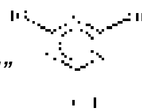
Cyanurics ~

Benefactor or bomb?

by Kent Williams, Executive Director of the
<u>Professional Pool Operators of America</u>

"If we put enough of this stuff in the pool, maybe we won't* ever *have to add chlorine!"



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PART I

Cyanuric acid ~ Valuable, magical, beneficial, profitable... misunderstood, misrepresented, problematic. These all apply, and more. This chemical pool additive may very well be the most controversial topic in the industry today. Indeed, you will hear more diverse advice from pool professionals, "experts," dealers, even from university and corporate chemists, on the subject of chlorine stabilization than on anything else in the world of pool-water chemistry. Maybe it's time the subject is reviewed from a reasonable, unbiased standpoint so well-read pool operators can be the knowledge leaders, not the misled.

Now this stuff is truly a *miracle worker* for the busy backyard pool owner and for the residential pool service tech. Hotel/motel operators with low-to-moderate-load pools find great value in the product. And it serves many public-pool applications very well too. In other busy public pools, however, misused stabilized chlorine performs quite poorly, hence industry concerns. Responsible training, in-depth investigation and appropriate, conservative use are necessary keys to unlocking the considerable benefits offered by CYA. Is cyanuric acid the right choice for your pool? Where can we look to find out...

With little common ground of agreement, even some district and state health departments are providing confusing guidance. In some cases, inspectors are prohibiting the use of cyanuric stabilizers in any of their public pools, while others have actually been *insisting* on its use. Still others say a pool operator must use at least 30 ppm if she or he chooses to use CYA at all. Among those sanitarians requiring it, there have been a few who did so even in cases of *indoor* pools! If the paragons of public health and safety can't agree, we begin to wonder how they expect public-pool operators and other common folk to get it right!

Most health departments deserve acknowledgment for seeking their own pool-related training and becoming technically knowledgeable in recent years, nonetheless the very *sources* for such technical guidance on cyanuric acid and its use are themselves inconsistent and, often, inaccurate. Claims abound: It makes your chlorine last ten times longer. You get better use out of your chlorine. Chlorine's more powerful with it. It balances the chlorine. Water is not balanced without it. Chlorine doesn't work without it. The law requires it... And the these claims become the essence of the "technical" advice or training provided by people with a financial interest in the promotion and use of cyanuric acid. This material creates a three-hundred-million-dollar-a-year industry, which tells us a few things - it's been a successful endeavor, there's plenty of motivation to continue promoting it, and it's not going away!

Surely you know that "what is right" for you and your pool may be quite different than what's right for someone else and his. As life is full of trade-offs, certainly this CYA business is no exception. While shifting through a car's gears we trade power for speed; in an electric transformer we trade voltage for current; when we restrict hydraulic flow with a valve we trade volume for pressure... In the case of pools using "stabilizer," we *simply <u>trade activity for longevity</u>.*

This trade off, while intolerable or inappropriate for some users, is what's so miraculous for others. Sometimes we need all the "activity" we can get. Much of the time, the longevity is more important. Just remember, you don't get somethin' for nothin' in this world. There is simply "no free lunch"!

CHARACTERISTICS: Like so many other products and chemicals around our pools, there's a number of names for this material, all identifying the same thing. Most pool folks use the official name - cyanuric acid - or, more commonly, cyanurics. (It's s-triazine trione in chemspeak...) Stabilizer, even "conditioner" are frequently used terms by the layman, as well. (This author considers the latter an irresponsible label, designed purely to sell product to the uninformed.) CYA is the common abbreviation. The term chlorinated isocyanurates or "isos" means more than CYA alone, it refers to one of two stabilized forms of chlorine or cyanuric-bearing chlorine (di-chlor and tri-chlor), discussed below.

CYA is an acid, as the name implies, but a rather weak one. It is sold in a white, dry granular form, fairly slow to dissolve. It produces a pH in concentrated solution of about 4.0; but, in the dilutions typical of pool applications, CYA has little pH effect on that large body of water.

It is "pure stuff," in other words full-strength material, not compounded or mixed with other chemical products; that makes dosing rather easy. A pound of CYA in a million pounds of water is, plain and simple, a part per million. Remember that handy figure of 120,000 gallons which weighs in at almost exactly a million pounds? Ten pounds of cyanuric acid is ten parts per million. That's a fairly common pool size, too, but if your pool is larger or smaller, you can factor up or down rather easily.

Cyanuric acid is not consumed in its beneficial work; once CYA is in there, it's in there to stay. Only dilution by replacing drained or lost water can reduce the CYA level. (An awkward exception is mentioned later...) Another good news/bad news story, one finds the complete elimination of CYA nearly impossible. Even if the pool is completely drained, a little always shows up in the refill. Interestingly, it was this phenomenon which *confirmed,* at the University of California at Davis, that a virtually non-measurable two or three parts per million cyanuric acid does, no matter what the guys who sell it say, make a significant - over 30% - savings in chemical costs!

Cyanuric acid is often described by well-meaning authors in extremely technical terms, picturing the molecular-structure diagram of the “enol form” complete with carbon ring, bonds, atomic strings, molecular weights and more. An advanced degree in organic chemistry would be nice to understand such material; otherwise, it’s over everybody’s collective head. Beyond being non-valuable information, it is simply inappropriate to include such chemistry detail in material targeted at everyday folks, especially when, invariably, the same article will contain weak generalizations, excessive over-simplifications and inaccurate parallels. “Sunglasses for chlorine” comes to mind, as well as that list of claims enumerated above. “Tiny little time pills”, silly as it sounds, is actually a pretty good analogy...

Somewhat simplified, the CYA molecule in water forms a weak and temporary “bond” with the chlorine ions in the water, during which time the ultraviolet energy from the sun can’t easily degrade the measured “chlorine” residual. If you could “see” into the microscopic world of H_2O, you’d find most compounds in water are in a constant state of change, as is our old friend hypochlorous acid (HOCl). This active compound comes and goes, as it ionizes (into OCl^- and H^+), “associates” back into HOCl again, attaches to and becomes released by CYA, kills tiny organisms, oxidizes all manner of organic flotsam and jetsam, maybe even combines with ammonia... Ultimately, it is either lost to dissipation/degradation or is consumed in the noble performance of those two distinct and critically important duties: oxidizing and disinfecting.

That’s a lot of goings on! The truth is we don’t really much care about all the hi-tech details, as long as we know how it all works out. *Results* are all that count, and if we get those two important items accomplished - oxidizing and disinfecting - we should be pleased. Without CYA, the chlorine better get to work fast, because it won’t be around long. With the stabilizer, the “bonding” of chlorine in a protected state affords much more time for at least some level of this work to be done before chlorine fades into oblivion. Sanitary water that’s crystal clear and non-irritating - if we get *this* result, the method we used to get there works just fine!

VALUE VERSUS RISK: So what’s the rub; where’s that trade-off? Is there a problem here? Let’s look at a few (some hotly disputed) basic facts:

1. Isocyanuric acid helps chlorine “last longer” in pool water.
2. The “stabilization” of chlorine significantly reduces its work value, its ORP.
3. Cyanuric acid always costs money, sometimes saves money.

No-one will disagree with item number one. And, with the reader’s permission, let’s decide upon the bottom-line economy in Part II, as we sum up this paper’s contents. That leaves the second item, which needs examining a lot more closely.

HOCl is inherently unstable, as we’ve all been taught. It is a real performer *for that very reason.* So what happens when chlorine is made more “stable”? The more stable or unchangeable a compound is, the less performance one might expect from it. Take a glance at common salt, sodium chloride, for example. It’s about the most stable chlorine compound on earth. In water, salt (NaCl) doesn’t oxidize, it doesn’t disinfect, it just drifts around in there being stable!

Assuming the validity of the “facts,” above, we might reason that higher levels of chlorine might help offset the detracting effect of the stabilizer. Indeed, most health departments require higher residuals when using stabilizer, which tends to bear out this belief. One concern that prompts authorities to raise the minimum level of chlorine is the false sense of security created by longer lasting residuals, while reduced effectiveness of the lower value may approach the danger threshold - where oxidation or even sanitation problems are likely to arise.

Additionally, the much touted savings afforded by stabilization - the net reduction in chlorine consumption - are somewhat offset by the cost of the CYA itself (both initial dose and make-up additions), and the required maintenance of higher residuals of chlorine. Then all savings bets are really off if clarity problems arise, algae gets a solid foothold, or the pool is closed due to an unacceptable bacteria count. CYA could get expensive!

All is not lost, however.

EFFECTS ON OXIDATION & DISINFECTION: If a little is good, than a lot must be better?

There is a point of diminishing returns with respect to the percentage of so-called stability, or “staying power”, achieved as stabilizer concentrations are increased. It seems reasonable that if we stay below that dosage point, cyanurics are sure to be useful - even in some busy outdoor institutional pools. But what dosage point? To determine some practical guidelines, exhaustive tests were run by a major manufacturer and other interested parties in 1984/6 - first in the Hall of Fame pool in Florida then at the University of Hawaii competitive pool. This field work was followed by a detailed study in a controlled environment, where sensitive laboratory instrumentation corroborated the findings: Oxidation-reduction potential (ORP), considered the best means of evaluating chlorine’s work value, falls off dramatically at a rapid and predictable rate as the CYA level is increased. This loss of “work value” can be stated, and plotted, in terms of equivalent free chlorine.

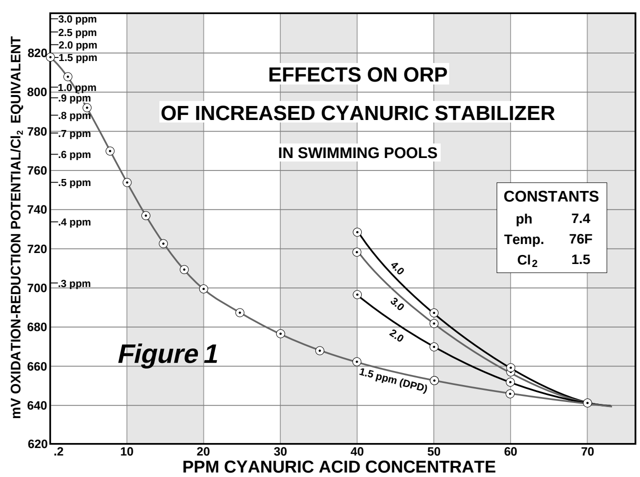


Figure 1

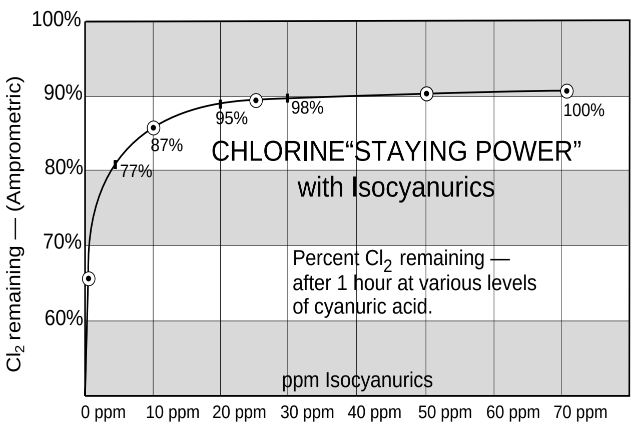
Referring to the chart above, we can see that at just 5 ppm CYA (pH at 7.4 and “free” chlorine residual 1.5 ppm - both held as constants), the equivalent chlorine effectiveness is more than 35% reduced! At 10 ppm CYA, the loss is 65%; at 20 ppm CYA the chlorine’s equivalent effectiveness is down a startling 80%! Beyond 25 ppm CYA we can expect, in terms of oxidizing power, about 10% more in additional losses with very little gain in retention (see Figure 2, below). This is the case, no matter how high you go -- a classic case of diminishing returns!

“Aw c’mon, how can that be?” you ask. “I know of pools with twice that much cyanuric acid. Their water’s clear, and the health guy says the plate count for bugs is OK...”

Remember what we are comparing: *Potential to oxidize*. If you don't need it all, you don't use it all and you're ahead of the game for a moment. In any pool, if the first .1 ppm can handle all the bugs, it does. If the next .3 or .4 ppm can handle all the organic contaminants, it does so as well. The rest shows up on the test kit as "residual" - that which is left - ready to do more useful work or, sadly and more likely, to decompose by the bombardment of sunlight.

Now add some stabilizer. The residual sticks around, appearing to be available to work. But the trade-off takes its toll. We've lost most of the power of the "insurance residual", that standby power of excess, measurable, active chlorine. Well, if this pool's out in front of a mom-and-pop motel with four swimmers a day, what little ORP is left will work just fine. Just stir in the football team after the Saturday game, a basketful of leaves or a dead cat, however, and see what you've got! This pool needs *more* than it's got, and you lose. You'd be asking that well-taxed 1.5 ppm, *acting as if it were only .3 ppm*, to handle half-a-part-per-million of ammonia. Not a chance...

You're paying the premiums on that insurance residual, so you might as well have the benefits... or most of them. Cyanuric use, balanced against experienced and predicted loads, is a tricky exercise reserved for the experienced pool operator who knows the consequences of too much stabilizer. Phoenix in the summer? Sunny, busy pool? Try ten parts per million or fifteen. Pool's not automated? Try up to 20 ppm. Walk that tightrope between demand and retention; the rewards are worth it. But, with so much less CYA than the guy at the pool-supply store recommends, will it *really* last longer?



With all this conversation on the ORP fall-off and lack of work value, let's examine just where we really stand on staying power, that ever-so-sought-after chlorine retention. We can't find our diminishing-return point without knowing what increase in residual lifetime to expect. Look at figure 2. (The data was extrapolated from public, technical bulletins of a major specialty chemical manufacturer, based on *their* in-house research.) This chart shows reasonable retention achieved with only 5 ppm CYA in use. Over 80% of *all* the retention potential available is achieved at 10 ppm, while values much over 20 ppm CYA exhibit diminishing returns, soon appearing beyond the cost-effectiveness threshold. These are not exactly the numbers you see advertised...

Another surprise: As effectiveness (in terms of ORP) is lost with rising cyanuric concentration, a flattening of the curve occurs around 70 ppm CYA; here's where no appreciable additions of chlorine will make *any* difference in the resultant level of ORP! Look at the three short curves in Figure 1 as they converge at about 12% of the original work value... no matter if you have 2, 3, 4 ppm chlorine or lots more! Stated simply, as CYA exceeds 70 ppm, *virtually any level of chlorine will result in no more than about .2 ppm equivalent effectiveness.* Longer lasting, yes. Better working, No. Levels of cyanuric from that point upward make any quantity of chlorine a pretty bad investment.

At much over 50 ppm CYA, *controllers* are a bad investment too; and as the water approaches 70 ppm CYA, controllers of ORP (the principle behind virtually every pool-chlorine automation device on the market today) simply quit - dead. If ORP won't rise when you pump the sanitizer into the pool, these systems won't meet set-point and *wont turn off.* Any claim to the contrary is simply *false*. (Try it in a bucket someday..!) All controllers will function OK at low levels of CYA (if you lie to the circuit by up-calibrating to compensate for the lost ORP) and *none* of them works at high CYA. Period.

Having investigated oxidation fall-off and "staying Power", what about disinfection - bug-killing power? We don't want anything alive in the pool but the kids, so sanitizing is generally the variable of greatest concern. And this is where stabilized chlorine gets its highest marks, too. While so much disagreement is found among the pros regarding this often-studied sanitation aspect, we *all* have to admit - if a bug dies in one-tenth of a second or in ten seconds (100 times slower) it's still a dead bug! Looking at the pair of curves in Figure 3 (published in Applied Microbiology back in 1966), however, a very tough-to-knock-off bug named pseudomonas auruginosa (hot-tub itch) takes an unacceptably long time to die with low chlorine residuals under stabilized conditions. You'll note the researchers didn't use levels of chlorine now commonly suggested for spas but lower values allowed in the early days of CYA use. (You will have to concede, however, these levels are still found every day in spas and pools by environmental-health specialists all over the country.) At 70 ppm, a CYA level all too commonly reached or exceeded in public spas and pools, a half-part per million takes 20 minutes for the desired 99.9% kill, and 70 minutes at .1 ppm! Either value of chlorine could kill this pathogen in 5 to 20 *seconds* if not impaired with cyanuric acid.

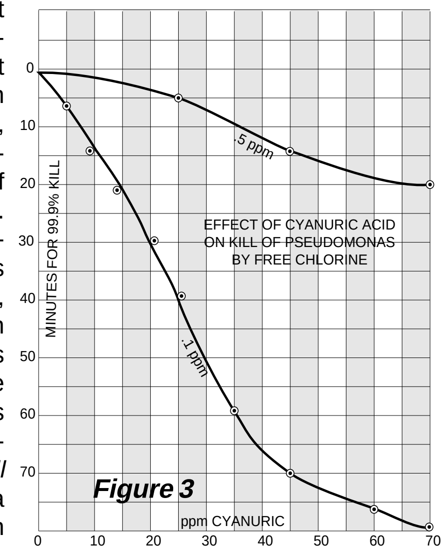


Figure 3

Most pathogens are much easier to do away with than pseudomonas. Kill times are often extremely short, even in the presence of stabilizer. The experiments above were done in "unstressed" laboratory water, while more true-to-life conditions have shown a few bacteria appear to die even *more* quickly in the presence of CYA! Nonetheless, in exhaustive tests based on even the easiest to kill bug of all, coliform, levels of ORP under 650 mV (millivolts) could not be relied upon to produce satisfactory kill - and CYA was the regular and dominant negative influence in this impaired capacity to sanitize. (See details in Part II.) Even the World Health Organization has established 650 mV to be the minimum safe ORP for sanitary water.

So stabilized pools, generally, remain safe from a health standpoint until ridiculous levels of CYA accumulate. Resultant water conditions don't appear to change for the worse until the demand threshold exceeds the greatly limited "insurance" ORP. Then the first thing to go is clarity. Second, if the conditions are right, comes severe and un-yielding algae. A distant third is unacceptable sanitation.

So when and how much? When chlorine demands and costs are out of hand due to hot, sunny outdoor conditions, when the organic load in the pool is moderate to low, and when the operator is trained and has time to more closely monitor water conditions, stabilizing may be in order. Establish levels of 5 to 12 ppm CYA, or a little more, for your outdoor automated pool. Allow 20 ppm or so to provide good retention in a manually treated pool. Don't EVER use CYA or stabilized chlorine in an indoor pool, and, even outdoors, *please* don't use as much as the guy who's selling it suggests...

There's much more to discuss, so check CYA Part II. We need to look at stabilized chlorine products - their value and their drawbacks, more on what motivates the CYA information sources, why testing is a problem in itself, how the Oregon Study on ORP applies, and what the Pinellas County Study misses... followed by a 24-item bibliography in support of this opinion.

Part II

Having covered in Part I cyanuric acid's significantly depressing effect on oxidation (ORP), it's resultant improvement in residual "staying power" and its slowing of pathogen deactivation, we should be able to wrap up the conversation here. As the hazards and drawbacks of stabilization continue to unfold below, we won't lose sight of the fact that cyanuric acid is an extraordinary product which serves the industry well when responsibly promoted and used.

ORP LOSS AND THE OREGON STUDY: To begin again, we will expand on a study alluded to in Part I, illustrating *oxidation/reduction potential*'s unique value as a measure of a disinfectant's quality as well as potential to oxidize. However unplanned, that very same research illustrates convincingly that excess CYA is trouble with a capitol T in public-spa water. We should examine Dr. Brown's report in the context of CYA use and misuse.

Quoting from *PrP issue 5 (ORP and Oxidation)* where the research was detailed: "...In this remarkable study, thirty public spas were examined for all normal pool variables, plate count (bacteria density) and, finally, ORP. Extremes showed up in pH from 5.7 through 8.3, combined chlorine from 1.4 to 34 ppm, free chlorine from 0 to 30 ppm, cyanuric acid (*what's it doing in a spa anyway*??) from 0 to 1,300 ppm, plate counts from 0 through 15,000, and even Pseudomonas up to 12,400! The *only correlation* that stood up throughout the study was the relationship between *ORP and the presence of pathogens*. Virtually no plate count existed in the spas where ORP values were found to be above about 630 millivolts, while lower values, no matter the free chlorine residuals present, all had dangerous or near-dangerous levels of pathogenic life.

Among the unsafe pools in the study, chlorine residuals bore no resemblance to the plate-count values. Even when the free chlorine was as high as 4 ppm, a significant plate count existed because the ORP in that spa was 537 mV. The pH was 6.9, so why was the ORP so low in that spa's water? Excessive cyanuric acid was the culprit, as was the case in *all but two* of the thirteen spas exhibiting ORP levels at or below 630 mV..."

This famous study corroborated other less known works and even the German DIN Standard, all establishing or confirming ORP thresholds and reasonable, universally recognized, standard values. An ORP level in water of <u>650 mV</u> is the most widely accepted minimum for qualitative results, worldwide.

650 mV of ORP can be achieved with a variety of chemical compounds, conditions, and influences. It is "qualitative". 650 mV is the same working value whether it takes only .1 ppm "free" chlorine at pH 7.2 with no CYA to get there or 3 ppm at pH 8 in the presence of 30 ppm CYA to make it. In the second of these two extreme examples it takes <u>30 times more chlorine to achieve the same results</u>. All it took was a pH elevation and the addition of cyanuric acid. Amazing...

Is 650 mV some kind of absolute drop-dead value? Of course not. Surely 620 mv or 640 mv will do the job under most conditions, sanitizing well and oxidizing adequately; the point is that 450 mV *won't* do it - and that's an easy low to arrive at with excessive CYA.

The Oregon study's most valuable conclusion was that no variable found in pools - not pH, free chlorine residuals, clarity, CYA, TDS, chloramine, *none* - could be linked to bacterial plate count. *Only* ORP was consistently reliable in predicting the sanitation of the body of water - above 650, consistently safe water; below 650, usually unsafe water. ORP is key, irrespective of the absence or presence of cyanuric acid or any other enhancer or detractor of chlorine. Yet <u>ORP is exactly what cyanuric acid depletes</u>.

Without stabilization, ORP levels well over 800 mV can easily be achieved with .9 to 1.0 ppm of free chlorine at pH 7.4, a work value which is knock-'em-dead generous. (See the ORP nomograph, *PrP* Issue #5, page 5.) This level of oxidation potential is simply un-achievable if stabilizer is present, however, at *any* practical residual of chlorine. If you need the ORP to handle consistently high organic loads in your pool, stabilization starts to look more expensive!

Over the years, many other "research" papers, articles and opinions have been written on the subject of stabilization. Most are favorable, even expressing unmitigated praise for CYA. Yet virtually every author writing positively about CYA addresses the subject of longevity and water *sanitation* only, with little or no concern (or even acknowledgment) for oxidation. The recent Pinellas County (Florida) CYA study is an excellent example of such incomplete work. A scholarly study, numerous and varied pathogens were summarily deactivated under even more numerous conditions of residuals and stabilization. The results were just like so many other sanitation-only reviews, quite positive. We already knew that bugs will die. C'mon, guys, that's the *easy* part. Get it together and do a study on organic oxidation and ORP in the presence of CYA, not give us more talk about sanitation. At least own up to the existence of this critical, unacknowledged variable. We can't stress enough that the two processes are different, and success in the bug-killing arena does not presume adequacy in oxidation, where its absence assures cloudy water, algae, and short filter cycles. As sanitation is so easy to come by, evaluating **oxidation** *must* be fundamental to the review of any sanitizer or stabilizer.

STABILIZED CHLORINE PRODUCTS: While the two common stabilized types of chlorine can't be covered exhaustively here, a some description of dichlor and trichlor and their use and misuse is necessary to complete this CYA inquiry.

Sodium dichloroisocyanurate (dichlor), a granular, stabilized chlorine product, is commonly sold for hand-feeding of residential and, sadly, public pools. It is promoted as "pH neutral". In fact, however, it is slightly acidic, producing a pH in a 1% solution of about 6.0. Unless your make-up water has a high pH, or some other high-side influence exists, your use of dichlor almost always requires some alkalizer (high pH material) for pH offset. Dichlor's cost is higher than most other chlorine products, but it is handy for small-pool users and is easily hand fed.

Dichlor should not be used as the routine sanitizer for public pools, mainly because it must be hand fed and most health departments require automatic feed systems. Moreover, caution has to be exercised when dichlor is used more than infrequently to avoid undesirable accumulations of CYA over time; by weight dichlor is 57% cyanuric acid! You'll be stuck draining the pool because you used too much of that high-priced chlorine for too long.

Dichlor is said to have a "62% available chlorine content" which means 1.6 pounds of this material in 120,000 gallons - a million pounds of water - yields a residual of one part per million. (One pound of elemental gas chlorine would yield the same, so divide 1 by 1.6; you'll get the advertised 62%.)

Dichlor is even promoted as an algaecide, usually under a disguised name at an elevated price. It will help kill algae, (maybe even that allowed to bloom because of excessive stabilization,) but so will the inexpensive chlorine products. True algaecides are a better bet for your money.

Use of Dichlor for superchlorination should be avoided as well, because of costs and the rapid CYA accumulation. Nonetheless, it is sometimes packaged and profitably sold for this very purpose. This is the *last* product you should use for superchlorination!

Moving on to *trichloroisocyanuric acid*, most often sold in tablets or sticks, we find a product that has grown immensely in popularity because it is idyllic for "erosion feeder" use. These simple plastic feeders are very inexpensive hence their proliferation; as they allow the hard-compressed, low-solubility tablets to dissolve slowly and continuously into a sidestream. ("Floater" feeders, the ultimate in cheap simplicity also based on the slow-dissolving principle, are found in many private-sector pools. They are generally not accepted by health departments, however.)

The characteristic pH of a saturated solution of trichlor is 2.9, an extremely low and aggressive value! On the other hand, the apparent chlorine content is high, calculated at about 90% - hence an easy sale to performance seekers. Performance, however, diminishes as CYA accumulates...

The cost is very high, responding to a market willing to pay. In a survey of pool service companies, *Service Industry News*, July 14, 1995, reports that trichlor dominates the market in sales in all regions of the country except Florida and Southern California - often holding an 80% preference rating. Sadly, many *indoor* pool owners are among these customers.

It takes 1.12 pounds of trichlor to equate to 1 pound of gas chlorine, in terms of resultant residual. Even though there's this apparent 90% yield, the product is, by weight, over 54% cyanuric acid. A busy 120,000-gallon outdoor high-school pool using only ten pounds per day, even figuring in backwash and other water-loss dilution, could gain 4 ppm CYA per day. The pool could rise from 20 ppm CYA to a staggering, debilitating 100 ppm in only twenty days! Go figure...

The popular tri-chlor erosion feeders are often a source of severe equipment damage too, as instructions for installation have routinely included the "looping of the pump". The installer gets his "free" erosion flow from the available pressure differential across the circulation pump, thereby introducing a very low pH solution prior to the pump impeller, the filter and the heater. You've seen installations like this... at all those hotel spas with the pretty turquoise plaster!

The untrained use of trichlor, even with properly installed systems injecting downstream from all a pool's equipment, often leads to equipment and plaster damage nonetheless. Uncorrected, the naturally low pH of the dissolved product erodes total alkalinity as well as the water's pH, causing the saturation index to plummet. A properly introduced alkalizer is absolutely necessary to maintain the necessary mid-seven pH in the water.

In the experience of this writer, mis-use of tri-chlor now rivals both gas chlorine and acid washes in the competition for the most common source of costly public-pool damage!

REGARDING INDOOR USE OF CYA: It must be emphasized here that ***the indoor-pool use of cyanuric acid or stabilized chlorine products is wholly inappropriate***. CYA serves only to reduce the loss of chlorine residual due to ultraviolet radiation from the sun; there's none of that indoors, so higher priced chlorine works much less and lasts no longer. It's the hoggish (or, more typically, uninformed) contractor who installs that cheap erosion feeder on a new indoor pool when the designer fails to specify a more appropriate sanitizer and feed system. That forces the owner to use the only type of chlorine that works in such a feeder - expensive, potentially damaging, less-effective trichlor. So as you're wasting your money you may be harming your plaster or destroying the metal pump, filter and heater too!

Those who knowingly sell CYA or stabilized chlorine for use in indoor pools or spas do so out of ignorance or greed. There can be no other reason.

TOTAL DISSOLVED SOLIDS - THE COVER STORY: Total dissolved solids (TDS) naturally elevates as the CYA and the sodium chloride build. As the stabilizer accumulation becomes excessive, TDS is often blamed for a noticeable and sometimes severe drop-off in oxidation and disinfection. Unacceptable cloudiness, algae and even bad health-department reports can be the result, but CYA is held blameless as fingers continue to point at TDS.

"Oh my gosh, you're nearing 3000 ppm TDS; drain your pool!" is a common cry. Don't buy this one. As reported in ***PrP #1*** (What's All This Fuss Over TDS), high TDS has been inappropriately maligned for as long as CYA's been around. 10,000 ppm and much more can be harmless in public pool water, as the predominant constituent of TDS in all "aged" pool water is common, everyday salt. In non-stabilized pools, lofty TDS allows perfectly satisfactory chlorine effectiveness. Even chlorine in sea-water pools, at 33,000 ppm TDS, works just fine! Published statements that even 50% reduction in chlorine's effectiveness occurs when TDS rises to "2000 ppm or 1000 ppm above the make-up water" are patently false.

"No, it's not TDS, it's the 200 ppm CYA..." might be the more accurate observation when cloudy water and algae appears. Drain, dilute, or otherwise reduce the CYA so some ORP emerges and chlorine can go back to work. Don't blame TDS!

LOW LEVELS OF CYA DO WORK AFTER ALL: "Little if any stabilization is available at levels of CYA less than 30 ppm" is a commonly heard admonishment. Some sanitarians *require* this or similar minimums. Actually, the stabilization curve declines smoothly, not abruptly (see Part I) and it is reasonable to expect some retention at very low values of the product.

A major Western university used CYA for a season, then experienced an interesting phenomenon. The operator loaded the pool to the "recommended" level of 50 to 60 ppm. He was not pleased with the result, as water cloudiness occurred any time the pool was heavily used (high organic introduction/low oxidation) and clarity was restored only after a light-use day or two. At the end of the season, he drained the pool completely, refilled and re-balanced. He learned that, while dilution with unstabilized water is the normal method of reducing CYA levels, total elimination of the stabilizer is quite difficult. Even a thorough draining won't eliminate all of it, as puddling and absorption in filter media, pipes, plaster and elsewhere retains small amounts. Such was the case at the university's pool.

During the season following the draining, surprising economies were noted, with chemical costs a bit more than the stabilized season but considerably better than two years earlier with no CYA. The water was analyzed, revealing less than 2 ppm CYA! It seems that, since cyanurics couldn't be removed entirely, the trace value was enough to effect a significant degree just what the operator was looking for!

SALES MOTIVATION: Alluded to throughout this paper, *sales* more than chemistry is often the science behind the promotion and use of cyanuric acid. Among the highest-profit items on the pool-supply guy's shelf, motivation to move product is obvious. CYA offers an unprecedented opportunity for irresponsible promotion and training, thus counterproductive mis-application. Responsible sales folks *ask* if a customer's pool is outdoors, what the organic load is expected to be, how much stabilizer is already in the water. Responsible trainers explain all the consequences as well as the advantages of CYA.

Those pool operators and owners who choose to stabilize their chlorine bite off a new responsibility, that of testing and maintaining the CYA at reasonable and consistent levels. Especially when electronic automation is used, where calibration of the unit is based on the artificial offset created by the level of the product, variations in CYA cause unacceptable errors in accuracy and control.

While the controller's consistency and calibration is dependent on a steady level of CYA, the readability of the already inaccurate testing methods is particularly poor at the low levels suggested here. Dosing and replenishing by calculation, measurement of make-up water and estimation of evaporation has worked best to achieve a constant value of stabilization.

SUMMARY COMMENTS: How about reducing cyanuric acid, since it is considered "permanent" in pool water? Melamine, the precipitant-forming reagent used in the test kits, can be purchased in large quantities, administered to the pool, left undisturbed with the pumps off for a couple of days... then the white residual can be vacuumed off the bottom. The impossible has been done; most of the CYA has been removed from the water. This is costly in chemicals and downtime, of course. The better way is to monitor, manage and limit your pool's stabilizer in the first place.

Upper limits are regulated in most states, usually to 100 ppm cyanuric acid. This limit is for *toxicity* reasons, however, not an endorsement of its use to that level. Neither is a value above the 100 ppm figure reason for serious health concerns, as levels in the thousands have not proven toxic in some studies. But, as one health official said, "If a higher concentration can't possibly do any more good, why take any chance that it might do harm?"

This writer has, by the way, used cyanuric acid successfully and with benefit in his own pool for years. Trash or treasure, curse or blessing, yin or yang, it's all in the context of consequence! We just hope, if you're using CYA, it is appropriate for you and it works for you. Frankly, for many operators, it's not and it doesn't. ~ KW

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