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Water Quality Control

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A newsletter especially for professional pool managers and operators.

Selected Major Articles and Features from Previous Issues of The Poolfax Newsletter

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Why Chlorinate Swimming Pool Water?

If asked that question, the vast majority of public pool operators would respond by saying: "for disinfection . . . to kill bacteria and other microorganisms which might infect bathers." That answer is not only incomplete, it is downright misleading. The primary reason for chlorinating pool water is to oxidize (destroy by chemical reactions) organic soil.

A comprehensive analysis of a gallon of water taken from a typical public pool would disclose a vast accumulation of organic and inorganic soil and a comparatively small accumulation of bacteria, mostly non-disease causing species. The analysis would show the presence of dust, algae, clay particles, oils, cosmetics, scale and scrapings from human skin and mucous-like discharges. There would be hair, insect fragments, lint from bathing suits and towels and the myriad forms of soil which cling to the skin surfaces of bathers.

All of the materials on this list would be harmless to bathers, even if swallowed in large quantity. Potentially harmful microorganisms, which might by chance be deposited in pool water, are rare indeed. Yet, because we commonly discuss chlorination in terms of disinfection (destruction of disease causing organisms), we overlook the big job that chlorine must do in a properly operated pool.

Chlorine Burns the Trash, Filter Removes the Ashes

Imagine two pools, each with identical dirt loads as described above. In one, the water contains one ppm of chlorine. In the other, the water contains no chlorine at all.

In the first pool, much of the dirt load would be destroyed by chlorine reaction long before it reached the filter plant. An infinite number of chlorine reactions would reduce the dirt load to a much smaller volume, much as a fire reduces a trash pile to a small volume of ashes. Obviously the filter has a far greater capacity when removing only the ashes of the fire rather than the entire trash pile before it is burned. This is how chlorine cooperates with the filter to make pool water transparent as well as safe.

In the second pool, with no chlorine present, the volume of dirt would continue to increase notwithstanding the fact that it is filtered. Filter cycles would become shorter and shorter. Ultimately the filter would lose out completely, and the water would become unusable.

More Chlorine Needed To Keep the Fire Burning

Less chlorine in the water means less oxidation, less water transparency and shorter filter cycles. More chlorine in the water means more oxidation (a "hotter fire"), greater water transparency and longer filter cycles. That is why one ppm of chlorine is better for swimming pool water than one-half ppm. It also explains in part why super doses of chlorine (as high as six or eight ppm) are often the solution to stubborn water problems and short filter cycles. The experienced pool operator knows that to maintain a truly polished water, he must periodically "burn out" the pool by super-chlorination.

The comparison of chlorine reactions to a fire can be carried a step further to assist in understanding chlorine hydrolysis (reaction of chlorine with water and with substances present in water). In the oxidation process the chlorine is used up and must therefore be replaced if water quality is to be maintained. Further, in an outdoor pool the chlorine will dissipate rapidly from water of any quality through exposure to sunlight. The pool operator who fails to take this into account will have, at best, a peak and valley chlorine residual and the risk of water problems and shortened filter cycles.

The ultimate clarity and polish of pool water is a result of chlorine oxidation, not filtration. The filter is merely an assistant in the process; by removing some of the larger soil particles and the "ashes of the fire" it frees the chlorine residual to deal the final blow that makes the water sparkle to its ultimate.

The Filter Cannot Substitute for Chlorine Oxidation

The swimming pool that is filtered but not chlorinated will quickly develop a dull cast and will eventually become opaque and discolored—a highly objectionable environment for swimming. Conversely, the pool that is chlorinated but not filtered can be kept quite safe, from a public health viewpoint, for a prolonged period of time. Without the assistance of the filter to haul away the ashes, however, the job would ultimately become too great for any amount of chlorine that would be comfortable to the bather.

This discussion of chlorination provides a foundation for exploring some of the more technical aspects of water chemistry such as pH factor, free versus combined residuals and total alkalynity. In the next three issues we will discuss the interrelationship of chlorine oxidation, pH and filtration, short filter cycles, cloudy and unpleasant water, eyeburn, chlorine odor, discoloration and the many other problems which can result from chemical imbalance in swimming pool water. ■

Why Super-Chlorinate?

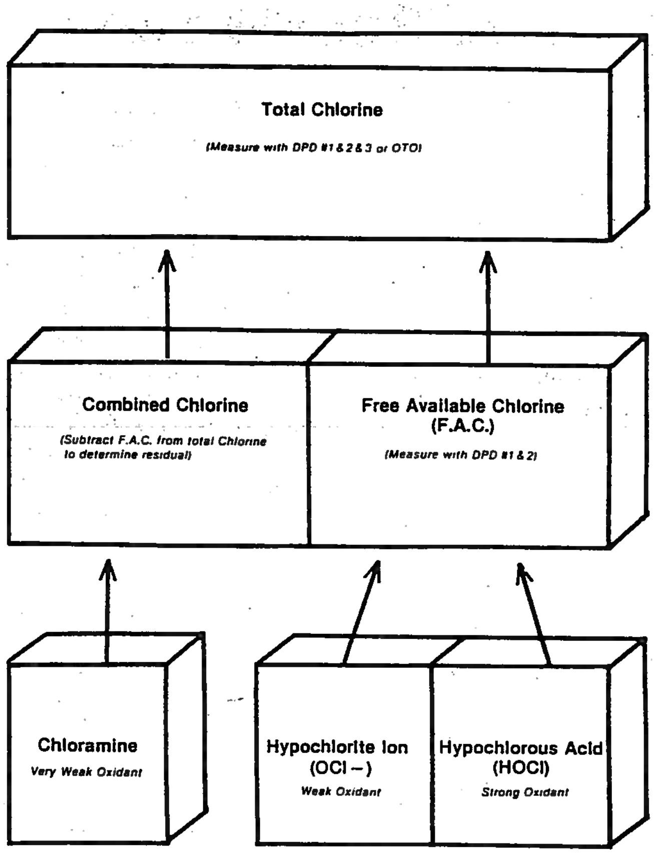
In last month's POOLFAX we discussed chlorination as a technique for destroying organic soil as well as for disinfection. Even though public pool water is chlorinated and chemically treated on a continuous basis, the water quality can gradually deteriorate. As a result, pools must be periodically super-chlorinated by bringing the chlorine residual to a very high level.

The Chemistry of Chlorination

We begin with some simple facts about the chemistry of chlorination.

1. Regardless of the chlorine used—gas, liquid or granular—the desired result of chlorination is the formation of hypochlorous acid (HOCl). When we speak of free residual chlorine we

Chlorine Terms



Why Super-Chlorinate

Continued

are referring to the presence of HOCl, the one form in which chlorine is a powerful disinfectant and oxidant.

2. Continuous chlorination of water does not insure the presence of free residual HOCl. The potency of chlorine is weakened by the presence of nitrogen-rich organic soils. Nitrogen is naturally present in pool water largely because of the perspiration and urine of bathers. When chlorine is added to pool water containing nitrogen-rich compounds, the chlorine reacts first with the nitrogen creating not the desired HOCl, but combined chlorine or chloramines (NH_2Cl and $NHCl_2$).

3. Chloramines are undesirable for several reasons. They have virtually no value as disinfectants or oxidants and they are the primary cause of eye-burn, chlorine odor and cloudiness in pools. Chlorine attacks nitrogen-rich products first. If the nitrogen content in the pool is high, the chlorine could exist entirely as chloramines. In such case bacteria and other micro-organisms can multiply rapidly.

4. Chloramines and free chlorine look the same when measured with an orthotolodine (OTO) test kit. OTO is the reagent which turns yellow in the presence of chlorine. The OTO test procedure can trick an operator into believing that he has adequate residual chlorine when, as a matter of fact, the residual of free HOCl could be but a small fraction of the measured total.

In order to separately measure the amount of free chlorine and chloramines one must use a DPD test kit, in which the reagent turns pink in the presence of chlorine. With a DPD test, one can first determine free chlorine residual and then determine total chlorine residual. When one subtracts the free residual from the total, the answer is the chloramine residual. Having made such a calculation it is then possible to predict the amount of chlorine needed to burn out and chemically destroy the chloramines by super-chlorination.

Super-chlorination must be periodically used to: a) Maintain adequate disinfection and oxidation, b) Keep the pool water free of eye irritation and, c) In an indoor pool, prevent chlorine odor.

The formula for calculating the amount of chlorine needed for super-chlorination is quite simple. Chlorine will destroy chloramines in a ratio of 8:1. However, this ratio is used in the laboratory. At the pool, a ratio of 12:1 should be used to allow sufficient margin for error in testing, calculating and dosing.

Let us select an example and go through the procedure.

Assume we are working with a 120,000 gallon pool which, at 8.3 pounds per gallon weighs one million pounds. Let us assume a free chlorine reading of 1.0 ppm and a 1.5 ppm total chlorine residual. When the free is subtracted from the total we have .5 ppm combined chlorine. To chemically destroy the .5 pounds of chloramines, the pool must be super-chlorinated to 12 times the quantity of chloramines, in this case 6 ppm net chlorine or 6 pounds in our million pound pool.

Now another calculation must be made. If a pool is treated with gas chlorine one must turn the chlorinator to its highest output and observe, by reference to the weighing scale, the point at which the chlorine cylinder weighs 6 pounds less indicating that 6 pounds of net chlorine has been added.

If the pool is treated with sodium hypochlorite, assume 1 gallon contains 1 net pound of chlorine so the dosage for super-chlorination with liquid sodium hypochlorite is 6 gallons.

If a pool is treated with granular calcium hypochlorite, it is important to note that only 65% of its total weight is net chlorine. Therefore one must divide the required dosage by .65 to calculate the right amount of calcium hypochlorite to use. In our example, 6 ppm divided by .65 would indicate that 9.3 pounds would be needed for effective super-chlorination.

When super-chlorinating, the pH of the pool water should be kept constant by taking proper corrective measures at the same time the super-chlorination procedure is being carried out. Continually add acid or soda ash as needed to maintain the pH between 7.2 and 7.8.

In addition to burning out chloramines, super-chlorination can be used to control black algae growth. Black algae is a problem limited mostly to outdoor pools in California, Arizona, Florida and other "sun belt"

Why Super-chlorinate?

states. Periodic super-chlorination to 10 ppm is usually the simplest method of halting black algae proliferation.

In textbook chemistry, the term "breakpoint chlorination" is used to describe the manner in which chloramines are chemically destroyed by quickly elevating residual chlorine. If less than the amount of chlorine needed to achieve breakpoint is added to the pool, the chloramine concentration will be unaffected.

In indoor pools, it may be necessary to dechlorinate after super-chlorination. The following formula for dechlorination appeared in the November issue of POOLFAX. It is repeated here:

Either of two chemicals may be used to dechlorinate the pool water safely.

1. Sodium thiosulfate - use 1/4 lb. to drop each 25,000 gallons of pool water 1 ppm.
2. Sodium bisulfite - use 2 oz. to drop each 10,000 gallons of pool water 1 ppm.

What is pH, Anyway?

When everything goes well, all you need to understand about pH are four points:

1. Keep pool water pH between 7.4 and 7.8.
2. Use commercial grade muriatic acid or sodium bisulfate to lower pH.
3. Use soda ash or caustic soda to raise pH.
4. Replace pH test reagents at least every 6 months.

To know how to stay out of trouble or how bad it really is when things aren't perfect, a deeper understanding of pH is helpful.

pH is a measure of the hydrogen ion concentration in water. The hydrgen ion is the chemical substance that determines whether water is acid or base. (The term alkaline is often mis-used in place of base.) pH is measured on a 0-14 scale in which pH 7 is said to be neutral, pH 0-7 is acid or acidic and pH 7-14 is base or basic. When water is pH 0-7, it tends to dissolve and carry away the minerals by which it passes. This process is called corrosion. Acids corrode. In general, water of pH 1 is more corrosive than water of pH 2, pH 3 more corrosive than pH 4, etc. Corrosion damage in public pools is almost always long-term and very costly to amend. It is the primary reason for mechanical equipment renovation in public pools. When water is pH 7-14 it tends to leave behind or precipitate the minerals it already has. This process is called scaling. Bases cause scale. In general water of pH 13 causes more scale than water of pH 12, pH 11 more scale than pH 10, etc. Scale is seldom a catastrophic problem in most public pools. Severe scale corrosion usually results in heater or heat exchanger replacement, but not total renovation.

Any corrosion is bad as it is irreversible. However, some scale is good as it can be in the form of a thin film which will protect the inner surfaces of plumbing and mechanical equipment.

Because a little scale is a good thing and because corrosion damage is much more likely to be a major problem than scale damage. the ideal pH range for public pools of 7.4-7.8 is very slightly basic. Allowing pool water to drift out of this range only a few times a year and for only a few hours at a time is not serious. Whatever damage might occur from minor, infrequent pH excursions of short duration will be inconsequential.

On the other hand, pool water which remains most of the time at pH 8.0-8.5 will almost certainly result in premature heater replacement. Pool water kept at pH 6.5-6.8 most of the time can shorten mechanical equipment life to as little as 2 to 3 years. The November POOLFAX issue told the story of a pool where the pH was kept at about 3.5. In that case an entire replumbing and equipment replacement was needed after 3 weeks.

In determining the possibility for scale or corrosion damage, pH is by far the greatest single determining factor. While the other three factors, total alkalynity, calcium hardness and temperature, are important, all three together are not as important as pH.

pH and Chlorine

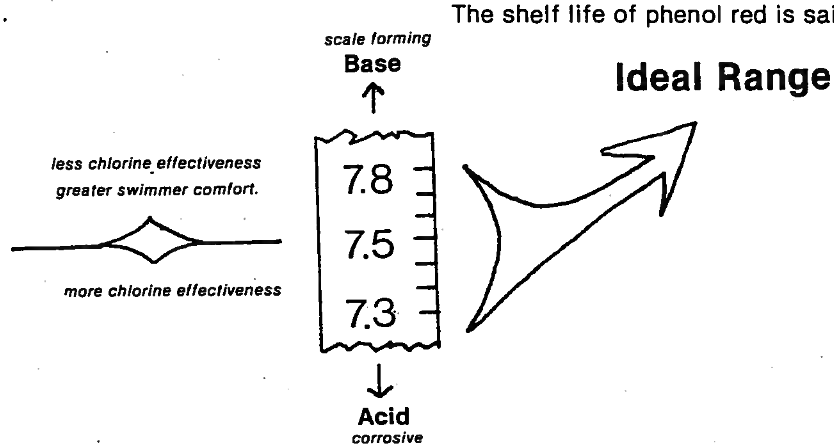
Wide excursions in pH generally have little or no effect on bathers in unchlorinated water. No human being has so far been able to tell the difference between unchlorinated water of pH 5 and pH 9. The pH of most popular soft drinks and alcoholic drinks is about 3 to 5. The pH of tomato juice is about 4. The pH of tap water in the United States ranges from 6.5-10.5.

However, when chlorine is added to pool water, the pH effect on comfort becomes important. Free available chlorine is far more active in water which is acidic and much less active in water which is basic. Hence, the higher the pH, the greater the swimmer comfort level, but also the less effective the oxidizing effect of the chlorine residual.

Because of the effect on swimmer comfort and because historically far more pools suffer corrosion damage than scale damage, many industry experts today are beginning to recommend pH 7.5-8.0 as the new ideal range for public pools.

Phenol Red

The most common pH test reagent used around public pools is phenol red. It is a red liquid which turns orange to pink in the test procedure. The shelf life of phenol red is said to



be six months but this time period is only true if the reagent is stored in a cool, dark place. Any light, especially sunlight and storage for any length of time in temperatures above 85 or 90 degrees can severely shorten the useful life of phenol red. It is a very inexpensive reagent and should be replaced regularly from a reputable supplier. It is generally a good idea not to buy phenol red from someone you don't know as some vendors are not careful about how long they store phenol red before sending it to their customers.

Moving pH

Muriatic Acid

The most common chemical used to move pH in hypochlorinated pools is commercial grade muriatic acid. This product is an inexpensive form of hydrochloric acid which is perfectly sufficient for use in public pools. Hydrochloric acid is readily available in a higher grade which is used in the laboratory. The higher grade is more expensive and not at all necessary for pool use. Muriatic is a fuming acid and should be kept tightly capped at all times. Make sure that the tank lids for muriatic storage fit tightly. If they do not use a weather strip or similar material to make them fit tightly, then you can use small pieces of sponge rubber or similar material to plug any other openings such as the small hole where the suction tube of a chemical metering pump might be lowered into the tank. In a very few years, if not months, muriatic fumes can destroy all electrical or electronic equipment in the room. Telephones, automatic controls, clocks, elevators and hoists can all be destroyed in short order given a little muriatic fumes, a little time and less than perfect ventilation. When transferring muriatic acid from one container to another, always wear rubber gloves, rubber apron and safety goggles.

If by accident you get a little muriatic acid on your skin, you can wash the area immediately to avoid serious harm. Some operators keep a small pail or bag of soda ash handy and sprinkle the affected area before washing.

Sodium Bisulfate

At some pools, sodium bisulfate is used to lower pH. This is a white granular or powdered material which is mixed in water. It is considerably more expensive to use than muriatic acid but does not require special care in handling, nor are its fumes as damaging to electrical equipment.

Soda Ash

Soda ash is used regularly in gas chlorinated pools and in brominated pools. A proper soda ash feed system involves a tank with mixer and a positive displacement chemical metering pump. The mixture of soda ash in water should be about 5% to 7%; about 20 pounds of soda ash per 50 gallons of water. The small orifices around the ball check valves of the soda ash feeder, especially the injection fitting where the slurry is actually fed into the recirculation system, must be cleaned frequently to prevent clogging.

Sodium Hydroxide

In some pools, sodium hydroxide, also called caustic soda or liquid caustic, is used to raise pH instead of soda ash. 25% or 50% strength sodium hydroxide is extremely effective in raising pH. It is less expensive than soda ash. It requires no tank, no mixer and a very small metering pump. Sodium hydroxide must be handled with a great deal of care and should never be transferred from one container to another. It should be fed directly from the container in which it was delivered. Also, sodium hydroxide begins to freeze at about 50 or 60 degrees depending on the solution strength. If the equipment room is likely to fall to or below these temperatures, a thermostatically controlled heating strap can be used around the container.

The use of bicarbonate of soda, also called bicarb or baking soda, to raise pH is a mis-use of this chemical. Bicarbonate of soda is used in pools primarily to raise total alkalynity. While it does raise pH, it is not the most effective chemical for the money to do so, and its effect on total alkalynity may or may not be advantageous.

There is absolutely no way of predicting how much acid or soda ash is needed in a particular body of water to move pH from one number to another. Calculations can be made in a laboratory which would lead to multiple graphs of information but would have little or no value to the public pool manager or operator. The factors of acid demand, base demand and titration curves are only of the most esoteric academic interest when maintaining a public pool. ■

Total Alkalinity, Calcium Hardness and the Saturation Index

If chlorine residual and pH level are hour-by-hour concerns of the public pool operator, then total alkalinity and calcium hardness are week-by-week concerns.

Alkalinity and hardness are terms used in measuring the amount (in parts-per-million) and to some extent the kinds of minerals which are dissolved in the source water used to fill and replenish pools. A detailed discussion of alkalinity and hardness would fill a thick volume. Fortunately, the public pool manager or operator need not be aware of the complex chemistry of these two terms. However, those compounds which are measured in a total alkalinity test and those which are measured in a test of calcium hardness are of importance.

In last month's POOLFAX, we discussed the way pH changes can lead to scale and corrosion damage to pool mechanical equipment. To a lesser extent, improper total alkalinity and calcium hardness levels can also lead to scale and corrosion damage even when pH is rigidly maintained. Test kits for total alkalinity and calcium hardness are inexpensive, reliable and sufficiently accurate for public pool use. Fortunately, total alkalinity and calcium hardness usually change very slowly in pool water so that weekly or monthly testing is often adequate.

Total Alkalinity

Total alkalinity is a measure of the resistance of water to pH change. The higher the total alkalinity, the more acid or soda ash is needed to change or maintain pH. The lower the total alkalinity, the less acid or soda ash is needed to change or maintain

Total Alkalinity . . . Cont.

pH. In water very low in total alkalinity (below 50 ppm) the operator may easily overshoot the target pH with even small acid or soda ash doses, creating the opposite pH problem.

Very low total alkalinity (again, under 50 ppm) is by itself a cause of severe eyeburn among swimmers even when all other pool chemistry factors are ideal.

The ideal range for total alkalinity is often suggested to be 100 to 125 ppm but in practice, 80 to 150 ppm is almost always adequate. Total alkalinity above 150 ppm can in some cases contribute to the possibility of scale damage. Total alkalinity below 80 ppm can in some cases contribute to the possibility of corrosion damage.

Total alkalinity at 80 ppm or below can be serious and deserves immediate correction. Total alkalinity at 150 ppm or above is usually not serious and does not present an immediate danger.

The best way to raise total alkalinity is by adding sodium bicarbonate (also called bicarbonate of soda, bicarb or baking soda) at a rate of 1.5 pounds per 10,000 gallons of pool water per 10 ppm increase.

Particularly in pools where sodium hypochlorite is used for oxidation or in gas chlorinated pools where sodium hydroxide is used for pH correction rather than soda ash, low total alkalinity can be a chronic problem requiring frequent bicarb dosing.

You can reduce total alkalinity by adding muriatic acid. While in the process of adding the acid to decrease total alkalinity, use sodium hydroxide or soda ash to maintain a pH of 7.4 to 7.8.

Calcium Hardness

Under conditions of relatively low pH and low total alkalinity, low calcium hardness can contribute to corrosion damage. Under conditions of relatively high pH and high total alkalinity, high calcium hardness can contribute to scaling.

There is no ideal range for calcium hardness but for reasons having to do with pool surface protection, keep calcium hardness above 140 ppm. If calcium hardness is above 600 ppm, consult a public pool expert or service company for help in determining whether or not a potential problem exists. Under some circumstances calcium hardness can be reduced by dilution with fresh makeup water. Under most circumstances, however, calcium hardness can only be reduced by softening, which for public pools is usually too expensive to be practical. In addition, some of the latest research indicates that calcium hardness levels even as high as 1000 ppm are not detrimental so long as pH and total alkalinity are maintained within ideal ranges.

To raise calcium hardness, add calcium chloride at a dosage of 5 pounds to raise 10,000 gallons of pool water by 40 ppm.

Saturation Index

The liklihood of scale or corrosion damage is predictable using the saturation index. The index is a method of weighing and manipulating the interrelationship of pH, total alkalinity and calcium hardness.

Technically, the index is officially called the Langelier Saturation Index of Water Balance, named for its author, Professor Langelier. The index takes temperature into account but Langelier was writing for several applications, not just pools. It takes wide temperature changes to affect the index appreciably and such changes do not occur in pools.

Using the index years ago, one converted total alkalinity and calcium hardness to certain values and then added those values to the pH number, subtracted it from a constant, and came up with a number on the index scale. On the scale, zero is neutral, negative numbers indicate a liklihood of corrosion and positive numbers indicate a liklihood of scale. The ideal range is said to be +0.5 to −0.5.

Using the index today is easiest with special circular or vertical slide rules available at little or no charge from test kit suppliers. No conversion or calculation is necessary using the slide rules.

The saturation index is not infallible. It is totally based on calcium saturation, virtually ignoring other compounds. If one or more factors of pH, total alkalinity or calcium hardness are way out of range, index prediction accuracy decreases. Also, in areas of unusual source water characteristics, prediction accuracy can vary.

Still, the index is a good indicator, a signpost pointing one direction or the other toward scale or corrosion tendencies.

A quick but not terribly precise use of the index can be made without conversion tables or slide rule. In a pool with a pH of 7.4 to 7.6, multiply total alkalinity times calcium hardness. If the result is less than the number 25,000, increase total alkalinity or calcium hardness, whichever is lower. If the answer is above 30,000, add acid to reduce total alkalinity until the same process would result in a number 25,000 to 30,000. Follow the instructions above for raising total alkalinity or calcium hardness or lowering total alkalinity.

The quick check approach described above is a simplification of Professor Langelier's work. Alkalinity and hardness are far too often overcomplicated by authors and lecturers. While description of the chemistry of carbonate ions, the components of temporary versus permanent hardness and the dangers of hydroxide alkalinity are of academic interest, they have a little or no practical value to the public pool manager or operator. Those interested in the chemistry behind the basic rules will find such information in almost any water chemistry text.

The important thing to remember is that if one sticks to the basics, one stays out of trouble:

1. Keep pH between 7.4 and 7.8.
2. Keep total alkalinity between 80 and 150 ppm.
3. Keep calcium hardness above 140 ppm.
4. Make sure that total alkalinity times calcium hardness equals 25,000 to 30,000.

Q & A

Q. Pool test kits range in price from $10.00 to $600.00. How much should I spend for a good one?
Fred Wightman, Tulsa

A. The homeowner can get by with a minimal investment but the professional needs a product of durability and reliability. Most experienced public pool operators use kits which today run about $70.00 to $130.00. Be sure to select a kit which uses large reagent bottles, has a strong case and offers free available chlorine as well as total chlorine tests plus tests for pH, total alkalynity, and calcium hardness.

The Care and Feeding of Chemical Feeders ...

and other info to protect your clothes, your safety and your job

Handling and storing aggressive pool chemicals and maintaining the equipment used to feed these chemicals are the most dangerous tasks of the public pool manager or operator. While most equipment malfunctions require outside service, the frequency of these malfunctions can be minimized. By following a few basic do's and don't's about chemicals and chemical feeders, you not only protect your own safety and the safety of other staff and swimmers, but you can also reduce pool operating costs by limiting the reliance on commercial vendors and service companies.

Gas Chlorinators

Check with the local distributor of your brand of gas chlorinator about his rebuild offer. Many gas chlorinator manufacturers offer to their distributors an inexpensive factory rebuild program. If such a program is available to you, send in your gas chlorinator with its ejector at least every two or three years. The chlorinator and ejector you get back may not be the same one you sent them but will be in like-new condition. Some pool operators have had the experience of sending in their old unit and getting a brand new one back.

If you do not now know how to repair a gas chlorinator, don't learn. While gas chlorinator repair is fairly simple, mistakes can be very dangerous.

If the gas chlorinator and the gas chlorine supply are housed in a separate, specially ventilated room, do not store the gas mask in that room. Check the instructions and labels on the gas mask to make sure that it has been checked or serviced within the appropriate length of time. If the gas mask needs to be replaced, replace it with an airpack. Airpacks are more expensive but offer far more protection. In addition, some states are now beginning to require airpacks rather than gas masks.

Be sure to use a new lead gasket with each cylinder change. Also be sure to pull the old one out. Have a proper cylinder valve wrench - leave it on the valve. Never open the valve more than three quarters of a turn. After hooking up a new cylinder, open the valve and check for leaks with ammonia vapor from a plastic squeeze bottle. Even very small leaks that are difficult to smell will produce a white smoke when in contact with ammonia.

Diaphragm Pumps

The chemical metering pumps used to feed hypochlorites, acids, soda ash, caustic or even specialty chemicals are almost always of the positive displacement diaphragm type. The most important word in diaphragm pump maintenance is "clean." Keep the chemical solution tightly covered or capped at all times so that it is as clean as possible. Keep the foot valve at the bottom of the suction tubing, the suction and discharge valves on either side of the pump head, and, most critically, the injection check valve at the point of chemical injection clean by disassembling and washing them frequently. This procedure may need to be repeated weekly with soda ash and diatomaceous earth slurries and with calcium hypochlorite solutions. Use rubber gloves, unplug the feeder, disassemble all the little ball check valves, clean them all thoroughly and reassemble them being very careful to get the o-rings in the right order.

Never use pliers on the plastic compression fittings of a metering pump. Cut off the end of the tubing to get to new material. Then tighten finger tight only.

The o-rings which are used as valve seats and the diaphragm of the pump are what are called elastomers. They are not intended to work forever without replacement. In most applications and with most models, the elastomers need to be changed every twelve months.

If the feeder is one that requires lubrication, lubricate it. If the feeder is one in which the motor or gears are immersed in an oil bath, the oil should be changed every six to twelve months. Use the oil recommended by the manufacturer. If the manufacturer's instructions have been lost, write the manufacturer for another manual.

Fix all leaks as soon as possible. When a leak occurs, most metering pumps will weep for a few days to a few weeks before significant damage is done to the pump housing or internals. The delay between the time when the leak starts and the time when the pump is ruined is your opportunity to notice the leak and fix it.

If you need to buy a new chemical feeder or replace an existing one, be sure to look into electronic models. Several companies now offer diaphragm type chemical metering pumps which use no motors, gears, pulleys, require no lubricants and best of all, operate on tiny amounts of electrical energy. They are inexpensive to buy, operate and maintain and will deliver chemical just as effectively and reliably as pumps using a 1/3 horsepower electric motor.

Automatic Controls

Automatic controls can be as simple as a float-operated makeup water valve or as sophisticated as an electronic panel in control of temperature, filter backwashing cycle, pH and chlorine residual. Most electronic control equipment requires on-site operator instruction by an experienced, trained representative of the manufacturer. If you have such equipment and have not received such instruction, request it.

While manufacturers' recommendations for service vary widely, almost all would recommend at least an annual checkup and recalibration by a trained service technician. In scheduling a routine annual checkup for a control instrument, request the visit when the serviceman is in the area on other business in the near future. Do not request immediate service if you do not need it. This technique will in most cases substantially reduce the cost of the service call.

If you think you have a problem that requires immediate service, it helps to have plenty of information at your fingertips. When you phone to make a service call request, ask for a service technician to take your call and recite the model number and approximate age of the device. Tell the technician which indicator lights are on and which are off, what meters or other indications are displaying and be as specific as you can about the nature of the problem or question.

In many cases a monitor or controller may appear to have a problem when in fact it is reporting or responding to an upset or malfunction of

The care and feeding...

some other kind in the pool system. A good technician can often discern this situation if given enough information on the phone. He can often advise you how to solve your own problem without the cost of a service call or steer you to a different kind of serviceman who would be capable of correcting the real problem.

When phoning for service about water quality control instruments, be sure also to report the results of test kit readings. While detailed telephone reporting may seem like a lot of work, remember that it is only for the benefit of your budget. As a general rule for dealing with all vendors, the more specific your request, the lower your bill.

In the world of instrumentation, devices which convert conditions to mechanical or electronic signals are called sensors. In pool applications these can be diaphragms in pressure switches, paddles in flowswitches, thermocouples in heaters, pH electrodes in water chemistry controllers, etc. Always keep spare sensors on hand for whatever kind of automatic controls you may have.

Operating Tips

There are several steps you can take to make your job easier. Most hypochlorite use. If you allow the acid and the hypochlorite to mix, the chemical reaction will at least shorten the life of the pump elastomers and at worst could create a cloud of poisonous gas.

Feed sodium hypochlorite full strength without dilution. To reduce feeder output, use the feeder output adjustment knob but do not dilute the chemical. Some operators dilute sodium hypochlorite under the theory that it is more stable when diluted. However, it is more likely that the tap water or pool water used for dilution will use up some of the oxidizing are free, the rest are inexpensive.

If you have a fully enclosed pool mechanical equipment room, put a small dehumidifier in it. By reducing the humidity level, you will have a more pleasant environment in which to work and you will extend the service life of much of the equipment and have fewer problems with electrical and electronic devices.

Many operators who have hypochlorinated pools flush out their hypochlorinators by feeding a little acid through them. This technique is a good one but remember to feed water through the pump to wash out the hypochlorite before you feed acid through it. Then feed water through it again before you restore the pump to power of the sodium hypochlorite or will precipitate the minerals that are dissolved in it because of the high pH of the hypochlorite. In the latter case, the result will be an increased frequency of the clogging of the injection check valve and the other small orifices in the chemical feed path.

Likewise do not dilute sodium hydroxide. However, it is okay to dilute muriatic acid.

If you are mixing soda ash in a 5% to 7% slurry solution and you still get frequent encrustation of the small orifices of the metering pump and at the injection check valve, try adding a little sequestering agent to the soda ash slurry tank before adding the soda ash. This technique helps in some cases, but not all. It's worth a try.

Keep handy and make use of rubber apron, goggles, and rubber gloves. Also, investigate an industrial eyewash station. High quality, industrial, portable eyewash stations are available well under $100.

Above all, keep chemicals covered and sealed. Most chemicals used in public pools are fuming chemicals. When left uncovered the fumes damage nearby equipment. Whether a particular chemical fumes or not, you will have fewer problems if you keep the solution clean by keeping it covered tightly. ∎

Chem treatment – a look back and a look forward

Chemical treatment came of age in the decade of the 70's. Greater environmental consciousness gave social impetus for change and improvement. At the same time, the electronic revolution turned imagined solutions into realistic techniques. Today water quality control can be precise, reliable, energy-efficient and affordable.

Our governments have been at the axle of change. In the 60's and 70's we saw new, tough anti-pollution regulations and government grants for improved waste water treatment projects. These giant steps in the direction of cleaner water coincided with the spin-off technology from the space program. Brought together these were literally the means, the motive and the opportunity for sweeping improvements.

In swimming pools, waste water, cooling and boiler water and in manufacturing process applications, electronic instruments handle a variety of chores. Some of these chores were previously done by people, others by energy-hungry mechanical linkages, and many simply were not possible to do at all.

Earlier, institutions and businesses could accord imprecise chemical treatment for the same reasons we could afford to drive big, heavy automobiles and heat our homes to 74 degrees. Hardware to prevent this imprecision, if available, might have taken years to pay for itself. Today the payback on electronic systems is measured not in years, but in months or weeks. In one application in the gold-plating industry, the payback on a $3000 pH control system is about 45 minutes.

In public pools, electronic monitoring and control of pH, chlorine and bromine have become commonplace. Automatic controllers are regarded as a routine part of new pool plans and as a sensible addition to existing pools.

Electronic chemical feed pumps are replacing inefficient motor-driven feeders with increasing frequency. The result is often a 95% reduction in electrical power consumption. The electronic pumps have no motors, gears, pulleys or oil baths and can do the work of a 1/3 HP motor at the power consumption of a child's night light.

Electronic flow and pressure measurement are more recent developments. While they are not yet fully appreciated in pool applications, it is only a matter of time. The packages are compact, the readout is incredibly accurate and the service life promises to be vastly greater than with prior means.

Chem Treatment . . .cont.

At the end of the 70's we saw the reversal of a seven-year-old downtrend in electronics prices. It seemed for awhile that electronic products dropped in price every month. Four-function pocket calculators went from $400.00 to $7.00 each between 1971 and 1978. Now prices are on an uptrend that is likely to last many years. Rises in the costs of transportation, raw materials, insurance and borrowed capital will more than offset the effects of further technological refinements.

The raw costs of distribution exceed the costs of manufacture of many products. For example, after the price of a transistor has fallen from $3.00 to 24¢, a further price halving will only save 12 ¢. What good is that savings when the price of delivering the finished product in a diesel powered truck jumps from $10 to $20? In some electronic products, the total price of the components today is less than the cost of postage needed to mail the bill.

In the 80's we shall of course experience a continued concentration on energy efficiency. We shall also see increased emphasis on what is called "operator interface"—a fancy term that refers to how easily the end-user can understand and maintain a sophisticated piece of equipment.

We expect a continued and even more rapid rise in the level of technical expertise among public pool managers and operators. Where before the operator had available to him only a day-long lecture program, there have begun to take place two and three day training seminars. These seminars are in a learning exchange style, making use of teaching techniques proven in other fields. The sharing of experience between veteran and rookie pool operators from different pools but in the same or nearby communities presents an opportunity we cannot ignore forever. Non-technical administrators are becoming more aware of the complexity of modern mechanical systems which require enhanced operator awareness and ability. By 1990, adding chemicals by the scoop will seem as backward as pounding the laundry on a flat rock.

Despite advances in the way we deal with basic water treatment problems, they are still basic. No one is likely to re-write the laws of nature or discover the ultimate miracle pill that eliminates all water quality problems—at least not any time soon. Chlorine residuals, pH, total alkalynity and the other essentials to which we must all refer will be as important tomorrow as they are today.

Progress is a change in focus, not in foundation. ■

Q. & A.

Q. At what part per million is the chlorine level detrimental to the health of a swimmer?
Roger Borr, Holland, Michigan

A. High chlorine residual in pool water is not detrimental to the health of bathers. There are cases in which people have been exposed to 25 to 30 ppm for 2 to 3 hours. The high concentration will tend to increase the rate at which body oils are leeched from the skin with a resulting feeling of dryness, but the tissues regain a proper fluid balance within a few hours.

As a matter of practice, if chlorine residual rises above 5 ppm it can be rather quickly and easily reduced to what we regard as normal desirable levels by dechlorinating with sodium thiosulfate.

Super-chlorination revisited

by Kent Williams, Contributing Editor

Ventilation, recirculation and other factors can insure or prevent successful super-chlorination.

We know that super-chlorination to levels 12 times the chloramine content will reach or exceed the so-called breakpoint and eliminate those ammonia compounds we call chloramines or combined chlorine. There is also some advantage gained in algae control. Super-chlorination seems to be a general cure-all for what ails pool water, but an expanded knowledge can put super-chlorination into a more realistic perspective allowing us to get the most from the procedure and the dollars.

Ventilation

As pool covers become more popular, we should be aware that breakpoint chlorination does not run to completion underneath a pool cover. Notwithstanding the damage one may do to the cover, the reaction remains incomplete. Breakpoint chlorination is a very complex series of chemical reactions which produce nitrogen and other gases which must escape to atmosphere. If you prevent this gas from being liberated with a pool cover, you will not have solved your chloramine problem.

Indoor pools have special problems due to the typically sluggish gas layer just above the surface of the water. Especially in confined areas such as small, high humidity spa rooms one finds unpleasant chloramine odor persistent before, during and after an attempt at super-chlorination. The results are less than rewarding.

Even in a large indoor pool, super-chlorination seems ineffective unless the air handling systems in the building are adequate, and the air can be moved across the pool water surface. A YMCA spa in Oregon had 2.0 ppm total chlorine, 1.6 of which was chloramines. After 30.0 ppm super-chlorination followed by de-chlorination, the new score at 2.0 ppm total was free 0.8; chloramines 1.2. A second attempt in this small, low ceilinged room was accomplished with the doors open and portable floor fans blowing air in and out of the room; this time free 2.0 - chloramines 0. A similar story can be told about a northern California indoor pool where super-chlorination was less than 50% effective until the open door and floor fan routine was attempted, after which breakpoint was accomplished completely.

There are some fairly reliable methods to determine, even at very high levels of chlorine, if breakpoint has been achieved. For those experienced pool operators with calibrated noses, you may be able to detect the rather sudden absence of chlorine odor. If it's a windy day or you have a head cold, try this: take any small clean container and scoop nine container fulls of distilled or deionized water into a large container. Then scoop one container full of pool water into the larger container. From this 1 part in 10 diluted pool water, a test can be run to determine if chlora-

Super-chlorination . . . cont.

mines still exist. Whatever value you read on your DPD test can be multiplied by 10 for reasonably accurate values in your highly chlorinated pool. You are of course looking for the absence of chloramines. The same procedure can be performed in a graduated cylinder with accurate milliliter markings, if one can be liberated from the chemistry department of a nearby school.

The most reliable method is of course to buy an extended range test kit. DPD kits are commonly available for 10 or 12 ppm levels. Having grossly over-shot your mark, there are special orthotolodine kits that read values up to 50 ppm or more. If the chlorine in your pool water has reached these lofty heights and if proper ventilation was provided, you can be confident that you don't have a trace of chloramines, that your total chlorine reading equals free chlorine reading.

Continuous breakpoint

Breakpoint chlorination can be maintained in a swimming pool. In many cases holding a certain level of chlorine is actually constant super-chlorination for small quantities of ammonia. Many pool managers have determined by experience what level is necessary to preclude the formation of chloramines. In these cases ammonia is burned out as it is introduced. This technique is not usually possible, however, if the levels of effective chlorine are running through the classic peaks and valleys which always occur in pools which are not automated. In the valleys the chloramines can form, while they are not burned out by subsequent peaks. Chloramines accumulate.

Maintaining breakpoint chlorination (and maintaining is the key) is the major advantage of chemical automation. Without automation, this maintenance of breakpoint chlorination cannot be accomplished without diligent attempts at holding a high and wasteful chlorine residual average.

Pool managers who have automation frequently ask what level of chlorine should be maintained to achieve constant breakpoint chlorine. This question is answerable only by empirical means (try it and see if it works). A quiet little YWCA in the Midwest with a few dozen swimmers a day and proper bather preparation successfully uses 0.4 ppm chlorine and finds manual super-chlorination required only once or twice a year. By contrast, a nearby rehabilitation center for the handicapped uses 3.0 ppm around-the-clock. Anything less and they find super-chlorination required more often than the program will permit. These examples are extremes. Recent regulations now require minimum levels above those necessary to successfully handle typical chlorine demand. 1.0 ppm is becoming common, while a few test counties in the West are requiring 3.0 ppm or more.

Considering the fact that oxidation and disinfection may only require the first 0.1 or 0.2 ppm active hypochlorous acid (HOCl) the remainder constitutes an insurance residual. This insurance, incidentally, more often than not pays back liberally making the "premiums" (the high maintained residual) well spent. We constantly benefit by the breaking out of ammonia compounds as they are introduced.

If your pool is not automated, a higher residual must be targeted if breakpoint chlorination is to be attempted on a continuous basis. Target value constitutes only an average of the unavoidable peaks and valleys. Periodic super-chlorination is, therefore, probably the best procedure in your situation.

After super-chlorination

Controversey clouds the question of when it is safe to swim following super-chlorination. Without fear of being proven wrong, it can be stated that the swimmers may return immediately following a *successful* super-chlorination. Successful implies that breakpoint has in fact occurred and has occurred throughout the entire pool's volume.

How does one insure this? Your circulation efficiency has a lot to do with this. Normally, once the calculated residual is achieved, testing has occurred to insure breakpoint completion and an hour or two has passed, the chlorine can be expected to have mixed thoroughly. There is no need to wait for a full filtration turnover. Super-chlorination is complete. Swim 'em! ■

Purchasing -

6 rules to help you get the most for your money

In the public pool field, customer-vendor conflicts are commonplace. These conflicts waste time, interrupt work or delay payments. Occasionally they end in lawsuits, bankruptcies or closed pools.

Public pool managers and operators frequently influence purchasing decisions and evaluate vendor performance. How well they succeed in getting the most for their money depends upon their awareness of the vendor's product, procedures, problems and past performance.

In the 1950's and early '60's, the pool industry expanded explosively to meet an overwhelming demand for all kinds and sizes of swim facilities. The pool companies in business before this growth spurt could not handle the increased demand for products and services. Predictably, this change attracted unscrupulous "fast-buck artists" who knew little and cared less about sound engineering practices or quality pool operation. While many have since departed the pool industry, some are still around. In the pool industry today they probably represent a larger fraction of the whole than in most other fields of business. As a consequence, you are more likely to be burned by a pool company than by a vendor from another industry.

Some of the following "rules to buy by" are universal and would apply to all purchasing functions and vendor relations. Others are more specific for dealing with contractors, service companies or equipment distributors. Some rules have more to do with new construction and major renovation, others have more to do with buying consumable supplies.

1. Free engineering isn't.

About four years ago in the Rocky Mountain states, a pool contractor designed a major renovation of a 20-year-old pool at no charge. After completing the design, he took a contract to do the work at a price considered fair by all parties involved.

Purchasing . . . cont.

The renovation met the local code requirements. However, after a few months' operation, it was apparent that the pool was suffering major electrogalvanic corrosion damage because of the use of dissimilar metals in the renovation. The damage was so severe that the pool had to be renovated again two years later.

What recourse did the owners have? Under the law, the original renovation had been designed by the pool manager himself with the help of the contractor. The owner - not the contractor - was ultimately responsible for design decisions. In this case, the "free" engineering cost more than the project itself.

There are variations of the same story. Some vendors have on staff registered professional engineers who stamp their plans and specifications to insure you of technical compliance with codes. In practice, however, the stamp is of little consequence if problems arise. The difference between sound engineering practice and malpractice is a gray area. Lawsuits over this kind of problem are usually dismissed or, if tried, drag on for years.

Engineering, design and product selection are functions performed on behalf of the owner for the benefit of present and future staff and users. On the other hand, equipment supply and installation are functions performed by the vendor for the benefit of his wallet. Designer-vendors who can keep everybody happy and still show a profit are few and far between.

Even engineering services at a fair price can be dangerous. Design consultants come in two flavors - those who truly design and consult and those who design, consult and also own a piece of the companies whose equipment they specify. In general, the former are top-notch, the latter are near or past the point of conflict of interest.

At a large university in the Midwest, a nationally known consultant specified a certain wall thickness for the steel tubes used in the ladders, guard chairs and diving stands. It just so happened that he was the major stockholder in the only company in the U.S. that could bend tubing of that dimension. It may have been the most expensive deck equipment ever provided.

2. Investigation prevents litigation.

To know well with whom you are dealing before you do business is a universally appreciated maxim that is unfortunately too often ignored.

It is easy to ask the vendor for a list of customers' names and phone numbers, but harder to make the time to place the calls. Nevertheless, phone as many as possible. Be sure to ask not only for the person whose name is given you on the list, but also for the person who shares your job function or title. If their experience with the vendor or designer was concerning a different kind of product or service, ignore everything except answers about timeliness and neatness of work, courtesy, etc. If the vendor has successfully installed a replacement guard chair someplace, it does not mean he can solve a water chemistry problem - and vice versa.

When appropriate, visit these references to personally observe an installation or system and interview staff.

Make a site survey. Visit the vendor's offices or manufacturer's plant. You want to see neat offices, busy staff, and an organized warehouse. Look for evidence of goods being received frequently and in quantity - a telltale sign of a healthy company.

Request the name and phone number of the vendor's bonding company and check their bondability and bond rating. Ask the agent who carries your facility's insurance to interpret this information for you.

With professional consultants, you may ask for a sworn affidavit of financial interest. You are not interested in how much he is worth or how much of any stock or business he owns, but only the list of which companies he is a part of. This information is difficult to verify, but if the consultant refuses to provide this disclosure, it is a signal to look for someone else.

Run credit checks on vendors that are new to you. If your facility does not subscribe to a credit service, ask your bank or a supplier from another industry with whom you do business regularly to run a check for you. Credit checks take two to ten days and cost little or nothing.

In the current economic climate, business bankruptcies are at an all-time high. Vendors in financial distress usually have trouble meeting delivery promises. They may be unable to clear past accounts with their suppliers or write checks for COD orders. They frequently have trouble getting parts and service from manufacturers. They may lay off the employee who knows your situation or a particular product line best.

Worse, a company on the brink of insolvency today probably won't be around tomorrow to back up their work. There is no point suing a defendant who is broke or out of business.

The company that is frequently lowest bidder is often the first to close its doors in hard times. By contrast, the company that will not take a contract at a cut price will have the resources to weather the worst of economic storms.

Small companies without a track record of performance may appeal to our natural desire to support the underdog or the newcomer, but watch out. New businesses get in trouble more frequently than old ones. Typically they are not well financed and management may be inexperienced. More importantly, the support of new businesses is probably not one of the stated purposes of your organization, but wise use of its budget probably is.

Remember, too, that in today's economy just because a company is big does not mean it is solvent. Remember Penn Central, Lockheed, W.T. Grant, and Chrysler. Each of these famous corporations made headlines. There are literally hundreds of thousands of others who didn't . . . and won't.

In campaigning to get an order, almost all companies will insist that they are able to perform. Expect them to make that insistence, but know that their insistence does not necessarily mean they really can.

3. Shop servicemen get lonely - call 'em.

The telephone is the most important tool in getting good shop service from a vendor. The best technique is probably the "three call method."

Make the first phone call before you send equipment in for service. Describe the problem to a shop technician. You may find that it is a simple condition you can correct yourself. The shop technician may have a special instruction for you about how to package the item or may ask for a special kind of work order or letter to accompany the request for repairs. Moreover, the shop technician will probably remember your call and give your repair special attention.

In the letter or work order you send with the package, request a phone call back from the shop technician with an estimate of the cost of repairs. This second phone call provides another opportunity to discuss the problem. It also avoids the unwelcome surprise of an expensive bill and gives you the opportunity to consider replacing the equipment rather than repairing it.

The third phone call comes after you have received the repaired equipment back at the pool. Call to make sure you understand exactly what the problem was and what the repairman did. If the repair is satisfactory be sure to mention it to him.

Shop technicians continually deal with problems and equipment that doesn't work. When something they did corrects a problem and satisfies a customer, they almost never hear about it. If you thank them for a good repair, they will remember you. Then when you need their help next time, they will be sure to give you their best efforts.

4. Plan ahead, panic is expensive.

Field service is expensive but frequently necessary. Many times problems develop from a chain of unusual circumstances that can only by analyzed on-site. Most public pool equipment cannot be taken out of service. You can't pack up your filter and send it in for repairs.

If you wait until the last minute to call for field repairs, you may then be asking the vendor for emergency attention. From the minute the serviceman leaves the vendor's place of business to the minute he returns you are, in effect, renting him, his vehicle, his tools and his parts inventory.

To get the most for your money, keep the period of that rental as short as possible. Assuming your pool is not a few blocks from the vendor, your objective should be to rent the service for as short a travel time as possible.

Call the vendor asking for field service when the serviceman is in your area or ask him to somehow add a visit to your pool onto another trip. At seasonal pools, request servicemen to drop by around opening time and give the vendor at least a month or two notice.

Even the best and most reliable vendors must charge more for emergency service than for a service call routinely scheduled along with other calls to be made in your area.

5. Tight specifications are only as tight as your inspections.

Be as detailed as possible when describing a product or service in a request for quotation. Instruct the bidder to note and explain all exceptions to the specification. When bidders ignore this instruction, do not let them get away with it.

A huge metropolitan school district buys calcium hypochlorite in vast numbers of 100-pound drums every year on a bid contract. The same company has been low bidder every year. Recently the school district discovered that 15% of what they were buying from this vendor was diatomaceous earth. Moreover, they learned that they had been buying 85% calcium hypochlorite and 15% DE for at least the last 6 years. No lawsuit has been filed as it is deemed to be too embarrassing to the school administrators.

In another example, a pool manager awarded a contract to a company which bid to specifications calling for a pair of highly sophisticated electronic ventilation controls. The specifications included nearly 100 individual product and performance details.

The vendor installed the systems and collected payment before the pool manager discovered that the systems lacked at least 10 of the specified features. Accordingly he insisted on an upgrade of the products to meet specifications. The manufacturer then modified both units at the pool site, but because no other product by that manufacturer was modified in that way, servicemen could not work on it. Two years later both systems were shut off and abandoned.

The key to avoiding problems like these is inspection - inspection before but most importantly after the specification is written.

Before writing the specification, inspect nearby installations, samples, models, inventory or work in progress at the manufacturing plant, drawings, renderings, owners' manuals, etc. The scope of your inspection depends on the scope of the project, but the more you inspect the better.

Then after bidding, inspect again to be certain you are getting what you are paying for. Inspect everything you can. Pool managers and operators should make these inspections personally and not delegate them to subordinates or helpers.

Loose specifications and loose inspections encourage free-for-all bidding. They not only make you judge between apples and oranges, you may wind up with sour grapes after it is too late to change.

6. Learn to live with leadtimes.

Every buyer in every sector of every industry needs quick delivery more often than not. In the public pool field, there are five reasons which cause us to request prompt shipment of goods. Think back to your most recent rush order. Which reason really applied?

First, goods may be needed urgently to open the pool or to keep the pool open. While certain equipment breakdowns and problems cannot be anticipated, most can with a little planning.

You can make yourself far less dependent on prompt vendor deliveries at the time of reopening a seasonal pool. At season's end, write yourself a detailed report. Detail everything you want to remember the next year such as problems encountered but not solved or goods or supplies needed, certain changes in operation you have thought of making, etc. Then at least two months before the pool reopens, retrieve and reread your report. With pen and notepad in hand, visit the facility. Inspect for off-season damage and jot down any further thoughts. Immediately after your visit, place all your orders and specify a delivery date on each one.

For most pools in North America this means visiting the seasonal pool in March and placing orders not later than the first of April, specifying the third or fourth week of May for delivery.

Second, goods are sometimes needed urgently to meet a program committment. As soon as a new program or special event is scheduled, write or request from staff a written list of all items needed. Every day that you or someone on the staff procrastinates in preparing that list is a day you may be without an essential item. This reason for needing immediate shipment can almost always be avoided.

Purchasing . . . cont.

Third, you sometimes need fast shipment so that another vendor or contractor will not have to interrupt work. Like the second reason, this one is almost always avoidable. Before signing the contract or placing the order for the major portion of the work or product, get delivery promises in writing from every supplier involved. Then specify those delivery dates on each order placed. Schedule the main portion of the work to coincide with the latest or longest leadtime items. Check on order status with all suppliers at least twice after placing the orders.

Too many times we schedule work in the hope that the last piece or part may show up early. This good fortune has probably come to no more than five public pool managers in the history of the Western world.

Fourth, delivery may be needed by the last day of the budget year. This reason is usually unavoidable. However, it presents a situation that definitely gets a vendor's attention. Vendors understand that money not spent is lost at budget year-end at many institutions. Knowing they will lose an order for sure if they do not make delivery often causes vendors to perform like magicians in getting product delivered. When this reason applies, let the vendor know. If he is convinced of your situation, you will not have to expedite. If it is remotely possible to meet your deadline, the vendor will do so without your encouragement.

Fifth and last, we occasionally think we need fast shipment when, in fact, we are just excited to be getting something new. While the feeling is real, the urgent need is probably imagined. In such a case it is better not to demand urgent delivery so, like the boy who cried wolf, we do not prejudice our chances of getting special attention from a vendor when we really do need something in a hurry.

Maintenance and operation of vacuum DE filter systems

by David Painter

Small changes in the operation of a vacuum DE filter system can sometimes result in significant operating economies. In general, when designed and operated properly, a vacuum DE filter system uses the lowest electrical power consumption of comparable commercial filters.

In order to optimize your filtration system it is necessary to develop certain fundamental information and technical data. Take an inventory of your filter system checking the following:

1. Establish the square feet of filter area available. You may find this information on the filter nameplate. If not, you can easily calculate it yourself. Measure the exposed area of each filter leaf. As an example, a rectangular leaf 30″ x 60″ would have 12½ feet per side or 25 square feet for each leaf. Multiply by the number of leaves and you will have an approximation of the square footage of your filter. Round leaves make it necessary to calculate the area from the diameter and subtract out the center hub area.

2. Establish the flow rate of the main circulation pump. This can also sometimes be taken from the nameplate. If not, a curve of the pump may be available from the manufacturer. It is important to know what the actual flow rate is. Filter systems are normally designed with a pump which has excess head capability. In operation, a throttling valve is used to hold the pump to design flow. Frequently the design flow is exceeded and the flow rate through the system is much higher than is required. A functioning flowmeter should give you an idea of the actual operating rate. Also, a vaccum gauge on the suction side of the pump and a pressure gauge on the discharge side of the pump will allow you to establish the total dynamic head that the pump is developing. If you have the curve of operation, you can then establish your flow rate.

3. After establishing the square feet of filter area and the flow rate, you can develop the flow per square footage of filter area. Divide the flow rate (gpm) by the total area of the filter. Vacuum DE filter systems should be sized in the range of 1.0 to 1.5 gpm/sq. ft. Filters operating above 1.5 gpm per sq. ft. will have considerably shorter filter runs. The use of a body feeder will help somewhat but it is not possible to totally compensate for the fact that the filter is too small. In some cases rates have been known to exceed 2.0 gpm per sq. ft. These rates are outlawed by most health codes. It is often possible to expand the size of the vacuum DE filter by adding more filter leaves. This is usually an inexpensive way to reach the 1.0 gpm per sq. ft. rate. It is not advisable to go below this rate as you may find it difficult to precoat the filter.

4. Establish the manufacturer's grade of diatomaceous earth that you have been using. Listed below is a chart of the common grades from the major manufactureres. The grades listed are suggested for pool use. Diatomaceous earth filtration is capable of removing the smallest particle of dirt of any commercial filter. Very fine grades of DE will remove particles down to approximately 0.1 microns in size. (The smallest particle visible to the unaided eye at 10″ distance is 80 microns). Longer filter runs may be achieved by using a coarser grade of DE. Since DE takes out such small particles, even a coarser grade will not normally

	Kenite (Witco)	Celite (John-Manville)	Dicalite (Grefco)	Celatom (Eagle-Picher)
Coarser	5500	None	5000	FW-80
Normal Pool	3000	Aqua Cel	4200	FW-60
Fine	2500	535	N/A	FW-50

change the clarity of the swimming pool significantly. With certain filters you may encounter difficulty in obtaining a good precoat with a coarser (heavier) powder so a test run should be made before switching grades completely. Conversely, if a very high clarity of pool water is required for a special event or underwater photography, you can achieve it by using a finer grade of DE, though this will result in a shorter filter cycle.

5. Every vacuum filter installation should have a vacuum limit switch installed between the filter and the circulating pump. This switch should be set up to sound a warning when the filter reaches 15" of mercury vacuum. This gives the operator an indication that he has reached a point where he is wasting horsepower trying to extend his filter run. It also gives protection to the vacuum filter elements in the case of damage due to excessive high vacuum.

Filter Maintenance and Operation

1. Any filtration system is desgned to maintain the required flow rate when the filter is in its dirtiest condition. A centrifugal pump will move considerably more water when the filter is clean. This higher flow will tend to shorten the filter cycle. You should establish procedures which, on starting up the filter after it has been cleaned, limit the flow and maintain only design flow. As an example, a pool with a turnover rate of 500 pgm may be turning over at a rate as high as 650 or 700 gpm when the filter has just been cleaned. Establish marks on the main filter pump throttling valve so that the 500 gpm rate is maintained. Over the length of the filter cycle, open this valve gradually to compensate for the increased head loss through the filter as it gets dirty. This can also be done through the use of a constant flow control valve. In addition to extending the filter run this throttling action will reduce the horsepower consumed by the pump.
2. Filter bags (covers) must periodically be cleaned with a mild acid and possibly a degreasing compound. Covers can be cleaned in place. A popular method is the use of oxalic or muriatic acid. Fill the filter tank, then add one pound of oxalic crystals per 16 cu. ft. of filter or one quart of muriatic (34% strength) per 4 cu. ft. of filter. Then put the filter on recycle for 30 minutes to 2 hours. Use a face mask if you plan to observe the cleaning action. If it is necessary to neutralize the solution before draining to sewer, add soda ash until the pH equals 7.0. Recycle again for just a minute or two. It is not advisable to clean covers in a washer-dryer combination.

   Occasionally, the filter bags may need to be degreased in addition to the above. A solution of "Spic 'n Span" or Calgon is recommended as a grease emulsifier. The leaves should probably be removed from the tank for this process. Degreasing would be done with a scrub brush and bucket.

   When the filter has just been cleaned the pressure drop through the filter should be zero. Visually inspect each cover periodically to check for torn covers or a dirty, clogged condition which would result in short filter cycles. Construction of filter covers is important. Filter efficiency is greatly increased if covers are made of mono-filament polypropolene thread. This material is difficult to obtain, however, and it is not uncommon to find bags made of cheaper multi-filament threads. You can tell which you have with a magnifying glass. A mono-filament material will look like metal wire under magnification, much like a window screen. Multi-filament material will look like a cotton shirt under magnification. This type of cover has a very poor dirt release capability. Since it cannot shed dirt easily on cleaning, it builds up pressure drops quickly, shortening filter runs.
3. Filter cycles can be extended by the continuous addition of diatomacious earth to the filtering system during operation. This provides fresh DE which will pick up dirt that the original coat could no longer hold. Either a dry feeder or a slurry type metering pump can be used to add DE. Both are troublesome and each individual pool operator must determine whether the extended filter cycle is worth the time and trouble involved. It is possible to approximate automatic body feeding equipment by manually adding diatomaceous earth daily or twice daily. The amount of body feed added during the course of the filter cycle should be roughly equal to the amount which was added on your initial start-up precoat. Thus, if your filter used 50 pounds of DE for start-up and you normally achieve a two or three week cycle, you should add another 50 pounds over the expected filter cycle. A common method of hand feeding DE is to use a 1 pound coffee can, which holds about ½ pound of DE.

Where DE comes from and how it works

Since the dawn of life on earth, the oceans have been full of tiny organisms called plankton. Plankton make up the beginning of the food chain in the ocean's ecological system. When plankton die, their remains settle on the ocean's floor. Given a few million years to do so, their skeleton-like structure fossilizes, becoming what is called a diatom.

Collections of diatoms are called diatomaceous earth or DE. DE exists in abundance on the floors of current oceans and on the floors of ancient oceans which are in many places now dry land.

The number of variations of DE particle size and structure is the same as the number of different species of plankton in prehistoric oceans. In other words, DE comes in all shapes and sizes.

In swimming pool filtration, DE particles larger than the openings in the fabric prevent the DE from passing through the fabric. The larger particles coat the element and create a layer on which the smaller DE particles are caught. The smaller diatoms can then trap the dirt particles which are smaller than the holes in the element fabric.

The precoat cycle establishes this layering naturally. At the beginning of precoating, the smallest DE particles sail through the filter fabric. Within seconds, enough larger DE particles are trapped to begin to capture the smaller ones.

Also, DE particles are porous. Their microscopic holes offer countless lodging points for the tiniest dirt particles.

4. A number of pools have had success in using what is sometimes called a "burp" cycle in their filter operation. As the vacuum begins to increase, the operator stops the filter circulating pump for approximately 30 seconds. At this point he will notice that the DE on the filter leaf bulges and expands somewhat, releasing the entrapped gases that have been picked up during the normal filter cycle. The circulating pump is started at the time the DE begins to fall off the leaf. You will note that the vacuum gauge has been considerably reduced. This "burp" cycle can be repeated periodically during the cycle until results are no longer visible. At that time the filter should be cleaned.

Chlorination: A matter of demand and dosage

For decades we have thought of free available chlorine residual in parts-per-million as the all-important consideration in pool water chlorination. Certainly holding free available chlorine residual at all times is crucial to trouble-free public pool management. However, exactly how much residual is far less important than keeping dosage paced with demand - expecially in spas and outdoor pools.

To appreciate the importance of dosage and demand it is first necessary for us to understand how easily we are misled by the concept of "residual." Consider a 240,000-gallon outdoor pool being used 12 hours a day. Let us assume that there is a 1.0 ppm free chlorine residual at the beginning of the day and the same residual at the end of the day. It would be typical for such a pool to be equipped with a 100 pound-per-day gas chlorinator operating at full output during the 12 hours of use. 1.0 ppm in this pool weighs 2 pounds and the chlorinator is adding 50 pounds of chlorine in 12 hours. In this situation the equivalent of the 1.0 ppm residual is actually being depleted and replaced 25 times in 12 hours.

For indoor pools the problem is less severe but, again, changes occur more rapidly than we suspect. Consider a 120,000-gallon indoor pool requiring about 8 gallons of sodium hypochlorite in a 16-hour day. Assuming the same residual is present at the end of the day as was at the beginning, 1.0 ppm is being depleted and replaced on the average of every 2 hours.

Because of variations in chlorine demand, chlorine residual is being dissipated at times in minutes and at other times in hours. This rate of turnover of chlorine residual tells us that there would be interludes when residual is much higher than the targeted level and other moments when it is at or near zero.

To insure proper oxidation of pool water and protection of swimmers, it is more important to match the variations in demand with the appropriate variations in dosage rather than to assume that test kit readings taken more than 15-30 minutes before have any validity whatsoever for the current situation.

Causes of chlorine demand

Sunlight and ***aeration*** dissipate chlorine. While these two factors are not what we call chlorine demand in the true sense, they nevertheless have more effect on chlorine dosage rates than other factors in outdoor pools. The dissipation of chlorine by ultraviolet light coming from the sun is well known. Aeration is a significant factor in chlorine demand and dosage at wave pools, waterslides, flumes, gysers and other attractions. While aeration affects few pools today, more and more of these special pools are being built all over North America. Anytime water is made to wash the air, the water picks up organics from the air which contribute to chlorine demand.

Other causes of chlorine demand in outdoor pools include the effects of ***wind*** and ***rain.*** Rain washes the atmosphere of organics and carries them into the pool. The effect of windborne organics varies greatly from one pool location to another. Anyone who has tried to manage a pool downwind of a construction excavation site knows what real problems can be.

The sweat effect

The principle cause of chlorine demand in indoor pools and a significant factor of chlorine demand in outdoor pools is sweat. Yes, swimmers sweat. Biochemists estimate that active adult swimmers sweat about 1 to 1½ quarts per hour. Medical texts support this estimate. Further evidence of this rate of sweating comes from the fact that competitive swimmers, especially distance racers, report losing 2 to 3 pounds in an average meet. Much of this weight loss is sweat.

Sweat is mostly water but includes traces of minerals, acids, salts and, of course, ammonia and bacteria. The relative amounts of these constituents of sweat vary with individuals, local climate, activity level, what the swimmer had to eat or drink the previous 24 hours, and even the season of the year. "Average" sweat is about 0.1% ammonia and ammonia-like compounds. It is impossible to judge the chlorine demand imparted by the other constituents of sweat. However, some experts estimate that the chlorine demand presented by the other constituents of sweat may equal that of the ammonia. If this is true (and it is the best guess we can find) then about 0.2% of sweat creates chlorine demand.

Through calculation we can deduce from the above information that the average adult active swimmer loses about 1/10th of an ounce of oxidizable sweat constituents per hour. To oxidize organics, the amount of free chlorine needed has to outweigh the amount of the organic by a ratio of about 8:1. (By the way, this same ratio is the fact in chemistry that causes us to use multipliers of 10 or 12 when calculating super-chlorination dosages.)

Thus the sweat from an average adult active swimmer creates a chlorine demand which requires a dosage of about 0.8 ounces of net chlorine per hour. However, this calculation does not provide the total picture of the extent of the problem. Everyone sweats all day long. Sweating, like urination, is a natural function of voiding waste. Mild sweating usually goes unnoticed because the water in sweat evaporates almost immediately upon reaching the surface of the skin. We usually notice sweating only when it is moderate or profuse.

When the water in sweat evaporates, all the other constituents of sweat are left behind on the surface of the skin. Even when bathers take nude, soap showers, they may be washing off some of these other elements but they are not sterilizing

Chlorination . . . cont.

themselves. Consequently, swimmers enter the water bringing with them a significant quantity of ammonia, bacteria and other organics.

The showered swimmer may bring with him or her organics to an extent that an ounce or two of chlorine is needed to meet demand upon their entering the water. Then another ounce or so would be needed during an hour's swim.

Interestingly, ammonia introduced into pool water through voluntary as well as involuntary urination is minor compared to the ammonia introduced into pool water from sweat. According to medical texts, the ammonia concentration in sweat is higher than it is in urine. Even the most inconsiderate swimmer cannot possibly urinate as much as he or she will sweat while swimming.

Chlorine demand in spas

The importance of dosage and demand is especially critical in spas. A few simple calculations lead us to conclusions about spas which are downright shocking. The special problems of spas make our prior concept of parts-per-million residual almost worthless.

A typical spa in an institutional facility is about 500-gallons capacity. This size is a little larger than most residential spas. One part-per-million in a 500-gallon spa weighs 0.064 ounce.

Biochemists have determined that relatively inactive spa bathers perspire at about the same rate as active swimmers in a typical swimming pool. Spa users sweat 1 to 1½ quarts per hour. Viewed another way, 4 spa users sweat about 1 to 1½ quarts in 15 minutes. So 4 adults entering a spa and staying there for 15 minutes might create a demand which requires a dosage of 1 to 2 ounces of chlorine.

One to 2 ounces may not sound like much chlorine, but in a 500-gallon spa it is a dosage of over 30 parts-per-million. About half of that dosage is required at the time the bathers enter the spa and the rest is required within the next 15 minutes.

To further complicate the problem with spas, bathers frequently have just come from the jogging track, the racquet ball court or sauna and are covered with sweat when they hop in the water. The chlorine demand created under these circumstances may require an immediate dosage of from 20 to 100 ppm. What good is a 3.0 ppm residual then?

In a heavy use athletic facility, the spa may accommodate 50 to 100 bathers per day. By doing a little multiplying we find that institutional spas have chlorine dosage requirements that probably range from 500 to 5000 parts-per-million per day. The turnover rate of chlorine residual in spas does not take place in hours or minutes, but in seconds and fractions of seconds.

Non-linear effectiveness

Another factor which compounds the problems for swimming pools as well as spas is that the relationship between free chlorine residual and the effectiveness of free chlorine is not linear. There is a substantial increase in chlorine effectiveness between 0.2 ppm and 0.4 ppm. However, there is very little increase in chlorine effectiveness between 1.5 ppm and 3.0 ppm. These ppm levels are chosen for example.

Charts and graphs abound in the literature of chlorination. In these charts the time to inactivate various bacteria is plotted against various chlorine residuals. The lines on these graphs are not straight lines, they are ski slopes. The first 0.1 ppm of free chlorine residual makes a big difference over no chlorine at all. The next tenth makes a big difference, too, but not as much. Over 1.0 ppm, additional tenths of a ppm make very little difference in how fast the test bacteria is being inactivated.

In other words, 2.0 ppm is not twice as effective as 1.0 ppm and 1.0 ppm is not twice as effective as 0.5 ppm, etc.

PPM Residual is over-simplification

It is easy to understand how chlorine residual in parts-per-million got to be the primary consideration in chlorination in our common understanding. Measuring chlorine in parts-per-million is inexpensive and requires a fairly simple test procedure. Workable public health regulations can be written using straightforward ppm minimums and maximums. Unfortunately, the over-simplification of referring to chlorination in terms of residual is misleading.

Frequent checks of residual in indoor swimming pools are helpful and practical. The more frequent, the better, of course. But in most outdoor pools and in all spas, occasional tests of residual reveal very little useful information and assure us of almost nothing.

Swimming pool chemistry is dynamic. It is constantly changing. Chlorine measurement in parts-per-million is only a way of spot-checking the process. Proper chlorination is a matter of matching dosage to demand.

Green water - control and treatment

By Raymond Gertz

A frequent cause of distress among swimming pool operators is green water. What makes it suddenly "appear" after periods of good clarity is a mystery that seems to defy understanding. What makes it stubbornly resistant to treatment is another chapter in the same mystery. Because of the complexities of each pool operation, and the variety of outside influences on the water, it takes a great deal of patience and understanding to learn how to cope with it.

Causes of green water are as varied as there are swimming pools. Once understood however, controls can be instituted to minimize the effect on a particular pool. The major contributing factors are due to one or more of four conditions that are commonly found in swimming pools. They can be categorized as mineral, organic, mechanical-physical and chemical.

Mineral causes

Iron, copper and manganese are sometimes present in solution in make-up water. When make-up water with minerals is added to the pool directly it may turn green or cloudy. The degree of discoloration would depend upon the mineral content in solution. Most pools will accept these minerals in make-up water, without discoloration, in total concentration of 1.0 ppm or less. Make-up water can be analyzed to determine what minerals are causing the

Green water . . . cont.

problem. Pretreatment by aeration/oxidation/filtration is usually necessary as a control method. Avoid direct make-up additions to pool. Industrial grade treating chemicals such as soda ash, bicarbonate of soda, aluminum sulfate (alum) and calcium chloride should be avoided as they may not be iron-free and their use could result in the same problem.

Organic causes

Swimming pool water is an ideal solution in which many organisms can flourish. These include algae, bacteria and plant spores. Introduced into the water constantly by the bathers and surrounding atmosphere, it is necessary to minimize their growth through the use of chlorine or some other sanitizing agent which actually kills the organism. A chlorine residual in the free residual range will give satisfactory results. Those pools which have an abundance of sunlight may require extra attention due to the fact that the organisms may be more responsive to growth under those conditions. It goes without saying that soap and water showers by the bathers prior to using the pool and routine sanitizing of the pool deck are important as controls.

Mechanical-physical causes

The most carefully designed pools can "go wrong" when wear and tear take their toll, when a lack of information exists regarding operational matters, and when carelessness or inattention to routine maintenance is allowed. Among the most common mechanical-physical deficiencies are the following:

1. Poor circulation due to plugged pipes and/or worn pump impeller resulting in insufficient filtration.
2. Loss of filter capacity due to calcification and/or grease build-up.
3. Infrequent vacuuming/cleaning.
4. Improper lighting in pool area.
5. Heat exchanger leakage causing release.
6. Corrosion of metallic parts.
7. Chemical feed pumps plugged.

Chemical causes

Control of pH and free available chlorine residuals are of primary concern in being able to maintain water of satisfactory sanitary condition. In addition, it is possible to minimize fluctuations in pH through control of alkalinity, an important aspect of the entire tratment program. Soft water is a special problem for pools where pH is allowed to fluctuate resulting in cloudy water. A chemical balance in which pH is a significant part of the total picture must be a standard operating procedure. Anything related to chemical treating involves frequent testing and record-keeping. Test kit reagents and color standards must be dependable at all times. Automatic monitoring and control devices are an answer to any pool where time does not permit constant evaluation of conditions by an operator.

Summary

This brief article cannot possibly cover the variety of conditions contributing to green water. However, there is sufficient information to use as guidelines in making a determination. Some basic steps can be taken to find out what the cause is in your case.

1. Make-up water can be analyzed for minerals.
2. Treating chemicals can be ordered as "iron-free."
3. Mechanical and physical deficiencies can be identified.
4. Organic material can be chlorinated.
5. Tighter bather controls can be instituted.
6. Water balance evaluation can be made.

How pool blankets save energy

Where do pool blanket energy savings really come from? This question is the most significant yet least understood consideration with regards to the use of pool blanket systems. In simple terms swimming pool blankets stop evaporation—it is only incidental that they insulate to a small degree. Insulation, the property usually attributed to blankets, contributes from one to ten percent of the energy savings for pools and possibly up to twenty percent of the total savings available from their use on spas. Evaporation retardation is overwhelmingly the larger contributor.

Without delving into the physics too deeply, a brief explanation helps one to understand the significance of evaporation. Water requires one calorie per milliliter to raise the temperature one degree centigrade. Conversely it loses one calorie as the temperature drops one degree. However, vastly increased amounts of energy are either given off or required to be "taken in" for changes between the vapor, liquid and solid states of water. It takes five hundred forty times as much energy to vaporize water than it does to raise that quantity of water one degree centigrade.

Here is an example: We have an outdoor spa with snow on the ground. Water temperature is 42 degrees centigrade (103 degrees F.) and the air temperature is freezing at 0 degrees centigrade (32 degrees F.)

The air in contact with the water being 42 degrees centigrade colder takes energy from the water. Ultimately, 42 calories are lost for each milliliter of water as it cools to the temperature of the air (or this much energy must be replaced by the heater to avoid the temperature drop). At the same time, each milliliter of water which evaporates absorbs 540 calories from surrounding water or *twelve times* the energy replacement requirement as the conduction energy exchange.

Wind and humidity as well as radiant energy affect this ratio, but a solid membrane stretched across the surface can halt evaporation, thus saving most of the energy which otherwise would be lost.

When the air and water are close to the same temperature but humidity is low and air movement is present, stopping evaporation is many hundreds of times more important than insulating.

A thin layer of insulating performs far more important roles: that of flotation, ease of handling, enhancement of strength, and mostly, keeping the blanket dry.

Does all this give you a clue as to the value of a wet blanket after a rain or one improperly pulled across the pool? A wet blanket is no blanket. A few puddles are insignificant but larger wet areas result in proportionately more energy loss, right through the blanket, as these puddles evaporate and the blanket dries. A bit of insulation helps—it slows the loss through the cover and "forces" the evaporation process to take more energy from the surrounding air.

In any case, it is clear that procedures to keep a blanket dry are in the pool owner's best interest.

To reduce humidity at indoor pools, blowers driven by electric motors circulate air through the natatorium. This air carries away heat from pool water. Owners then have to buy the fuel to replace that heat to the pool water to maintain the pool at a comfortable swimming temperature. This process of heat dissipation and replacement goes on 24 hours a day through every season of the year.

Because the blowers are not required to be on as much as without a pool blanket, there is a substantial reduction in electrical cost. Depending on the electrical rate, electric motors cost between 3 cents and 10 cents per hour per horsepower to operate (See Formula File). As an example, if air handler motors were 5 horsepower total, the savings would be between $1.20 and $4.00 per day for a pool blanket used 8 hours each night.

Energy conservation with a pool blanket is a complex subject, and accurate calculations are difficult. But the proof is in the puddin' (or savings) and pool owners are finding that even eight hours of "cover time" a day is often saving up to one-half of their heating costs usually paying for the blanket in six months or less. It's all possible if the blanket is carefully maintained, thoroughly understood, and properly (and religiously) used.

K.W.

Saturation index vs. TDS

There has been a recent increase in discussion of the factor of total dissolved solids (TDS) in pool water. Some authors have heavily emphasized the importance of TDS in pool water balance. More than the slightest emphasis on TDS as an important factor in pool water is misleading.

The Saturation Index depends on five variables: pH, total alkalinity, calcium hardness, temperature and total dissolved solids. These are listed in descending order of importance.

pH variations are by far the greatest influence. 1/10th of a pH decade (the difference between pH 7.5 and 7.6, for example) shifts the Saturation Index 0.1. By contrast, TDS must change more than 1000 ppm for an equivalent shift. By the way, that same shift of 0.1 in the Saturation Index requires about a 10 degree fahrenheit temperature change, a 50 ppm total alkalinity change, or a 100 ppm calcium hardness change when all these factors are considered at their average levels.

Moreover, TDS has so little influence over the final number of the Saturation Index that it is left out entirely in all the literature describing the abbreviated calculation.

In general practice TDS factors of 1000-2000 ppm are extremely common in pools, and 3000-4000 ppm are acceptable. Values upwards of 5000 ppm are cause for little concern. In any given case, the particular major contributor toward the TDS value will determine whether a particular level is offensive and may thus establish a rough threshold beyond which the pool should be drained or diluted. For instance, sodium salts are sometimes noticeable to swimmers at levels above 3000 ppm. Some swimmers find this offensive. On the other hand, there are salt water pools in North America with sodium salts levels of 30,000 ppm which are crowded all the time with happy swimmers. These salt water pools experience scale and corrosion damage at about the same rate as fresh water pools. The corrosion and scale associated with sea water is the result of the action of small and microscopic marine life, not the salt content.

It is the Saturation Index, not the TDS level, that should be the main concern. The Saturation Index is not the be-all and the end-all of water balance as it was devised for closed systems, not pools - but it is the best available guide for us at this time.

Using specialty chemicals

Almost all the problems of public pool water chemistry are preventable or solveable by using the common pool chemicals. By common we mean chlorine or bromine in some form or other, a base such as soda ash, and an acid. Although needed less frequently, bicarbonate of soda (baking soda) and calcium chloride may also be considered as common rather than specialty chemicals.

Simply stated, all other chemicals are "special" and may be needed in special circumstances. For example, the pools in northeastern Minnesota have an unusually high iron content compared to pools in most other regions. Pool managers there use a specialty chemical to help control the effects of high iron.

More than a few pool managers have needed a specialty chemical after vandals threw a box of detergent in their water or after a drowning.

The biggest danger in specialty chemicals is using one not designed to do what you want it to do. To stay on the safe side, follow both of these rules:

1. Never use a product in pool water or on a pool deck that is not specifically labeled for pool use or sold by reputable public pool supply outlets. Beware of locker room cleaners or coatings not meant to be used around chlorinated water. If in doubt, ask your local public health official or send the label of the product in question to us here at POOLFAX.
2. Never use a chemical the ingredients of which are ammonia, ketone or ester. If any of these words appear, it's not a public pool product regardless of the label or instructions. (Some swimming pool algaecides contain ammonia but these algaecides are not recommended for public pool use.)

Here are a few common problems which are frequently solved by specialty chemicals:

ALGAE – The first line of defense against algae is proper routine chlorination and periodic super-chlorination. Regular super-chlorination to control chloramines is usually sufficient but if additional super-chlorination for algae control is needed, use about a 3 ppm dosage for green algae and about a 10 ppm for black algae.

However, if algae persists after super-chlorination, then it would be appropriate to use **ALGAECIDE**. Avoid the so-called "quats" which are inexpensive but contain ammonia. You get enough free ammonia in your pool water from swimmers. You don't need to buy it. Avoid copper or silver or other metal based algaecides, too, as they can cause staining.

Many managers of seasonal public pools use algaecides at seasonal openings and closings.

STAINS – Black, green or brown stains around main drains, gutters or ladders or in pool corners have to be cleaned out by hand, but use of **SEQUESTERING AGENT** can stop them from coming back. Sequestering agents increase the ability of water to hold minerals in solution instead of precipitating to form stains. Use a powdered kind - it's more economical than the liquid - and follow instructions which usually call for weekly addition of a pound or two depending on pool size. There are many kinds of sequestering agents available and most are used on heating and cooling water. Be sure to use a sequestering agent specifically meant for pool applications.

DIRTY D.E. FILTER BAGS – If one had to pick a single chemical that would do a better job than any other single chemical in cleaning D.E. filter bags it would be **OXALIC ACID.** However, there are commercially available filter bag cleaners which are a combination of **ACIDS AND BIODEGRADABLE DETERGENTS** which are better than oxalic acid by itself.

If you have a fairly small filter tank and can afford to be shut down for a few hours, you can let the bags soak in the filter tank itself. Most operators, however, would remove the filter bags to a plastic container for soaking.

FOAM OR SUDS – This problem is a chronic one at most spas. The box of detergent thrown over the fence into the pool at night by vandals is not an unusual experience. The solution is a particular type of **SERFACTANT,** or wetting agent specifically menat for pools and is usually called a **DEFOAMER.** This chemical works by reducing the ability of water to form bubbles. Even if your pool does not now and has never had a foaming or a sudsing problem, a bottle of defoamer on the shelf will come in very handy when the vandal with a box of bubble bath breaks in some night.

TOO MUCH CHLORINE – When chlorine residual is too high, the best dechlorinating agent you can use is **SODIUM THIOSULFATE.** This chemical comes in a powdered form and a little of it should be kept on hand at all pools for emergencies. The product does not deteriorate with age so has no shelf life to be concerned about. Use this formula: 0.7 x the weight of 1 part-per-million in your pool x the number of parts-per-million of chlorine to be neutralized. The answer is the number of pounds of sodium thiosulfate needed.

Add half of your calculated dosage, wait an hour or so and retest before adding the second half. If you have made an error in any of your calculations or in your tests, and if you overshoot with this chemical, it may take substantial chlorine dosage to establish a residual again.

STUBBORN CLOUDINESS – The primary cause of cloudiness in pools is a buildup of chloramines which is solved by super-chlorination. The second greatest cause of cloudiness in pools is an improper balance of pH, total alkalinity and calcium hardness which can be solved by balancing the pool properly to the Saturation Index. If cloudiness remains after a proper super-chlorination and after the pool is balanced to the Saturation Index, and if the filters have been checked and are working properly, it may be time to use a **POLYMER FLOC.**

Instructions for use typically indicate weekly dosages, but well maintained, properly functioning pools have no need for regular use of polymer floc. However, when pH has inadvertantly been allowed to bounce very high or very low or if, by accident, the pool has been loaded with dirt or DE, a polymer floc can be very helpful.

Mix double the initial recommended dosage in a bucket of water and then broadcast over the surface of the pool. Wait an hour. Then shut down the main recirculation system. The water will begin to clear from the surface, and the border between clear and cloudy water will move gradually down to the floor of the pool, at which time you very slowly and carefully vacuum to waste. If cloudiness continues, repeat the procedure once.

The polymer floc is an extremely large molecule which collects small contaminants into big chunks which sink to the bottom of the pool or are picked up on the filter.

By the way, use of a polymer floc is recommended after a drowning has taken place in a pool. Every two or three years we hear of a drowning victim being discovered in a pool several hours after the drowning took place. In such cases, the water would be very cloudy. Some of this cloudiness comes from organic matter and therefore the pool should be superchlorinated at once. However, some of the cloudiness is coming from inorganic material which will take most filter systems two to three days to clear up. The use of a polymer floc can shorten that cycle.

There are thousands of different kinds of polymers in use in industrial applications particularly in waste treatment. POOLFAX recommends "Crystal Clear" by Robarb of Atlanta, Georgia or "Clarifier" by Great Lakes Biochemical of Milwaukee, Wisconsin.

DECKS & SHOWERS – Many pool managers avoid problems and economize operation by using only **CALCIUM HYPOCHLORITE (HTH)** and **TRISODIUM-PHOSPHATE (TSP).** Use the TSP for a degreasing agent where needed. Pour a little calcium hypo into your full mop bucket and brush it across the decks and the floor of the shower room with a stiff bristle brush. It disinfects, has a good cleanser action and most importantly doesn't cause any problems when mixed with chlorinated pool water.

There are commercially available deck and shower room cleaners specifically designed for use around pools and the best ones are combinations of acids and biodegradable detergents sold specifically as pool and tile cleaners. **H.S.**

Glossary

• **Chloramine** - any of several compounds of chlorine and another nitrogenous substance, usually ammonia; a weak oxidant which in pool water can cause eyeburn, cloudiness, severe chlorine odor, and the need for frequent filter backwashing; also called "combined chlorine" and "N-chloro compound."

• **Free available chlorine (FAC)** - the combination of hypochlorous acid (HOC1) and hypochlorite ion (OC1-) in water, specifically excludes the chloramine or combined chlorine forms, measurable by reagent type test kit using DPD or BW method only or by electronic analysis.

• **Hypochlorous acid (HOC I)** - that portion of free available chlorine which serves as the principal oxidant in pool water; excellent disinfectant, sanitizer, bactericode, and algaecide; not specifically measurable by any reagent type test kit now available.

Back to basics . . .
approaching a consensus about pool water chemistry

Ninety percent of pool water problems are preventable or solvable by consideration of 5 critical factors for which you can test quickly and inexpensively.

Sanitarians, engineers, chemists and experts by experience may disagree about the ideal range of those 5 factors, but almost all would agree with the selection of these 5—and how serious are the problems of their mismanagement.

This article attempts to express the consensus of knowledgeable pool managers, public health officials and leading figures in the public pool industry. We have combed through the POOLFAX files of textbooks, journal articles and reader mail. We have discussed these points with our colleagues and associates. We have taken into account what is heard "on the road" as Stranco and POOLFAX staff travel North America and Western Europe.

Here we express the consensus—that point immediately before the degression of divergent views and opinions.

The 5 most critical factors in pool water chemistry:

Free available chlorine residual
Total chlorine residual
pH
Total alkalinity
Calcium hardness

Experts would agree with these 5 and most would agree that they are listed here in the relative order of importance one to another. Certainly all would agree that free available chlorine is the most important of the 5. Total alkalinity and calcium hardness belong at the bottom of the list by reason of their being less important than pH and chlorine residual and by reason of their requiring less frequent checking and changing.

Improper management of these 5 factors leads to the most common of public pool problems. Here are 11 common maladies of public pools which could be avoided by proper management of the 5 critical factors:

Eyeburn
Odor
Cloudiness
Scale
Corrosion
Short filter cycles
Filter calcification
Green algae
Water discoloration
Pool surface problems
Bacterial/viral proliferation

Occasionally, equipment malfunctions or other sorts of upsets will cause some of these symptoms. However, the most frequent cause of each one is mismanagement of one or more of the 5 critical factors.

Free available chlorine residual

The experts all agree that free chlorine is the most important single factor in public pool water management. The only reliable method of testing for free chlorine is with the DPD test kit. Flash readings or refrigerated samples with the OTO test reagent are unreliable.

The experts also agree that the absolute, rock bottom, minimum free available chlorine residual to be carried at any time in a public pool is 0.4 ppm. This figure is not a target, but a minimum. By setting the target free available chlorine residual higher than 0.4 ppm, and by careful management and monitoring and use of the latest equipment, you can prevent free chlorine from dropping below this minimum level.

Experts disagree widely about a maximum level for free chlorine, if any. POOLFAX interviewed swimmers who had been bathing in 5, then 10, and on up to 25 ppm free chlorine. In the files we found the story of a junior high school pool that was mistakenly carried at 60 ppm free chlorine for about a week's time. We interviewed one individual who had been swimming in 200 ppm free chlorine for 30 minutes. In each of these cases pH and other water chemistry factors were almost perfectly balanced. Complaints in the above cases were of bleached bathing suits, dry skin, and mild eyeburn.

Remember that chlorine is nonlinear. The oxidation value of 200 parts-per-million is not much more than 2 parts-per-million. Actual measurement of oxidation potential reveals that the first 0.4 ppm accomplishes most of the goal of chlorination.

As a practical matter, the high limit for free available chlorine residual is in some areas dictated by local public health regulations. In other areas, the high limit is that point when people begin to complain about bleached bathing suits.

There is no agreement among experts as to the ideal target between the low limit of 0.4 ppm and the high limit of the local regulation or the bleached suits. Moreover, there is no accepted evidence that pools maintained at one target residual or the other, in the long run, are better, safer or more comfortable pools.

Experts agree that when a greater margin for error is needed, a higher target residual should be chosen. If because of automatic controls or especially expert care, a lesser margin for error is needed, a lower target residual is possible.

Total chlorine residual

Experts generally agree that total chlorine residual should never exceed free available chlorine residual by more than 0.5 ppm. In other words, total chlorine residual is only important as it reveals the chloramine residual present when compared to a free chlorine test. At that point the experts seem to say that 0.5 ppm chloramine is about the time to superchlorinate.

Some experts argue for chloramines not to exceed 0.3 ppm, others say 0.4, most agree at the 0.5 figure. Others have called for chloramines to be burned out anytime they exceed 1/3 of the total. In practice, all agree chloramines are undesirable and should be controlled by super-chlorination as frequently as is necessary and practical.

pH

pH is of concern to almost all of science so there is a massive body of literature about pH. pH has been researched and experimented with in every conceivable way.

At the same time, pH is common enough that it is frequently used and misused in consumer products advertising.

pH is not critical to swimmers. Waters in lakes and rivers and "old swimming holes" in North America range from pH 6 to almost 11. (This past summer I personally had the experience of swimming in water that I learned later was pH 5.0. If after my swim I had not checked, I would never have known or even suspected such was the case as the water appeared and felt fine.)

In contrast, pH is critical to metal, grout, plaster—pool surfaces and mechanical equipment of all kinds. In addition, pH frequently determines the performance of other chemicals added to the pool. In general, most pool chemicals work best at pH of about 7.5.

The experts used to focus on a target range of pH 7.2 to 7.8. More recently higher pH levels have been targeted because of the epidemic of corroded plumbing and dissolved plaster and grout in North American public pools. In an earlier article, POOLFAX suggested a new pH range of 7.5 to 8.0. Others have suggested pH factors even higher than 8.

There are a variety of reasons for a lot of different pH targets. However, no one can find fault with a range of pH 7.4 to 7.6. This range represents a kind of consensus by default. Experts all choose their favorites and they vary widely, but all agree that there is nothing wrong with the 7.4 to 7.6 target.

While it may be difficult to maintain pH in such close tolerance, it can be done in most situations. Automatic controls, prevalent on so many pools today, are capable of maintaining pH within this range given a properly sized, working chemical feed pump and a proper chemical supply. It is not at all difficult to maintain a pH of 7.4 to 7.6 in hypochlorinated, indoor pools. In such pools pH shifts are gradual enough that operators can counteract them effectively. Certainly it is far more difficult to maintain such tight pH control in gas chlorinated, outdoor pools without automation.

Pinpoint pH control is the single most important factor in long term costs of public pool operation. Why does one pool mechanical system or plaster finish last 35 years and another 3 years? In almost every case, the answer to that question has to do with the management or mismanagement of pH.

Total alkalinity and calcium hardness

These two factors cannot be considered separately. We consider them together because the target for one influences the target for the other.

pH, temperature, total alkalinity and calcium hardness make up the 4 major factors used in the short-form calculation of what is known as the Saturation Index. The Saturation Index is a measure of the tendency of water to scale or corrode the surfaces by which it passes. The Saturation Index is complicated but has been simplified in recent years by the introduction of special slide rules.

Experts agree that in picking a target for total alkalinity and calcium hardness, the Saturation Index must be considered. The experts go on to agree that in pools maintained between 78 and 85 degrees F and at pH levels of 7.4 to 7.6, pH and temperature can effectively be considered constants, not variables. Hence, an even greater simplification of the Saturation Index is possible.

In general, keep total alkalinity between 50 and 125 ppm while you keep calcium hardness between 200 and 500 ppm. More importantly, total alkalinity times calcium hardness in ppm should equal the number 25,000 — give or take a thousand or two. If total alkalinity is 50 ppm, calcium hardness should be about 500. If total alkalinity is 125 ppm, calcium hardness should be about 200.

It is important to understand that this 25,000 rule only works if the pH is 7.4 to 7.6 and the temperature is somewhere around 78 to 85 degrees F. If pH is not within the 7.4 to 7.6 range, get it there first before you worry about total alkalinity or calcium hardness.

Precisely where in this range for total alkalinity and calcium hardness you operate your pool is a matter of makeup water characteristics, bather load and chemicals used. Most pool managers today are aware that they fight a continuously de-escalating total alkalinity. If this struggle is the case for your pool, you should think in terms of maintaining total alkalinity at the lower levels of around 50 to 80 ppm and countering with a higher calcium hardness. Remember that total alkalinity tends to drop in most pools under normal operations because it is reduced by the feed of gas chlorine and the feed of muriatic acid.

Calcium hardness, on the other hand, is a comparatively stable factor in pool water chemistry. So, let the total alkalinity drop a little ways but not below 50 ppm. Counter by feeding calcium chloride at the appropriate dosage to achieve a calcium hardness level that satisfies the 25,000 rule.

In new pools where there is fresh plaster, grout or concrete, it can be argued that they be maintained at a Saturation Index level not of 25,000, but more like 30,000 or 35,000 for the first 6 to 12 months while the surface finish is still new.

Other factors

Some experts would argue for the inclusion of a sixth or seventh critical factor. Some would argue for temperature, others for total dissolved solids (TDS) and others perhaps for the level of chlorides.

Temperature is controlled for all practical purposes by the program. Pools used competitively tend to be a little cooler than pools used primarily for recreation or for elementary or special education purposes. The range of temperature which swimmers prefer is so narrow that it is an unimportant factor in considering life and service of mechanical equipment, swimmer safety, etc. Pool water temperature is a matter of comfort. Specific selection of water temperature between 78 and 85 degrees F. is less important than the relationship between water temperature, air temperature and air humidity level.

Some experts claim that total dissolved solids (TDS) is an important factor. Rather than argue about whether it is important suffice it to say that virtually all agree that if the 5 factors listed above are kept within their target ranges, one never has to worry about TDS. TDS only comes into play when some of the other 5 factors are badly out of line.

Like TDS, chlorides are unimportant when the other 5 factors are properly managed. Some of us may imagine that pools high in chloride levels—salt—might experience corrosion problems. We think of boats and ships in sea water having more corrosion problems than those in fresh water. This corrosion in the sea comes from marine life. Under proper chlorination, we would hope that such plant and animal life does not exist in the pool.

There are many salt water pools in North America. The only differences between them and fresh water pools are the taste of the pool water and the degree of swimmer buoyancy.

Again, under proper management of the 5 most important factors, chloride levels can be ignored.

Isocyanuric Stabilization — Benefactor or Bomb?

Another controversial subject in the world of pool water care is the much-discussed and little-understood business of cyanuric acid stabilization. Is it the real money saver and problem solver, as the ads say? Yes — and no. In simple terms, sure, it is an excellent product if properly used in poorly-maintained or infrequently-serviced public pools. (Indeed, it is a necessity in almost all residential and motel pools.) But the answer might well be an emphatic NO somewhere else. There are a number of trade-offs which make cyanuric acid (CYA) a poor choice in many if not most high-use, well-cared-for, institutional swimming pools. Let's look at a few facts:

1. Isocyanurics do help chlorine "last longer" in the pool; that is, a residual shows up on the test kit for a longer period of time after administration of the product.
2. This "stabilization" of chlorine, however, degrades its "work value."

Let me explain the second item a little better. HOC1, the active chlorine compound in pool water, is inherently unstable. It is highly effective by virtue of the very fact that it is unstable. So what would you expect when chlorine is made more stable? A classic paradox exists, where effectiveness is traded for longevity. You don't get something for nothing!

From these three facts, an equal number of assumptions can be made:

1. The increased longevity of measurable chlorine residual might evoke a false sense of security, while the reduced effectiveness could place oxidation and disinfection potentials dangerously close to a point where problems begin to arise.
2. Higher residuals of chlorine should almost always be maintained to offset the reduced work value. (Target values two or three times "normal" might be wise.)
3. The expense of the initial cyanuric dosing plus make-up additions, along with the cost of maintaining the higher residuals of chlorine, surely will degrade the much wanted cost effectiveness. Indeed, there must be a break-even point beyond which we are spinning our (paddle) wheels.

All is not lost, however. There is, in fact, a point of diminishing returns with respect to the percentage of "stability" achieved for increasing values of stabilizer. It seems reasonable that if we stay below that figure, isocyanurics may well prove useful. But what is the number? To determine some practical guidelines, tests have been run by STRANCO in a controlled pool environment in Florida, then in Hawaii. This field work was followed by a detailed study in a laboratory atmosphere in California. Sensitive electronic instrumentation corroborated the findings: Oxidation Reduction Potential (ORP), the best means of evaluating chlorine's work value, falls off dramatically at a rapid and predictable rate which can be stated (and plotted) in terms of equivalent free chlorine.

Referring to Figure 1, we can see

FIG. 1 EFFECTS OF INCREASED CYANURIC STABILIZER IN SWIMMING POOLS

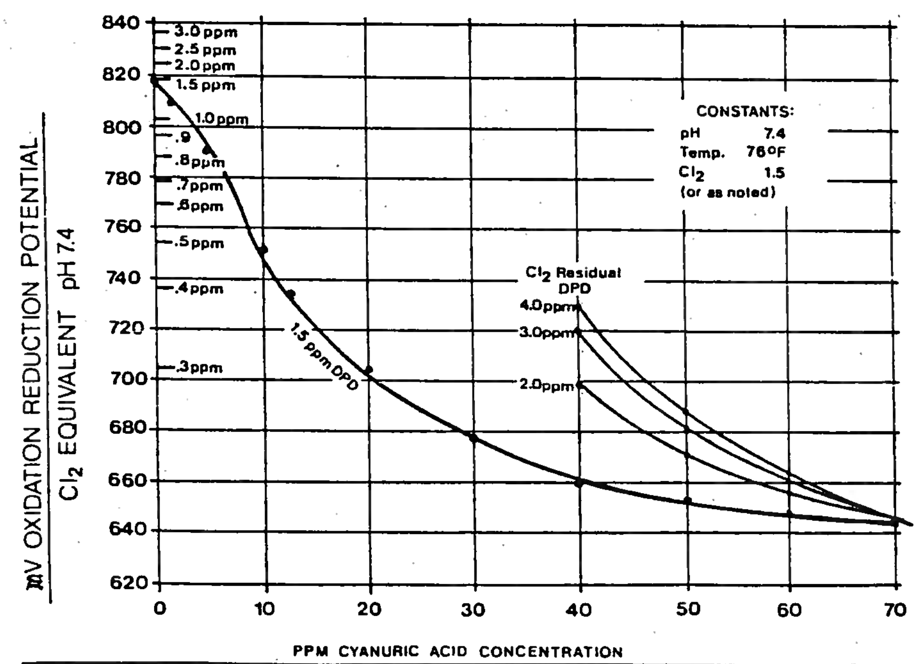
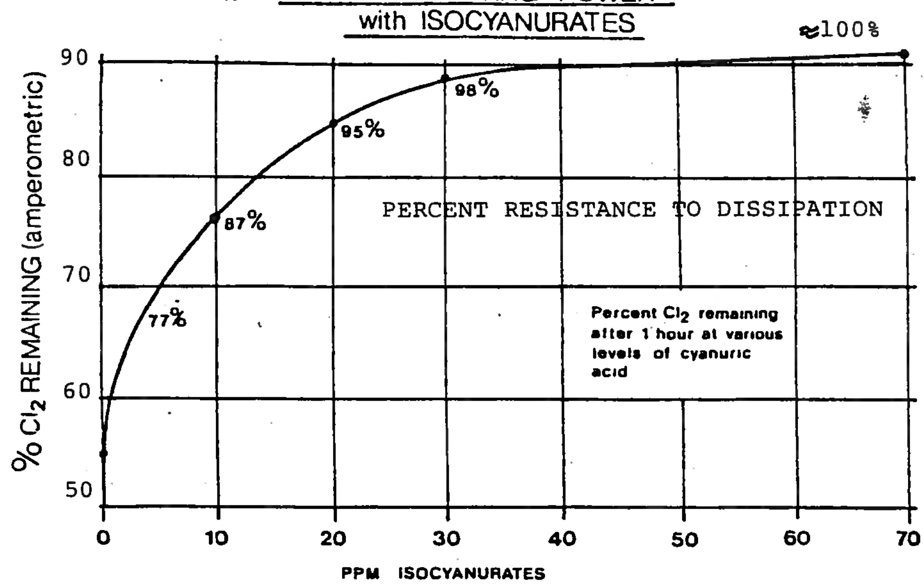


FIG. 2 CHLORINE "STAYING POWER" with ISOCYANURATES



Stabilization, cont.

that at 5 ppm CYA, (pH 7.4, Chlorine residual 1.5), the equivalent chlorine effectiveness is more than 35% reduced; at 10 ppm it is about 65% reduced, at 20 p pm, chlorine equivalent effectiveness is down a startling 80%. Beyond 25 ppm CYA we can expect, in terms of oxidizing power, only 15% of what we'd have if the chlorine were unstabilized.

"Aw c'mon, how can that be? We know of pools with twice that much CYA. The water's clear — and the health guy says the plate count is OK."

Well, remember what we are comparing: POTENTIAL to oxidize. If you don't need it all, you don't use it all. If the first .1 ppm can handle all the bugs, it does. If the next .1 or .2 ppm can handle all the organics, it does as well. What we've lost, however, is virtually all the "insurance residual." Just stir in another 100 kids, or a dead cat, and see what we've got! Just ask that well-taxed .3 ppm equivalent to handle half-a-part-per-million of ammonia. No way. You're paying the premiums on that insurance residual, so you might as well have the benefits ....or most of them.

With all this detail on the fall-off of effectiveness, just where do we stand on staying power? We can't find our diminishing return point without knowing what increase in residual lifetime to expect. Look at Figure 2. (Data is from a tech bulletin of a major specialty chemical manufacturer.) This chart shows reasonable staying power achieved with only 5 ppm cyanuric in use. Over eighty percent of all the staying power achievable is found at a 10 ppm cyanuric while values much over 20 are clearly beyond the cost-effectiveness threshhold. These are not exactly the numbers you hear advertised.

One more surprise: In these laboratory tests, a rather amazing fact came to life. As effectiveness is lost, and the CYA reaches about 70 ppm, the ORP (Oxidation/Reduction Potential) curve levels off at about 12% of the original work value which resulted from the 1.5 ppm unstabilized chlorine. From that point upward, all reasonable levels of chlorine additions converge to approximately that value! In simple terms as cyanuric levels exceed about 70 ppm, 1 part-per-million will result in about a .2-part-per-million equivalent effectiveness; so would 2 parts per million chlorine dosage. So would 3. And so would 10 ppm! Values of cyanuric from that point upward make chlorine in any quantity a pretty bad investment.

Another interesting note: The "stabilization" gained is almost entirely in the presence of sunshine. CYA in indoor pools and spas is totally inappropriate.

The use of cyanuric-based dichloro and trichloro products, commonly used for spas, has convenience value only, since it costs more and works less. (Dichloro does dissolve handily in water and has little affect on pH). When using cyanuric-based chlorine products in spas, frequent (weekly) dumpings will keep CYA from building up.

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 swimmers, so this is quite often the variable of greatest concern. And this is where CYA gets its highest marks. In the twenty-two articles, technical treatises, and papers on CYA referred to by this author, virtually all reported on the study of CYA with respect to disinfecting power of chlorine. (None addressed themselves to oxidation!) Much disagreement is found among the pro's and pH's regarding the oft-studied sanitation aspect (so much that a few state health departments do not allow CYA at all while others demand it in large public pools!): Some lab data in unstressed (non-pool) water showed Pseudomonas Aeruginosa kill to take up to 100 times longer with, as compared to without, CYA (low residuals of chlorine), while other, less scientific but more true-to-life testing showed a few bacteria appear to die more quickly in the presence of CYA!

Although little agreement exists, one thing seems clear — the disinfectant fall-off is somewhat behind the oxidation loss. So pools, generally, remain safe from a health standpoint until ridiculous levels of CYA accumulate, not so uncommon, I fear. Therefore, as CYA increases, possibly from the use of dichloro- or trichloro-types of sanitizers, on top of initial "stabilization," chlorine's power to oxidize continues to fall off more and more.

Resultant water conditions don't appear to change for the worse until the demand threshhold exceeds the greatly limited "insurance" ORP.

Suppose you have a three-quarter-million-gallon outdoor pool and find yourself doing marathon cylinder changes trying to keep up with the chlorine demand. You've heard that cyanurics can double or triple the chlorine's life in your pool. What would be a reasonable course of action in this case?

Prepare yourself for a new responsibility — that of testing and maintaining your CYA at reasonable and consistent levels. A procedure can be instituted to frequently check that level with an accurate (there aren't very many) CYA test kit. The pool should be dosed from 5 to 12 ppm cyanuric (in this case, 80 lbs. at a cost of approximately $200.00) in an automated pool or up to 20 ppm or so in a non-automated pool (near $400).

Then, knowing the chlorine effectiveness has been reduced, the old residual must be approximately tripled and maintained. In the example above, 2 ppm is not at all unreasonable, while upwards of 3 ppm is recommended. (Some localities have required even 5 ppm.) You will realize a reduction in chlorine consumption over all, even maintaining higher residuals. Super-chlorination may be needed slightly more often, especially to combat algae. This cost, and the cost of the initial dose of cyanuric acid and make-up doses, must be considered when computing overall savings.

The bottom line — the cost-effectiveness and ultimate suitability of cyanuric stabilization — can only be determined by you through your investigations or personal experience. Use the information in this article as just one of your sources.

A footnote: when you have heavily stabilized your pool, you are committed to at least some level of stabilization for years to come. Draining the pool — even multiple drainings and (heaven forbid) acid washings — cannot eliminate isocyanurates entirely from your freshly refilled pool. It has a way of impregnating plaster, filter elements and media, even scale or residue in heaters and pipes. One has difficulty returning to the fully-active low residual used prior to the initial stabilization attempt. Take heart, however, a few large-pool owners report that, after attempting CYA at substantial levels but giving up on the idea after a test season, they drained their pools, refilled, and subsequently experienced the most cost-effective year ever! It seems the trace of CYA that remained, unmeasurable on most test kits, accidentally worked out to be the best compromise for them.

Total alkalinity and eyeburn

Remember the question "Which came first, the chicken or the egg?" Whether low total alkalinity causes eyeburn is a similar proposition.

In past issues you have read that at total alkalinity levels below 50 ppm, bathers will complain about eyeburn. There are many cases in which eyeburn complaints were eliminated after raising total alkalinity from below 50 ppm to above 80 ppm. Yet there are pools maintained at low total alkalinity levels where eyeburn complaints are not a problem.

Like many generalizations about public pools, eyeburn as a result of low total alkalinity is not universal. Why eyeburn in some pools and not in others?

We asked this question of contributing editor Kent Williams in California and of J. J. Tepas, Consulting Scientist, Olin Corporation's Pool Chemical Division.

WILLIAMS: 5 ppm to 10 ppm total alkalinity makeup water is common in many parts of California. Even with frequent bicarb dosing (and in some cases bicarb used in place of soda ash on gas chlorinated pools) many pools operate at a total alkalinity level of 30 ppm to 40 ppm. In those pools eyeburn is not a problem so long as operators burn out chloramines and maintain pH at 7.4 to 7.6.

TEPAS: There are numerous pools across North America with little or no chloramine residual, a pH of 7.4 to 7.6 and no eyeburn problems even with total alkalinity as low as 35 ppm. To understand why eyeburn is a problem in some pools of low total alkalinity and not in others, we may find that aggressive water rather than low total alkalinity is the real culprit. Remember that at a pH of 7.4 to 7.6, the total alkalinity times calcium hardness should equal 25,000 to insure minimum possibility of scale and corrosion damage.

POOLFAX: Few operators hold low total alkalinity and high calcium hardness by choice. Individual pool and makeup water characteristics have carried these pools in that direction.

WILLIAMS: Heavy calcium chloride dosing is prevalent in many areas of California. Calcium hardness levels of 300 ppm to 400 ppm predominate in virtually all pools that have low total alkalinity but no eyeburn.

TEPAS: Water of pH 7.4 and total alkalinity of 50 ppm requires a calcium hardness of 500 ppm to be theoretically in balance on the Saturation Index *(25,000 divided by 50 equals 500 - ed.)*

POOLFAX: If we consider a pool with a pH of 7.4, total alkalinity of 50 ppm and calcium hardness of 200 ppm, we might comment that total alkalinity was too low. We would be correct, would we not?

TEPAS: Yes, but it is also correct to say that if calcium hardness were raised to 500 ppm, the pool would be balanced.

WILLIAMS: The operator of such a pool would have several choices. He could raise the total alkalinity to 125 ppm, he could raise the calcium hardness to 500 ppm, or he could raise both the total alkalinity and the calcium hardness to any combination in which one multiplied by the other would equal 25,000.

POOLFAX: Most of the literature on public pool management would indicate that total alkalinity should be increased from 50 ppm.

TEPAS: Raising calcium hardness would be better in the long run. An overshoot of calcium hardness does not create as serious a problem as an overshoot of total alkalinity.

WILLIAMS: Raising calcium hardness would be the better approach for the pools with which I am most familiar. In many pools, keeping total alkalinity residuals above 80 ppm requires very frequent bicarb addition which is both bothersome and expensive. The continual de-escalation of total alkalinity can be a daily headache.

TEPAS: I endorse the statement in the January POOLFAX that far more pools suffer corrosion damage than scale damage and that pH is the greatest single factor in determining scale or corrosion tendencies. However, holding pH levels of 7.5 to 8.0 as some experts prescribe today is less of a solution than carrying higher levels of calcium hardness than those to which most pool managers are accustomed. pH levels above 7.6 can lead to scale damage much faster than calcium hardness levels of 300 ppm to 500 ppm and above. Either approach helps prevent corrosion, but you are less likely to overshoot and create a scale problem by carrying a higher level of calcium hardness than by carrying a higher pH level.

POOLFAX: A word of caution is appropriate here. Total alkalinity is important not only as it affects the Saturation Index, but also as it affects the resistance of water to pH change. We could satisfy the Index with a total alkalinity of 10 ppm to 2500 ppm of calcium hardness, but pH would fluctuate widely and be more difficult to control.

WILLIAMS: Pool managers should try to hold at least 80 ppm total alkalinity to counter this effect. But if doing so means they have to add bicarb every day or two, they may find it less hassle to let total alkalinity slide below 80 ppm and establish a calcium hardness level high enough to satisfy the Saturation Index.

POOLFAX: It seems, then, that total alkalinity below 50 ppm is a cause of eyeburn complaints insofar as low total alkalinity water is frequently corrosive water and corrosive water can be an irritant to bathers. Agreed?

WILLIAMS: Yes, the Saturation Index describes the appetite of water for certain minerals and ions. Corrosive water is aggressive water. It will satisfy its appetite by any means available. If you don't feed it what it wants by dosing bicarb or calcium chloride, it will satisfy itself any way it can. It will attack steel, plaster, and even eyeballs.

TEPAS: I would agree also, but low total alkalinity water does not have to be corrosive. By raising calcium hardness to satisfy the Saturation Index you can minimize both scale and corrosive damage. These same steps may minimize eyeburn if chlorine residual is properly managed, too.

So, does low total alkalinity cause eyeburn? The answer is yes, unless calcium hardness is increased to satisfy the Saturation Index - even though this increase may take a pool to what may seem to most of us to be unusually high calcium hardness levels.

Check-off List for Home Swimming Meets

By Dr. Jack Welch

Editors' note: Dr. Welch is Aquatics Director at the University of New Mexico. Here he shares with us the check list he wrote and uses for home swim meets. You may wish to modify it to fit your particular situation.

Two Weeks Before Meet

_____ 1. Reconfirm date and time with visiting team.
_____ 2. Submit request for premeet meal.
_____ 3. Submit request for official's pay.

One Week Before Meet

_____ 1. Put up signs if recreation swim hours are affected.
_____ 2. Line up referee and fifteen helpers.
_____ 3. Reserve public address system.
_____ 4. Make meet program.
_____ 5. Order towels.

One Day Before Meet

_____ 1. Check out timing system.
_____ 2. Pick up public address system.
_____ 3. Get twelve stop watches to pool.
_____ 4. Move life-guard chair to filter room.
_____ 5. Pick up meal and referee's checks.
_____ 6. Clean pool deck.
_____ 7. Clean bottom of pool.
_____ 8. Get out recall rope.
_____ 9. Move bleachers, if needed.
_____10. Move table(s) in place.
_____11. Bring calculator to pool.
_____12. Check starting pistol and blanks.
_____13. Gather necessary forms: Scorer's form _____; coaches contestant cards _____; timer's cards_____; carbon paper _____; diving forms _____.
_____14. Bring twelve pencils to pool.
_____15. Cover timing wires with mats.
_____16. Have N.C.A.A. Rulebook at pool.
_____17. Have whistle _____; diving flash cards _____; visual lap counters _____; backstroke pennants _____.
_____18. Open spectator door.
_____19. Check with head coach to see if any special arrangements or tasks need to be completed.

Day of Meet, Assign

_____ 1. Referee
_____ 2. Stroke judges (2)
_____ 3. Turn judges (2)
_____ 4. Pick-up judges (4)
_____ 5. Announcer
_____ 6. Diving judges (3)
_____ 7. Manual timers
_____ 8. Auto timers
_____ 9. Head timer
_____10. Usher
_____11. Scorers
_____12. Clerk of course
_____13. Recall rope persons (2)
_____14. Runner
_____15. Towel person

Q. & A.

Q. I have two questions. First, since the installation of our gas chlorinator, which ran at 20 lbs./day for approximately 1 week, our pool has been super-chlorinated at a level well above 3.0. The chlorinator has not run for approximately 3-4 weeks since this condition was discovered. The pH is very alkaline at over 8.4 and approximately 12 gallons of muriatic acid were added without any noticeable change. Our pool capacity is approximately 260,000 gallons. Any suggestions?

Secondly, prior to any use of our facility it was found that a leak had occurred in one of the water mains pressurized by our filtering system. This main provided influent water through two bottom inlets. The leak was not repairable since it occurred beneath the pool. The main was capped and the pool inlets were covered. Prior to this "repair" we were losing 1½-2 inches of water per day. Now after "repairs" we are losing about ¼ inch per day. Is this ¼-inch water loss common with these conditions or should I suspect the possibility of an additional leak?

— Debra Faber,
Operational Director,
Founders Family Center
Katy, Texas

A. In answer to your first question, the first step is to add sufficient muriatic acid to achieve a pH level of 7.4 to 7.6. The fact that you have already added about 12 gallons of muriatic acid without achieving any noticeable change is not unusual. Remember that your Phenol Red test kit for pH registers all pH values at 8.4 and above as looking the same. Just keep adding acid until you get an accurate test of pH and until you have achieved the optimum pH level. After you have done so, you will want to balance the pool to the Saturation Index which will require that you take note of the feature in the February 1981 issue of POOLFAX and that you be able to test for total alkalinity and calcium hardness. You may be able to borrow a test kit from the local water department if you do not have one for these parameters.

The answer to question two is easy. A quarter of an inch of water a day is typical evaporation for the conditions you have described. Do not waste your time looking for leaks. ■

For the record

Actually heard in halls of a public recreation complex:

1. Pool manager: "How's the pH?"
2. Lifeguard: "It's fine. We add pH everyday."

Sump Stories

A change in make- up water

Three years ago in the northwest United States, conditions changed at the city park pool. Suddenly it seemed chlorine demand quadrupled. Chloramines formed. The pool staff superchlorinated and then more chloramines formed in abundance. Superchlorination was repeated, successfully burning out the chloramines that had existed but high chloramine residuals were present a day later.

The usual calling in of experts took place. There was much ranting and raving and pulling of hair - to no avail.

Finally, the pool manager had an idea. He phoned his local water department and asked them what was new.

"Nothing," answered the man from the water department.

"Come on," asked the pool manager, "What's different about the water?"

"Nothing, it's still water," answered the man.

After what seemed like several minutes of re-asking the same question and getting the same response the man from the water department finally said, "Oh, maybe you mean our new pump. We got it because we put too much chlorine in. See, the State says we have to chlorinate but we can't chlorinate too high and we were putting too much chlorine in before."

"Why do you need a new pump to put in less chlorine?" asked the pool manager.

"No, no, we still add it like we always did, only now we have the new pump on downstream. It makes our tests come out better," said the man from the water department.

"What does the new pump do?"

"It does real good, adds that stuff as fast as we can fill the drum."

"What do you fill the drum with?" asked the pool manager.

"Ammonia."

Editor's note - every public pool manager or operator should frequently test his incoming makeup water. You may not be able to detect a few parts-per-million of ammonia, but you need to know pH, total alkalinity, calcium hardness and other factors you can test for. Almost all water departments will provide recent test reports of the chemistry of the makeup water they are sending into the distribution system for your use.

Just as a pilot won't take off without knowing what kind of fuel is in his airplane and a carpenter won't start to saw without knowing what kind of wood he's working with, the public pool manager or operator has to know what kind of water he's being given with which to work.

The Pool That Got Shallower

A few years back a motel manager in the north central U.S. phoned the engineering expert at his chain's regional management center.

"The pool is getting shallower," the manager cried. "The interior finish looks like hell and we noticed that the water coming out of the inlets into the pool was coming out slower and slower and now doesn't come out at all. In fact, the main recirculation pump hasn't taken a turn in over a week. Please come and help us."

Naturally, the engineer flew out to visit right away. On arrival, after a quick look at the pool he headed for the equipment room with the operator. Unusually, this pool was gas chlorinated. The engineer asked the operator to describe the operation of the gas chlorinator to him and to show him the operator's procedure for changing cylinders and so forth. Through this exercise, the engineer learned that the operator was a bright and dedicated man with an unusually high loyalty and desire to do the job right. However, the operator was illiterate. He did not read.

The engineer asked if the operator added any soda ash to the pool. The operator replied that he added soda ash frequently and pointed to a stack of sacks against the wall. Because he did not read, the operator had simply memorized the appearance of the letter "S" on the face of the bag and had been adding the bags with the name that started with "S." When the engineer walked over to look at the bags, he read the word "Sakrete."

Pop Quiz

As a long-timer in the institutional pool business I am usually pleased with the results I get when I train municipal pool operators. Arriving at one job recently I was somewhat chagrinned, however, to find my man using a phenol red test kit slide and DPD reagents to find the chlorine level. I patiently and tactfully pointed out his error, then further reviewed the difference between the DPD tests for free and total chlorine. Testing his knowledge a bit further I asked "do you remember what a chloramine is?" He hesitated a moment and then with a sheepish grin asked "a baby chlorine?"

Aquatic graffiti

A few years back we had the privilege of touring a beautiful new Natatorium in Western Canada. We admired the large spectator section for the 50-meter, 8-lane pool. Seemingly skyhooked over the diving well were the one- and three-meter boards and the five- and ten-meter platforms on their tower.

Here was 600,000 gallons of polished, perfect pool water.

Down two flights of stairs we came to the mechanical equipment room housing the 2,000-square-foot vacuum DE filter and the latest in chemical treatment hardware, handling 1700 gallons per minute.

From the equipment room we entered a small area used for underwater observation. On one wall was the window from which we peered upwards through three fathoms of water and appreciated the skill of the divers then practicing.

To the right of the window was a small, hand-lettered sign. It read, "In Case of Fire, Break Glass." ■

Sump Stories

The Mysterious White Cloud

In early 1974, a public pool expert was invited to help solve a chronic cloudiness problem at an indoor municipal pool in Canada.

The 200,000-gallon pool was gas chlorinated where soda ash was used for pH correction and it had an open tank vacuum diatomaceous earth (DE) filter. Bathing loads were heavy all day with cloudiness increasing throughout the day and clearing slightly each night.

Thinking the problem was due to unoxidized organics because cloudiness increased with bather load, the expert superchlorinated on the Monday he arrived. To his surprise by Tuesday afternoon the cloudiness seemed unimproved.

Working literally day and night, sampling, testing, dosing, observing staff procedures, the expert first deduced that the cloudiness was because of suspended inorganic particles. After determining these particles to be loose diatomaceous earth (DE) in the pool, he dismantled the filter and inspected the filter bags and leaves carefully for damage which would have allowed the DE into the pool. None was found.

By week's end, the city fathers began to lose faith in their expert who was beginning to question his own ability to solve the problem.

Friday evening after the pool closed at 10:00, a weekend-only lifeguard headed downstairs to the filter room. The expert followed quietly. The lifeguard shut off the recirc pump.

"What did you do that for?" asked the hired troubleshooter.

"I backwash every Friday night. Those are my instructions," answered the young man.

Knowing the filter had been effectively backwashed the day before in the process of examining it, and knowing the vacuum gauge and flowmeter indicated near perfect filter conditions, the expert started to interrupt the lifeguard but decided to stand back and watch instead.

After draining that tank and hosing down the elements, the guard closed the valve to the sump, closed the return line to the inlets, and opened the precoat line. He then filled that tank with pool water and started the recirc pump.

So far, so good, thought his observer.

Picking up a fifty pound bag of DE, the guard dumped its entire contents into the filter. Then, without hesitation, he reached for the valve to open the return line to the inlets.

"What are you doing?" screamed the expert.

Startled, the young man froze.

"You have to wait for the filter to clear," said the expert fighting to control his emotions. "That stuff now is just like milk. Open that valve and you'll put fifty pounds of DE right in the pool."

Looking a little shocked and confused, the lifeguard responded, "But I do it this way every week."

The Rancher's New Pumps

Like every story to appear in this feature, the following is absolutely true.

About eight years ago in California a chemical metering pump distributor shipped three diaphragm type chemical pumps with three tanks and covers to a first-time customer. The customer, a rancher, needed the pumps to pre-treat his irrigation water. The pumps were sophisticated electronic drive models which are $545 apiece today, not including the tanks and covers.

After a few days the rancher phoned the distributor to say the pumps didn't work at all.

When the serviceman arrived at the ranch, he was led to a shack where he saw the three tanks. They were full of chemicals and had their covers loosely fitted on top. But there were no pumps in sight. The serviceman had expected to find the pumps on shelves above the tanks or even sitting on top of the covers.

Then he noticed that from under each of the covers a power cord and a length of tubing extended out over the tank lip. The power cords were gathered at a wall receptacle and the lengths of tubing were stretched over to injection points in a large pipe.

"Where are the pumps?" asked the serviceman.

Angry and impatient, the rancher answered, "Right where I put 'em since the day I got 'em, and they ain't worked yet. There's one at the bottom of each of them tanks."

Q. & A.

Q. How often should a pool be drained? *Art Murphy, St. Louis*

A. The only reasons to drain a pool are to re-paint, re-tile or otherwise maintain the surface of the innershell or to correct the inadvertent addition of any substance which cannot be chemically destroyed or filtered such as certain insecticides or other poisonous housekeeping chemicals. Many pools have operated 10 to 15 years and more without being drained and re-filled.

A fine performance

It seems underwater viewing windows are the source of many adventures. Those of you who follow Sump Stories carefully will remember "Aquatic Graffiti" in the May 1981 POOLFAX and "X Marks the Spot" in the August 1981 POOLFAX.

Late one night about ten years ago an executive arrived by private jet at a west coast airport. With his retinue of three assistants he checked into an area motel around midnight.

Given ground floor rooms right at poolside, the group of gentlemen decided on a swim. Not having swimsuits in their luggage, they walked from room to pool towel-clad and returned the same way after a refreshing 20-minute dip.

Of course there had been an underwater window, the other side of which opened onto a semi-darkened bar which was open and busy until 2:00 a.m.

Next morning the corporate foursome entered the coffee shop at its busiest time of about 7:30. There were a few snickers from other patrons, a couple of pointed fingers, that sort of thing.

Then one gentleman at a prominent table stood up, faced the bewildered executive and his staff and led all the others in a round of applause.

Sump Story

X Marks the Spot

It had been a long, difficult week so they naturally headed for their favorite watering hole. A few months before, the four members of the pool builder's crew had adopted this motel bar after installing a new 40,000 gallon pool there.

The pool sat adjacent to the cocktail lounge. The roof of the bar formed the deck of the pool and there was an underwater window 4′ square between the two. This unique arrangement gave the lounge a special atmosphere and appeal.

The crew chief and his three cement finishers had been stopping there occasionally after work ever since. This night, the drinking went on until closing time, until only these four and the bartender were left.

"You know", boasted the crew chief, "If I get up and go over there and scratch that glass with a diamond, she'll let loose."

"How can that be?" asked the others.

"The two sides of that window are different. This side's got a special hardening on the surface that is critical to the strength of that piece of glass doing that job. You mess with that surface and it's good-night Irene."

"No way, that can't be true." echoed the younger three.

"Wanna bet?" challenged the older man, extending his hand.

They all laughed. In jest, they wagered an unrecorded amount. It got to be closing time. After counting his register, the bartender stepped out to deliver the night's receipts to the front desk. Then one of the younger men more affected by drink than the others, climbed down off his barstool and approached the window into the pool with his small diamond ring held tightly between his fingers. In half-drunken disbelief, the others looked on as he started in the lower left corner and traversed to the upper right making a long, thin mark.

Nothing happened.

The crew chief sat aghast. The other two younger men laughed, claimed a victory in their wager and called for their winnings. Then the man at the window muttered something and started again with the ring. This time he began in the upper left corner and scribed his way to the lower right, completing a giant X on the pane.

Still nothing happened. Seconds passed.

The crew chief sighed with relief, gladly paying off his opponents in the bet and all four stumbled to the exit where the returning bartender met them with a hail and farewell.

Fortunately, all were just outside in the hall when the glass gave way. A quarter of a million pounds of water exploded across tables and chairs and barstools and bottles, wrecking the juke box and spraying glasses, ashtrays and window fragments in all directions. The electrical breakers opened plunging the flood into darkness.

Miraculously, no one was hurt. Later, the pool builder would fire his crew. The motel owner would fire the bartender, refill the pool and redecorate the lounge.

Where the window used to be there is today a very sturdy concrete wall.

Tower of Flame

Over a decade ago at an outdoor park pool near Chicago, the operator received instructions to cure a slight green algae problem with a bucket full of calcium hypochlorite (HTH in this case) and a quart of algaecide. As mentioned, he was efficiency-minded so to save himself a walk from equipment room to poolside, he first filled a bucket with HTH and then poured the algaecide in on top. After all, it was all going in the same pool, so why not?

He scooped up the bail in one hand and headed out for the pool. Within a few steps, as he later reported, he noticed the bail getting hotter and hotter. Within seconds it was too hot to hold. He dropped the bucket squarely to the deck and took off in a run for his life. When he was 20 paces or so away, his bomb let go, sending up a brief but most impressive tower of flame, guessed at 20 feet to 40 feet high by various witnesses.

By the way, algaecide isn't the only material that will cause such a ferocious if short lived conflagration. Almost anything will do: other specialty chemicals, food or drink, even dust or water. Keep calcium hypochlorite dry and covered at all times - unless it has been a dull day and you feel like re-enacting the attack on Pearl Harbor.

What you don't see can't hurt you

About fifteen years ago there appeared on the market the first liquid evaporative retardant for use in pools. The chemical is dosed in tiny quantities daily, putting a layer only one molecule thick across the surface. The chemical is comparatively expensive to use but really does reduce evaporation and heat loss.

An enterprising salesman in the Rocky Mountain area called on a ski resort where there operated a year-'round outdoor pool. The steam from the 85 degree pool poured from every square inch of the surface into the frigid, winter mountain air. To be two or three feet out in the water was to be totally hidden from view.

The salesman convinced the manager to try what was then his new chemical product. Just as predicted, the steaming stopped. Presumably, heating cost savings would more than pay for the chemical. Certainly, too, the change enhanced swimmer safety.

Then the unexpected happened. Guests came to the front desk, checking out of the resort in droves. Those who paused long enough to complain said, "Why'd you turn off the pool?"

The manager explained the new chemical and its use. However, the explanation didn't help. Within a day's time, almost a third of the patrons had cleared out.

Naturally, the manager added no more of the chemical and after a few days, the initial dosage had been caught on the filter. The steam rose once again. The hotel filled to capacity as before.

Perhaps the guests just liked the way the steam looked. But this resort did a lot of couples business. Now you don't suppose . . . ?

Sump Stories

Just a few weeks ago in the southwest United States a public pool manager returned from a vacation to avert what would have been an unusual problem.

It seems the pool needed painting. Upon leaving for vacation, the pool manager left word with his assistants to drain the pool and then to acquire the paint and have it on hand when he returned.

Sure enough, his first day back from a delightful week with his family, the pool manager found an empty pool ready for painting. Then he went to look at the paint. It seems that his assistants had assumed that because they were painting the "interior" of the pool, they needed interior paint. There in the storage room just off the pool deck, in quantity sufficient to paint a 25-yard by 6-lane pool was Sears' Best Interior Latex paint.

After a few seconds, the pool manager regained his composure and then went to see the assistants about returning the paint to the store while he would get on the telephone to order the appropriate pool paint.

Things were to get worse before they got better, however, as after confronting the pool assistants the pool manager learned that in their efforts to please their boss, they had acquired the paint on sale.

The Cloudy Pool Blues

It was to be a gala affair. There would be musicians playing over by the pool deck at the deep end, waiters would wander with trays of hot and cold snacks, two open bars and everyone in their best attire.

The long-planned silver wedding anniversary pool party was now only hours away. But the fresh fill in the pool was still an opaque, muddy brown. The anniversary couple panicked. What could they do but call for help. First one and then another pool company begged off the impossible task of clearning the water by cocktail hour.

Finally, the worried pair found one man who would help. They talked by phone several minutes. Then following his instructions the wife called the florist while the husband phoned the rent-all store.

Meanwhile the serviceman packed his truck with only two chemicals: sodium thiosulphate, a de-chlorinating agent, and Crystal Violet which is a stain used to test recirculation patterns. Crystal Violet stains pool water purple in the absence of chlorine and clears completely when chlorine is added.

The serviceman arrived at the pool and first de-chlorinated the ugly, brown water. Then he helped the husband set up the flood lights that had just arrived from the rent-all store. Next, he added the crystal violet and within an hour the whole pool was deep purple in color. The wife pulled in the driveway with the station wagon full from the florists.

Later that evening, all the guests marvelled at the stunning beauty of the occasion. It was the perfect party and a sight never to be forgotten: a flood-lighted, purple pool on which floated one hundred white gardenias.

Sump story

Among the verifiably true tales of aquatic horror is one about the Best Looking Pool Operator in the World.

In 1973, in a midwestern suburb, a young lady acquired the job of managing pool water chemistry at an aged city pool. She had just received her Master's degree in chemistry. But more to the point of the story, on a scale of 1 to 10 she was a 14. Bikini clad, test kit in hand, she was on the pool deck daily, causing a 22% increase in paid attendance.

She knew that chlorine was more effective at lower pH ranges, so she turned off the soda ash feeder, allowing the gas chlorinator to drop the pH. She left the soda ash feeder off for 3 weeks before noticing the rather brown color of the water.

The city fathers called in a local expert to diagnose the reason for the brown color and to comment on the unusual number of new leaks in the steel piping.

The pH was found to be 3.5. The leaks and brown color were of course the result of highly corrosive pool water having almost completely dissolved the recirculation and filtration systems. The repair bill exceeded $100,000.00.

The next summer, the young lady was rehired for the same job. After all, she had only made the one mistake.

"Don't dump that spa — bottle it!"

While responding to a recent call for assistance at one of our local spas in northern California, I ran across a unique idea for generating revenues.

The problem at the spa was a typical one of strong chlorine odor with associated eye irritation and cloudy water. As I wound my way through the locker room in route to the spa area, my trusty test kit in hand, I could strongly detect the evidence that the age-old battle against the chloromine was going down in particularly bloody defeat. When I arrived at the "battle field" I found a middle-aged gentleman reclining peacefully amidst the swirling bubbles. He watched somewhat more inquisitively than most as I proceeded with my alchemistic duties. When he inquired about my activities, I explained that there had been a few complaints about the chlorine being slightly high, so I was there to remedy the problem. Needless to say I was taken aback when he stated rather biligerently "Don't you dare!" He said, "I've been coming here for the past year specifically for those nice strong chlorine fumes. My doctor says I have a growth in my eye that is going to get worse, but ever since I've been comin' here it's been gettin' better; so don't you dare cut back on the chlorine. Instead, you ought to bottle the stuff and sell it as eye drops!"

Well, in this case the majority had to rule, so we super-chlorinated the spa anyway (after the gentleman had left). Although I've yet to see a bottle of "SPAZINE" on the drug store shelf, I still never pass up the chance to throw out the line, "Instead of draining, why don't you just bottle it and sell it?"

Sump Stories

Dilution was no solution

"That gas chlorinator's a piece of junk," Paul complained to his boss. "It won't feed any gas, and this isn't the first time."

Remembering that Paul was new on the job, the pool manager decided to have a look for himself. Together they walked to the equipment room of the 450,000-gallon outdoor park pool. First, the manager saw that their Strantrol water chemistry controller was signaling a low pH alarm condition.

"When that red light is on," the manager shouted over the noise in the room, "it means the pH is below 7 and that's too low, so to make sure it doesn't get any lower, the machine won't let the chlorinator over there feed any gas. The real question is how come the pH is too low."

"This caustic pump been runnin' okay?" asked the manager.

"Yea, but I think it uses too much of that stuff," answered Paul.

"Why?"

"It just feeds that stuff all the time and I know caustic is expensive. That's why I stretched it."

"You what?"

"Stretched it," repeated Paul. "I figured I'd save the city some dough, use less of that stuff. So I been addin' water to that drum, makin' it go farther. But that little bitty pump just runs all the time."

"Paul, this is caustic, not soup."

Q. & A.

Q. In your November 1980 issue you recommend dechlorination with sodium thiosulfate or sodium bisulfite. Which would be better? Which is more economical? What effect would the use of either chemical have in water that is being controlled minimally with cyanuric acid?

—Dr. Karen Klisch, Frederick, Maryland

A. Sodium thiosulfate is almost always more economical. Theoretically, 0.7 ppm of sodium thiosulfate would neutralize 1 ppm chlorine while 1.46 ppm of sodium bisulfite is required to neutralize the same 1 ppm chlorine. In other words, a pound of sodium thiosulfate will do the same work as 2 pounds of sodium bisulfite.

Both chemicals are slightly acidic. Sodium bisulfite is slightly more acidic. However, in the small quantities used for dechlorination the downside pH shift may be so slight as to be immeasurable.

Neither dechlorinating agent is reactive with vinyl, paint, tile, concrete or grout. Materials of pool construction would not influence one's choice between the two chemicals.

We have found no evidence to indicate that cyanuric acid has any effect on either dechlorinating chemical.

Q. We are presently compiling a pool manual for our use. Would you please send any information you might have on operations and maintenance of pool facilities. Or if you know where we might find such information that would be of help, too.

— Terry Butler, Somerville, New Jersey

A. Detailed information on the operation and maintenance of public pool facilities is limited. However, some excellent booklets are available.

Write the National Spa & Pool Institute at 2000 K Street NW, Washington, DC 20006 for current pricing of the SWIMMING POOL OPERATORS HANDBOOK by David G. Thomas and the PUBLIC POOL CARE GUIDE by Frank L. Strand.

Write Taylor Chemicals, Inc., 7300 York Road, Baltimore, MD 21204 for a copy of the TAYLOR 2004-WATER BALANCE AND TREATMENT GUIDE WITH TABLES.

Write Hoffman Publications, Inc., P.O. Box 11299, Ft. Lauderdale, FL 33339 for how to order their book SWIMMING POOLS - A GUIDE TO THEIR PLANNING, DESIGN AND OPERATION and other publications they may have available on public pool maintenance.

Guilt by association

This month's anecdote was mailed to us in the midst of this Summer's season from one of our Missouri readers.

"What ya doin, Mister?" said the little boy.

The pool operator looked up from his kneeling position over his test kit there at the edge of the pool to see a boy about 6 years old. It was a typical long, hot day at the crowded pool. The operator just then lacked the patience that was needed to explain testing for pH to a little boy he knew was only innocently curious.

"Well, sonny, I'm checking to see if anyone did something they weren't supposed to in the pool," answered the operator.

"You mean went potty?" asked the little boy.

"That's right."

At that moment the operator was about to dose the sample vial with 5 drops of Phenol Red for his regular pH test at this time of day.

"Now you see if this pool water in this little test tube turns red when I put in these drops, that will mean somebody did it," said the operator with an accusing look toward the child.

He added the 5 drops as he always did and held the now bright pink tube up for the little boy to see. The coloration would have looked like 7.4 or so in the comparator.

The operator then looked from the sample vial over to the youngster whose eyes were cast down, chagrined.

"I'm sorry, Mister," said the boy with a shuffling of feet. "It was me."

Glossary

Alkalinity - a term which refers to the amount of hydroxide, carbonate and bicarbonate compounds in water. Also a measure of the resistance of water to pH change.

Hardness - term referring to the amount of certain kinds of calcium and magnesium compounds in water. Occasionally expressed in grains of hardness, it is conventionally expressed in parts-per-million in public pool applications.

Formula File

What does it cost to operate the main recirculation pump?

The electrical cost of operating the main recirculation pump all day every day at a public pool facility is usually a higher figure than most of us would guess. The table below tells the story. This table is calculated on 1800 RPM motors running at full load.

First, you need to determine your cost of electricity per kilowatt hour. Then locate the closest figure across the top of the table below. Then simply use the horsepower ratings on the left hand side to find the approprlate cost of operation per year within the table.

H.S.

Motor @ 1800 RPM	Operating Cost Per Year (8760 hours) at Stated Cost per kWh ($)							
Size HP	.03	.04	.05	.06	.07	.08	.09	.10
10	$ 2,665	$ 3,553	$ 4,441	$ 5,330	$ 6,218	$ 7,106	$ 7,994	$ 8,883
15	4,118	5,491	6,863	8,236	9,609	10,982	12,354	13,727
20	5,271	7,029	8,786	10,544	12,301	14,058	15,815	17,573
25	6,551	8,735	10,919	13,103	15,287	17,471	19,655	21,839
30	7,511	10,014	12,518	15,022	17,525	20,029	22,532	25,036
40	10,070	13,427	16,784	20,141	23,498	26,855	30,211	33,568
50	12,378	16,504	20,630	24,756	28,882	33,008	37,134	41,260

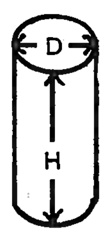
Formula File

Calculating DE Charges

To determine the optimum amount of diatomaceous earth (DE) with which to charge a pressure or vacuum type DE filter, you must first determine the area of the filter.

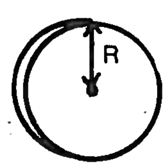
For cylindrical elements:

(diameter in inches × height in inches × number of elements) ÷ 46*



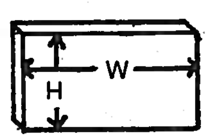
For circular elements:

(radius in inches × radius in inches × number of elements) ÷ 23*



For rectangular elements:

(width in inches × height in inches × number of elements) ÷ 72*



Next, divide the filter area in square feet by 8 to arrive at number of pounds of DE with which to charge the filter which should result in a cake of DE ¼" thick.

The same amount should be fed daily after the first day in a continuous body feed during the hours of pool use.

*The factors take into account, where each is appropriate, the number of element sides, π as 3.14, and conversion from square inches to square feet.

Sizing feeders for soda ash and caustic

When soda ash is used for pH control in gas chlorinated pools, the chemical feeder is frequently undersized for the application. When liquid caustic soda (sodium hydroxide) is used for pH correction in gas chlorinated pools, the chemical feeder is frequently oversized.

Here are a couple rules to follow in picking the right size soda ash or caustic feeders.

For every 100 pounds per day of gas chlorine feed capacity you have, you need 300 gallons per day output capacity in the soda ash slurry feeder.

For every 100 pounds per day of gas chlorine feed capacity, you need only 8 gallons per day output capacity for a metering pump feeding 50% strength caustic.

Dechlorination

Either of two chemicals may be used to dechlorinate pool water safely:

- Sodium thiosulfate - use ¼ pound to drop each 25,000 gallons of pool water 1 ppm.
- Sodium bisulfite - use 2 ounces to drop each 10,000 gallons of pool water 1 ppm.

Formula file

Calculating pressure and vacuum

Pounds per square inch (PSI) and feet of head are two ways of measuring the same thing. Just as we have two temperature scales, fahrenheit and centigrade, we have two ways of measuring pressure. Vacuum is measured in inches of mercury. Sometimes compound problems require that we calculate factors from both the vacuum and the pressure side. These tables give you the conversion factors necessary to make these calculations.

POUNDS p.s.i. TO FEET OF HEAD

POUNDS PER SQ. IN.	FEET OF HEAD
1	2.30
2	4.61
3	6.91
4	9.22
5	11.52
6	13.82
7	16.13
8	18.43
9	20.74
10	23.04
15	34.56
20	46.08
25	57.60
30	69.12
40	92.16
50	115.20
60	138.23
70	161.27
80	184.31
90	207.35
100	230.39

FEET OF HEAD TO POUNDS p.s.i.

FEET OF HEAD	POUNDS PER SQ. IN.
1	0.43
2	0.87
3	1.30
4	1.73
5	2.17
6	2.60
7	3.03
8	3.46
9	3.90
10	4.33
15	6.50
20	8.66
25	10.83
30	12.99
40	17.32
50	21.66
60	25.99
70	30.32
80	34.65
90	38.98
100	43.31

INCHES OF MERCURY TO FEET OF HEAD TO POUNDS p.s.i.

INCHES OF MERCURY	FEET OF HEAD	POUNDS PER SQUARE INCH
1	1.13	0.49
2	2.27	0.98
3	3.40	1.47
4	4.54	1.96
5	5.67	2.46
6	6.80	2.95
7	7.94	3.44
8	9.07	3.93
9	10.21	4.42
10	11.34	4.91
12	13.61	5.89
14	15.88	6.88
16	18.14	7.86
18	20.41	8.84
20	22.68	9.82
22	24.95	10.81
24	27.22	11.79
26	29.48	12.77
28	31.76	13.75
29.921	33.930	14.697

NOTE: Values may be added. To determine 21, for example, add values for 20 and 1.

Formula File

To raise total alkalinity, add sodium bicarbonate (bicarb) at a rate of 1.5 pounds per 10,000 gallons of pool water per 10 ppm increase. For example, a pool that is 180,000 gallons has eighteen 10,000 gallon units. If total alkalinity were 60 ppm and 130 ppm were desired, it would take seven increments of increase of 10 ppm each. Multiply 1.5 times 18 times 7 to get an answer of 189 pounds of bicarb needed.

To raise calcium hardness, add calcium chloride. Add 5 pounds to raise 10,000 gallons of water 40 ppm. Again, multiply 5 pounds times the number of 10,000 units which make up the pool for each 40 ppm increase.

	IDEAL RANGE	TO LOWER ADD	TO RAISE ADD
pH	7.4-7.8	acid	soda ash or caustic
TA	80-150	acid	bicarb
CH	above 140		calcium chloride

DE dosage update

In the March 1981 POOLFAX, we advised daily body feed equivalent to the initial dosage of diatomaceous earth. This advice exists in the procedures of an earlier era but is not the best today.

In the days when undersized filters and haphazard chemical management were almost universal, large daily body feed doses were helpful.

We now find many operators achieving maximum DE filter runs by daily feeding about 10% of initial dosage. We amend our recommendations to these levels. ■

Formula File

Super Chlorination

Step 1

To "burn out" chloramines in a pool through super-chlorination, it is first necessary to determine the weight of one part-per-million (ppm) of the pool. This calculation need only be done once and the answer can also be helpful in other pool treatment procedures.

To determine the weight of 1 ppm, multiply the gallonage (in U.S. gallons) by 8.3, then divide that answer by one million:

$$\frac{\text{gallonage} \times 8.3}{1{,}000{,}000} = \text{wt. of 1 ppm}$$

Check your answer against this table of approximations:

U.S. Gallonage	Wt. of 1 ppm
30,000	¼ lb.
60,000	½ lb.
90,000	¾ lb.
120,000	1 lb.
150,000	1 ¼ lb.
180,000	1 ½ lb.
210,000	1 ¾ lb.
240,000	2 lb.
360,000	3 lb.
480,000	4 lb.

Step 2

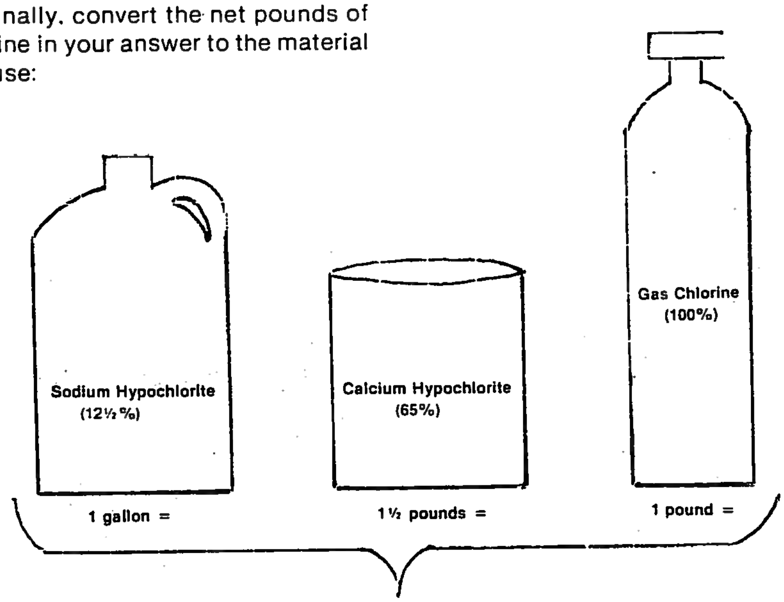
To determine super-chlorination dosage, multiply the chloramine residual by the weight of 1 ppm and multiply again by 12.

Chloramine residual x wt. of 1 ppm x 12 =

Superchlorination dosage in *net* lbs. of chlorine

Step 3

Finally, convert the net pounds of chlorine in your answer to the material you use:



1 pound *net* chlorine

Q & A

Q. We use muriatic acid to lower the pH level in both our pool and spa. Having inhaled the unpleasant fumes of this solution one time too many, I am genuinely concerned. What precautions can we take to minimize the harmful effects of muriatic acid? *(Michael S. Komich, Babson Recreation Center, Wellesley, Massachusetts)*

A. To eliminate the risk of muriatic acid, use sodium bisulfate instead. Sodium bisulfate does not fume, comes in a white powdered form which is mixed with water in a small tank and then fed to the pool with a chemical metering pump. Adding sodium bisulfate by hand may be easy but is not recommended.

Using sodium bisulfate is about 3 to 4 times more effective than using muriatic acid. However, the total cost of acid is probably an insignificant amount when compared to your overall chemical budget.

If you continue to use muriatic acid, keep it tightly covered at all times; when working around it or its metering pump, be sure to use rubber apron, gloves and goggles.

Q. I am responsible for our 330,000-gallon municipal swimming pool and am currently having problems with water bugs. We are chemically automated and are able to maintain break point chlorination making it unnecessary to superchlorinate. However, I noticed an increase in the number of water bugs and felt superchlorination was called for in an effort to be rid of them. Superchlorination decreased the number considerably but did not do a total job.

Would you please tell me what is the best means of keeping a swim pool free of these creatures?

— *Betty Kurz, League City, TX*

A. Superchlorination is the only answer of which we are aware for the control of surface water bugs. In your previous superchlorination efforts we understand you have alleviated but not eliminated the water bug problem. More frequent superchlorination and/or superchlorination to higher chlorine residuals than those to which you have been dosing would probably further alleviate the water bug problem.

Pool Puzzles

During average daily use, there is no detectable chlorine odor in the natatorium and lifeguards report no eyeburn complaints. However, during swim team practice, team members experience eyeburn and there is a strong chlorine odor present within five or ten minutes after practice begins.

At this 150,000-gallon indoor pool, recent public health reports have been okay. The pool is equipped with rapid rate sand filtration at about an eight-hour turnover. Chemical feed is by means of sodium hypochlorite and muriatic acid fed by chemical metering pumps responding to automatic chlorine and pH sensing and controls. The controller is calibrated to maintain a free chlorine residual of 1.0 ppm and a pH of 7.5.

The free available chlorine residual is 0.8 ppm. Total chlorine residual is 1.0 ppm. The pH is 7.2, total alkalinity is 80 ppm and calcium hardness is about 250 ppm. No cyanuric stabilizer is present.

Which of the following steps should be taken?

A. Bring pH up to about 7.5 using soda ash.
B. Super-chlorinate using 3 gallons of sodium hypochlorite.
C. Super-chlorinate using 15 gallons of sodium hypochlorite.
D. Increase total alkalinity to 100 ppm using about 50 pounds of sodium bicarbonate.
E. Increase total alkalinity to 125 ppm using about 220 pounds of sodium bicarbonate.
F. Decrease calcium hardness to 140 ppm using portable softening equipment.
G. Increase chlorine residual setpoint on automatic controller to maintain free available chlorine residual of 1.5 ppm.
H. Increase output setting of hypochlorite feeder by at least 50%.
I. De-chlorinate using 1 pound of sodium thiosulfate.
J. Decrease output of acid feeder by at least 50%.
K. Increase pH setpoint on the controller to 7.8.

Answer

D, H, & J. Increasing total alkalinity to 100 ppm balances the pool water to the Saturation Index and the 50-pound dosage of sodium bicarbonate also had the effect of bringing the pH up to 7.5 so that soda ash would probably not have to be added to accomplish the pH change. A chloramine residual of 0.2 is probably not worth superchlorinating, but if one were to do so the proper dosage would be that indicated in Answer B.

The essence of the problem is that when the controller calls for chemical feed it is not delivering enough hypochlorite fast enough to keep up with the peak demand when the swim team is in the pool. The wolution is to simply increase the output of the feeder so that the controller can respond faster. The controller is probably responding too fast to pH correction by slightly overfeeding acid, a problem solved by reducing the output of the acid feeder. Changing setpoints on the controller will not solve the problem.

The swim must go on, but how?

Imagine yourself in charge of a gas chlorinated 300,000-gallon outdoor pool complex. Half your last soda ash order was back-ordered by the supplier. You eventually run out of soda ash with no possibility of more being delivered for at least a week. Other pools and industrial plants in your area are low on soda ash, too, or have run out completely. The pH of your pool is dropping, now passing through 7.0.

What can you do to keep the pool open? What are the alternate chemicals you should try to find? List the appropriate steps starting with the best possible solution, then the next best, and so on.

Answer

Before you do anything else, turn off the gas chlorinator even if this means you will have to close the pool that day. If you have any sodium or calcium hypochlorite around, begin using it to keep the pool open. How far you are willing to go on this list depends on how badly you need to keep the pool open. Some of the latter recommendations may be outside your budget.

1. Try to find sodium hydroxide (liquid caustic). You want to find it in five or ten gallon carboys as you probably won't need any more than that. Feed it directly out of the carboy using your soda ash metering pump turned down to about 1/10th of its soda ash output setting.
2. Start using sodium bicarbonate in place of soda ash but keep an eye on total alkalinity as you do so. Try not to let the pool get too far out of balance on the Saturation Index even if it is only for a week or so.
3. Start using sodium hypochlorite or calcium hypochlorite instead of gas chlorine. Then when the pH climbs up above 7.6, turn on your gas chlorinator and let it run until the pH is back down to about 7.2. Then go back to sodium or calcium hypochlorite. This step is a little more expensive and a little more hassle than the first two.
4. If by chance makeup water pH is above 7.8, start diluting the pool with fresh water. This is a poor approach and will probably mean restricting bather loads and bather hours so that you use as little gas chlorine as possible.
5. Visit your local supermarkets with a pickup truck and buy as much household bleach as you can find. This remedy could get to be expensive as there is less than a half pound of net chlorine per gallon of grocery store bleach. If you tell your tale of woe to the supermarket manager, he would probably prefer to give you the phone number of his source of bleach supply than to have you clear out his shelves.

Q. & A.

Q. Can you settle an argument? I've heard that the Shamrock Hilton Hotel pool in Houston is the largest pool in the U.S. Is it?
Ron Scribner, Oklahoma City

A. No. To the best of our knowledge the largest recirculated swimming pool in the world is the Finnup Park Pool in Garden City, Kansas which is 220 feet wide by 315 feet long, holding 2,750,000 gallons of water. In addition to swim meets, the pool has hosted sailboat and water ski demonstrations.

Pool Puzzles

Problem: Severe Eyeburn Complaints

At this 240,000-gallon outdoor pool, recent public health reports have been perfect. The pool has a vacuum diatomite (D.E.) filter with about a 7½-hour turnover. Pool water temperature varies from 79 to 83 degrees F.; bathing loads vary from 300 to 1200 per day. Chemical feed is with gas chlorination and sodium hydroxide (liquid caustic soda) regulated by a Strantrol automatic controller.

Total chlorine residual is 1.2 ppm and free available chlorine is 1.2 ppm. The pH is 7.4, the total alkalynity is 40 ppm and the calcium hardness is 150 ppm.

Cyanuric stabilizer was used once in this pool years before, but it has been drained, cleaned and refilled since. Left over cyanuric residual is estimated to be 2-3 ppm.

What is causing the eyeburn complaints and what can be done about it?

A. Pool is chemically good. Eyeburn due to loose D.E. in pool. Shut down recirc. system, let D.E. settle and vacuum to waste.
B. Eyeburn due to excessively low total alkalynity. Add bicarbonate of soda to achieve approximately 100 ppm or more of total alkalynity.
C. Eyeburn due to chloramines. Superchlorinate to about 15 ppm (12 x 1.2) and increase chlorine setpoint on controller.
D. Eyeburn due to leftover cyanuric stabilizer. Drain pool, acid wash and refill.

Answer to December Pool Puzzle - B. Total alkalynity level below 50 ppm is almost always a cause of severe eyeburn. Even when all other factors in pool water are perfect, low total alkalynity will cause severe eyeburn complaints. While adding bicarbonate of soda to achieve a level higher than 50 ppm may be sufficient to eliminate the eyeburn complaint, it is important to raise total alkalynity to at least 100 ppm for other reasons having to do with the potential for corrosion damage. Also, raising total alkalynity to 100 ppm or more gives you that much more margin for error and extends the time before which you will have to add more.

By the way, in answer D it was suggested that an estimated cyanuric residual of 2 to 3 ppm could be eliminated by draining and acid washing. However, once a pool has been stabilized with cyanuric acid, some cyanuric will always remain and there is absolutely nothing you can do to get rid of all of it.

Problem: Short filter runs

At this 300,000-gallon outdoor pool, all but a few of the health reports have been okay. The pool has pressure diatomaceous earth filters which must be flushed and recharged (backwashed) daily. Flow rate provides for an eight-hour turnover, water temperature is a fairly constant 81°F and pool water clarity varies but is usually only fair. Chemical feed is by gas chlorination at 100 ppd all day and shut off at night, soda ash is fed by hand as needed. Bather load is about 1200 per day.

Total chlorine residual is 0.8 ppm, free available chlorine residual is 0.4 ppm. pH 7.3, total alkalinity is 200 ppm, calcium hardness is 120 ppm. Cyanuric stabilizer residual is 20 ppm.

Assuming the filters are properly sized for the pool, what is the first thing that can be done to extend the filter runs?

A. Increase cyanuric stabilizer residual to 50-60 ppm.
B. Superchlorinate to 4.8 ppm (12 times 0.4).
C. Add acid to reduce total alkalinity.
D. All of the above.

Answer to March Pool Puzzle - B. Half of the total chlorine in this swimming pool is in the form of chloramines which are the primary cause of short filter cycles in public pools.

Problem: Occasional Eyeburn Complaints

At this 200,000-gallon outdoor pool, recent public health reports are excellent. The pool has a high-rate sand filter and a six-hour turnover. Pool water temperature is fairly constant at 79 degrees F; bathing loads are about 700 per day. Chemical feed is with a gas chlorinator set at 80 pounds-per-day during the day and 10 pounds-per-day at night, a 5% soda ash solution is fed at 120 gallons per day during the day and is shut off at night. Pool water clarity is excellent.

Total chlorine residual is 1.5 ppm, free available chlorine residual is 1.5 ppm. pH is 7.0, total alkalynity is 80 ppm and calcium hardness is 200 ppm. No cyanuric acid has ever been used in this pool.

What is causing the occasional eyeburn complaints and what can be done about it?

A. Eyeburn is due to chloramines. Super-chlorinate to 18 ppm (1.5 x 12).
B. Eyeburn is due to excessive free chlorine. De-chlorinate and reduce chlorinator output.
C. Eyeburn is due to low total alkalynity, add bicarb to reach 120 ppm.
D. Eyeburn is due to effect on free chlorine of low pH, add soda ash and leave soda ash feeder on at night.

Answer to January Pool Puzzle - D. When pH is below the ideal range the effectiveness of a strong free available chlorine residual is increased. While not all swimmers may complain of eyeburn, some usually will. Correcting the low pH condition is the immediate solution. Maintaining a higher pH number by increasing the soda ash dosage is the long-term remedy.

Answer B was close but not as good an answer as D. 1.5 ppm is not universally considered to be excessive free chlorine. At a pH of 7.5, rather than 7.0, this much chlorine residual seldom causes swimmers to complain.

Pool Puzzles

Ready for swimmers?

Yesterday was your first day in charge of the new 260,000-gallon indoor pool. Your institution has officially accepted the project.

The pool has a plaster finish, sand filters and gas chlorinator. The water is clear and holding steady at 83°F. Air temperature in the natatorium is 72°. The humidistat is set at minimum.

The contractors superchlorinated before leaving the job so both free and total chlorine registered 3.0+ ppm in your test kit. pH read 8.4.

You have already added muriatic acid moving pH down to 7.6. You have dechlorinated by adding sodium thiosulfate a little at a time. Now both free and total chlorine register about 1.2 ppm.

Ready for swimmers? Not quite. The list below includes several worthwhile tasks, but only three are important to swimmer comfort and save money at the same time. Which are those three?

A. Dechlorinate further to 0.8 ppm.
B. Request inspection by public health official.
C. Floc the filters.
D. Add a sequestering agent.
E. Clean the deck with a fungicide.
F. Increase room air temperature to within 3° of water temperature.
G. Scrub the deck with a calcium hypochlorite and water solution.
H. Backwash the filters.
I. Balance total alkalinity and calcium hardness to the saturation index.
J. Install a 24-hour control timer on the main recirculation pump.
K. Establish 69-65% Relative Humidity.
L. Add the appropriate dose of algecide.

Answer to Pool Puzzle: F, I and K. The contractor probably superchlorinated using the gas chlorinator which would have reduced both pH and total alkalinity. The fact that pH stayed high is not unusual for new plaster pools. Your further addition of muriatic acid would have decreased total alkalinity even further. It is now critically important both for swimmer comfort and to prevent corrosion damage that the total alkalinity and calcium hardness be balanced to the saturation index.

82° water and 72° air will make for a cold trip back from the pool to the showers. By keeping air and water temperature with 3° of each other and by maintaining a relative humidity of about 65%, swimmers are made most comfortable. Moreover, by balancing air temperature, humidity and water temperature in this way, overall energy costs are minimized.

All but one of the other answers might have been worth doing depending on conditions. The inappropriate answer under any conditions is J. Using a 24-hour control timer to shut off the recirculation system during periods of non-use is a trick the residential owner may be able to get away with, but it is strictly forbidden for public pools.■

Problem: No problem . . . Or is there?

Even when no one is complaining, the conscientious pool manager or operator keeps an eye on the numbers.

Consider this 220,000-gallon indoor pool where the recent public health reports have been perfect. The pool has rapid sand filtration with a nine-hour turnover, water temperature is 80°F, pool water clarity is fair to good and bather load averages about 400 per day.

Chemical feed is by calcium hypochlorite in solution fed at 2 gallons per hour all day. Acid is added by hand as needed.

Pool water tests reveal that total chlorine residual is 1.2 ppm and free available chlorine residual is 1.0 ppm. The pH is 7.9, the total alkalinity is 240 ppm and the calcium hardness is 600 ppm. No cyanuric acid stabilizer has ever been used in this pool.

Which is the most accurate and useful statement:

A. Pool is perfect-no solution needed.
B. Water clarity can be improved by superchlorinating to 2.4 ppm (0.2 times 12).
C. Calcium hardness is too high, begin softening water.
D. Potential scale problem exists, add acid to reduce pH and total alkalinity.

Answer to February Pool Puzzle · D. With a pH of 7.9, a total alkalinity of 240 ppm and a calcium hardness of 600 ppm, the heater on this pool was already at the end of its service life. In almost all cases the calcium hardness level of 600 ppm would be too difficult or expensive to reduce. However, the addition of acid would drop pH and total alkalinity into ideal ranges, thereby correcting the immediate problem.

For a long term remedy, a chemical metering pump should be used for dispensing muriatic acid. The problem stated "acid is added by hand as needed." Anytime a chemical is added "by hand" it is very seldom added "as needed."

Q. & A.

Q. In the November issue you mentioned that pools must sometimes be drained because of the presence of insecticides. We have to use insecticides around our pool regularly. What can we do?
Tom Johnson, Webster, New York

A. Never use an insecticide on a pool deck. Use a dilute solution of calcium hypochlorite and water. You can mop the deck with this solution but if you have a severe insect problem, use a heavy, long-handled brush or shop broom that will permit you to use a scrubbing action. Insecticides, even in tiny quantities, don't mix well with swimmers. Severe eye irritation and swimmer discomfort will result even from the smallest traces in pool water of almost all insecticides.

Pool Puzzles

Problem: Cloudy Water

At this 80,000 gallon indoor pool, recent public health reports have been okay. The pool has high rate sand filters with an 8-hour turnover. Pool water temperature is 84 degrees. F., bathing load is about 200 per day. Chemical feed is with 12% sodium hypochlorite (bleach) fed at ½ gallon per hour during use periods with acid added by hand "as needed."

Total chlorine residual is 1.0 ppm and free available chlorine residual is 0.4 ppm. The pH is 7.6, the total alkalynity is 160 ppm and the calcium hardness is 200 ppm. No cyanuric stabilizer has ever been used in this pool.

What is causing the cloudiness, how do you clear the water now and how do you keep it clear?

A. Cloudiness due to high total alkalynity, hardness and pH. Add acid.

B. Cloudiness due to inadequate filtration. Renovate, designing for 4- to 6-hour turnover.

C. Cloudiness due to chloramines. Super-chlorinate to 7 or 8 ppm (12 x 0.6) and increase hypochlorinator output to achieve 1.0 free available chlorine residual.

D. Cloudiness due to high temperature and unusually high bather load for this size pool. Decrease thermostat setting to 78 degrees and try to better enforce bather preparation regulations.

Answer to November Pool Puzzle - C. A is wrong because total alkalynity, hardness and pH by themselves almost never contribute to cloudiness. B is impractical and does not solve the root of the problem which is chemical in nature. D is wrong because temperature variations of 6 or 8 degrees have no noticeable effect on water clarity. C, super-chlorination and increased hypochlorinator output goes right to the heart of the problem with a quick fix as well as a long-term remedy.

Eyeburn again

Several swimmers complained about eyeburn at this 180,000-gallon indoor pool. This pool has a bank of rapid sand filters and operates at about an 8-hour turnover. Recent public health reports have been okay and pool water clarity is good, but has been better on other occasions.

Yesterday the total chlorine residual was 2.5 ppm and free chlorine residual was 1.5 ppm. pH was 7.7, total alkalinity was 80 ppm and calcium hardness was 100 ppm. The water temperature has stayed about 82 degrees F.

Late yesterday the pool was super-chlorinated using the appropriate dosage (in this case, 15 gallons of sodium hypochlorite.) After super-chlorination, both total and free chlorine residual read 3.0+ on the test kit and so 2 pounds of sodium thiosulfate were added after which total chlorine and free chlorine both read 1.5 ppm. pH at that point was 7.6.

Now swimmers still complain about eyeburn. The pool operator draws the conclusion that super-chlorination does not work and is not a solution to the eyeburn problem.

Is the operator correct? If his conclusion is wrong, why? Also, how do you solve the eyeburn problem now?

Answer to Pool puzzle

The operator is wrong. In this situation eyeburn is coming from two sources. Chloramines present before super-chlorination were causing eyeburn and this problem was solved by a proper super-chlorination and dechlorination sequence.

However, this pool is low in the Saturation Index. That, too, can be a cause of eyeburn. The operator should now increase calcium hardness to about 250 ppm by adding about 300 pounds of calcium chloride. This last step should finally alleviate the eyeburn problem and water clarity should improve as well.

If the operator had raised calcium hardness first, he would still have had to super-chlorinate to solve the eyeburn problem.

Problem: Brownish, cloudy water

At this indoor 250,000-gallon pool recent public health reports have been okay. The pool has a vacuum DE filter sized for a six-hour turnover and water temperature is 80 degrees F. Pool water clarity is poor, brownish and cloudy.

Chemical feed is by the use of 12% sodium hypochlorite fed at 2 gallons per hour all day, reduced to ½ gallon per hour at night. Approximately a 5% muriatic acid solution is fed at 0.2 gallons per hour all day and shut off at night.

Pool water tests indicate total chlorine of 0.8 ppm and free available chlorine at 0.6 ppm. The pH shows 8.4 on the phenol red test. Total alkalinity is 160 ppm, calcium hardness is 320 ppm. No cyanuric acid stabilizer has ever been used in this pool.

Which is the most accurate statement and instruction?

A. Brownish cloudy water due to too high pH and hardness. Increase acid feed to reach pH 7.4.

B. Cloudy water due to precipitation of minerals. Let pool quiet down and vacuum to waste.

C. Cloudy water due to precipitation of minerals. Super-chlorinate to 3 ppm.

D. All of the above.

Answer to April Pool Puzzle:

D - all of the above. The problem stated that "the pH shows 8.4 on the phenol red test." Remember that phenol red test kits read only up to 8.4. At higher pH levels, other test reagents are needed. Therefore all we know for sure is the pH is probably at or above 8.4. At this pH level, it is common for minerals to come out of solution and be visible in suspension causing the brown color and the cloudiness.

A was the only answer that suggested dropping the pH. B was the only answer that suggested letting the suspended particles fall to the bottom of the pool and vacuuming them to waste. Both A & B are right. C recommended super-chlorination. Whenever cloudiness or discoloration of pool water is observed, super-chlorination may help and it certainly won't hurt. Undoubtedly A & B are better answers than C but the most correct answer had to be all of them.

Pool Puzzle

At this outdoor 180,000-gallon swim club pool, recent public health reports have been excellent. The pool has a vacuum DE filter sized for a 6-hour turnover and water temperature is 80 degrees F. Pool water clarity is superb almost all the time but occasionally has a greenish cast that lasts a few days.

Chemical feed is by 12% sodium hypochlorite and a 5% muriatic acid solution. A Strantrol controls the feed of hypochlorite and acid to setpoints of 1.0 ppm free chlorine and a pH of 7.4.

Pool water tests indicate free chlorine of 1.0 ppm and total chlorine of 1.2 ppm. pH is 7.4, total alkalinity is 80 ppm and calcium hardness is 140 ppm. No cyanuric acid stabilizer has ever been used in this pool.

The club has been through two heaters in six summers of use.

What can be done, if anything, to extend heater life and reduce or eliminate the occasional periods when pool water is slightly green?

A. Pool chemistry is perfect, nothing can be done.

B. Green water and short heater life problems can be solved by burning out the chloramines. Super-chlorinate to 2.4 ppm (0.2 times 12) and begin dosing algaecide periodically.

C. Green water is coming from green algae, increase free chlorine setpoint on the controller to 2.0 ppm. Heater problems may be a result of faulty insulation. Have independent engineer inspect.

D. Occasional green color comes from copper tubes in the heater which are being corroded by aggressive water. Add 162 pounds of calcium chloride to increase calcium hardness to 300 ppm and elevate pH setpoint on the controller to 7.6.

Answer to July Pool Puzzle

D - even though total alkalinity, calcium hardness and pH are within the ideal ranges, all are at the minimum of the ideal ranges. Because of their interaction with one another, the water is slightly corrosive. The effect so far is to corrode the copper in the heater which is why the water is occasionally greenish and also explains why two heaters have been needed in the last six summers. Any manipulation of the Saturation Index to achieve balanced water would extend heater life and probably eliminate the occasional green water problem. Raising calcium hardness and selecting a slightly higher setpoint for pH control are easy and inexpensive ways to balance the pool water.

Q. & A.

Q. We are thinking about installing a spa for the members in our facility. I have heard bad things about spas -that they are a lot of trouble. Is this true?

— *Carl Martin, Chicago, IL.*

A. Yes, it's true. Because spas are small, we automatically assume they are less hassle than larger pools, but the reverse is true.

There are several reasons that spas offer the problems they do. People tend to treat spas like bathtubs, frequently jumping in after a sweaty workout on a track or in a gym. In the hotter water, typically 95-110 degrees F, chlorine is even more unstable than at 80 degrees F. The ratio of bathers per day per gallon is much lower than in larger pools. Suppliers typically undersize spa mechanical systems using filters that are too small and recirculation rates that are too slow.

All prior notions of part-per-million residuals can be discarded. Two racquet ball players soaking in the spa after a match may create chlorine demand requiring a dosage of several ounces of chlorine. This dosage can be equivalent to hundreds of parts-per-million in most spas.

What now, boss?

Imagine that you have just been made manager of a new, high budget, first-class aquatic facility. Your new boss demands perfection at any reasonable price. The pool is 240,000 gallons capacity. Water clarity is good but could be better. The test kit is first-class and the reagents are fresh. Your first day on the job you decide to balance the pool water. Here's what you find with your test kit:

pH 7.4
total alkalinity 100 ppm
calcium hardness 80 ppm
total chlorine 1.5 ppm
free available chlorine 0.6 ppm
cyanuric residual 0
temperature 80 degrees F.

What steps do you take to balance the water? If chemical dosages required can be predicted as to quantity, how much of each will be needed?

Answer to May Pool Puzzle

First, super-chlorinate to 10.8 ppm by adding 21.6 pounds of gas chlorine, about 22 gallons of sodium hypochlorite or 32 to 34 pounds of calcium hypochlorite. Second, raise calcium hardness to 250 ppm by adding 510 pounds of calcium chloride. Maintain pH at 7.4 to 7.6 throughout the process by adding acid or soda ash as needed. Finally, de-chlorinate if necessary with sodium thiosulfate at a rate of 1.4 pounds for each 1.0 ppm of chlorine to be reduced.

Super-chlorination and de-chlorination dosages require your determining the weight of 1 part-per-million in a 240,000-gallon pool. Super-chlorination dosage should be 12 times the chloramine residual, de-chlorination dosage is 0.7 times the excess free chlorine residual.

The reason for increasing calcium hardness is to satisfy the Saturation Index by making total alkalinity in ppm times calcium hardness in ppm equal 25,000. In this case, 100 ppm total alkalinity is okay. Dividing 25,000 by 100 ppm total alkalinity reveals the desired calcium hardness level.

In an upcoming issue, our feature article presents the steps you can take to solve the unique problems of spas.

Spas are very much enjoyed and are being added to institutional athletic facilities at an increasing rate. They can be kept as clean, clear, pleasant and sanitary as larger pools - but it takes new techniques and just as much, if not more, operator time than does the larger pool.