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Introduction to Pool Chemistry

Congratulations!

As the owner of a pool/spa, endless hours of entertainment, recreation, and relaxation await you. Moreover, maintaining your pool in tip-top shape will enhance these benefits.

Caring for your pool/spa will become a routine and pleasant part of your daily activity. You will be able to keep your pool/spa water clear and healthy, and maintain your pool/spa equipment in excellent condition.

Of course, learning to use treatment chemicals economically and effectively requires some understanding of water chemistry. Even though you may say "I Never Liked Chemistry", you'll see how the application of a little water chemistry can make the ownership of a pool more enjoyable.

Let's begin!

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Pool Capacity - it's important

Capacity is the number of gallons of water your pool contains. By knowing the capacity you will be able to select a properly sized filter and pump. In addition, for existing pools you will be able to add the correct amount of treatment chemicals to obtain balanced, clean water.

To calculate capacity, find the average depth and refer to the appropriate formula below. Make all measurements in feet. If your pool/spa has an irregular shape or sloping sides, ask your POOL/SPA Dealer to help you calculate capacity. Fill in the blanks in the appropriate locations.

1) Determine Average Depth (in Feet)

Measure the depth at the deep end of the swimming pool _____

Measure the depth at the shallow end of the swimming pool _____

Shallow end depth _____ + Deep end depth _____ = _____ divided by 2 = _____ average depth.

2) Determine Length and Width

Measure the length of the swimming pool _____

Measure the width of the swimming pool _____

3.) Determine Capacity of the Swimming Pool

Length of the pool _____ x width of the pool _____ x average depth of the pool _____

x 7.5 = _____ total gallons

4.) Total Gallons of water in your Swimming Pool: _____

Tip: Remember the gallons of water in your swimming pool. Good quality test kits will have a chart or graph to allow you add proper amounts of chemicals based on the size of the pool. This is important!

CIRCULATION/FILTRATION- must be efficient

Your pool's/spa's circulation system contains a filter and pump. Together, these components function to provide adequate distribution of treatment chemicals and removal of algae, dirt, dust, and leaves through filtration. Thus, a good circulation is very important with treatment chemicals to keep your pool's/spa's water clean.

To be efficient, the circulating system needs to be operated for the proper amount of time each day, and maintained in superb condition. You can care for this system simply by following the filter and pump manufacturer's recommendations.

Should problems arise, consult your POOL/SPA DEALER. He or she can assist with any difficulties.

Suggested Filtration times:

GOOD: 8-16 hours a day in season and 6-12 hours a off season

BETTER: 12-24 hours a day

TESTING - your key to beautiful sparkling water

Your key to obtaining and maintaining water of exceptional quality is TESTING. By testing, you will be able to balance water, to disinfect water, to maintain your pool in great condition . . . year after year.

Testing is easy. All that you need is an accurate, reliable test kit. If you choose a BASIC test kit which only tests pH and disinfectant levels, occasionally take a water sample to your POOL/SPA DEALER to have water balance tests performed. On the other hand, you may elect to use a more COMPLETE test kit which enables you to test for disinfectant, pH, acid demand, base demand, total alkalinity, calcium hardness, and stabilizer... all the tests necessary for you to personally maintain balanced, clean water. We recommend this type of test kit. It's also a good idea to take a sample of your pool/spa water to your POOL/SPA DEALER at the beginning and end of each pool/spa season.

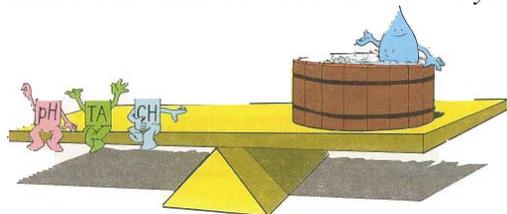
We recommend the Taylor Pro test kit manufactured by **Taylor Technologies**.

Taylor Technologies, Inc. 31 Loveton Cir., Sparks, MD 21152 Phone: (410) 472-4340

BALANCED WATER - pH, Alkalinity and Calcium

Balanced water is water that will neither corrode nor scale pool/spa surfaces and equipment.

Balanced water ensures that pool/spa plaster will not be etched and that metal pipes and heater elements will not be corroded. Also, balanced water protects pool/spa surfaces, pipes, and heater elements from unsightly scale deposits, which reduce the efficiency of pool/spa equipment. Note that chlorine is not included in balanced water. *Chlorine is your sanitizer and has little to do with balanced water.*



Balanced water is the interaction of pH, alkalinity and calcium hardness.

You can obtain balanced water by correctly adjusting a few chemical components in the water. Specifically, you will need to adjust pH, total alkalinity, and calcium hardness. !
Let's look at these components

pH – acid or base

Measured on a scale that runs from 0 to 14, pH indicates whether water is neutral, acidic, or basic. pH test is usually done by color comparison. Simply fill a test cell with pool/spa water, add a pH indicator, and compare the developed color-to-color standards. Be sure to follow your test kit's instructions and test pH daily.

IDEAL RANGE 7.4 to 7.6

POTENTIAL PROBLEMS: **pH TOO LOW:** etches the plaster, corrodes the surface, eye irritation and causes damage to equipment

pH TOO HIGH: Scale deposits, cloudy water and poor sanitizer efficiency

To adjust pH use one of the following two chemicals: Soda ash or muratic acid. Soda ash will raise the pH and Muratic Acid will lower the pH. Please refer to your test kit directions for adding proper amounts.

TOTAL ALKALINITY – Balanced water starts here

There are minerals in your pool's water that act as buffering agents. Total Alkalinity is the measurement of these alkaline materials that help prevent changes in pH, which could result in corrosion and staining. If you want to save your pool equipment, and also save money on treatment chemicals, then try to maintain the correct amount of total alkalinity in your pool's water. This will keep the water's pH consistent, while allowing for economical pH adjustments.

Tip: start balancing your water by adjusting your alkalinity first. Once your alkalinity is in the proper range, the rest of the pool care is a snap!

IDEAL RANGE: 80 to 120 ppm

POTENTIAL PROBLEMS **TOTAL ALKALINITY TOO LOW :** pH difficult to maintain - it drifts. Corrosion tendencies

TOTAL ALKALINITY TOO HIGH : pH remains high, difficult to adjust, cloudy water

To adjust the alkalinity the following chemicals are used: Soda Bicarbonate and Muratic acid. Soda Bicarbonate will raise the total alkalinity and muratic acid will lower the alkalinity. Please refer to your test kit directions for adding proper amounts.

CAUTION: lowering the total alkalinity with muratic acid can greatly affect the pH. **LOW pH CAUSES DAMAGE TO YOUR POOL!** It is recommended that you contact a **POOL** professional before making a drastic change in your alkalinity. Remember the old saying “everything in moderation.” Large rapid changes in your alkalinity should be left up to the pool professionals. It is perfectly acceptable to lower your alkalinity over several weeks if needed. If in doubt call a professional.

CALCIUM HARDNESS

Calcium hardness is the third and final component that needs to be considered to obtain balanced water. Calcium hardness is the amount of dissolved calcium in your pool's/spa's water.

If the water is deficient in dissolved calcium, it will etch plaster surfaces. If the water contains too much calcium, however, it will deposit the excess on pool/spa surfaces and equipment.

Obviously, neither of these situations is desirable since it could cost you money in repairs and/or clean up.

IDEAL RANGE: 200 to 400 ppm.

POTENTIAL PROBLEMS:

CALCIUM HARDNESS TOO LOW: plaster and concrete surfaces may be etched.

CALCIUM HARDNESS TOO HIGH: may contribute to cloudy water and scaling of surface, piping, and equipment.

ADJUSTING: Calcium hardness is easily raised by the addition of calcium chloride according to the table provided in your test kit. Decreasing calcium hardness levels requires that pool/spa water be drained and then replaced with water containing lower calcium hardness levels.

CHLORINE –the sanitizer

When choosing chlorine as a disinfectant, learn to use it economically. **Ideal Range: 1-3 PPM**

Economical use is largely influenced by the pH of your pool's/spa's water, at high pH levels, above 7.6, chlorine's ability to disinfect is significantly reduced. But, at lower pH levels, 7.6 to 7.2, chlorine's disinfecting ability is enhanced. Thus, at lower pH levels, you get more disinfectant for your money. With balanced water and proper pH balance you will get more effectiveness out of your chlorine and will use less of the sanitizer.

Tip: As mentioned earlier, chlorine has little to do with water balance but water balance will have an effect on the efficiency of the chlorine.

Chlorine's only effect on the water balance is, that different forms of chlorine all have different pH values as they dissolve in the water. As you add the chosen chlorine for your pool just remember what effect it will have on the pH and alkalinity. Make any adjustments as needed. See the below chart for the pH values of the most common forms of chlorine and their effect on the water.

Chlorine type	pH value when dissolved in water	Common uses/ advantage –disadvantage/ Adjustments
Tri-chlor- 3 “tablets	2.8	Most common form of chlorine, easily handled and stored, very acidic as the tablets dissolve, lowers alkalinity and pH, high base demand
Cal-hypo granular	11	Good for spot algae treatment, easily handled, raises pH, high acid demand, clouds and scales the pool when used as the sole form of sanitizer
Liquid Chlorine	13	Good all round use, soluble in water, clean, short shelf life, raises pH, high acid demand, needs stabilization
Di-Chlor granular	6.7	Good for spas and above ground pools, Great form of chlorine but more expensive than other forms. Little or no effect on pH

CHLORINE STABILIZATION – sunscreen for chlorine

Cyanic acid, stabilizer, isocyanuric acid, conditioner and CA are some of the common names of this important companion to swimming pool chlorination. In 1958, cyanuric acid (a weak acid) was discovered to inhibit chlorine depletion by sunlight. In other words, cyanuric acid stabilized the free chlorine in the pool water and protected the chlorine from sunlight destruction. Chlorine in the water is sunlight sensitive. Cyanuric acid acts like a sunscreen. Refer to your test kit manual for proper amounts of CA (cyanuric acid) to add to your pool based on the gallons of your pool and the amount of CA already in your pool.

Tip: The different forms of chlorine will require different amounts of CA. It is important not to over stabilize the water with CA. Note: some forms of chlorine come with stabilizer built in; this will add to a build up of CA.

Recommended range: every type of chlorine requires different amounts of this chemical.

They accepted rule is 40-60 ppm.

SHOCK TREATMENT - the miracle cure

Adding disinfectant to pool/spa water in amounts much larger than normal is called "shocking". An occasional treatment destroys algae, bacteria, chloramines and human wastes. Refer to your test kit manual for proper amounts of chlorine to shock your pool and when to shock your pool.

LET'S REVIEW

To briefly summarize, you should:

1. Calculate the capacity of your pool/spa.
2. Learn to operate and maintain the circulation and filtration system.
3. Purchase an accurate, reliable test kit.
4. Balance your pool's/spa's water by adjusting: pH, Total Alkalinity and Calcium Hardness
5. Add chlorine and stabilizer in the proper amounts per your test kit instructions
6. Shock as needed.

Above all, if you need help, consult with your POOL/SPA DEALER. Their expertise and knowledge will help you enjoy all those endless hours of entertainment, recreation, and relaxation.

SUMMARY OF TESTS

TEST	IDEAL RANGE
pH	7.4–7.6
Total Alkalinity	80–120 ppm
Calcium Hardness	200–400 ppm
Chlorine	1.0–3.0 ppm

Excerpts on *Introduction to pool chemistry* were taken from "I never Liked Chemistry" by Taylor Technologies, Inc. © 1

Glossary of Pool Terms

- **ACID DEMAND** - The amount of acid required by your pool water to achieve the proper pH level.
- **ACID** - A chemical that lowers pH and total alkalinity when dissolved in water by providing hydrogen ions. Hydrochloric Acid and Sodium Bisulfate are two commonly used acids.
- **ALGAE** - A microscopic one-celled plant organism. These organisms are continually introduced into the pool by winds, dust storms, rain showers, and the like.
- **ALGAECIDE** - A chemical used to kill or more commonly control algae.
- **ALGAE SPORES** - Dormant algae residing in atmospheric conditions. They are introduced into the pool water by rain showers, winds, dust storms, etc.
- **ALKALINE** - A condition when water is above 7.0 on the pH scale.
- **BACTERIA** - An unseen, but dangerous organism that occurs in all water. Bacteria are controlled by the use of disinfectants such as chlorine or bromine.
- **BALANCED WATER** - Pool water which is maintained with a PH level between ~ 7.2 and 7.6 and contains the proper total alkalinity, calcium hardness, and temperature to yield a Langelier Saturation Index of plus or minus 0.5 is said to be chemically balanced. See Chart "Balanced Water".
- **BASE DEMAND** - The required amount of soda ash to increase the PH level of _ pool water to the ideal range of 7.2 -7.6.
- **BROMINE** - A sanitizer and disinfectant that kills bacteria and prevents algae. L.
- **CALCIUM** - Metal ion contained in water, which can form salts such as calcium carbonate thus causing cloudiness or scaling. It usually exists due to improper balance of PH.
- **CARTRIDGE FILTER** - A filter, which utilizes a replaceable element and does not require backwashing.
- **CHLORAMINES** - The chlorine in the water that has been weakened by the presence of contaminants such as urine, perspiration, etc. Eye irritation occurs when chloramines build up.
- **CHLORINE** - A strong oxidizing agent available for use as a sanitizer and disinfectant to kill bacteria and prevent algae. May be obtained in granular or liquid form.
- **CHLORINE, AVAILABLE** - Residual chlorine or chlorine that is available to destroy bacteria on contact.
- **CHLORINE DEMAND** - The amount of chlorine required to destroy bacteria or algae.
- **CONDITIONER** - A sun-screening chemical that reduces the loss of chlorine due to evaporation by the sun.
- **CORROSION** - A chemical reaction caused by unbalanced water which causes metals or minerals to dissolve.
- **CORROSION RESISTANT** - The ability of maintaining original surface characteristics under prolonged use.
- **CYANURIC ACID** - A sun-screening chemical that reduces the loss of chlorine due to evaporation by the sun.
- **D.E.** - "Diatomaceous Earth" is formed from the skeletons of microscopic water plants called diatoms. Each skeleton is an extremely porous framework of almost pure silica.

- DPD - Technical name "Diethyl-P-Phenylene Diamine is an indicator reagent for chlorine testing. D.PD. #1 tests for free available chlorine, D.P.D. #3 tests for total chlorine.
- DRY ACID - A granular material used to lower the total alkalinity and PH. Technical name Sodium Bisulfate.
- EFFECTIVE FILTRATION AREA - The total surface area through which the design flow rate will be maintained during filtration.
- ELECTROLYSIS - an electrochemical reaction that can result in a black stain near any metal used In the pool, such as ladders and pool lights
- EPA - Abbreviation for the Environmental Protection Agency.
- FILTER AID - A type of finely divided media usually diatomaceous earth, processed perlite, or similar material used to coat a septum of diatomite type filter.
- FREE CHLORINE RESIDUAL - The active chlorine level in pool water after the chlorine demand is satisfied.
- G.P.M. - gallons per minute
- HARDNESS - The amount of calcium, magnesium, iron, carbonates, sulfates, chlorides, nitrates, phosphates, and silicates dissolved in the water. Scale deposits are formed when there are high levels of hardness present in pool water.
- HYPOCHLOROUS ACID - The free state of chlorine, which actually destroys the bacteria and other organic wastes.
- IMPURITIES - Any substance dissolved or suspended in water that alters the chemical and/or physical properties of the pure substance.
- IODINE - A disinfectant and sanitizer that kills bacteria and prevents algae growth.
- LANGELIER SATURATION INDEX - A formula developed by Dr. W. F. Langelier to determine the scale forming or corrosive tendencies of water.
- LITHIUM HYPOCHLORITE - Quick dissolving, leaves no residue, 35% available chlorine.
- MAGNESIUM - A dissolved mineral in swimming pool water. Contributes to water hardness and turbidity.
- MURIATIC ACID - Hydrochloric acid in liquid form used for lowering total alkalinity of PH.
- N.S.F. - National Sanitation Foundation.
- OTO - An indicator reagent used with a test kit to determine the amount of chlorine in the water.
- PARTS PER MILLION (PPM) A measurement used to calculate the "part, per million" or "pounds per million pounds" of the chlorine, hardness, and alkalinity of your pool water.
- PH - The total of the acidic or alkaline particles in the water. The recommended ideal range is PH 7.2 to 7.6.
- PHENOL RED - An indicator reagent used with your test kit to determine the PH of pool water.
- SAND FILTER - Type of filter using silica sand media for filtration, requires backwashing. Typically predominant in colder climates with a closing season, permits easier spring startup with green water

- **SCALE** - A crusty substance usually gray, white, or brown that attaches itself to tile or plaster. Normally caused by a calcium carbonate (hard water) buildup.
- **SHOCK TREATMENT** - Super-chlorinating accomplished by adding 5.10 times the normal chlorine dose every seven to ten days to help convert Chloramines to free chlorine. Also to oxidize the contaminants in the water
- **SKIMMER** - An inlet at water level to catch large debris thus preventing damage to the filter.
- **SODA ASH** - A chemical, Sodium Carbonate, that raises PH.
- **SODIUM BICARBONATE** - A chemical, similar to baking soda, that raises total alkalinity and has little effect on PH.
- **SOLIDS** - Dissolved and suspended matter in water. Dissolved solids are those which are in solution and not removed by filtration; suspended solids are removed by filtration.
- **STABILIZER** - A chemical when used properly is a very effective control of chlorine. Inhibits the ultra violet rays of the sun from destroying the chlorine. Cyanuric acid is normally used as a stabilizer in swimming pool water.
- **T.D.S.** - Total dissolved solids. When high levels of T.D.S. build up in pools due to evaporation can be interference with chlorination. Not typically a problem in outdoor pools in high rainfall areas or areas that partially drain pools for winterization
- **TEST REAGENTS** - Various chemicals that make a test kit work. In either liquid or dry form they change colors or indicate readings on the test kit's scale. Typically good for 6 months and should be replaced at the start of a spring season. Discolored OTO should be discarded
- **TOTAL ALKALINITY** - The number of carbonates, bicarbonates, and hydroxides, measured in ppm that is present in pool water.
- **TURBIDITY** - Cloudiness caused by fine visible and/or colloidal material in suspension that interferes with the normal passage of light through liquid.
- **TURNOVER**- The period of time required to circulate a volume of water equal to the water volume of the pool. Typical turnover rates should be between 6 to 12 hours or 2 to 4 times per day
- **VELOCITY** - The rate of movement of water measured in feet per second or gallons per minute.
- **WORKING PRESSURE** - The maximum operating pressure recommended by the manufacturer.