Aquatic Consulting Services
1220 Rosecrans Street #915 · San Diego · California · 92106

Pool Tip #53: Problems Reaching Breakpoint

Although rarely a problem in outdoor pools, since sunlight destroys chloramines, and the objectionable odors blow away, many pools operators have a great deal of difficulty ridding their indoor pools of chloramines. Unfortunately, HOCl also reacts with UV light (sunlight) and becomes an inactive chloride ion or salt (Cl^-).

Some pools have enormously high bather load to water volume ratios, resulting in heavy organic loading, and high levels of ammoniated impurities in the water. Spray features at amusement parks, health club spas, therapy pools, swim school pools, and children's wading depth pools with interactive play features, for example, often have chlorine levels unfathomable to operators of more traditional swimming pools. It is not surprising to find that an 18,000 gallon swim school pool maintained at 94° Fahrenheit having a bather load of 300 pre-school aged children per day, will have a continuing problem with chloramines. Ten thousand gallon children's wading pools at successful commercial waterparks may have bather loads exceeding 2,000 children per day. It is not unusual to find amusement park water spray features with interactive fountains that have more users coming into contact with the water than number of gallons of water in the water feature. These same pools often have problems reaching breakpoint or keeping chloramines within acceptable levels.

If a chloramine residual persists in a pool in spite of the operator following proper breakpoint chlorination techniques, and continues to be a chronic nuisance, some of the following suggestions should be tried.

Regular Dilution

Drain and replace with 30 liters (approximately 8 gallons) of fresh water per user per day, as recommended in the German DIN (Deutsch Industrie Normen) Standard 19,643: "Treatment & Disinfection of Swimming & Bathing Pool Water". The DIN Standard has been adopted by the European Community, and FINA requires water standards compatible with the DIN standard during international swimming competition.

Increase Exposure Time and Chlorine Concentration

You may be successful in reaching breakpoint by superchlorinating for longer periods of time with higher levels of chlorine.

Draw Water from the Pool Surface

Chloramines are concentrated near the surface of the water, as are most organic contaminants. During breakpoint chlorination, turn off the valve which draws water from the main drains and direct all the water through the perimeter overflow system. By circulating only through the skimmers or gutters, you will speed up the process by removing the water where chloramines are concentrated first.

GAC Filtration

Install secondary granulated activated carbon (GAC) filters and remove ammonia through filtration. GAC filters can be used to treat a slip-stream of water continually drawn off the main effluent line, or to treat source water prior to its being added to the pool. Many pools in areas of the country where municipal water utilities are adding ammonia to the source water to prevent trihalomethane formation in drinking water are installing GAC filters to pre-treat fill water to keep ammonia levels below 0.02 ppm. Chloramination has become a common practice by water utilities in order to comply with U.S. EPA water quality standards for drinking water to prevent formation of chloroform, a known carcinogen. Since chloramines do not react with raw water organic precursors which form when vegetation decays, monochloramines are commonly being used to treat water which has been stored in reservoirs. This practice is causing havoc in swimming pools.

Non Chlorine Oxidizers

Potassium peroxymonosulfate (AKA: monopersulfate), can be used instead of chlorine to shock , or oxidize chloramines and other organic contaminants from the water. The product is a buffered chemical compound which utilizes oxygen to prevent or destroy the eye irritation and odor qualities of pool water by reacting with ammonia to produce chloride and nitrogen. Sold under various trade or brand names, the product has be successfully marketed to homeowners, and is beginning to make inroads into the commercial pool market.

Unlike chlorine which must reach a "breakpoint", any amount of potassium peroxymonosulfate added to water will oxidize some material. Normally though, between 5 ounces and one pound per ten thousand gallons of water is added on a weekly basis to pools, and daily basis to spas. Non chlorine oxidizers will not raise chlorine levels, are totally soluble, do not cause bleaching, and they don't affect water balance or pH. Monopersulfates are especially recommended for pools or spas with high bather load to water volume ratios where total dissolved solids and ammonia normally build-up at a rapid pace.

The pool owner should be cautioned however, that regular use of non chlorine oxidizers may irritate bathers causing them to itch. Also, potassium peroxymonosulfate is known to have an effect on DPD reagents in both liquid and tablet form, causing water samples to turn dark red, and may cause a false high free available chlorine reading. DPD reagent #3 is oxidized by monopersulfate so the test actually reads the monopersulfate residual preventing

an accurate reading which distinguished between free and total chlorine. Some test kit manufacturers sell FAS-DPD reagents that eliminate monopersulfate interference.

Some pools maintain a residual of monopersulfate to help eliminate bather waste and the build-up of organic contaminants, as a preventative rather than corrective treatment. One manufacturer (U.S. Filter) has patented a continuous breakpoint halogenation and peroxygenation system. Potassium peroxymonosulfate doesn't react with chlorine, but rather oxidizes contaminants and reduces the demand on the sanitizer. It should be noted though that not all products sold as non chlorine oxidizers contain the active ingredient potassium monopersulfate. For example, sodium percarbonate (AKA: sodium carbonate peroxyhydrate) releases or produced hydrogen peroxide, and reacts with chlorine.

Eliminate the Chlorine to Eliminate the Chloramines

Hydrogen peroxide or sodium thiosulfate can be added to the pool to drop the chlorine level to zero. This eliminates the free chlorine residual by converting chlorine back to chlorine salt. When chlorine is eliminated from the water, chloramines will also be eliminated. However, when chlorine is reintroduced, it will start combining with the ammonia which is still present in the water and form chloramines, but hopefully in a gradual manner and as a less objectionable monochloramine rather than nitrogen trichloride.

A word or two of caution – don't overdo the amount of hydrogen peroxide or sodium thiosulfate you add to the water or you will create a chlorine demand and have a difficult time reestablishing a chlorine residual. Also, do not add products containing hydrogen peroxide to a pool which utilizes diatomaceous earth filters, since hydrogen peroxide reacts with and dissolves D.E.

Zeolites

Zeolites with a high (at least 80%) percentage of clinoptilolite can be used as a filter media instead of #20 silica sand in sand filters. Zeolites are a family of granular, extremely porous volcanic minerals capable of removing ammonia from the water as well as particles down to 5 microns in size, equivalent to the filtering capabilities of a diatomaceous earth filter. Zeolites for swimming pool filtration are marketed under various trade names by Neptune Benson (Clinopure 80), British Zeolite Co. (Zeoclere-30), Innovative Water Science (Zeo-Pure 90), Eco Smarte (Hydroxite #2), and others.

When a layer of 10% sodium chloride (table salt) is added to the filter bed an ionic reaction occurs which causes the absorption and removal of ammonia as the water passes through the filter, thereby reducing chloramine formation. The pool operator must regenerate filter media every 6 months by backwashing, shocking with a salt solution, allowing the bed to reactivate for 24 hours, agitating the media, then backwashing. Zeolites supplied by a reputable distributor should have a life expectancy 5 to 7 years.

Corona Discharge Ozone Systems

Organic contaminants are slightly reactive with ozone, but after being partially oxidized, microflocculation allows their removal by filtration. Inorganic contaminants such as ammonia react significantly with ozone when the pH is maintained below 9.0. Ozone constantly oxidizes monochloramines to form chloride and nitrate ions. Unfortunately, ozone also destroys high free chlorine residuals in the process of destroying chloramines, so chlorine lost in the process must be constantly replaced.

Ultraviolet Light

UV light whether from natural sunlight or from UV light sanitation systems can be used to destroy chloramines and aerosolized chlorine compounds. If natural sunlight cannot be brought into the natatorium, UV light sanitation systems can be installed to provide supplemental sanitation and destroy chloramines.

UV light systems are installed in-line and are used in combination with either hydrogen peroxide or chlorine which provides a residual sanitizer and oxidizer in the pool water. The system consists of a treatment chamber installed on the filter effluent line, control box and power supply. Photolytic liners are permanently attached to the internal surfaces of the treatment chamber. Water flows through clear, quartz glass or Teflon tubes through the treatment chamber, passes the UV lamps (arc tubes) and pathogens are destroyed. UV kills microorganisms by destroying the DNA in the cells. There is no change in water color, temperature, taste, pH or chemical composition, however, turbid water will absorb UV light and make UV less effective as a disinfectant.

Disinfectant level is related to light intensity and exposure time. UV dosage is measured in either microwatt seconds per square centimeter (MWS/cm^2). You may also see intensity and exposure time expressed in millijoules per square centimeter (mJ/cm^2) instead. Six thousand to 10,000 MWS/cm^2 or a minimum of 60 $mJ/cm^2$are needed to destroy pathogenic organisms.

There are two types of UV lamps: low pressure (with an electromagnetic spectrum between 185 and 254 nanometers); and more commonly used today, medium pressure high intensity (with a wider electromagnetic spectrum between 180 and 400 nanometers, and not affected by water temperature). UV is most germicidal in wavelengths between 240 and 280 nanometers. Organic compounds are best photo oxidized by hydroxyl radicals in wavelengths below 230 nanometers. The bond between chlorine and nitrogen is broken, and chloramine destruction is most effective in the range of 245 and 340 nanometers, making low pressure bulbs a poor choice for chloramine destruction.

Increase Airflow Over the Water Surface

It is not possible to superchlorinate below a pool blanket or inside an enclosed pipe. By definition, oxygen is needed for oxidation to occur and off gassing into the air must take place. If there isn't enough oxygen over the pool, breakpoint will not be achieved. Think of a fire. If the fuel is present but oxygen is lacking, combustion will not occur. Do whatever you can to get more air moving over the pool. So open the windows and doors, turn on the exhaust fans to move large volumes of air.

Unfortunately, as you speed up the removal of chloramines from the water, you release them into the air in the natatorium. Since like an outdoor pool, you do not have the ever present wind to blow away the odors and irritants, the air handling system must be designed to take the place of nature.

Chloramines are very volatile and easily vaporized into the air surrounding the pool. You can reduce the chloramine concentration in the air, by increasing the percentage of outside air brought into the natatorium and diluting the objectionable chloramine odors and irritants with fresh air. There should be at least 8 complete air exchanges per hour. Open air dampers to permit 100% fresh air to be brought in especially during breakpoint chlorination. During regular operation, as little as 15% fresh air may be permitted by code, but a minimum of 40% is recommended (up to 100%) depending on usage patterns, natatorium design, and equipment installed. For instance, pools that have water features installed that agitate water or aerosolize water vapor, particulates, or pathogenic organisms should exchange more air.

The location and placement of supply registers and return/exhaust ducts should be such that air is supplied low, moved across the water surface at a velocity less than 25 feet per minute to move the heavier than air gasses concentrated and settled directly over the pool, and exhausted high near ceiling level. Pollutants travel from positive to negative pressure areas, so natatoriums should be positively pressured in relation to the out of doors, and negatively pressured in relation to surrounding occupied spaces.

The air handling system installed should be capable of providing thermal environmental temperatures acceptable to 80% or more of the primary/priority facility users, averting sick building syndrome problems, and preventing discernible odors, without evident drafts, stratification of air, thermoclines or temperature gradients.