveness

1.5 Total Dissolved Solids (TDS) Requirements

Total Dissolved Solids (TDS) provides a general indicator of pool water acceptability. If the level is too high, the pool should be partially or completely drained to reestablish acceptable levels. Pools that have not been drained over extended periods can accumulate large quantities of TDS. Evaporation will also cause increases particularly in arid areas (TDS remains behind).

Basically, TDS is an indicator of the amount of matter dissolved in the water. Many factors contribute to TDS, including virtually all pool chemicals. TDS is measured electrically, and not all dissolved material shows up in TDS measurements. Therefore, as TDS increases, so does the build-up of pollutants from bather waste and other sources. This is important because bather waste consumes chlorine.

1.6 Nitrates, Metals

There should be no nitrates in your pool water. Most often Nitrates are associated with fertilizers. A high level of nitrates may cause a higher than normal demand on Chlorine, often lowering the Chlorine level down to zero.

NOTE: THE OZONE SYSTEM WILL PRECIPITATE ANY NITRATES, HELPING TO SOLVE THIS WATER QUALITY ISSUE

Certain metals may either stain the pool and/or cause chlorine levels to decrease. If testing shows a presence of metals in your pool, consult a pool professional for methods of removal.

OZONE WILL REMOVE IRON AND MANGANESE FROM WATER.

2 The Langelier Saturation Index

Stable water quality is based on the proper use of this saturation index and formula. Various factors are used to calculate saturation levels (pH, total alkalinity, total hardness, total dissolved solids and temperature). When these factors are placed into the formula, the result provides the information needed to balance the pool water and correct its condition.

First all parameters of the formula must be tested with the appropriate test kits, then the applicable "factors" (see Table below) area placed into the following formula:

pH: measured from test kit
TF: temperature factor; measured at pool
CF: calcium hardness factor, measured from test kit
AF: alkalinity factor, measured at pool

Ideal readings for proper water balance:
- pH 7.2 to 7.6
- Total Alkalinity 80 to 125 ppm (parts per million)
- Calcium Hardness 175 to 300 ppm (parts per million)

Formula Result:
Between – 0.5 and +0.5 = water is balanced
Above +0.5 = water is over-saturated (scale-forming)
Below – 0.5 = water is under-saturated (corrosive)

Temperature F ° = TF	Calcium Hardness = CF	Total Alkalinity = AF
32° = 0.0	5 = 0.3	5 = 0.7
37° = 0.1	25 = 1.0	25 = 1.4
46° = 0.2	50 = 1.3	50 = 1.7
53° = 0.3	75 = 1.5	75 = 1.9
60° = 0.4	100 = 1.6	100 = 2.0
66° = 0.5	150 = 1.8	150 = 2.2
76° = 0.6	200 = 1.9	200 = 2.3
84° = 0.7	300 = 2.1	300 = 2.5
94° = 0.8	400 = 2.2	400 = 2.6
105° = 0.9	800 = 2.5	800 = 2.9
128° = 1.0	1000 = 2.6	1000 = 3.0
Saturation Index = pH + TF + CF + AF – 12.1		

Example:
Test results:
pH reading is 7.0
Water Temperature is 84° (TF is .7 from chart)
Calcium Hardness reading is 300 ppm (CF is 2.1 from chart)
Alkalinity reading is 25 ppm (AF is 1.4 from chart)

Saturation Index =
(pH) 7.0 + (TF) 0.7 + (CF) 2.1 + (AF) 1.4 – 12.1 = -0.9

Since the equation solution equals –0.9, this indicates a corrosive water condition.