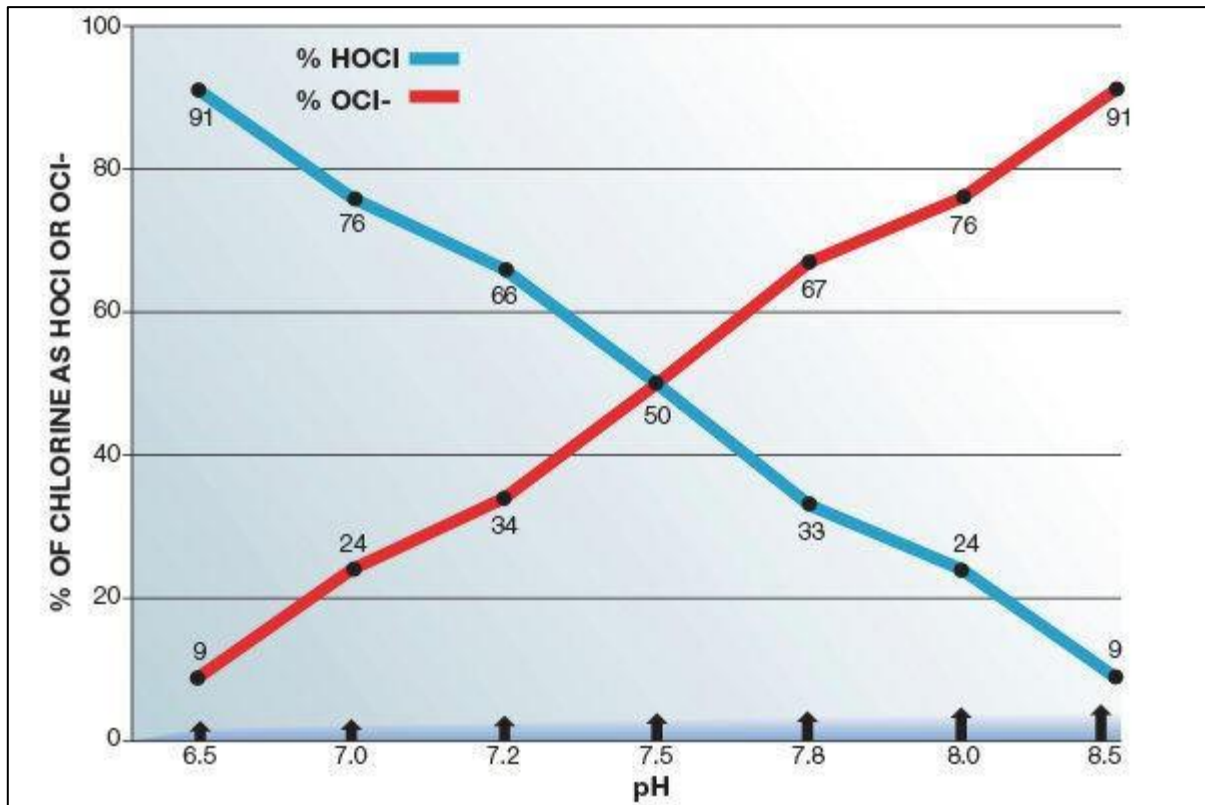


### pH (Acidity)

pH is a crucial factor that directly influences the chemical reactions in swimming pool water. It measures the acidity or basicity of water on a scale of 0 to 14.

- Very acidic = 0
- Neutral = 7
- Very basic (alkaline) = 14



The pH level affects the effectiveness of chlorine in killing microorganisms and oxidizing matter. As pH increases, chlorine's ability to perform these tasks diminishes. Moreover, a pH over 8.0 may lead to scaling (mineral precipitation) and cloudy water. On the other hand, a pH below 7.0 (acidic water) can cause irritation to swimmers' eyes and mucous membranes, as well as damage metal parts and plaster finishes of the pool system.

### Chlorine (Free and Total)

Chlorine is the most commonly used chemical for treating swimming pool water. It serves a dual purpose by disinfecting the water, killing bacteria and algae, and oxidizing other substances like dirt and chloramines.

When chlorine compounds are added to pool water, they produce hypochlorous acid (HOCl) and hypochlorite ions (OCl<sup>-</sup>), with their relative proportions determined by the water's pH level.

pH	pH Percentage of free chlorine as	
	Hypochlorous acid (HOCl) %	Hypochlorite ion (OCl <sup>-</sup> ) %
6.0	97	3
7.0	75	25
7.2	63	37
7.5	49	51
7.6	39	61
7.8	28	72
9.0	3	97

Hypochlorous acid is a highly effective disinfectant due to its low molecular mass and lack of electrical charge. These properties enable it to penetrate bacterial cell walls and target enzymes, leading to the destruction of microorganisms and their subsequent death.

On the other hand, hypochlorite ions are approximately 100 times less effective as disinfectants compared to hypochlorous acid. The reduced effectiveness is attributed to the negatively charged nature of hypochlorite ions, which hinders their ability to penetrate bacterial cell walls that also carry a negative charge.

To meet regulatory requirements, chlorine must be introduced into pool water using an approved automatic chlorinator. When chlorine, in any form, is added to water, it produces a weak acid called hypochlorous acid. It is this acid, rather than the chlorine itself, that imparts the water with oxidizing and disinfecting abilities. Proper chlorination and filtration processes contribute to the clear and sparkling appearance of pool water.

Different forms of chlorine are available for pool water treatment:

1. Liquid chlorine (sodium hypochlorite): Contains 12-16% available chlorine, higher than the chlorine content in household bleach.
2. Solid chlorine (powder or granules):
  - A. Calcium Hypochlorite: Contains 65-75% available chlorine.
  - B. Chlorinated Isocyanurates: Contains varying percentages of available chlorine.
  - C. Lithium Hypochlorite: Contains 30-35% available chlorine.
3. Gaseous Chlorine: Contains 100% available chlorine. However, due to its high toxicity, special procedures are required when handling gaseous chlorine.

Chlorine demand refers to the portion of available chlorine that is consumed during the disinfection

and oxidation processes in pool water. The remaining hypochlorous acid, after satisfying the chlorine demand, is known as the free chlorine residual. This residual chlorine level is measured when testing the pool for chlorine.

### **Alkalinity**

Alkalinity refers to the presence of alkaline (basic) substances in water. In the pH range of 7.2-7.8, alkalinity exists as bicarbonate material. Total alkalinity, measured in parts per million (ppm), indicates water's ability to resist pH changes. Alkaline substances act as buffers, maintaining pH stability. The recommended alkalinity level for swimming pool water is 80-120 ppm.

When alkalinity is below 80 ppm, it is advisable to increase it. This can be achieved by adding baking soda in the following ratio: 170 grams of baking soda will raise alkalinity by 10 ppm in 10,000 liters of water. It is also recommended to lower pH with Hydrochloric Acid before adding baking soda. Bicarbonate can be dissolved quickly in warm water in a bucket before dosing.

Maintaining balanced alkalinity levels is essential for overall water balance, preventing damage to pool surfaces and equipment, and reducing chemical expenses. Low alkalinity increases acid demand and chlorine demand, which leads to increased pH and further decreases total alkalinity. Total alkalinity is the most important parameter when trying to balance your pool. Correct alkalinity levels will also keep chemical usage in check.

### **Calcium Hardness**

Maintaining the proper calcium hardness level in your pool is crucial for ensuring water quality and preventing potential issues such as plumbing corrosion and surface scaling. Calcium hardness refers to the measurement of your pool water's hardness or softness and the amount of dissolved calcium. It is ideal to keep your calcium hardness levels between 150 and 400 parts per million (ppm), with the goal of maintaining it around the midpoint of this range. Deviating too much from this target can result in water that is either too soft or too hard, leading to future problems.

Unlike regular water chemistry tests that focus on pH and alkalinity levels, checking calcium hardness does not require frequent monitoring. Typically, it is recommended to test the hardness levels every one or two weeks, depending on the water quality in your area and how frequently you need to refill your pool.

To bring the calcium hardness into balance in your pool, you can follow these steps:

1. Clean your pool: Before conducting any tests, thoroughly clean your pool to remove any contaminants.
2. Balance your water chemistry: Prioritize balancing the pH and alkalinity levels before addressing

water hardness. The chemicals used to adjust pH and alkalinity can have an impact on calcium hardness.

3. Adjusting high or low hardness levels: If your water hardness level exceeds 400 ppm, you will need to lower the calcium hardness. Conversely, if it falls below 150 ppm, you will need to increase it.

Raising hardness levels is generally easier than lowering them. To raise the hardness levels, simply add calcium chloride to your pool according to the recommended guidelines. Remember, maintaining proper calcium hardness is essential for the long-term health and maintenance of your pool.

### **Cyanuric Acid (Stabilizer)**

The decomposition of free chlorine by ultraviolet rays from the sun can be significantly reduced by "stabilizing" the chlorine through the addition of cyanuric acid. It is important to regularly measure the cyanuric acid level in a pool using a dedicated test kit. The recommended range for cyanuric acid is 20-50 ppm, and levels exceeding 100 ppm are not acceptable. If the levels surpass this threshold, a portion of the pool water must be removed and replaced with fresh water, as there are no other effective means of reducing cyanuric acid in a pool.

However, it is important to note that the stabilizing effect of cyanuric acid does not increase as the levels rise. In fact, when cyanuric acid levels exceed 100 ppm, the chlorine becomes "locked in" and may become less effective in eliminating bacteria and algae. Simply put, higher levels of cyanuric acid do not result in better chlorine stabilization.

In many cases, pools unknowingly accumulate excessive levels of cyanuric acid, particularly when powdered chlorine products containing cyanuric acid are used over an extended period of time. Pool operators should verify if the chlorine they are using contains cyanuric acid/stabilizer. Powdered chlorine products containing cyanuric acid typically include one of the following active ingredients:

1. Potassium dichloro-s-triazinetrione (potassium dichloroisocyanurate).
2. Sodium dichloro-s-triazinetrione (sodium dichloroisocyanurate).
3. Trichloro-s-triazinetrione (trichloroisocyanurate).

It has been observed that bacteria are destroyed at a slower rate in the presence of cyanuric acid. Therefore, in stabilized pools, it is crucial to maintain a free chlorine residual level above a minimum of 1.5 ppm to counteract this effect.

### Langelier Saturation Index (LSI)

The Langelier Saturation Index (LSI) is a formula that originated from studies conducted by Dr. Wilfred Langelier in the early 20th century. It serves as the foundation for water balance and saturation, and understanding its basic concept is highly beneficial for pool owners and operators.

To simplify the concept, envision the LSI as a scale with a balancing point. A perfect LSI score is zero (0.0), representing perfectly balanced water. This water is saturated with the appropriate levels of calcium and dissolved solids while maintaining a stable pH. Water, being a universal solvent, naturally seeks balance and equilibrium, aiming for an LSI of 0.0. For example, if there is an insufficient amount of calcium, water will dissolve and extract it from the pool's plaster walls, resulting in etching.

The Langelier saturation index determines whether water is corrosive (negative LSI) or scale-forming (positive LSI). The widely accepted LSI range is between -0.3 and +0.3, with 0.0 being the ideal balance.

The crucial aspect here is saturation. An LSI of 0.00 indicates perfect saturation. Water strives for equilibrium and will take necessary measures to achieve it. When water is undersaturated, it becomes corrosive, while oversaturation leads to scale formation. Water has a limit to the amount of calcium it can hold in suspension. If water is in equilibrium, neither etching nor scaling will occur. As pool professionals, our goal is to initially balance the water (and maintain it) according to LSI standards, ensuring the prevention of both etching and scaling.

A low LSI not only causes plaster etching but can also corrode pool equipment and plastics, including vinyl liners and PVC pipes. Similar to calcium, water can dissolve metals and keep them in suspension until the water becomes oversaturated. At that point, metals such as copper, aluminum, or magnesium (commonly found in pool products like algaecides) will precipitate out of solution and potentially stain pool surfaces.

To calculate the Langelier Saturation Index, you need to consider six variables:

1. pH
2. Temperature (°F)
3. Calcium Hardness (ppm)
4. Alkalinity (ppm)
5. Cyanuric Acid/Stabilizer (if applicable, with a correction based on pH)
6. Total Dissolved Solids (ppm)

Numerous LSI calculators are available online, allowing you to easily search and choose one that suits your needs.

### Proper handling and storage of swimming pool chemicals

Proper handling and storage of swimming pool chemicals is of utmost importance. It is essential to exercise caution to ensure safety. The following guidelines should be followed:

1. Chemicals must be stored separately from each other at all times. Under no circumstances should they be mixed together. This precaution is necessary to prevent hazardous chemical reactions from occurring. Mixing pool chlorine and pool acid, for example, can produce chlorine gas, which, if inhaled, can be fatal.
2. When adding chemicals to the pool, never do so while it is open for use. Sufficient time should be given for the chemicals to circulate throughout the pool before allowing swimmers to enter. This rule does not apply to chlorine introduced through an automatic chlorinator.

By adhering to these guidelines, you can ensure the safe handling and storage of swimming pool chemicals, promoting a secure and enjoyable swimming environment for all.

### **Disclaimer**

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