

WATER CHEMISTRY BACK TO BASICS

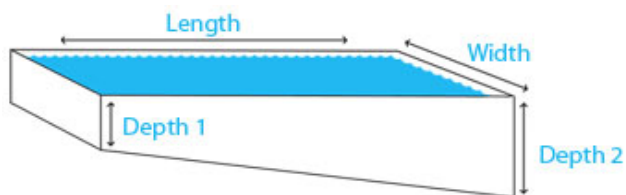


Safe, Healthy, Crystal Clear Pool and Spa Water



WATER VOLUME CALCULATIONS

How to determine water volume:
RECTANGLE, SQUARE ETC.



IMPERIAL (Feet and inches)

Length' x Width' x Average Depth' x 7.5 = Volume in U.S. Gallons

Length' x Width' x Average Depth' x 28.3 = Volume in Litres

METRIC (Meters)

Length x Width x Avg. Depth x 264.17 = Volume in U.S. Gallons

Length x Width x Avg. Depth x 1,000 = Volume in Litres

ROUND

IMPERIAL (Feet and inches)

Avg. Depth x Radius² x 3.14 x 7.5 = Volume in U.S. Gallons

Avg. Depth x Radius² x 3.14 x 28.3 = Volume in Litres

METRIC (Meters)

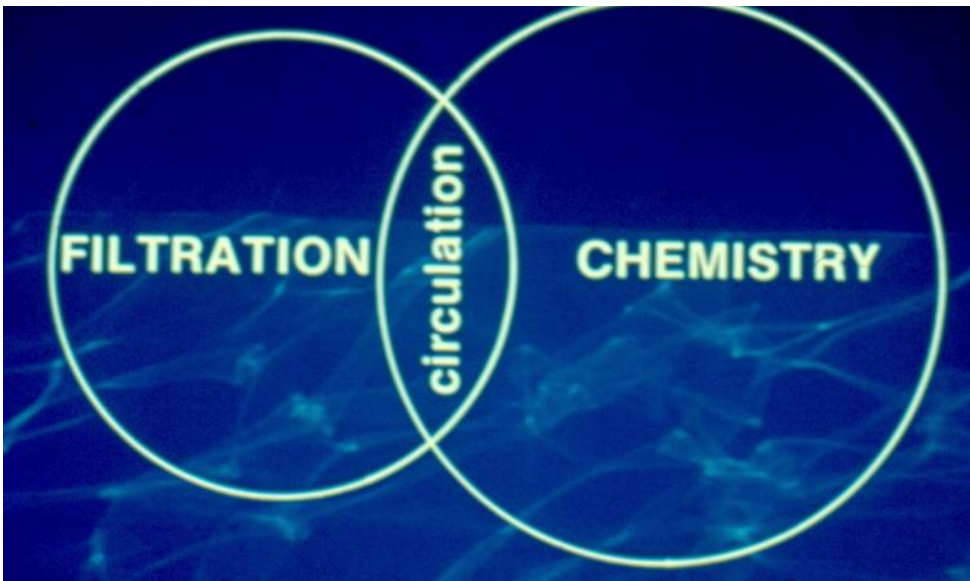
Avg. Depth x Radius² x 3.14 x 264.17 = Volume in U.S. Gallons

Avg. Depth x Radius² x 3.14 x 1,000 = Volume in Litres

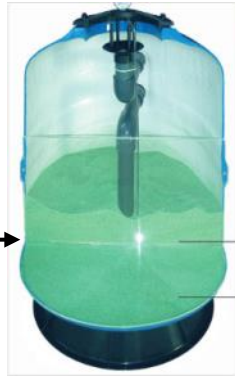
PART 1

WATER BALANCE



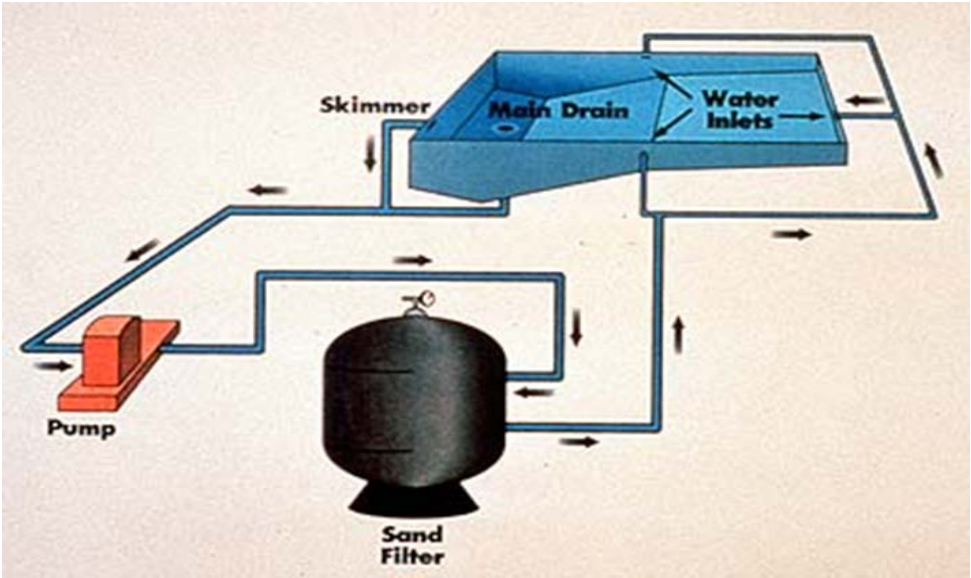


Filtration



GRADE 1 FINE
GRADE 2 COARSE
25 LB BAGS

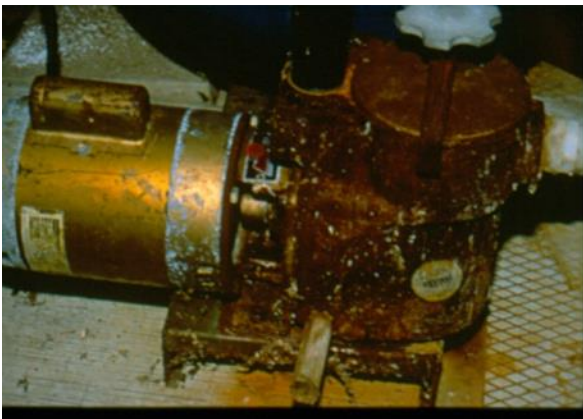
Circulation



WATER BALANCE

TELLS US ONE OF THREE THINGS:

1. CORROSIVE Water is aggressive
2. SCALING Water is giving off
3. BALANCED Water is in a state of equilibrium



WATER BALANCE

WHY?

1. PROTECTION OF POOL/SPA SURFACES AND EQUIPMENT

(Protection of the Consumers' Investment)

2. DISINFECTANT EFFICIENCY

(Better Value for the Consumers' Dollar)

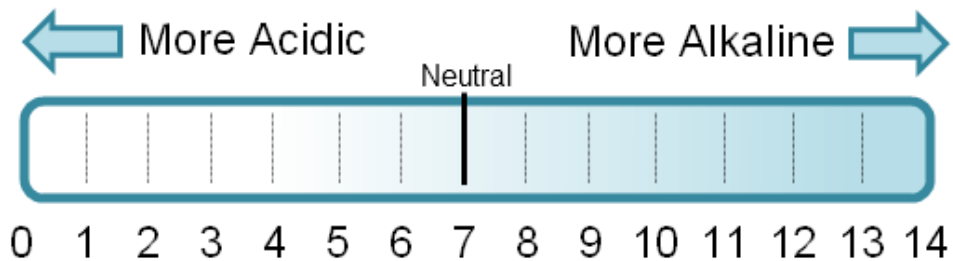
WATER BALANCE

FACTORS THAT DETERMINE WATER BALANCE

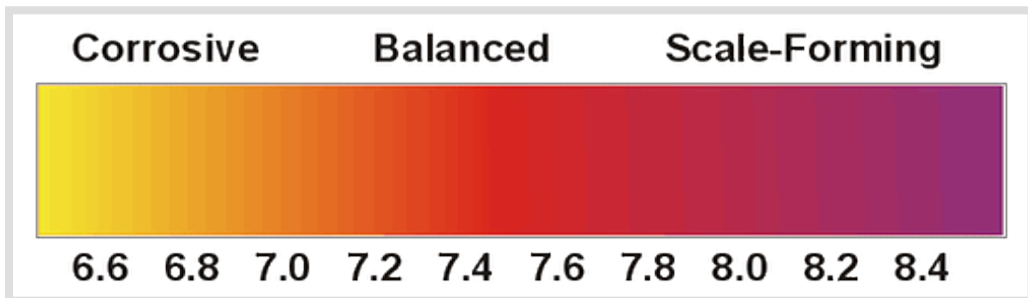
- pH
- Total Alkalinity
- Calcium Hardness
- Temperature
- Total Dissolved Solids

pH

A Convenient Scale



$$\text{pH} = -\text{LOG}(\text{H}^+)$$

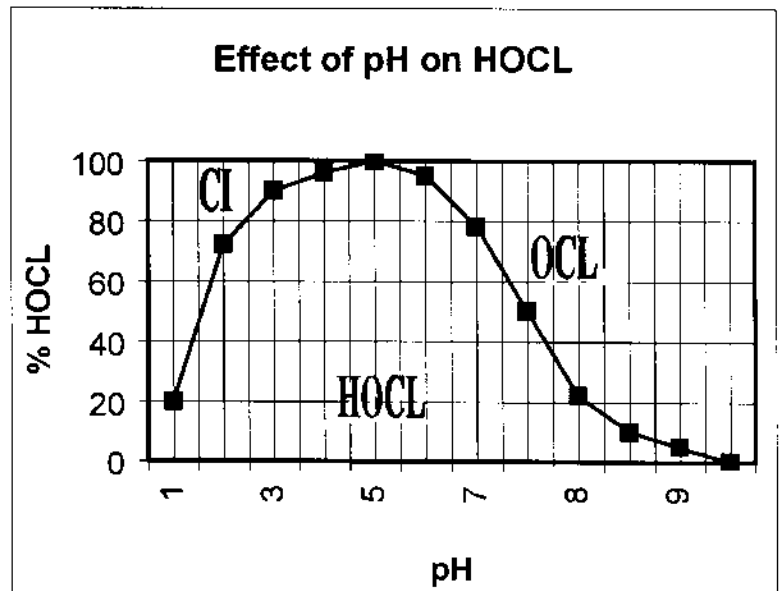


↑ ↑

**Ideal Range
Swimming Pool
7.4-7.6**

THE EFFECT OF pH ON CHLORINE (HOCL)

pH	PERCENTAGE HOCL
1	20
2	72
3	90
4	96
5	100
6	95
7	78
7.5	50
8	22
8.5	10
9	5
10	0



- OCL⁻** – Poor kill efficiency. About 100 times less than HOCL⁻
- HOCL⁻** – Chlorine in its most efficient killing form
- CL²** – Chlorine gas

At a pH of 7.5

- 50% of the chlorine is in the killing form
- 50% of the chlorine is in the non-killing form

At a pH of 8.5

- 10% of the chlorine is in the killing form
- 90% of the chlorine is in the non-killing form

Therefore, at a pH of 8.5 you need five times as much chlorine to do the same job as you do at a pH of 7.5

pH

LOW pH PROBLEMS

- Corrosion
- Liner Wrinkle
- Pitting of Concrete
- Metal Stripped
- Staining
- Rapid Dissipation of Chlorine
- Eye Irritation





INCREASING pH USING "EASY UP"

Drops of Taylor BDR*	2000L	20 000L	40 000L	80 000L	200 000L
1	7.50g	75.0g	150.0g	300.0g	750.0g
2	15.0g	150.0g	300.0g	600.0g	1.50kg
3	22.5g	225.0g	450.0g	900.0g	2.25kg
4	30.0g	300.0g	600.0g	1.20kg	3.00kg
5	37.5g	375.0g	750.0g	1.50kg	3.75kg
6	45.0g	450.0g	900.0g	1.80kg	4.50kg
7	52.5g	525.0g	1.05kg	2.10kg	5.25kg
8	60.0g	600.0g	1.20kg	2.40kg	6.00kg
9	67.5g	675.0g	1.35kg	2.70kg	6.75kg
10	75.0g	750.0g	1.50kg	3.00kg	7.50kg

Easy Up should be directly added to the pool water when the pH has dropped below 7.2

Precautions:

Avoid contact with skin & eyes. Do not mix with other chemicals. Keep out of reach of children.



pH

HIGH pH PROBLEMS

- ❑ Scaling
- ❑ Chlorine Inefficiency
- ❑ Scale Forms on Equipment
- ❑ Short Filter Runs
- ❑ Cloudy Water
- ❑ Eye Irritation





DECREASING pH USING "EASY DOWN"

Drops of Taylor ADR*	2000L	20 000L	40 000L	80 000L	200 000L
1	15.0g	150.0g	300.0g	600.0g	1.50kg
2	30.0g	300.0g	600.0g	1.20kg	3.00kg
3	45.0g	450.0g	900.0g	1.80kg	4.50kg
4	60.0g	600.0g	1.20kg	2.40kg	6.00kg
5	75.0g	750.0g	1.50kg	3.00kg	7.50kg
6	90.0g	900.0g	1.80kg	3.60kg	9.00kg
7	105.0g	1.05kg	2.10kg	4.20kg	10.50kg
8	120.0g	1.20kg	2.40kg	4.80kg	12.00kg
9	135.0g	1.35kg	2.70kg	5.40kg	13.50kg
10	150.0g	1.50kg	3.00kg	6.00kg	15.00kg

Easy Down should be directly added to the pool water when the pH reads above 7.6.

Precautions:

Avoid contact with skin & eyes.
Do not mix with other chemicals.
Keep out of reach of children.



DECREASING pH USING "MURIATIC ACID"

Drops of Taylor ADR*	2000L	20 000L	40 000L	80 000L	200 000L
1	12.0mL	120mL	240mL	480mL	1.20L
2	24.0mL	240mL	480mL	960mL	2.40L
3	36.0mL	360mL	720mL	1.44L	3.60L
4	48.0mL	480mL	960mL	1.92L	4.80L
5	60.0mL	600mL	1.20L	2.40L	6.00L
6	72.0mL	720mL	1.44L	2.88L	7.20L
7	84.0mL	840mL	1.68L	3.36L	8.40L
8	96.0mL	960mL	1.92L	3.84L	9.60L
9	108mL	1.08L	2.16L	4.32L	10.80L
10	120mL	1.20L	2.40L	4.80L	12.00L

MURIATIC ACID should be added in the deep end of the pool in concentrated dosages.

Precautions:

Avoid contact with eyes, skin and clothing. Do not breath fumes. Do not mix with other chemicals.



TOTAL ALKALINITY

THE KEY TO WATER BALANCE

Ideal Range 100 – 120 ppm

TOTAL ALKALINITY is the measure of the ability of a body of water to BUFFER itself from wide swings in pH.

TOTAL ALKALINITY

LOW T.A. PROBLEMS

- Corrosion
- Pitting of Concrete
- Metals Stripped
- Staining
- pH Bounce





USING "M.S.R" FOR LOW TOTAL ALKALINITY

If Total Alkalinity is below 50 ppm, **M.S.R** should be added to the pool water prior to the adjustment of Total Alkalinity.

Dosage:

10 000L	20 000L	40 000L	80 000L	100 000L	200 000L
250 mL	500 mL	1 L	2 L	2.5 L	5 L

M.S.R. should be added slowly to pool water near returns.

Precautions:

Do not mix with other chemicals prior to addition to the pool.

Keep out of reach of children.

Acidic product, avoid contact with skin and eyes.





INCREASING TOTAL ALKALINITY USING "BUFFER"

REQUIRED CHANGE	2000L	20 000L	40 000L	80 000L	200 000L
+10ppm	36.0g	360g	720g	1.44kg	3.60kg
+20ppm	72.0g	720g	1.44kg	2.88kg	7.20kg
+30ppm	108.0g	1.08kg	2.16kg	4.32kg	10.80kg
+40ppm	144.0g	1.44kg	2.88kg	5.76kg	14.40kg
+50ppm	180.0g	1.80kg	3.59kg	7.18kg	18.00kg
+60ppm	216.0g	2.16kg	4.31kg	8.62kg	21.60kg
+70ppm	252.0g	2.52kg	5.03kg	10.10kg	25.20kg
+80ppm	288.0g	2.88kg	5.75kg	11.50kg	28.80kg
+90ppm	324.0g	3.24kg	6.47kg	12.90kg	32.40kg
+100ppm	360.0g	3.60kg	7.19kg	14.40kg	36.00kg

Buffer may be added directly to the pool when the Total Alkalinity has dropped below 100ppm. Add **Buffer** by broadcasting over the pool surface.



TOTAL ALKALINITY

HIGH T.A. PROBLEMS

- Scaling
- Scale Forms on Equipment
- Short Filter Runs
- Cloudy Water
- pH Drift to 8.4

TOTAL ALKALINITY

CYA WILL TITRATE AS T.A.

Adjustments Required

<u>pH</u>	<u>Correction Factor</u>
8.5	.38
8.0	.36
7.5	.30
7.0	.21
6.5	.10

- Step 1:** Multiply CYA level by appropriate correction factor.
- Step 2:** Subtract result of Step 1 from the measured T.A.
- Step 3:** Result is adjusted T.A.

DECREASE TOTAL ALKALINITY USING "MURIATIC ACID"

Mursatt's *Muriatic Acid* should be used to decrease the Total Alkalinity of the pool water. Six steps are required in the slugging method.

Step 1: Add 40% of total Mursatt's *Muriatic Acid* required from the dosage chart on the next page. In the deep end of the pool, add acid in concentrated dosages, allowing the acid to curl towards the pool bottom. When column is 2/3 of way to pool bottom, stop and repeat a few feet away. Add acid where pool turbulence is minimal. A pH drop will be noticed. Therefore, allow 2 - 3 days for pH to rise back to normal.

NOTE: Do not cover pool during process.

DECREASE TOTAL ALKALINITY USING MURIATIC ACID

- Step 2:** Repeat Step 1 using 25% of the total acid. Wait 2-3 days (pH above 7.2)
- Step 3:** Repeat Step 1 using 15% of the total acid. Wait 2-3 days.
- Step 4:** Repeat Step 1 using 10% of the total acid. Wait 2-3 days.
- Step 5:** Repeat Step 1 using 10% of the total acid. Wait 2-3 days.
- Step 6:** Have water re-tested by dealer.

DECREASING TOTAL ALKALINITY USING "MURIATIC ACID"

REQUIRED CHANGE	2000L	20 000L	40 000L	80 000L	200 000L
-10ppm	32.5mL	325mL	650mL	1.30L	3.25L
-20ppm	65.0mL	650mL	1.30L	2.60L	6.50L
-30ppm	97.5mL	975mL	1.95L	3.90L	9.75L
-40ppm	130.0mL	1.30L	2.60L	5.20L	13.00L
-50ppm	163.0mL	1.63L	3.26L	6.52L	16.30L
-60ppm	195.0mL	1.95L	3.90L	7.80L	19.50L
-70ppm	228.0mL	2.28L	4.56L	9.12L	22.80L
-80ppm	260.0mL	2.60L	5.20L	10.40L	26.00L
-90ppm	293.0mL	2.93L	5.86L	11.70L	29.30L
-100ppm	325.0mL	3.25L	6.50L	13.00L	32.50L

Precautions:

Avoid contact with eyes, skin and clothing. Do not breath fumes.
Do not mix with other chemicals.



CALCIUM HARDNESS

THE FORGOTTEN PARAMETER

Ideal Range (Concrete) - 200 – 275 ppm
(Vinyl) - 150 – 275 ppm

CALCIUM HARDNESS is the quantity of dissolved calcium in the water.

The term hardness comes from the fact that water that has a large amount of dissolved calcium or magnesium makes it difficult to dissolve soap. It is hard to form a lather**HARD WATER**.

CALCIUM HARDNESS

LOW C.H. PROBLEMS

- ❑ Aggressive Water
- ❑ Pitting of Concrete
- ❑ Metals Stripped
- ❑ Staining
- ❑ Liners Go Brittle





INCREASING CALCIUM HARDNESS USING "MOR-CAL"

REQUIRED CHANGE	2000L	20 000L	40 000L	80 000L	200 000L
+10ppm	30.0g	300.0g	600.0g	1.2kg	3.0kg
+20ppm	60.0g	600.0g	1.20kg	2.4kg	6.00kg
+30ppm	90.0g	900.0g	1.80kg	3.6kg	9.0kg
+40ppm	120.0g	1.20kg	2.40kg	4.8kg	12.0kg
+50ppm	150.0g	1.50kg	3.00kg	6.0kg	15.0kg
+60ppm	180.0g	1.80kg	3.60kg	7.2kg	18.0kg
+70ppm	210.0g	2.10kg	4.20kg	8.4kg	21.0kg
+80ppm	240.0g	2.40kg	4.80kg	9.6kg	24.0kg
+90ppm	270.0g	2.70kg	5.40kg	10.8kg	27.0kg
+100ppm	300.0g	3.00kg	6.00kg	12.0kg	30.0kg

MOR-CAL is completely soluble in water and should be directly added to the deep end of the pool.

Precautions:

Do not mix with other chemicals.
Keep out of reach of children.



CALCIUM HARDNESS

HIGH C.H. PROBLEMS

- ❑ Scaling
- ❑ Short Filter Runs
- ❑ Cloudy Water
- ❑ Coats Elements





USING "SHIELD" WITH HIGH CALCIUM HARDNESS

	2000L	20 000L	40 000L	80 000L	200 000L
INITIAL	20.0ml	200.0ml	400.0ml	800.0ml	2.0L
HIGH C.H.	40.0ml	400.0ml	800.0ml	1.6L	4.0L
WEEKLY	5.0ml	50.0ml	100.0ml	200.0ml	5.0Lkg

Shield should be diluted in a bucket before being added to the pool.

Precautions:

Do not mix with other chemicals.
Keep out of reach of children.

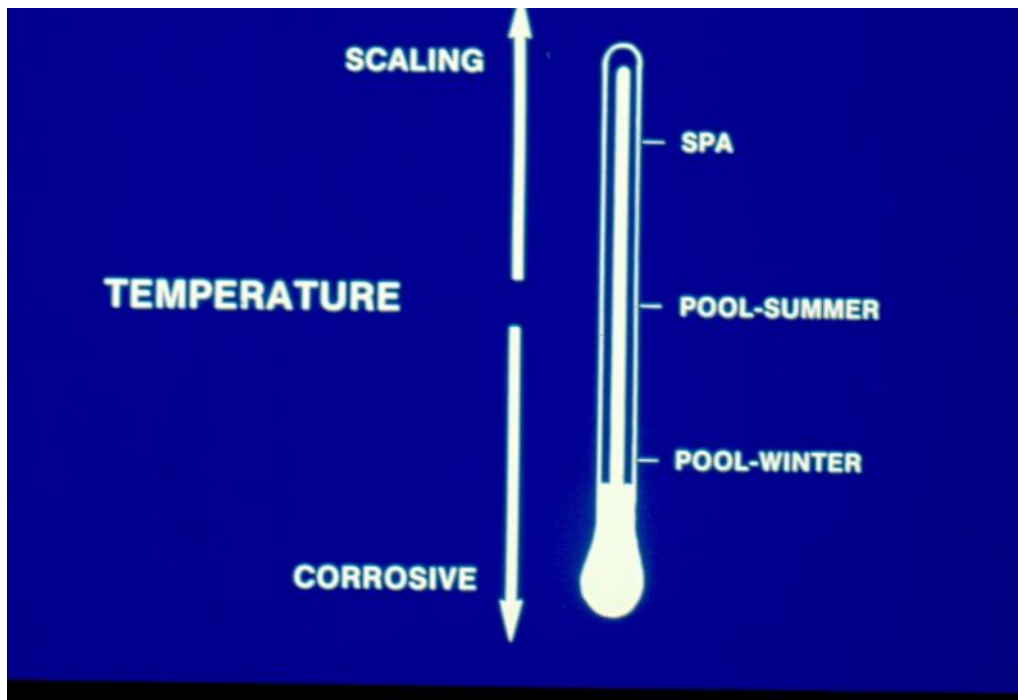


TEMPERATURE

Ideal **POOL** Temperature - 25°C TO 28°C

Ideal **SPA** Temperature - 104°C Maximum

EFFECT ON WATER BALANCE



TEMPERATURE

EFFECT ON WATER BALANCE

HIGH TEMPERATURES

- Scaling occurs as calcium is less soluble
- Gases in water less soluble therefore creates the gassing off carbon dioxide resulting in a rise of the pH

LOW TEMPERATURES

- Corrosive
- Cold water in the winter time can be quite aggressive; therefore, pool water should be balanced accordingly during winterizing

TOTAL DISSOLVED SOLIDS (T.D.S.)

Ideal Range 300-2000 ppm

Potable Water	200-1000 ppm
Chlorine Generator	1500-4500ppm
Sea Water	35,000 ppm
Great Salt Lake	260,000 ppm

HIGH T.D.S. PROBLEMS

- ❑ Increases turbidity when combined with a high pH
- ❑ Enhanced scaling on heating elements and surfaces
- ❑ Staining
- ❑ Increased natural corrosion, increased conductivity
- ❑ Enhanced mineral deposits on waterline and water features



TOTAL DISSOLVED SOLIDS (T.D.S.)

TDS AND THE CHEMICALS WE ADD

1 kg of any dry chemical = 1 kg of dissolved solid
4 litres of Muriatic Acid = 1 kg of dissolved solid
4 litres of Liquid Chlorine = 1 kg of dissolved solid

Conversion to TDS ppm - 1 litre of water weighs 1 kg

For a 10,000 l pool - the water weighs 10,000 kg

1,000,000/weight of pool water = TDS increase for every 1 kg of solids added. Therefore
 $1,000,000/100,000 = 10 \text{ ppm/kg}$

3 kg Shock = 30 ppm TDS **4 litre Liq Chl** = 10ppm TDS

For a 2,000 litre spa – the water weighs 2,000 kg

$1,000,000/2,000 \text{ kg} = 500 \text{ ppm/kg}$

1 kg of Spa Chlor = 500 ppm TDS

POOL SALT ADDITION CHART



NOTE: It is very important to use “pool salt” for a chlorine generator pool. Pool salt does not contain YPS (yellow prussiate of soda) and anti caking agents. Which will stain pool surfaces.

Always test salt level before adding. Tap or source water contains a level of salt.

Required change	2000L	10,000L	40,000L	100,000L
100ppm	200g	1 kg	4 kg	10 kg
500ppm	1 kg	5 kg	20 kg	50 kg
1000ppm	2 kg	10 kg	40 kg	100 kg
1500ppm	3 kg	15 kg	60 kg	150 kg
2000ppm	4 kg	20 kg	80kg	200 kg
3000ppm	6 kg	30 kg	120 kg	300 kg

POOL SALT ADDITION CHART



CONDITIONER CL: Is a blended product that increases salt level and cyanuric acid level (CYA) together.

Required change	Change in CYA level	2000L	10,000L	40,000L	100,000L
100ppm	1.7 ppm	200g	1 kg	4 kg	10 kg
500ppm	8.5 ppm	1 kg	5 kg	20 kg	50 kg
1000ppm	17 ppm	2 kg	10 kg	40 kg	100 kg
1500ppm	25 ppm	3 kg	15 kg	60 kg	150 kg
2000ppm	33 ppm	4 kg	20 kg	80kg	200 kg
3000ppm	50 ppm	6 kg	30 kg	120 kg	300 kg

LANGLIER INDEX

SATURATION INDEX (S.I.)

This is the formula that quantifies each of the water balance parameters to arrive at a number that tells us if the water is in balance.

$$SI = pH + TF + CF + AF - 12.1$$

If: $SI = + 0.3$ Water is Scaling

$$SI = \begin{array}{l} + 0.3\text{-----} \\ 0.0 \text{ Water is Balanced} \\ - 0.3\text{-----} \end{array}$$

If: $SI = - 0.3$ Water is Corrosive

LANGLIER INDEX

CONVERSION TABLES

Temperature		Calcium Hardness		Total Alkalinity	
F	= TF	ppm	= CF	ppm	= 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

LANGLIER INDEX

INDEX PROBLEMS

Case # 1: $SI = pH + TF + CF + AF - 12.1$
 $SI = 7.6 + 0.6 + 0.3 + 2.0 - 12.1$
 $SI = -1.6$ Corrosive Water

Case # 2: $SI = pH + TF + CF + AF - 12.1$
 $SI = 9.2 + 1.0 + 1.9 + 0.0 - 12.1$
 $SI = 0$ Perfectly Balanced Water

What is the problem here?

Case # 3: $SI = pH + TF + CF + AF - 12.1$
 $SI = 7.5 + 0.7 + 1.9 + 2.0 - 12.1$
 $SI = 0$ Perfectly Balanced Water

LANGLIER INDEX

CORRECTIONS OF PARAMETERS

T.A.

C.H.

pH

Increase:

Buffer

Mor-Cal

Easy-Up



Decrease:

Muriatic
Acid

Shield

Easy Down
Muriatic Acid



SANITIZERS

EFFECT ON pH

	<u>pH</u>
Chlorine Gas	1.0
Chlorine Generator	11.7
Liquid Chlorine	13.0
Shock	11.0
Shock n' Shine	7.0
Pucks	2.8
Sta-Chlor	6.8
Bromine Tabs	4.8

OTHER CAUSES OF CORROSION

CORROSION: Is the deterioration of a substance (usually a metal) or its properties because of a reaction with its environment.

GALVANIC: The passage of electric current between two metals will cause one of the metals to corrode in order to protect the other. One metal will sacrifice itself to the other.

OTHER CAUSES OF CORROSION

Galvanic Series

Magnesium
Zinc
Galvanized Steel
Aluminum
Mild Steel
Cast Iron
Lead
Tin
Bronze
Nickel
Brass
Copper
Silver Solder
13% Cr. Stainless Steel
Titanium
Silver
Gold
Platinum

Corrode the
Most



Corrode the
Least

*Magnesium used for sacrificial anodes.
Magnesium will sacrifice itself to all other metals.*

OTHER CAUSES OF CORROSION

EMF (Electric Motor Force) is the voltage between two different metals exposed in the same environment.

Example: This is why sacrificial anodes made of magnesium were used with the older metal filter tanks.

Example: Steel wool scouring pad disintegrates after one use when left wet and stored on the edge of a stainless steel sink.

EROSION: Not corrosion but may remove corrosion film exposing fresh metal to corrode. Flow rates of 7 to 8 feet per second will erode copper piping.

HIGH TDS: Enhances electric current conductivity (a conductivity meter is used to test for TDS). High TDS can cause copper pipe to erode at flow rates in excess of 2 to 3 feet per second.

Important for chlorine generator pools.

Part 2

SANITATION & OXIDATION





SANITATION

SANITIZER

An agent that reduces the level of microorganisms present by significant numbers, usually 99.9 % more.

In 1900 Municipalities began filtering and chlorinating drinking water. Average life expectancy was 47 years.

Through the elimination of waterborne disease our average life expectancy is now mid 80's.

Alternative Product Comparison Chart

Reprinted from Pool and Spa Marketing
 Author: Dr. R. Neil Lowry

PRODUCT	DESCRIPTION	SANITIZE	OXIDIZE	RESIDUAL
Chlorine or Bromine	Any products in this category	Yes	Yes	Yes
Oxone	Non chlorine shock	If Chl. or Br. is present	Yes	If Chl. or Br. is present
Ozone	Generators	Yes	Yes	No
UV	Ultra Violet Light	Yes	Yes	No
Ionizers	Copper/Silver Ion Generatrion			
Magnets	Permanent Magnets			
Vision (Fountainhead)	Oxidative Catalysts Silver/Copper			Some
Zincolators	Zine metal/Zinc Ion			Yes

SANITATION

CHLORINE DEMAND

The amount of chlorine which will react with wastes in the pool before any chlorine is left unreacted.

CAUSES OF CHLORINE DEMAND

- (A) Micro organisms
- (B) Organics

CHLORINE PERCENTAGES

- (A) Active Percentage
How much of this product is active?
- (B) Available Chlorine Content
% Relative to Chlorine Gas



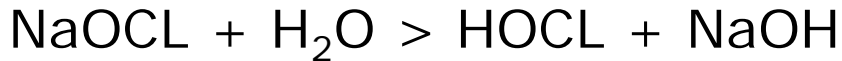
OXIDIZERS

UNSTABILIZED CHLORINES

- (A) Chlorine Gas
- (B) Sodium Hypochlorite (Liquid Chlorine)
- (C) Calcium Hypochlorite (Shock)

LIQUID CHLORINE

Sodium Hypochlorite – NaOCL



Active Strength - 10.8%

Available Chlorine Content - 10.3%

pH - 13

Available Sizes

4x4L

2x10L

20L Handle Pack



LIQUID CHLORINE

Factors That Affect Product Life

1. Temperature
2. Exposure to Sunlight
3. Product Quality
4. Strength

LIQUID CHLORINE

Decomposition Rates

Temp	Months				
C	0	1	2	3	4
21	12.3%	10.7%	9.5%	8.5%	7.5%
27	12.3%	10.0%	8.0%	6.8%	5.5%
32	12.3%	8.3%	6.2%	4.6%	3.0%

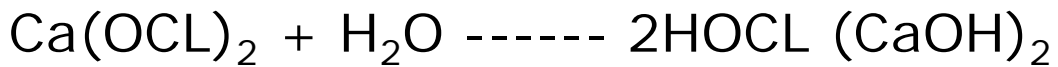
% STRENGTH A.C.C.

Not affected by freezing. Liquid Chlorine stored at -25° C or lower will retain its strength indefinitely.



SHOCK/SUPER SHOCK

Calcium Hypochlorite – Ca (OCL)₂



Active Strength - 65%

Available Chlorine Content - 65%

pH - 11

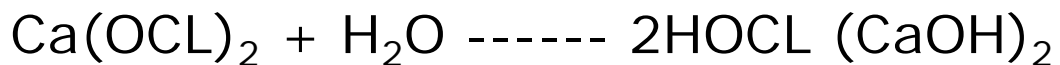
New
Stand-up
Pouch
design





SKIMMER CAPSULES

Calcium Hypochlorite – Ca (OCL)₂
300g tablet encapsulated in a plastic sleeve



Active Strength - 70%

Available Chlorine Content - 70%

pH - 11

"The ideal solution for sanitizing pool water without increasing stabilizer (cya) levels."





SHOCK/CAL HYPO

Precautions

- **Never** mix with any other chemicals.
- **Always** add Shock to water, **Never** add water to Shock.

For Best Results dissolve Shock in a plastic pail filled with water and add directly to the pool.





SHOXITE

Non-Chlorine Oxidizer (Potassium Monopersulfate)



Advantages

- Fast Dissolving
- Completely soluble

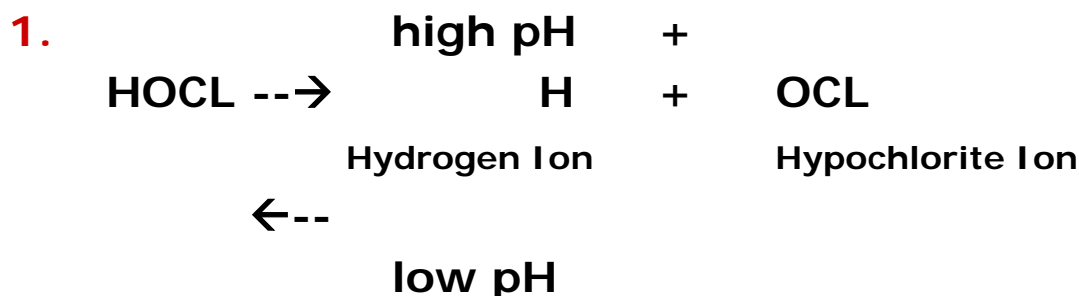
Disadvantages

- Not a sanitizer
- Reacts with DPD #3



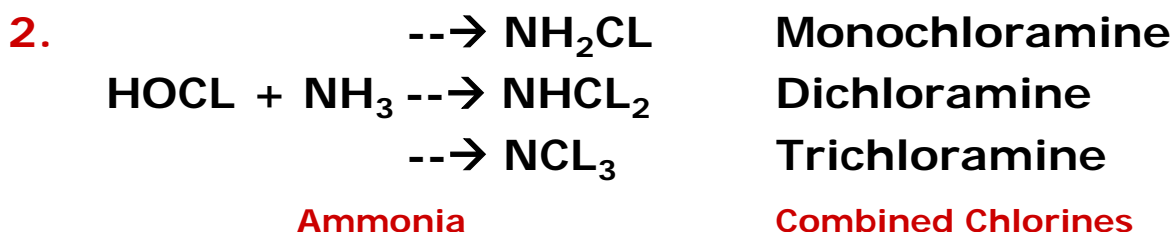
EXAMPLES OF THE CHEMISTRY OF HOCL

These equations give us an insight into the chemistry of HOCL.



The first example shows why HOCL is an acid as it dissociates to yield hydrogen ion. Does HOCL affect the pH of pool water?

EXAMPLES OF THE CHEMISTRY OF HOCL



The second equation shows how HOCL combines with ammonia, a waste product of swimmers. What are some of the properties of the combined chlorines? Are they good sanitizers?

EXAMPLES OF THE CHEMISTRY OF HOCL



The third equation illustrates that in the destruction of bacteria and the oxidation of organics that HOCL itself gets reduced to an inactive form, namely chloride ion or salt.

EXAMPLES OF THE CHEMISTRY OF HOCL

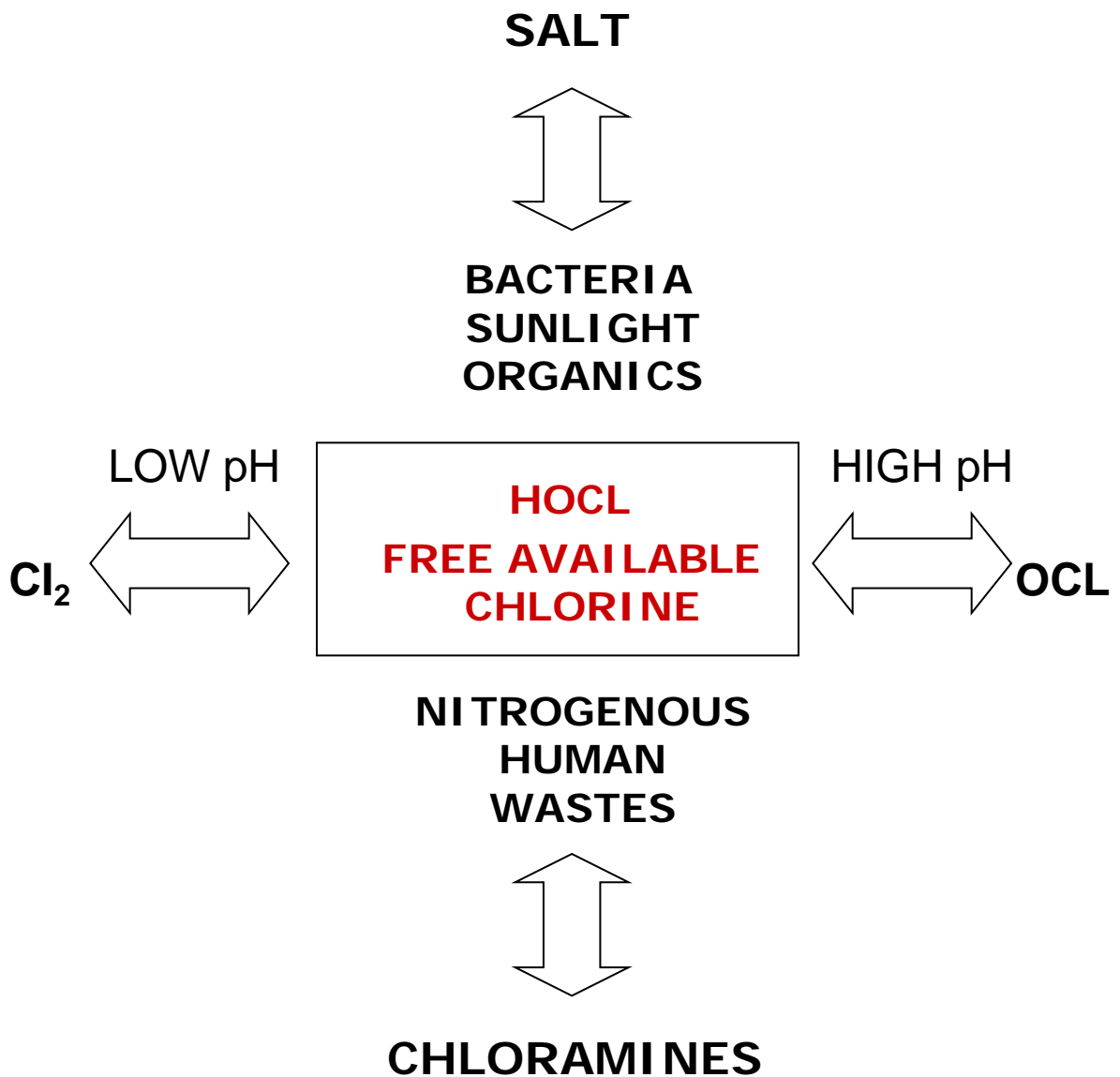
4. HOCL + Sunlight ---→ Salt

The final equation illustrates how the ultra violet rays of the sun also reduce HOCL to the inactive chloride ion.

HOW DOES HOCL SANITIZE?

Hypochlorous acid is an extremely powerful oxidizing agent. It readily diffuses through the cell walls of micro organisms and oxidizes the sulphur groups in key enzymes. In addition to this, at higher concentrations cell protein matter is denatured. In both cases the bacteria cell dies. The Hypochlorite ion has trouble entering the bacteria cell and is a much less effective sanitizer. Other factors which affect the kill efficiency are pH, temperature, contact time and concentration.

HOW DOES HOCL SANITIZE?



3 TYPES OF CHLORINE RESIDUALS

F.A.C. FREE AVAILABLE CHLORINE

Chlorine that is free and available to do the killing. It is the workhorse of sanitation killing pathogens and oxidizing organics.

C.A.C. COMBINED AVAILABLE CHLORINE

Chlorine that has formed from the reaction of F.A.C. and nitrogen waste. Chloramines (or as they are sometimes called, “combined chlorine”) cause the characteristic chlorine odour of heavily used pools and can also cause eye and mucous membrane irritation.

T.A.C. TOTAL AVAILABLE CHLORINE

The sum of F.A.C. and C.A.C.

$$\text{T.A.C.} = \text{F.A.C.} + \text{C.A.C.}$$

BREAKPOINT CHLORINATION

Breakpoint Dosage = 10 x C.A.C.

Example: F.A.C. = 0.4
T.A.C. = 2.0
C.A.C. = 1.6

Breakpoint Chlorination

$$10 \times 1.6 = 16 \text{ ppm}$$

You would need to introduce 16 ppm of F.A.C. to eliminate the C.A.C.

How much "Shock" would you need for a
80,000 litre pool?

$$123\text{g} \times 16 \text{ ppm} = 1,968\text{g} \text{ or } 1.968 \text{ kg}$$

AMOUNT OF SANITIZER REQUIRED TO PRODUCE FREE AVAIL CHLORINE

1 PPM

CHLORINE SANITIZER	% ACC	2000L	20 000L	40 000L	80 000L	200 000L
CHLOR GAS	100	2.00 g	20.0 g	40.0 g	80.0 g	200.0 g
PUCKS	90	2.22 g	22.2 g	44.4 g	88.8 g	222.0 g
SHOCK	65	3.07 g	30.7 g	61.3 g	123.0 g	307.0 g
STA-CHLOR	62	3.45 g	34.5 g	69.0 g	138.0 g	345.0 g
LITE SHOCK	35	5.71 g	57.1 g	114.0 g	228.0 g	571.0 g
LIQUID CHLOR	10.3	20.0 ml	200.0 ml	400.0 ml	800.0 ml	2.0 L

30 PPM

CHLORINE SANITIZER	% ACC	2000L	20 000L	40 000L	80 000L	200 000L
CHLOR GAS	100	60.0 g	600.0 g	1.200 kg	2.400 kg	6.00 kg
PUCKS	90	66.6 g	666.0 g	1.332 kg	2.664 kg	6.66 kg
SHOCK	65	92.1 g	921.0 g	1.839 kg	3.690 kg	9.21 kg
STA-CHLOR	62	103.5 g	1.035 kg	2.070 kg	4.140 kg	10.35 kg
LITE SHOCK	35	171.3 kg	1.713 kg	3.420 kg	6.840 kg	17.13 kg
LIQUID CHLOR	10.3	600.0 ml	6.00 L	12.00 L	24.00 L	60.00 L

CHLORINE NEUTRALIZATION

Clor-Out

“Chlorine Neutralizer”

Fast dissolving, safe and easy to use.

Quick and practical solution to chemically reduce or neutralize excessively high levels of Chlorine or Bromine.

Can be added directly to the pool by sprinkling on the pool surface.

Reduce by	Dosage	Dosage
By 1 ppm	20 gr	140 gr
By 5 ppm	100 gr	700gr
By 10 ppm	200 gr	1.4 kg
	Per 10,000L	Per 80,000L





STABILIZED CHLORINES

Sta-Chlor (Granular)

Active Strength	- 100%
Available Chlorine Content	- 62%
Stabilizer Content	- 57%
pH	- 6.7





STABILIZED CHLORINES

Mini Pucks/Pucks/Super Pucks and Sticks

Active Strength	- 90 to 100%
Available Chlorine Content	- 90%
Stabilizer Content	- 56%
pH	- 2.8%

20 g Tab

60 g Tab

200 g Tab

250 g Stick





STABILIZED CHLORINES

SHOCK N' SHINE Shock Treatment

A blended shock treatment that combines oxidizing properties with water polishing benefits and a clarifier.

- Active Strength - 47%
- Available Chlorine Content - 47%
- Stabilizer Content - 37.5%





STABILIZER

Cyanuric Acid – CYA

pH - 6.3

Slow dissolving

Not destroyed by any chemicals

3 Forms:

Granular



Liquid



Stick



STABILIZER

The only method to remove CYA from pool water is to remove that water from the pool.

NEVER add CYA to a pool without testing for it first.

Proper Ranges

Pool using a stabilized daily sanitizer – 25 to 75 ppm

Pool using an unstabilized daily sanitizer – 50 to 75 ppm

DOSAGE

TO INCREASE STABILIZER BY	STABILIZER DOSAGE PER 50,000 L
------------------------------	-----------------------------------

10 ppm	500 grams
20 ppm	1.00 kg
25 ppm	1.25 kg

Stabilizer level usually only needs adjustment at the beginning of the pool season if a stabilized chlorine is being used as the daily sanitizer. By using a stabilized chlorine sanitizer, the Cyanuric Acid level is maintained.

PRECAUTIONS:

- Do not mix with other chemicals.
- Keep out of reach of children.
- High stabilizer levels can cause serious water problems.

OVERSTABILIZATION

REQUIRED

pH = 7.4	CYA = 25 ppm	F.A.C. = 1.0 ppm
	50 ppm	1.2 ppm
	100 ppm	1.6 ppm

pH = 7.6	CYA = 25 ppm	F.A.C. = 1.8 ppm
	50 ppm	2.0 ppm
	100 ppm	2.8 ppm

High CYA buffers pH around 6.8.



BROMINE

BROM'N8 TABLETS/BROM'N8 SUPER-TABS

Available Bromine	$61\%/2.25 = 27.1\%$
Available Chlorine	$27\% = \underline{27.0\%}$
A.C.C.	$= 54.1\%$

pH - 4.8

You divide the available Bromine by 2.25 to represent the difference in molecular weight.

20 g Tablet

NEW PRODUCT



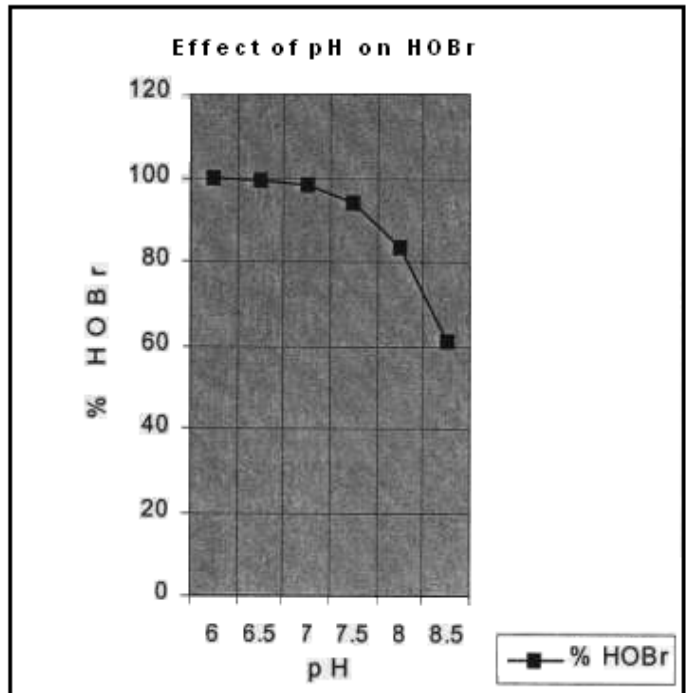
BROM'N8 SUPER TABLETS

- 100g Tablets
- Packaged in 1 kg sleeves
- Offered in 7kg and 15 kg sizes



THE EFFECT OF pH ON BROMINE (HOBr)

pH	% HOBr
6	100
6.5	99.4
7	98
7.5	94
8	83
8.5	61



HOBr – Bromine in its most efficient killing form.

At a pH of 7.5 - 94% of the bromine is in the killing form.

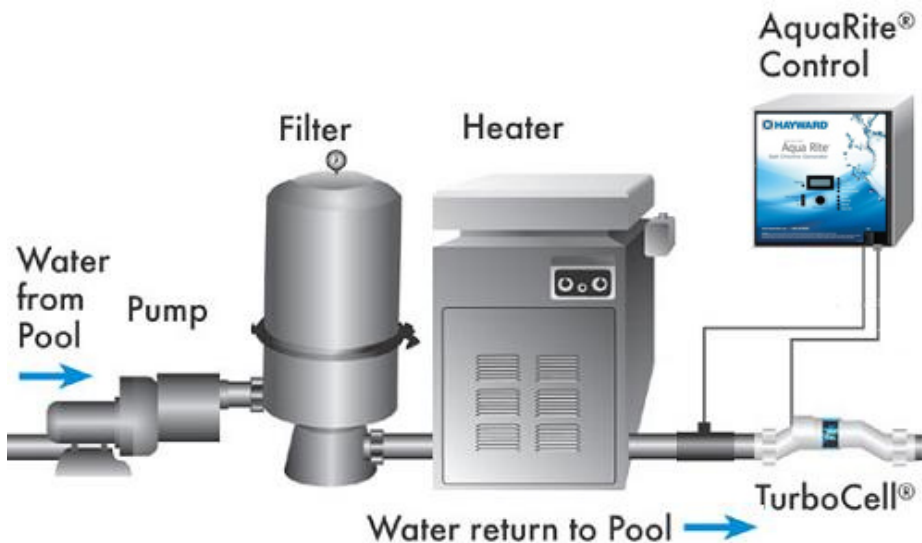
At a pH of 8.5 - 61% of the bromine is in the killing form.

CHLORINE GENERATORS



A Chlorine Generator uses salt in the swimming pool water to generate HOCL.

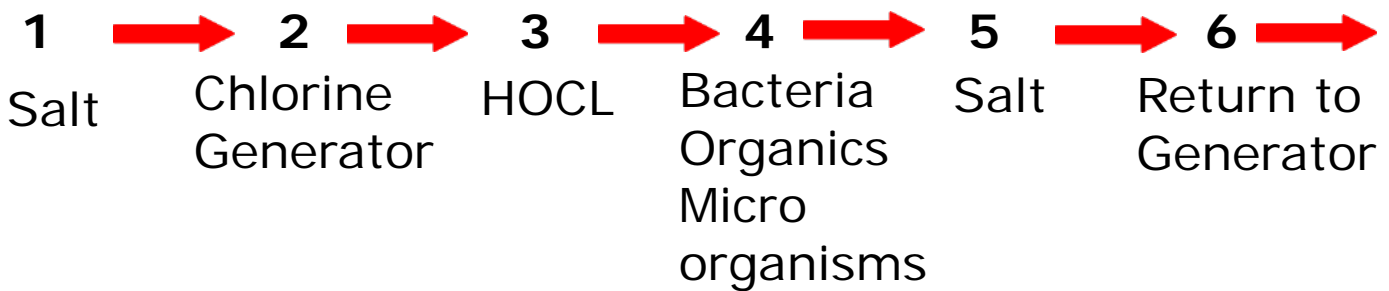
Different Manufactures require different levels of salt in the water to function properly. Always test your water first and adjust using the chart from **Page # 32**.



CHLORINE GENERATORS



How They Work.



1. Salt is added to the swimming pool water. Pg #32.
2. Water enters the chlorine generator where it passes through two electrodes. Sodium hydroxide is generated at the cathode (negative pole) and chlorine gas is generated from the Anode (positive pole).
3. The chlorine gas (HOCL) becomes our sanitizer.
4. The chlorine comes in contact with and destroys bacteria, organics, and micro-organisms.
5. The by-product of this reaction is salt.
6. The salt is returned to the chlorine generator where the process begins again.

Note: A Chlorine generator is a closed system. Once you have met the salt requirement you do not need to add any more salt. The only way to remove salt from the pool is to remove water.

CHLORINE GENERATORS



PROS VS CONS

PROS

- Constant feed system.
- Can eliminate human error.
- Reduction in chloramines through constant oxidation.

CONS

- High pH pressure.
- Greater importance of water balance.
- Scaling.
- Evaporated Solids on pool surface and water features.
- Promotes a corrosive environment.
- Environmental issues disposing of water containing salt.
- False Consumer belief that " salt" is the sanitizer.
- Water will erode metal at lower flow rates.

PART 3

ALGAECIDES





ALGAECIDES

“A Good Insurance Policy”

4-L-G and MBA-60 “Polyquats”

Are effective in killing a wide variety of algae strains.

Non foaming. Good for pools with water features.

40%



60%





ALGAECIDES

"A Good Insurance Policy"

Algon and Alkil

"Duo-Quat" and "Mono-Quat"

Rarely successful in killing thick walled algae strains (i.e. black and brown algae)

10%



5%





ALGAECIDES

“A Good Insurance Policy”

40-Winks

“ Duo-Quat”

Winterizing algaecide

Ideal for storage of lock in covers



PART 4

SPECIALTY PRODUCTS





CONDITIONERS

Pool Polish

“Aluminum Sulphate (Alum) or Floc”

May be used in pools with or without filters.

Will help remove fine colloidal particles that normally pass by the filter.

Use as a filter aid with sand filters only. Cartridge filters may collapse due to pressure build-up.





CONDITIONERS

Nu-Blu

“Liquid Floc Treatment”

Easy to use

No pH adjustment required

Do not use with a cartridge filter

Liquid form

20 g Tablets





CONDITIONERS

Polish Plus "Organic Polymer"

Does not require pH adjustment

Improves filter efficiency

Is effective with any type of filtration system





FILTER AIDS

Filter Plus

“Combination of D.E. and Cellulose”

When used with sand filters acts as an additional filter media.

When used with cartridge filters improves filtration and greatly reduced the frequency of chemically cleaning the filter.





FILTER AIDS

Fast Flo

Contains a strong acid which helps degrease filter media.

Improves flow rates of restricted filters.

May be used with both sand filters and diatomaceous earth filters.





FILTER AIDS

Filter-Nu

“Cartridge Cleaner”

Contains a corrosive chemical which dissolves rust, scale, calcium and loosens grime and oils.

Will extend the life of filter cartridges and increase filter efficiency.





FILTER AIDS

Filter-Re-New

“All Natural Sand & Cartridge Cleaner”

A highly concentrated deep cleaning solution that removes deep set oil, greases and scum build-up on pool filters.

Will extend the life of filter media and increase filter efficiency.





STAIN AND SCALE CONTROL

Shield

Prevents rust, corrosion, scale, stains and discolouration caused by metals and minerals.

Helps to protect metal equipment, fittings, ladders, filters and pumps against corrosion.





STAIN AND SCALE CONTROL

M.S.R

“Stain Removal and Prevention”

Removes established metallic stains from plastic and vinyl surfaces caused by iron, copper and manganese.

Removes iron, copper and manganese from pool water and prevents staining from these metals.





CLEANERS

Cover Care

"Cleans and Deodorizes"

Removes soils, grease, slime and algae deposits.

For use on solar blankets, winter covers and spa covers.





CLEANERS

Tile-X

"Chlorinated Cleaner"

Removes grease, oil, dirt and most stains.

Does not contain abrasives and will not harm vinyl surfaces or cloud water.

For use on tile, vinyl liners, acrylic, concrete and chrome.





CLEANERS

Vinyl Plus

"Concentrated Alkaline Liquid"

Removes oils, grease and dirt.

Effective for cleaning water-line, skimmers, water bags, slides, diving boards, vinyl, plastic, chrome and much more.





CLEANERS

Rock'n Tile Re-nu

"Concentrated Mineral Deposit Cleaner"

Cleans mineral efflorescence from tile, stone and rock.

Acidic formula with built in emulsifiers that help dissolve rust, copper, scale, and calcium. Loosens grime and soil.



PROGRAMMING YOUR CUSTOMER'S POOL



ABC POOL COMPANY
11 REGALCREST COURT
WOODBIDGE, ONT.
L4L 8P3

SWIMMING POOL WATER PROGRAM FOR

JOE POOL OWNER
22 PLEASANT AVE.
TORONTO, ONT.
L1L 1L1

For safe, clean, healthy, enjoyable pool water follow this program.

- 1) **Water Test:** Take a water sample to your Mursatt Dealer and have it tested at least every 30 days. This is the only way to know what your pool needs!
- 2) **Balance the Water:** Follow the dealer directions to protect your pool surfaces and equipment.
- 3) **Sanitize:** Protection for the bathers in your pool. Add _ to your chemical feeder every Sunday night.
- 4) **Oxidize:** Rid your pool of organic waste. Shock your pool with _____ of _____ every Sunday night.
- 5) **Algaecide:** Protect your pool against the formation of algae. Add _____ of _____ every Monday morning.
- 6) **Enjoy:** If you follow this program you can be confident that your pool water is safe, clean, and healthy.

PART 5

SPA CHEMISTRY

SPA CHEMISTRY

Two Unique Factors

1. High Temperatures

(a) Tendency to scale

Calcium is less soluble

(b) Increased evaporation

(c) Accelerated secretion of body wastes

(d) Increased chemical reactivity

(e) Gases less soluble..... gassing off of carbon dioxide..... rise in pH

2. Small Volumes

(a) High bather loads

(b) Fast turn over

(c) Chemical sensitivity

SPA WATER BALANCE

TELLS US ONE OF THREE THINGS

1. CORROSIVE
2. SCALING
3. BALANCED

SPA WATER BALANCE

FACTORS THAT DETERMINE WATER BALANCE

- Total Alkalinity
- pH
- Calcium Hardness
- Total Dissolved Solids
- Temperature

All of these factors are **important**
to balanced spa water.

TOTAL ALKALINITY

THE KEY TO WATER BALANCE

Ideal Range 100 – 120 ppm

Low T. A. Spa Problems

- Corrosion
- Pitting of concrete
- Metals stripped
- Staining
- pH Bounce



To Correct Add: Spa Buffer

TOTAL ALKALINITY

High T. A. Spa Problems

- ❑ Scaling
- ❑ Short filter runs
- ❑ Reduced circulation
- ❑ Cloudy spa water
- ❑ pH drift to 8.4

To Correct Add: Spa Down – Citric Acid
Spa Minus



pH

Ideal Range 7.4 – 7.8

Low pH Spa Problems

- Corrosion
- Pitting of concrete
- Metals stripped
- Staining
- Chlorine loss
- Liner wrinkle
- Skin and eye irritation

To Correct Add: Aerate the spa or
Add Spa Plus



pH

High pH Spa Problems

- ❑ Scaling
- ❑ Short filter runs
- ❑ Reduced circulation
- ❑ Chlorine inefficiency
- ❑ Skin and eye irritation

To Correct Add: Spa Down
Spa Minus



CALCIUM HARDNESS

Ideal Range 100 – 150 ppm

Low C.H. Spa Problems

- Corrosion
- Pitting of concrete
- Foaming

To Correct Add: Spa Cal



CALCIUM HARDNESS

High C.H. Spa Problems

- Scaling
- Short filter runs
- Reduced circulation
- Cloudy water
- Heater element failure

To Correct Add: Spa Glo



TOTAL DISSOLVED SOLIDS (T.D.S.)

Ideal Range 300 – 2000 ppm

High T.D.S. is more of a concern in a spa than a pool because the higher spa temperatures cause evaporation. Only the water evaporates with the solids left behind to accumulate. Makeup water with more solids are added causing the T.D.S. to continually build up. Before long the T.D.S. can cause a problem.

TOTAL DISSOLVED SOLIDS (T.D.S.)

High T.D.S. Spa Problems

- ❑ Increased conductivity of water causing natural corrosion
- ❑ Increased turbidity (cloudiness)
- ❑ Increased scum formation
- ❑ Foaming
- ❑ Increased erosion

Solution: Dump the water!

TOTAL DISSOLVED SOLIDS (T.D.S.)

The following schedule provides the recommended frequency (in days) for water change.

Volume in litres

10 x (Average Number of Bathers Per Day)

Example: 1000 litre spa / (10 x 2 people per day)
= 50 days between water change.

A good schedule of water replacement will eliminate many spa problems before they happen.

TEMPERATURE

Ideal Range 32° C - 40° C or 90° F - 104° F

High Temperature Spa Problems

- ❑ Temperatures above 104° F are dangerous to your health
- ❑ Increased evaporation.....Higher TDS
- ❑ Increase scale formation
- ❑ Increased secretion of body wastes
- ❑ Increased chemical reactivity

Safety Tip

<u>Temp F</u>	<u>Bather Duration</u>
104	15 minutes max
102	30 minutes max
100	45 minutes max
98.6	No time limit

SPA SANITATION

“Four bathers in a 400 gallon spa at 100° F
consume about 3.5 ppm of
Free Available Chlorine in 15 minutes”

The key to proper spa sanitation is to keep a constant level of chlorine or bromine in the water. This is difficult to do because of the two unique aspects of spa water.

1. High Temperatures
 - Increased secretion of body wastes
 - Increased chemical reactivity
2. Small volumes
 - High bather loads
 - Small total reserve of sanitizer
(concentration x volume)

SPA SANITATION

Sanitation Problems

When the sanitation level diminishes or approaches zero a rapid build-up of pathogenic micro-organisms to infectious levels can occur. Let's take a look at some of the more common pathogens.

SPA SANITATION

Pseudomonas aeruginosa

The most common abundant pathogen found in spa water. It is found in the soil and thrives in a spa environment, grows over a wide range of pH and high temperatures.

Symptoms:

“Swimmer’s ear”, out ear infections. Red bumpy, itchy skin rash, looks like measles or poison ivy. Urinary tract infections.

SPA SANITATION

Legionella pneumophila

“Pontiac Fever” – mild form of Legionnaires’ disease. Legionnaires’ disease, Pneumonia – fatal in 15% of those infected with it.






Therefore, we need to keep sufficient levels of chlorine or bromine sanitizer in the spa water.

Let us now compare the “PROS” and “CONS” of the Spa sanitation products available.

Alternative Product Comparison Chart

Reprinted from Pool and Spa Marketing
 Author: Dr. R. Neil Lowry

PRODUCT	DESCRIPTION	SANITIZE	OXIDIZE	RESIDUAL
Chlorine or Bromine	Any products in this category	Yes	Yes	Yes
Oxone	Non chlorine shock	If Chl. or Br. is present	Yes	If Chl. or Br. is present
Ozone	Generators	Yes	Yes	No
UV	Ultra Violet Light	Yes	Yes	No
Ionizers	Copper/Silver Ion Generatrion			
Magnets	Permanent Magnets			
Vision (Fountainhead)	Oxidative Catalysts Silver/Copper			Some
Zincolators	Zine metal/Zinc Ion			Yes

Product	pH	'Pros'	'Cons'
Chlorine gas	1.0		-strips T.A.
Sodium Hypochlorite (liquid chlorine)	13.0		-increases pH -increases T.D.S.
Calcium hypochlorite (Shock)	11.0		-increases pH -increases C.H. -solubility
 Trichlor - (Spa Pucks)	2.8	-constant feed -strong -slow solubility	-decreases T.A. -decreases pH -increases CYA -chloramines
 Sodium Dichlor (Spa Chlor)	6.8	-rapid solubility -pH neutral	-increases CYA -chloramines
 Blended Shock (Spa Shine)	7.0	-rapid solubility -clarifier	-chloramines -Increases CYA
Potassium Monopersulfate	3.0	-rapid solubility -chloramines	-decreases pH -decreases T.A. -not a sanitizer
 Buffered Potassium Monopersulfate (Brome Ox) (Spa Boost)	6.0 to 8.0	-rapid solubility -pH balanced -Chloramine reducer	-not a sanitizer
Ozone	7.2 to 8.0	-strong oxidizer -no T.D.S. -constant feed -pH no effect	-not a sanitizer -attacks rubber -poor solubility -half life < 20 min.
 Bromine Tablets (Brominating Tablets for Spas)	4.8	-slow solubility -constant feed -bromamines	-decreases pH -decreases T.A. -not registered

SPA SPECIALTY PRODUCTS

Spa-Glo

Provides three beneficial functions in a spa.

- Sequestriant
- Clarifier
- Protection



SPA SPECIALTY PRODUCTS

Bubble-Burst

Eliminates foaming immediately.



Tile-X

Is a non-abrasive cleaner formulated for spas.



SPA SPECIALTY PRODUCTS

Vinyl Plus

Is a concentrated liquid cleaner.



Cover-Care New Formula

Cleans, deodorizes and preserves spa covers.



SPA SPECIALTY PRODUCTS

Neutralizer

Chemically reduces or neutralizes excessively high levels of Chlorine or Bromine in spas.



Spa Soft

A liquid, unscented softener. Makes bathing more comfortable by protecting the bather from dry, itchy and irritated skin.



SPA SPECIALTY PRODUCTS

Spa Flush

Plumbing, pipe and surface cleaner specifically designed to get rid of accumulated dirt, contaminants, oils, and biofilm build-up in the plumbing lines of spas.



Spray & Rinse

Easy way to clean and degrease spa cartridge filters. Simply spray and rinse filter elements.

SPA SPECIALTY PRODUCTS

Filter-Nu

Cleans filter cartridges, dissolves minerals and loosens soil.



Spa Perfect

Is a natural enzyme that assists in spa maintenance.

Note: Ask your sales rep about other products available from Natural Chemistry



PROGRAM YOUR CUSTOMER'S SPA!



- 1) Test and balance the source water.**
Put the customer on a program for balancing their source water every time they refill the spa.
- 2) Recommend an oxidation and sanitation system that best suits your customers needs.**

Bromine System

Sanitizer - Brominating Tablets in a floater
Oxidizer - Spa Chlor, Spa Shine, or Spa Boost



Chlorine System

Sanitizer - Spa Pucks in a floater
Oxidizer - Spa Chlor or Spa Shine



- 3) Recommend a maintenance dosage of *Spa-Glo* and *Spa Perfect*.**
 - To protect the spa from scale
 - To protect heating element and exchangers
 - Gives the spa water extra sparkle



- 4) Place the spa customer on a water replacement program.**
Eliminate potential problems by using fresh water.
-

PurEssence

Bi-Monthly Kit

Natural Water Care System

FOR HOT TUBS



What's Inside.....

PURE Part One

- Non-acidic phosphate free formula designed to Protect hot tub surface and equipment.
- 240 ml/1500L or 2 Caps Bi-weekly

ESSENCE Part Two

- Contains Enzymes, phosphate removers, clarifier, pH and alkalinity buffers.
- 240 ml/1500L or 2 Caps Bi-weekly

Alternate Between **One** and **Two** Weekly



Oxygen Pods

- Non-chlorine oxidizing pods. 1-2 After each use or weekly

WATER TESTING PROBLEMS



□ Testing for disinfectant residual

DPD: High levels will bleach out test

OTO: Does not distinguish between total and free chlorine.

We recommend the Taylor titration method. FAS Drop test kits K-1515 (chlorine) and K-1517 (Bromine).

2) Testing for pH

Phenol Red: Affected by high chlorine levels. Limited range.

3) Testing for Alkalinity

- High chlorine bleaches indicator
- Can register a negative alkalinity
- CYA will titrate as alkalinity

WATER TESTING PROBLEMS



4) Testing for Calcium Hardness

- Copper will interfere with the end point

5) Testing for Cyanuric Acid

- Results very subjective
- Temperature can change results

6) Testing for Dissolved Minerals

- Chlorine interferes with results

STEPS TO PROPER WATER TESTING



- 1) Use an uncontaminated container
- 2) Take sample 12" – 14" below surface, away from any skimmer or inlet (composite sample)
- 3) Fill sample cell to bottom of meniscus
- 4) When using drops hold bottle straight up and down
- 5) Do not handle tablets
- 6) Use caps provided
- 7) Rinse test cells well

PRECAUTIONS FOR TESTING WATER



- 1) Test spa water frequently and keep a continuous record
- 2) Never use the same test tube for both chlorine and pH tests
- 3) Never add drops of OTO directly to the pool or spa
- 4) Avoid exposing reagents and comparator to direct sunlight, freezing or high temperatures
- 5) Rinse all testing equipment thoroughly
- 6) Store equipment properly
- 7) Anticipate requirements for new reagents