Cyanuric Acid: It Controls Your Pool

by Robert W. Lowry

What? I thought water balance, pH, total alkalinity or chlorine controlled the pool. How can a chemical that protects chlorine from sunlight control a pool?

The science of the chlorine/CYA relationship has been known definitively since at least 1974 but either workers in the swimming pool and spa industry do not understand the chlorine-cyanuric acid (CYA) relationship or they *do* understand, but believe that it does not apply to their pools. **This paper will change the way you take care of pool water and give you a new understanding of pool chemistry**. CYA has been a controversial subject since its introduction to the pool industry in 1956.

Cyanuric acid (CYA), also known as conditioner, stabilizer and isocyanuric acid, has been the subject of many articles, papers, discussions and even a presentation at a conference with the title “The Great CYA Debate in 2004”. A Google search for cyanuric acid in pools brings back 75,600 hits. It is no wonder that everyone is confused about all of the things that CYA does. Here are the things that CYA does:

- CYA protects chlorine from UV (ultraviolet rays from the sun).
- CYA controls how well the chlorine in the water works
- CYA buffers both pH and chlorine itself

Thus CYA affects pH, total alkalinity, water balance, the Saturation Index and the killing power of the chlorine while protecting the chlorine from sunlight. That’s pretty impressive for a single chemical.

Chlorine Loss is 75% in 2 Hours in Sunlight without CYA

It is well known that CYA protects chlorine from UV degradation. It has been quoted many times 90-95% of unprotected chlorine is lost within 2 hours by direct exposure to sunlight. This is realistic when the water is very shallow and if the pH is near 7.5. The half-life of hypochlorous acid (HOCl) in direct noontime sun is about 2 hours while for hypochlorite ion (OCl^-) it is about 20 minutes and for a 50/50 mix of HOCl and OCl^- near a pH of 7.5, it is roughly 30 minutes. After 2 hours in sunlight, chlorine concentration is reduced to 90-95%. At 4.5 feet depth, the half-life is about 1 hour and **the more typical loss after 2 hours is around 75%** (with no bather load). Nevertheless, the main point here is that with no CYA in the water, the chlorine is degraded rapidly in sunlight.

CYA slows down the UV catalyzed degradation rate of chlorine. In fact, **30 ppm CYA keeps chlorine in the pool water roughly 8 times longer than without it.**

Chlorine in Water Reactions

Before discussing how CYA works, we must first understand that when we add chlorine in any form to water, a rapid reaction occurs which produces hypochlorous acid (HOCl). The only differences are in what else these different types of chlorine add to the water. Here is what happens when each type of chlorine is added to water:

$$Cl_2 + H_2O \rightarrow \mathbf{HOCl} + HCl$$

gas chlorine and water forms **hypochlorous acid** and hydrochloric acid

$$NaOCl + H_2O \rightarrow \mathbf{HOCl} + Na^+ + OH^-$$

sodium hypochlorite and water forms **hypochlorous acid** and sodium ion and hydroxyl ion

$$Ca(OCl)_2 + 2H_2O \rightarrow 2\mathbf{HOCl} + Ca^{2+} + 2OH^-$$

calcium hypochlorite and water forms **hypochlorous acid** and calcium ion and hydroxyl ion

$$LiOCl + H_2O \rightarrow \mathbf{HOCl} + Li^+ + OH^-$$

lithium hypochlorite and water forms **hypochlorous acid** and lithium ion and hydroxyl ion

$$Cl_3C_3N_3O_3 + 3H_2O \rightarrow 3\mathbf{HOCl} + H_3C_3N_3O_3$$

trichlor and water forms **hypochlorous acid** and cyanuric acid

$$NaCl_2C_3N_3O_3{\bullet}2H_2O + H_2O \rightarrow 2\mathbf{HOCl} + H_3C_3N_3O_3 + Na^+ + OH^-$$

dichlor dihydrate and water forms **hypochlorous acid** and cyanuric acid and sodium ion and hydroxyl ion

The important compound here is hypochlorous acid (HOCl). It is the killing form of chlorine. HOCl is the disinfecting form of chlorine in water that kills bacteria, algae, mold, mildew, protozoa and other undesirable, disease-causing organisms including the inactivation of viruses. Chlorine kills many bacteria with 99.9% reduction in less than 1 minute. It also is the active form of chlorine used in substitution reactions which produces combined chlorine and disinfection by products. Some is also used in oxidation.

A second dissociation reaction is nearly instantaneous: Hypochlorous acid (HOCl) produced by adding any type of chlorine dissociates (comes apart into its ions) according to the following equation:

$$HOCl \leftrightarrows H^+ + OCl^-$$

hypochlorous acid dissociates into hydrogen ion and hypochlorite ion

This is a reversible reaction as is indicated by the arrows pointing in opposite directions. It also indicates that this reaction is not only reversible but it is in *equilibrium*. This means that a change on one side of the reaction is immediately compensated for by a shift or change on the other side of the reaction to maintain equilibrium. If some HOCl is removed from the water by it destroying bacteria, it is immediately compensated for by some OCl^- converting back into HOCl. Equilibrium will be maintained. As HOCl is used up, more and more OCl^- converts into HOCl to do the killing and destroying. So the OCl^- is a reservoir for HOCl.

Together HOCl and OCl^- are free chlorine and total chlorine.

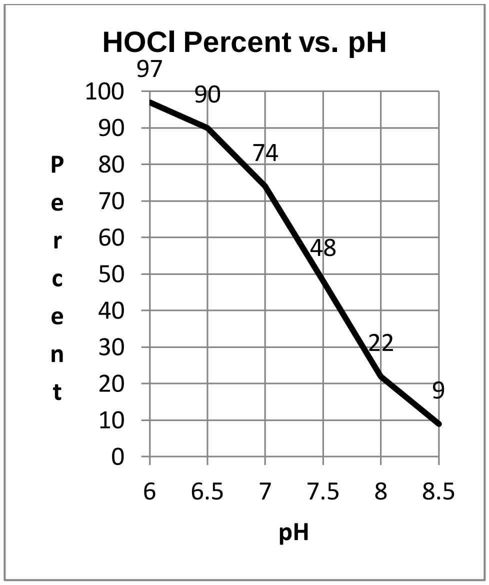
Effect of pH on HOCl and OCl^-

As the above equation shows, the H^+ concentration (pH) determines how much HOCl and OCl^- are produced. The lower the pH (greater amount of H^+), the more the equilibrium reaction shifts to the left. The lower the pH the more hypochlorous acid or the more chlorine is in the killing form. The most effective or strongest killing form of chlorine in pool water is HOCl. OCl^- kills at a slower rate but it is about 30 to 100 times less effective than HOCl, depending on the organism and water conditions.

The pH of the water determines how much HOCl and OCl^- there is.

Here is a chart and a graph showing the percentages of HOCl and OCl^- at various pH values at a typical pool temperature of 80 °F with no CYA.

pH	% HOCl	% OCl–
6.0	97	3
6.5	90	10
7.0	74	26
7.2	65	35
7.4	54	56
7.5	48	52
7.6	43	57
7.8	32	68
8.0	22	78
8.2	16	84
8.5	9	91



When the pH goes from 7.5 to 8.0 with no CYA, you can see from the chart that HOCl goes from 48% down to 22%, a drop of more than 50%.

However, when CYA at 30 ppm is present and the pH goes from 7.5 to 8.0, the drop in HOCl is only 15%. So CYA buffers against (prevents) the huge drop in HOCl as the pH rises.

Most articles and written information about chlorine only show the above chart and do not discuss the fact that CYA has this huge buffering effect on HOCl, OCl^- and chlorine bound to CYA.

CYA Slows Down Chlorine Kill Times

When chlorine and CYA are in the water, the chlorine is bound to CYA and that is determined by chemical equilibrium. The slowdown in kill times is significant. This slowdown has been known for decades in multiple scientific peer-reviewed papers in respected journals. HOCl, OCl^- and all forms of chlorine bound to CYA together are free chlorine (FC) and total chlorine (TC**). It is up to you to know how much of the chlorine that is in the water is in the killing form (HOCl). This requires knowing the pH and CYA level in addition to FC.**

The most dominant reaction in water with Chlorine and CYA is:

$$Cl_2C_3N_3O_3^- + H_2O \rightleftarrows HOCl + H_2C_3N_3O_3^-$$

chlorine bound to cyanuric acid and water forms hypochlorous acid and cyanurate ion

Notice that the arrow pointing to the left is larger than the arrow pointing to the right. This is because at typical CYA levels in a pool, the vast majority of chlorine (97%) is bound to CYA with only a small amount being hypochlorous acid (HOCl). Fortunately, it only takes a small amount of active chlorine (HOCl) to kill most disease-causing organisms. It takes a higher amount of HOCl to prevent algae from growing which is why for residential pools, the FC and CYA levels should be set at levels high enough to prevent algae.

Again, this shows that cyanuric acid (CYA) is a reservoir for the active killing form of chlorine (HOCl).

A simple analogy is having front-line soldiers with rifles and separate soldiers in reserve. The rate of killing the enemy has nothing to do with how many soldiers you have in reserve or how quickly the soldiers in reserve replace those fallen on the front-line (assuming that replacement rates are reasonably fast such as in seconds for the FC test). Just as OCl^- is essentially a reserve for HOCl, so is the chlorine attached to CYA ($Cl_2C_3N_3O_3^-$).

Having 30 ppm CYA in the water lowers kill times by a factor of at least 15 to 30.

When Cl is attached to cyanuric acid, it is protected from sunlight though the rate of chlorine loss is greater than predicted solely on the basis of the remaining unbound chlorine in the water. Therefore, it is possible that some chlorine breaks down even when bound to CYA, but that it is far less frequent because it has a longer half-life.

Killing Bacteria and Algae

For bacteria, the time it takes to double in population under ideal conditions is around 15 to 60 minutes. For algae, the time it takes to double in population is around 3 to 8 hours. Clearly the kill rate must exceed the growth rate for bacteria or algae. Specifically, that means killing more than half of the bacteria or algae in the time that it takes bacteria or algae to double in population.

The rate of killing algae is directly proportional to the HOCl concentration. Therefore, the total chlorine concentration is relevant only to ensure that the sole killing form of chlorine HOCl is not depleted. The amount in reserve has nothing to do with the rate of killing algae – only the concentration of HOCl matters for that.

This concentration is roughly proportional to the FC/CYA ratio. Remember the soldier analogy – it doesn't matter if you've got millions of soldiers in reserve if you've only got a handful on the front lines doing the actual killing.

Minimum FC 7.5% of CYA

It is necessary to maintain an [FC]/[CYA] ratio wherein the algae kill rate significantly exceeds growth rate considering other factors such as imperfect circulation. For each CYA concentration, there is an [FC]/[CYA] ratio such that hypochlorous acid is present sufficiently to control algae under all possible conditions.

Within limits, an increase in the concentration of nutrients, such as phosphates or nitrates, will promote algae growth only up until some limiting factor is reached for some nutrient. And there is always such a factor since the amount of sunlight is fixed and the rate of cell division is also ultimately limited by temperature due to the rates of chemical reactions and to physical processes.

This is why pools even with high phosphates and nitrates can still have algae completely controlled using chlorine alone. Although such pools are on the edge, so if the FC gets too low the algae grows faster than the chlorine kills it. However, it would take algae about 3 hours to double, so it's not in seconds or minutes. For bacteria, the doubling time is 15 minutes or so, which makes the growth more noticeable since one bacterium can become 4 billion in 8 hours if there is a doubling every 15 minutes. For algae, even with 3 hour doubling, one algal cell can become 256 after one day. This is why algae growth almost always starts out being invisible with a seemingly mysterious increase in chlorine demand and then only later becomes visible often as dull water, then cloudy, and then green (some algae go pretty much straight to green as even small amounts make their chlorophyll visible).

So shocking the pool (adding 10 ppm of chlorine or more) increases the FC/CYA concentration ratio. This causes more of the FC to exist as unbound HOCl, the killing form of chlorine. Increasing the FC and CYA concentrations such that their ratio remains constant does not alter the HOCl level or consequently, the kill rate. Increasing the CYA concentration without a compensating FC increase reduces kill rate. Here, the [FC]/[CYA] ratio is reduced with a compensating loss of HOCl. However, it is the HOCl concentration that is immediately important. If the proper FC/CYA level is maintained at all times, then shocking a pool is not necessary.

It should be very clear that, given a minimum FC concentration, the FC/CYA ratio (free chlorine to cyanuric acid ratio) determines algae growth rates. When the FC is 7.5% of CYA concentration, then algae growth can be suppressed in almost every manually dosed pool. For saltwater chlorine generator (SWG) pools, the minimum FC concentration is about 5% of the CYA level.

Many pools are treated with trichlor tabs and have the CYA rise and then pool owners wonder why they get algae as the swim season progresses in spite of having the recommended 2-4 ppm FC levels. **It is important to understand that it is the FC/CYA ratio that determines the active chlorine level that inhibits algae growth and not FC alone.** If a pool started out with 30 ppm of CYA then 7.5% of 30 ppm is 2.25 ppm of FC. But as time goes by the CYA level can build up to 50 ppm, 80 ppm or 100 ppm. This would require 7.5% x 50 = 3.75 ppm FC, 7.5% x 80 = 6.0 ppm FC and 7.5% x 100 ppm = 7.5 ppm FC. You can see that 2.0-4.0 ppm of FC will only prevent algae when the CYA level is less than 50 ppm

CYA levels can quickly climb from using products containing CYA – trichlor and dichlor. Here are the amounts without needing pool gallons or product concentrations:

For every 10 ppm of FC (free chlorine) added by trichlor, it raises CYA by 6 ppm

For every 10 ppm of FC (free chlorine) added by dichlor, it raises CYA by 9 ppm

How CYA Works

Cyanuric acid (CYA) absorbs ultraviolet (UV) radiation directly which shields the lower depths of water and protects chlorine in those lower depths from UV decomposition. A primary result of the presence of CYA in the water with hypochlorous acid is that they combine to form a set of chemical species collectively called chlorinated isocyanurates; these compounds also absorb UV without significant decomposition. There are 6 different species of chlorinated isocyanurates (that is, chlorine attached to CYA) and 4 different species of cyanuric acid and its dissociated ions. There are 13 simultaneous chemical equilibrium equations of the CYA, chlorinated isocyanurates, hypochlorous acid and their combinations.

Chlorine combines with CYA to form new chemicals – chlorinated isocyanurates. These new chemicals are not significant disinfectants or oxidizers. CYA has a moderately strong affinity for chlorine so most of the chlorine in the water is thus bonded and held in reserve.

For example, when the pH is 7.5, 3.5 ppm FC and 30 ppm CYA, 97% of the chlorine is bonded to CYA. Nevertheless, this chlorine is accounted for by the DPD free chlorine test because the chlorine is released from the CYA quickly enough to replenish the chlorine that is consumed by the test. **The DPD free chlorine (FC) test does not measure active chlorine, only the chlorine reserve which is largely inactive.**

Simplified Chemical Equations

This will get a little technical but there is not a convenient alternative way to say it**. It is important because it is the basis for understanding the Chlorine-CYA relationship.**

We focus on the dominant chemical species found at the usual pool water pH. There are 6 different chlorine-CYA reaction compounds.

The following is the primary relevant chemical equation to focus on:

$$Cl_2C_3N_3O_3^- + H_2O \rightleftarrows HOCl + H_2C_3N_3O_3^-$$

chlorine bound to cyanuric acid and water forms hypochlorous acid and cyanurate ion

Notice that the arrow pointing to the left is larger than the arrow pointing to the right. This is because at typical CYA levels in a pool, the vast majority of chlorine (97%) is bound to CYA. "Bound", in this case is technically a separate chemical compound, not just some sort of loose association.

At chemical equilibrium, most molecular collisions do not result in chemical reactions. For the above system, the equilibrium constant is small, indicating that at equilibrium, the chlorine bound to cyanuric acid is present in larger quantity than that of HOCl.

In fact, at a pH of 7.5, 97% of the chlorine is bound to CYA. Therefore, with a pH of 7.5 there is 1.5% hypochlorous acid (HOCl), and 1.5% hypochlorite ion (OCl^-). Remember that at a pH of 7.5, we have about 50/50 $HOCl/OCl^-$.

Reaction Speed and Testing

The equilibrium constant for this system is small which indicates that the dominant reaction is right to left and it indicates that the reaction time is slower. If all of the hypochlorous acid were depleted, then it would take approximately 4 seconds for half of the amount of chlorine bound to CYA to be converted to hypochlorous acid. In practice, very little gets converted (unless chlorine is exhausted rapidly), and the reaction decelerates until eventually it ceases altogether. All this occurs in less than one second. Because of this and similar reactions occurring so quickly, free chlorine tests don’t measure HOCl concentrations. Instead, they determine the sum of the concentrations of the chlorinated species in the above equation, the sum of the concentrations of the active and reserve chlorine.

Here is the Math

The above equation is described by a chemical equilibrium constant as shown by the following:

$[H_2C_3N_3O_3^-] * [HOCl] / [HClC_3N_3O_3^-] = 2.4x10^{-6}$

I will not show you all the math and rearranging the above equilibrium constant. The bottom line is that

[HOCl] is approximately $2.4\text{x}10^{-6}$ * [FC] / [CYA]
hypochlorous acid is .0000024 × free chlorine/cyanuric acid

With a couple of more conversions so the units of measure equal, we finally have:

HOCl is approximately 0.31 * FC / (CYA – (1.8 * FC))
hypochlorous acid is 0.31 × free chlorine/(cyanuric acid minus (1.8 × free chlorine)

With an FC of 3.5 ppm and CYA of 30 ppm this results in 0.046 ppm FC which is within 10% of the correct result which is 0.051 ppm.

You can see where the FC/CYA ratio comes from – it is a direct result of the chemical equilibrium between chlorine attached to CYA vs. separate chlorine and CYA.

It should be understood that HOCl concentration is a very small part of what is read in a FC test. In fact, HOCl concentration is about 1.5% of the total amount of FC at a pH of 7.5. Accordingly, 3.5 ppm chlorine in the water with 30 ppm CYA is converted only to 0.051 ppm HOCl.

The minimum HOCl concentration in pool water for preventing algae population growth is, by consensus, 0.05 ppm. However, this is debatable: The World Health Organization suggests the minimum for disinfection is 650 mV which corresponds to about 0.011 ppm HOCl and still claims from other sources vary from 0.02 to 0.1 ppm HOCl.

Based on the above information, the minimum FC concentration to prevent algae growth and to keep bacteria under control is 7.5% of the CYA concentration.

This chart shows the minimum FC level based on 7.5% of the CYA level.

CYA, ppm	Min FC, ppm
20	2
30	2
40	3
50	4
60	5
70	5
80	6
90	7
100	7

Notes:
For CYA levels, over 80 ppm, you should drain part of the water and refill to lower the CYA level. Having more than 6 ppm of FC in the pool with CYA is not recommended.

Indoor Pools Can Benefit from Using CYA Too.

The primary reason for using a small amount, say 20 ppm CYA, in indoor pools is to be able to keep a lower active chlorine concentration with an ample chlorine reserve. A 4 ppm FC with 20 pm CYA is equivalent to around 0.2 ppm FC with no CYA at 77ºF. This equivalence increases with temperature. Reducing the FC concentration decreases harshness on swimsuits, skin and hair and produces less nitrogen trichloride. (Nitrogen trichloride is a chloramine that can be in the air above the water in indoor pools. It can cause asthma and some people may develop sensitivity to it.)

Note that indoor pools not exposed to sunlight frequently require supplemental oxidation such as UV; ozone or MPS (monopersulfate) to help control organic compounds from bather load and some disinfection by-products. Using CYA in indoor pools contradicts recommendations and sometimes regulations of many states for commercial or public pools although CYA is permitted in outdoor pools everywhere except New York. This inconsistency comes from the incorrect belief that CYA only shields chlorine from sunlight, and ignores the chlorine/CYA relationship regarding hypochlorous acid.

Chlorine Lock

Chlorine lock is a myth. The weak chlorine-CYA bond is broken by anything oxidizable with the concurrent release of chlorine. There is no chlorine lock. At low [FC]/[CYA], usually as a result of a CYA concentration increase without a proportional increase in FC concentration, the growth rate of algae population exceeds the chlorine kill rate. At first, and without visible indication of algae, this can appear to be caused by some mysterious chlorine demand. Probably, this is the origin of the “chlorine lock” concept. Bacterial catalyzed conversion of CYA to ammonia can occur if the FC concentration approaches zero. That would seem to be a form of chlorine lock, but the explanation is that more chlorine is needed to compensate for this ammonia production.

CYA Capacity to Buffer pH

A common misconception is that TA (total alkalinity) is a direct measure of pH buffering. This is not true. **Total Alkalinity is only a measure of pH buffering CAPACITY, and against a decrease in pH.**

Buffering System

Water contains:

CO_2 (aq) (aqueous carbon dioxide)

H_2CO_3 (carbonic acid)

HCO3$^-$ (bicarbonate anion)

CO_3^{2-} (carbonate anion)

Only HCO_3^- (bicarbonate ion) and CO_3^{2-} (carbonate ion) comprise Total Alkalinity (TA). The carbonate concentration is much less than that of the bicarbonate ion at these pH values. The governing concept regarding the dissolution of atmospheric carbon dioxide is summarized by this equation:

$$CO_2(aq) + H_2O \leftrightarrows HCO_3^- + H^+$$

Aqueous Carbon Dioxide + Water <---> Bicarbonate Ion + Hydrogen Ion

At a pH of 7.5, the equilibrium concentrations of bicarbonate ion and aqueous carbon dioxide are 94.1% and 5.7% respectively. Therefore at typical pool pH values, bicarbonate ion (HCO_3^-) is the primary buffer against a decrease in pH.

A similar analysis for the cyanuric acid buffering system shows that the following equation is primary:

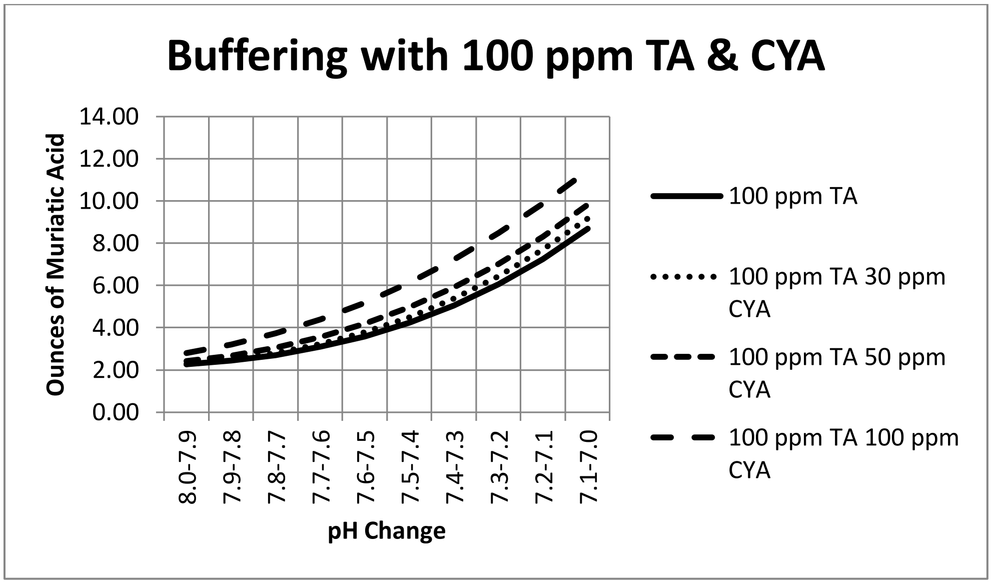
$$H_3C_3N_3O_3 \leftrightarrows H_2C_3N_3O_3^- + H^+$$

Cyanuric Acid <---> Cyanurate Ion + Hydrogen Ion

At a pH of 7.5, the distribution is 82% cyanurate ion ($H_2C_3N_3O_3^-$) and 18% is cyanuric acid ($H_3C_3N_3O_3$), the cyanurate ion, should be counted as part of the Total Alkalinity. It is not counted in the calculations of the Saturation Index because here, only the carbonate contribution is required.

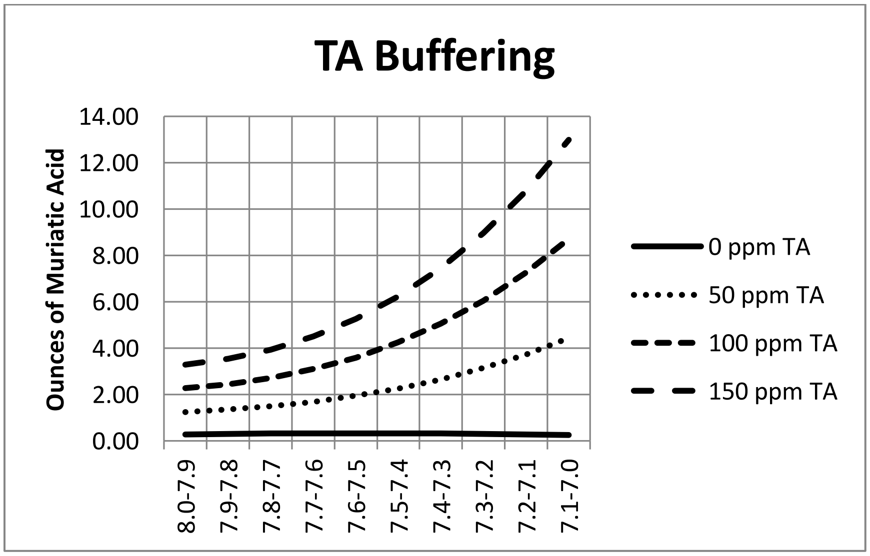
Together bicarbonate ion and cyanurate ion make up the buffering system against a lowering of the pH.

Here is a graph showing the buffering capacity of pool water with 100 ppm TA and various amounts of CYA.



As you can see, at a pH near 8.0 about the same amount of muriatic acid is required to lower pH by 0.1. As the pH approaches 7.0 the buffering capacity of CYA becomes evident. With 100 ppm TA and no CYA it takes 8.7 oz of muriatic acid to make a 0.1 pH change. With 100 ppm TA and 30 ppm CYA it takes 9.18 oz of acid. With 100 ppm TA and 50 ppm CYA it takes 9.82 oz of acid and with 100 ppm TA and 100 ppm CYA it takes 11.45 oz of acid. This is more than 30% more acid to make a pH change. CYA buffers the pool water to resist downward changes in pH.

Just for your information about buffering of pool water, here is a chart showing the amount of acid required to make a 0.1 pH change with 0, 50 ppm, 100 ppm and 150 ppm TA. It clearly shows how TA buffers against downward changes in pH. No CYA only takes 0.26 oz of muriatic acid to make a 0.1 pH change. However at a pH of 7.1 it requires 4.44 oz of acid with 50 ppm TA, 8.7 oz of acid with 100 ppm TA and 12.98 oz of acid with 150 ppm CYA.



CYA Adjustments to TA and the Saturation Index Calculation

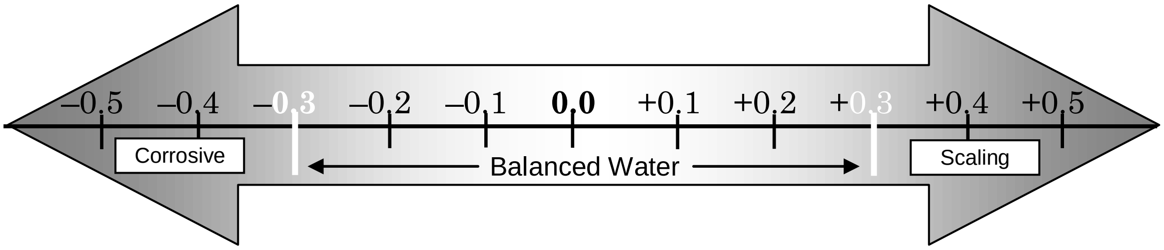
It is not necessary to use any index to maintain proper pool or spa water. You can simply choose to keep the water in the pool or spa according to the industry guidelines or the guidelines suggested by others. If all the chemical parameters are within the ideal ranges, the water will be balanced and not cause any problems.

The most widely used Index is the Langelier Saturation Index (sometimes called The Saturation Index or SI) although it has been modified, revised and adapted many times to numerous water treatment processes and bodies of water.

The new Saturation Index uses the six Water Balance Factors (instead of five) as the basis for this determination.

pH
Calcium Hardness
Total Alkalinity
CYA
Temperature
TDS

Once the tests are made, the six factors are determined and plugged into the formula. The calculation is made and a result is obtained. The goal of “perfectly balanced water” is to have an SI that is 0.00 (zero). Values between –0.3 and +0.3 mean balanced water.



Calculating the Saturation Index

The newest version of the Saturation Index uses the following formula:

$$\mathrm{SI} = \mathrm{pH} + \mathrm{CH} + (\mathrm{TA} - (\mathrm{CYA} \times \mathrm{F})) + \mathrm{TF} - \mathrm{TDSF}$$

Saturation Index	pH as tested	Calcium Hardness Factor	Total Alkalinity minus (CYA x Factor)	Temperature Factor	TDS Factor

Saturation Index Factors

CH Calcium Hardness Factors	
Calcium Hardness, ppm	**Factor**
5	0.3
25	1.0
50	1.3
75	1.5
100	1.6
150	1.8
200	1.9
300	2.1
400	2.2
800	2.5

TA Total Alkalinity Factors	
Total Alkalinity, ppm	**Factor**
5	0.7
25	1.4
50	1.7
75	1.9
100	2.0
150	2.2
200	2.3
300	2.5
400	2.6
800	2.9

CYA Cyanurate Factors	
pH	**Factors**
7.0	0.23
7.2	0.27
7.4	0.31
7.6	0.33
7.8	0.35
8.0	0.36

TF Temperature Factors	
Temperature °F	**Factor**
32	0.0
37	0.1
46	0.2
53	0.3
60	0.4
66	0.5
76	0.6
84	0.7
94	0.8
105	0.9

TDSF TDS Factors	
TDS, ppm	**Factor**
100	-12.10
1000	-12.19
2000	-12.29
3000	-12.35
4000	-12.41
5000	-12.44

Saturation Index Example Calculation:

SI = pH + CH + (TA– (CYA x F)) + TF– TDSF

SI	pH	CH	(TA– (CYA x F))	TF	TDSF
Saturation Index	pH as tested	Calcium Hardness Factor	Total Alkalinity minus (CYA x Factor)	Temperature Factor	TDS Factor

Test Results:		Factors:
pH	7.4	7.4
TA	120 ppm –(50 x 0.31) =104.5 ppm	2.0
C. Hardness	300 ppm	2.1
Temp.	80° F	0.6
TDS	900 ppm	-12.10
CYA	50 ppm (used in TA adjustment above)	
	Total	0.00

The factors are determined by looking up the test results in the above Tables.

In Conclusion

CYA affects pH, total alkalinity, and water balance because it is a pH buffer and contributes to total alkalinity. CYA affects the Saturation Index calculation – you must make a CYA adjustment to TA for the calculation. CYA affects the killing power of the chlorine – 97% of chlorine is bound to CYA. CYA acts as a chlorine buffer as the pH rises from 7.5 to 8.0 the HOCl drop is only 15% instead of 50%. CYA protects chlorine from sunlight as it keeps chlorine in the water 8 times longer than without it. That's pretty impressive for a single chemical.

CYA, it really does control your pool.