Pool Chemistry Basics

Pool Water - A study at Harvard University concluded that one active adult swimmer loses two pints of perspiration per hour. Perspiration is loaded with organics resembling the chemistry of urine. The body is also constantly shedding microscopic skin particles sloughed off by the friction of water. These are all "involuntary wastes" such as expectorant, nasal discharge, fecal matter and urine and you begin to appreciate the ***bather load*** created.

Four bathers in a 7-foot 600 hundred gallon spa is the equivalent to 250 bathers in a 25'x 50'x 4' swimming pool. That is NOT a very big pool for that many people!

Alkalinity

(Always adjust Total Alkalinity first) 80 - 120 ppm

The alkalinity of your pool has to do with the ability of the water to resist change in pH. The alkalinity helps manage or control the pH. It acts as a buffer. Many of you may have heard the term pH bounce. This is typically caused by out of balance alkalinity levels. Keep you alkalinity level between 80-140. If you have a salt-water pool or use Tri-Chlor tablets keep the alkalinity between 120-140. If you use Sodium Di-chlor keep the alkalinity between 100-120 ppm. If you are using Liquid Chlorine, Cal-Hypo or Lithium Hypo keep the alkalinity in the 80-100 ppm range. When alkalinity is lower than 80 ppm it becomes aggressive and the pH can easily swing up or down. When alkalinity is on the high side above 140 the water can become clouded and scale forming.

In most cases if the pH is high the alkalinity will be as well. If the alkalinity is low or high it is likely that the pH is affected similarly. Alkalinity can be adjusted with some of the same products you would use to adjust pH. Always add chemicals in smaller increments. Do not add more than 1 pint at a time. Keep the pool circulating and wait for a few hours and then retest your water. Make another adjustment if necessary. In some cases it may take several attempts to get it right. Never mix water with acid first. Always add acid to water. Be careful and cautious at all times. Always test you water before adding any chemicals. ALWAYS-read manufacturers labels.

PROBLEMS	
LOW T/A	**HIGH T/A**
Corrosive Water	***Scaling Water***
Pitting of concrete	Plugged filters
Metals dissolve	Reduced circulation
Staining of walls	Cloudy pool
Non-Balance problems	***Non-Balance problems***
PH bounces	PH drifts upward

pH

PH	% of HOCI	% of O CI
6.0	97	3
7.0	75	25
7.5	50	50
8.0	23	77
9.0	3	97

pH of Common Liquids:

Battery Acid 0
Stomach Acid 1.4-1.8
Vinegar 2.9
Soft Drink 3.0
Wine 3.5
Coffee 5.0
Urine 6.0
Blood 7.35-7.45
Tears 7.3-7.5
Seawater 8.0
Soaps & Shampoos 8.0-9.0
Milk of Magnesia 10.0
Household Ammonia 11.8

PH of Pool & Spa Chemicals:

Muriatic Acid 0.1
Gas Chlorine >1.0
Dry Acid 1.4
Trichlor 2.5-3.0
Cyanuric Acid 3.0
Bromine Tabs 3.6
Sodium Dichlor 6.8-7.0
Baking Soda 8.3
Sodium Sesquicarbonate 10.1
Lithium Hypochlorite 10.7
Calcium Hypochlorite 11.8
Soda Ash 13.0
Liquid Chlorine 13.0

pH is measured on a scale from 0-14. pH is considered neutral at 7. Anything less than 7 is acidic and anything more than 7 is basic or alkaline. pH affects many things in your pool and it is something you must regularly. Depending on pools circulation system, time of year and other need to check as much monitor closely and the efficiency of your usage, temperature, factors you may as once a day.

The pH scale is logarithmic meaning that every unit below or above 7.0 is 10 times more acidic or basic than the previous reading. Therefore, a pH of 6.0 is 10 times more acidic than a pH of 7.0 and a pH of 3.0 is 10,000 times more acidic than a pH of 7! The pH range recommended for pool/spa waters is slightly alkaline, which assists bather comfort. The pH of the body is about 7.3-7.5, slightly alkaline. This would be the same for your eyes and blood. If the pH is high or low it affects bather comfort. Most people have experienced this at one time or another. This is why we must keep the pH in the range of 7.2-7.8. Ideally you would keep it towards the lower side of this scale.

The pH of a pool effects chlorine in a crucial way. When any type of chlorine is added to a swimming pool it combines with the water H2O to form Hypochlorous acid HOCI (The active sanitizing agent) and Hypochlorite Ion OCI (this is less active). You can have different percentages of each not to exceed 100%. The percentage of Hypochlorous acid HOCI is more important than the OCI because it is a much more effective sanitizer (see below). The pH of the pool drastically affects its ability to do its job. PH affects HOCI and OCI in this manner:

At a pH of 6.0 the HOCI, the active sanitizing agent is 97% unfortunately this low of a pH reading is detrimental to both you and your pool. If you go to the other end of the scale 9.0 pH than you have the same sort of problem just different symptoms. In a balanced pool environment you would take advantage of the highest percentage of sanitizer with the most comfortable pH in this case that is around 7.5 Looking at the pH graph above you can see the importance of maintaining a reasonable pH reading. Many people wonder why they are using so much chlorine, high pH could be one of the reasons.

The ideal range of pH is 7.4-7.6 with an acceptable range of 7.2-7.8. To increase pH add Ph up. Add Muriatic Acid or Sodium Bisulfate (dry acid also called pH down) to decrease pH. pH is measured on a scale of 0-14 with 7.0 being neutral. Anything less than 7.0 would be considered acidic and anything over 7.0 would be considered basic (or alkaline).

Chlorine levels above 10 ppm can render pH tests useless because it will bleach the re-agents used for measuring pH. Make sure that your chlorine level is within an acceptable range (1-3 ppm).

Alkalinity and pH play a major role in the proper balance of a swimming pool. Both affect sanitation efficiency, which effects health and bather comfort and the longevity of pool finishes, surfaces and pool equipment. Additionally these two measurements are the easiest and most commonly adjusted balance parameters when using a saturation index.

Calcium Hardness

Hardness refers to the amount of calcium and magnesium mineral saturation in the pool water. At this time the only way to bring the calcium content down in a swimming pool is by dilution or drain and refill. If the calcium level is low, then you would need to add calcium chloride to increase the level of hardness otherwise the water tends to extract what it needs from plaster, concrete, grout. the vinyl liner, or anything else to satisfy the demand. Sequestering agents are available that when added to water will chemically bond with calcium and other minerals to make them more soluble. The calcium will still be present but will be in a form that will be less likely to cloud the water or form scale. Anything added to your pool water will increase TDS (Total dissolved solids) this also has its drawbacks. Calcium hardness levels should be kept between 250-400 ppm, which is ideal. Levels as high as 800 are acceptable, just not ideal. If the calcium hardness gets higher than 800-1000 it is time to consider draining and refilling the pool. Keep in mind this reduces calcium hardness and TDS giving you a pool full of fresh water which in turn should make it easier to maintain a balanced pool water environment. Otherwise you may be wasting money medicating a sick pool. Calcium levels in Fiberglass Pools are not a concern

Calcium is temperature sensitive the higher the temperature the more probable it is to precipitate out of solution. This can happen in spas and in areas where the water might be very shallow like spillways, dam walls, rock water features and areas where the water might be on a horizontal surface like the decking or coping. As the water heats up and evaporates the calcium precipitates out of solution leaving a residual.

PROBLEMS

LOW Calcium Hardness	HIGH Calcium Hardness
Corrosive water	***Scaling water***
Etching of plaster	Plugged filters
Pitting of concrete	Reduced circulation
Dissolving of grout	Cloudy pool
Pitting of pool decks	Heater inefficiency

Types of Chlorine

The types of chlorine vary widely. The costs associated with the different types vary as well. They all make the same thing when added to water Hypochlorous Acid (HOCI) and Hypochloric Ions (OCI). The application is different and the benefits of each type vary. Here are brief descriptions of the different types.

1. **Sodium Hypochlorite** - This is liquid chlorine. It usually comes in gallon jugs for consumers and has the most chlorine content in it the day it was bottled. Heat and time take away its effectiveness and causes it to deteriorate. It has a relatively short shelf life. The amount of chlorine content at the plant is typically around 15%. By the time it hits the shelves at the store and makes it home with you it is likely around 10%-12%. It has a high pH of around 13-14. So as you are adding liquid chlorine you are increasing the ph level in your pool. You may need to neutralize this.

2. **Gas Chlorine** - This is the commercial grade stuff that requires a license and pretty stiff EPA, DOT and other governmental regulation. It is elemental chlorine in its purest form

and its strength is (100%). The actual cost of the product is inexpensive; it is the cost of storage, transportation, liability and compliance with state and local codes that make it a pool service company product only. Additional chemicals like **sodium sesquicarbonate** must be added to the pool to offset some of the negative affects of less than >1.0 pH. Special rules and guidelines dictate the handling of gas chlorine. Bottom line you do not want to mess with it unless you know what you are doing.

3. **Calcium Hypochlorite** - Is the granular form of chlorine. It is approximately 65-70% chlorine. It has a pH of around 11.8 if you use it you will be increasing the pH in your pool. It is granular or tablet in form. This type of chlorine when exposed to an organic compound will produce a fire. "Be careful", do not handle with bare hands and only store in its original container. Never mix any pool chemicals. Always mix the chemical with water not water with the chemical.

4. **Lithium Hypochlorite** - Lithium based chlorine is said to be very easy on skin. It is more expensive than other types of chlorine, which is the primary reason it is not used widely. It comes in a concentration form of around 35% and has a pH of 10.7. It is granular in form and is fast dissolving and non-clouding because it has no calcium in it. It can be used in vinyl liner pools. It is non-flammable and has a long shelf life. It cannot be used in a chlorine feeder.

5. **Sodium Dichlor** - This type of chlorine is popular because it has a near neutral pH thus it does not require the addition of other chemicals to offset high or low pH. It is considered stabilized chlorine because when it is manufactured it is combined with cyanuric acid for stabilization. This gives it a long shelf life. Dichlor as it is commonly called comes in a formula with 56-62% chlorine by volume. Dichlor is considered by many as expensive, however additional chemicals are not needed to offset high or low pH. This saves money and may offset its additional costs. Dichlor can be used for shocking or super-chlorinating because it dissolves quickly. It cannot be used in dry chemical feeders.

6. **Trichlor** - Trichlor is very popular in sun-belt regions. Trichlor is 90% chlorine by volume it has a pH of about 2.8-3.0. It is a stabilized form of chlorine because cyanuric acid is added when it is manufactured. It comes in many forms from sticks to tablets ranging in size from 1"- 6". It has a long shelf life and is slow to dissolve making it a good choice for erosion type chlorine feeders. It also works well with the chlorine floaters that are sold. Because it dissolves slowly it would be a poor choice for shocking and super-chlorination.

TDS

TDS (Total Dissolved Solids) is the least worrisome of the factors you must monitor. The TDS is the sum of all materials dissolved in the water. Some dissolved solids do not have an adverse affect on the pool. For instance if you have a chlorine generator (Salt water system) on your pool then the pool is filled with sodium chloride or ordinary table salt. These are very soluble and do not create an adverse affect unless misused. There are many types of chlorine generators; manufacturers specify the salt level range for their product. When you test for TDS you should subtract this amount from your reading. When TDS gets higher than about 1500-2000 ppm it may be time to drain and refill the pool. Just to be clear, if a salt water pool requires a level of 3000 ppm then you would not need to do this until the TDS is at 4500-5000 ppm. Elevated TDS causes hazy and cloudy water conditions, difficulty in maintaining water balance, reduction in sanitizer activity and foaming. Testing for TDS every 6 months will usually be sufficient.

The only way to reduce TDS in a pool is by dilution or drain and refill.

Cyanuric Acid

Is also known as Stabilizer or Conditioner, it acts like a sunscreen for your chlorine. Keep levels in the range of 20-100 ppm maximum. Because it helps stabilize chlorine it makes the chlorine less active. You walk a fine line with this stuff. Make sure you do not over use it. Remember when you use any stabilized chlorine like Dichlor or Trichlor you are adding to the Cyanuric acid levels in the pool. The only way to reduce the Cyanuric Acid level is to dilute the pool or drain and refill. Swim World prefers to keep Cyanuric Acid levels on the low side. However, if you have a Salt Water Chlorine Generator (SWCG) The Cyanuric Acid will need to be in the 70 -80 ppm range. A SWCG produces unstabilized chlorine and requires a higher level of Cyanuric Acid to keep a chlorine residual. If levels get over 100 ppm this can cause problems and you will need to drain the pool and add fresh water.

Temperature

Water temperature is another important factor in swimming pool or spa chemistry. High temperature water has a greater tendency to scale than water at lower temperatures. When using a saturation index temperature is one of the five factors used to determine whether or not the water is balanced. Depending on what the pool is being used for usually dictates a desired temperature. Spas should never be set at temperatures above 104 degrees. Recreational swimming pools are usually set at 78-82 degree. Competitive pools are usually a little lower.

Chemistry Parameters

Alkalinity 80-140 ppm (See Above)
PH 7.2-7.8 (Best at 7.2-7.4)
Calcium Hardness 250-400 ppm (Must live with it up to 800-1000 ppm)
TDS levels - no greater than 2000 ppm
Chlorine levels FAC 1-3 ppm pools 3-5 ppm spas CAC 0 ppm
Cyanuric Acid 20-100 ppm

Water Testing

Take water Samples at least 18" below surface. Take the sample away from inlets into the pool and in an area that would be considered representative of all the water in the pool.

Everything discussed here is important. Balanced water helps your sanitizer work effectively and efficiently. It also will keep your pool equipment working for many years with minimal problems. Many pool problems can be traced back to inadequate circulation and filtration or bad water balance and or sanitation problems. Swimming pools should be easy to maintain and enjoy. Use common sense. Always-read manufactures labels and store chemicals in a safe place. Do not keep chemicals outside or near your pool equipment. Be safe! Swim safe!