Water Treatment – Swimming Pools

Chlorine

Chlorine performs two functions in the pool:

1. It acts as a disinfectant.
2. It oxidizes organic and inorganic materials.

Chlorine reacts with water to form hypochlorous acid (HOC1). If nitrogen compounds are present in the water chloramines (chlorine combined with these compounds, i.e combined chlorine) will also be formed.

Free Available Chlorine (FAC): Chlorine that has not combined with other compounds in the pool, and is "available". Hypochlorous acid and hypchlorite ions make up the free chlorine for disinfection and oxidation.

> **Hypochlorous acid (HOC1)** is the active disinfectanct. The free chlorine DPD test tests for both active and inactive forms of chlorine. The ratio of active to inactive changes significantly over the pH range allowed in pools. At pH 7.2 most of the free chlorine is active hypochlorous acid (HOC1). As the pH increases there is less HOC1 formed and more inactive hypochlorite ions ($OC1^-$) form until most of the free chlorine is inactive at pH 7.8.

Combined Chlorine (Chloramines): Is chlorine that has combined with ammonia compounds in the pool and is also called chloramines. Combined chlorine is ineffective as a disinfecant, causes eye irritation, encourages algae and bacterial growth, and produces an irritating chlorine odor.

Total Chlorine: The sum of free chlorine and combined chlorine. Ideally, the combined chlorine should be kept as low as possible and no higher than 0.5 ppm.

Breakpoint Chlorination

Breakpoint chlorination refers to increasing chlorine dosage to a point at which all ammmonia compounds are completely oxidized and removed. This will rid the pool of combined chlorine compounds (chloramines) which can cause eye irritation and an irritating chlorine smell. Breakpoint chlorinate when combined chlorine exceeds 0.5 ppm, or when chloramines are first detected.

To breakpoint chlorinate: Add enough chlorine to equal ten times the combined chlorine concentration. This should only be done when the pool is closed.

Example: A 30,000 gallon pool has a combined chlorine concentration of 0.8 ppm, and you want to superchlorinate with calcium hypochlorite. One pound of calcium hypochlorite per 10,000 gallons of water raises chlorine levels by 8 ppm. In this situation, you need 0.8 ppm x 10, or 8 ppm of chlorine to superchlorinate. Since the pool is 30,000 gallons, and our dosing information is for 10,000 gallons, multiply one pound calcium hypochlorite/10,000 gal. by 3. Three pounds of calcium hypochlorite are needed.

Dechlorination

At times, chlorine levels will be too high following superchlorination. A dechlorinating agent can be added to the pool to reduce the chlorine concentration:

For each 1-ppm of chlorine you want to decrease, add:

4 oz. sodium thiosulfate per 25,000 gallons of water or

2 oz. sodium bisulfite per 10,000 gallons

Add only part of the dechlorination agent at a time and check the chlorine levels between additions. It is very easy to add too much.

pH

the pH is a chemical notation used to describe the amount of hydrogen ions in the water, or the relative acidity or alkalinity of the water. A pH less than 7.0 is considered acidic, while a pH above 7.0 is considered alkaline (basic). The scale runs from 1 to 14.

Desirable range for pH in pools is 7.2 - 7.6. A pH of 7.2 - 7.4 is ideal maximum disinfectant activity.

Low pH may cause:	Corrosion damage Eye irritation
High pH may cause:	Cloudiness and discoloration of water Scale formation Eye irritation Reduced effectiveness of oxidation and disinfection capabilities of chlorine

To lower pH add diluted acid evenly around the pool. Use the acid demand test to determine the necessary amount.

Total Alkalinity

Total alkalinity is an index of the water's ability to "buffer" or resist fluctuations in pH. Alkalinity is related to bicarbonate (HCO_3). **The desirable range** for pools is 80-150 ppm

Low total alkalinity may cause:	pH Bounce Increased corrosion Staining of metal
High total alkalinity may cause:	High pH and difficulty in changing the pH Scale formation

To increase total alkalinity, add sodium bicarbonate ($NaHCO_3$). For each 10,000 gallons of water, add 1.5 lbs. of sodium bicarbonate to raise the alkalinity 10 ppm.

To decrease total alkalinity, use muriatic acid or sodium bisulfate. This is a somewhat more complicated, but not difficult process. You may contact your pool service company for guidance. One quart of muriatic acid per 10,000 gallons of water will lower alkalinity by 12.5 ppm. Sodium bisulfate, added at a rate of 2.3 lbs. per 10,000 gallons of water, would lower the total alkalinity by 10 ppm. Add acid slowly over a period of hours or days, testing frequently. Do not allow pH to go below 7.2.

Example: You want to raise alkalinity from 40 ppm to 80 ppm in a 30,000 gallon pool. To calculate the amount of sodium bicarb needed, remember that 1.5 lb/10,000 gal. = 10 ppm total alkalinity.

1. (1.5 lb. $NaHCO_3$/10,000 gal.) x 3 = 4.5 lb $NaHCO_3$ in a 30,000 gallon pool will raise total alkalinity 10 ppm.
2. (4.5 lb $NaHCO_3$) x 4 = 18 lb $NaHCO_3$ in a 30,000 gallon pool to raise total alkalinity 40 ppm.

Calcium Hardness

Hardness is an indicator of minerals present in the water. Calcium hardness refers to soluble calcium salts. **The desirable range** for a plaster pool is 200-400 ppm. For a vinyl, painted, or fiberglass pool, 175 -300 ppm.

Low calcium hardness may cause:
- Etching of plaster, making it hard to clean
- Increased corrosion
- Shorter plaster life and grouting around tile
- Wrinkling of liner

High calcium hardness may cause:
- Scale formation – especially in heaters and piping
- Discolored surfaces
- Rough plaster
- Cleaning difficulties

To increase calcium hardness, add flaked calcium chloride ($CaCl_2$). For every 10,000 gallons of water, adding 1 pound of calcium chloride will increase calcium hardness 11 ppm. Do not add large amounts all at once. Calcium chloride will dissolve better in smaller amounts and more evenly distribute.

To decrease calcium hardness, you can partially drain the pool to dilute the calcium in the pool.

Testing Tips

1. Rinse test vials well before and after use.
2. Taker water sample away from pool inlets, about 18" below surface.
3. Fill test well to the correct water level.
4. Use vial caps, not fingers, for mixing samples.
5. Use correct amounts of reagents, and be careful about mixing brands of reagent and test wells.
6. Hold dropper vertically when counting drops.
7. Know the limitations of your test kit, particularly the ranges for chlorine and pH readings.
8. Use a test kit able to test the chlorine level normally present in your pool. Occasional samples outside the test kit's range may be tested by doing a dilution of the sample before testing.
9. Conduct tests in a well-lit area.
10. Record the results of all tests.
11. Rinse test vials and store test kits and reagents in a cool, dry place, out of direct sunlight. Keep excess reagents refrigerated to prolong shelf life.
12. Do not allow reagents to freeze.

Environmental Health Services

Multnomah County Health Department

Public Health
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Test Kits

A good test kit should test for:

1. Free and Total Chlorine (using DPD)
2. pH
3. Acid Demand
4. Base Demand
5. Total Alkalinity
6. Calcium Hardness
7. Cyanuric Acid (if using cyanurates)
8. Temperature

Additional tests which may be helpful:

1. Iron
2. Copper
3. Total Dissolved Solids (TDS)

Safe Handling of Pool Chemicals

1. Store chemicals in a cool, dry, clean, well-lit place.
    a. Store incompatible chemicals apart from each other.
    b. Store chemicals at or below eye level.
    c. Keep absorbent bags or boxes of chemicals up off the floor.
    d. Keep containers closed when not in use.
    e. Clean up spills immediately.
    f. Large spills of chemical may require cleanup by hazmat personnel. If in doubt call for help.
2. Keep chemicals out of reach of children (and all unauthorized personnel).
3. Do not transfer contents to unlabeled containers, reuse empty containers, nor use contents of unmarked containers.
4. **Never mix chemicals together except in the pool itself.** Add them to the pool separately.
5. When mixing chemicals, **never add water to the chemical**, always add the chemical to the water.
6. Rubber gloves, goggles, and a rubber apron should be used when handling chemicals.
7. Wash your hands thoroughly after handling chemicals. If a chemical is spilled on your body, get under a shower immeditately, and wash with large quantities of soap and water.
8. If a chemical gets in your eyes, flush immediately with copious quantities of running water for at least 30 minutes.
9. Never smoke cigarettes in the chemical storage room.
10. **ALWAYS FOLLOW LABEL INSTRUCTIONS FOR CHEMICAL USE**.
11. It is always better to add part of the required amount of chemical over several occasions, than all at once **(EXCEPTION: breakpoint chlorination)**.
12. Use separate, clean utensils to handle and measure chemicals.
13. If gas chlorine is used, there are many additional safety precautions. Please contact your pool service company, Oregon OSHA or the health department for more information.

Amount of Chlorine Necessary to Raise Chlorine in 10,000 Gallons

LIQUID	10%	1pt.	1ppm
GRANULAR	65%	2 oz.	1ppm
GAS	100%	.083lb	1ppm

847 NE 19th Ave Suite 350 • Portland, OR 97232 • mchealthinspect.org • Phone: 503.988.3400 • Fax: 503.988.5844

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