

# Studies Look at Pool Chemistry Hazards

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Millions of Sunbelt families know that the secret to keeping a happy home is having a pool in the backyard. It not only keeps summer vacationing children occupied and happy, it also provides welcomed relief from high temperatures combined with high humidity.

Swimming is recommended by most physicians as a healthy, low impact exercise that relieves stress while improving muscle tone and causing unneeded weight to melt away.

Your backyard pool can be one of the safest and healthiest things available to you and your family, or one of the most potentially hazardous. When not properly sanitized, warm pool water is a perfect breeding ground for disease-causing organisms and bacteria. Jump into an inadequately sanitized pool and you and your family may be at risk. The risk does not end there.

Most of the 6.5 million residential swimming pools in the U.S. are tested and chemically treated by a member of the family. Most homeowners rely on an automatic pool cleaner to remove debris from the pool and rely on the local pool store clerk to periodically test the water and tell them what to do. They are sent home with hazardous chemicals, such as chlorine, acid, algicide, stabilizer, pH up, pH down, defoamer, clarifier, and calcium hardness increase.

## **STORING AND ADDING CHEMICALS**

Chemicals are typically stored at home within the pool equipment enclosure, to be added as instructed. The most common chlorinated compounds sold are chlorinated isocyanurates (in powder or tablet form), usually called dichlor or trichlor tablets, sodium hypochlorite (liquid bleach), and calcium hypochlorite.

These chemicals are incompatible with each other. Any intentional or accidental mixing of the chemicals with each other or with unrelated materials, such as gasoline, oil, paint,

solvents, swimming pool acid, oily rags, etc., can create a chemical reaction ignition, explosion, and release of highly toxic vapors. Powder and tablet chlorine compounds may become a hazard when a small quantity of water is splashed on them, triggering violent reactivity.

Pool chemicals cause serious injuries when they come into direct contact with a person's eyes, respiratory system or digestive system. These injuries usually occur when powdered chemicals are broadcast, when liquid chemicals are poured into the pool, or when children or pets gain access to the chemicals.

Cumulative data compiled by the American Association of Poison Control Centers' National Data Collective Systems reveals tens of thousands of exposures, many resulting in serious injury or death, with an alarming increase in exposures and injuries.

## **CONTAMINATED POOL WATER**

The U. S. Center for Disease Control (CDC) likens swimming to "communal bathing." On average adults will have 0.14 grams of feces on their bodies which, when rinsed off, will contaminate pool water. They will shed a layer of dead skin cells, excrete a pint or more of perspiration and a small amount of urine and mucus. Children may accidentally introduce larger quantities of urine and fecal matter into the pool. Chemicals and debris, such as fertilizers, pet droppings, dirt and leaves may be washed or blown into the pool from the surrounding area. These bodily fluids and materials contain millions of germs and pathogens, causing contamination of swimming pool water.

Contaminated water can cause a variety of diseases and infections, such as bacterial gastroenteritis, diarrheal illness, skin rashes, dermatitis, ear infections, upper respiratory infections, wound infections and legionnaires disease. It may take several weeks before symptoms of illness are experienced. People often do not connect their illness with swimming, so many pool-related outbreaks go unreported.

Pool store chemicals regularly tested and added to maintain pool chemical levels at the "ideal" range may kill some germs and bacteria, but cannot kill the most dangerous contaminate found in swimming pools—this especially chlorine resistant organism is commonly referred to as "crypto."

## **CRYPTOSPORIDIUM**

The elderly and people with compromised immune systems are especially vulnerable to severe illness from this highly contagious organism. The most common cause of water-born disease, cryptosporidium is found in swimming pools in every region of the United

States.

Typically, symptoms of illness appear 2-10 days after exposure, which can be diarrhea, dehydration, weight loss, stomach cramps, fever, nausea and vomiting.

An unaware carrier with no symptoms of illness, by introduction of fecal matter into a pool, can pass millions of parasites—enough to contaminate a large pool. Ingesting as few as two parasites can cause illness.

Chemicals purchased at the swimming pool supply store and added as directed with levels maintained as instructed, are not effective against cryptosporidium. Swimming in a so-called “perfectly balanced pool” will not protect you or your family against this parasite. According to the U. S. Centers for Disease Control and Prevention, only “hyperchlorination” can inactivate this parasite.

## **HYPERCHLORINATION**

The only residential swimming pools maintained in a state of “hyperchlorination” are pools serviced with chlorine gas. Injected directly into pools, gas achieves breakpoint chlorination, creating free available chlorine, the only truly effective form of chlorine. Because the gas is so effective, algicides, clarifiers, muriatic acid and shock powders are not needed, reducing costs for gas service providers. Free available chlorine is the agent that destroys soluble organic waste in the water; more importantly, it kills pathogenic organisms that might enter the water. At higher concentrations of chlorine, the rate of kill is much more rapid.

## **CHEMICAL COSTS**

Pure chlorine gas is the most effective and least costly of all forms of chlorine. Packaged chlorinated compounds are manufactured by combining the gas with solids or liquids, such as caustic soda, calcium or cyanuric acid. The manufacturing process necessary to create packaged chlorinated compounds is energy intensive and extremely costly.

Markups in price from the manufacturer, distributor, wholesaler and retailer, combined with the costs of packaging, shipping and warehousing, drive the cost of producing chlorinated compounds to high levels, especially when compared to the original cost of the pure chlorine gas. Gas is purchased for as little as twenty cents per pound, compared to three dollars per pound paid by many homeowners for chlorine.

## **GAS SERVICE**

Gas chlorine is a non-flammable, non-explosive hazardous chemical and can only be provided by companies whose service personnel are specially licensed and trained to

safely apply it. Gas technicians service the pools once each week, test the pool water and add chemicals needed to keep the water balanced and hyperchlorinated. Chemicals are never left or stored at the home.

Gas service is a high volume business, intended to service a lot of pools at a low price. The smallest companies treat hundreds of pools, and some have thousands of customers. A chemical company located in California has an organization that services more than thirty-five thousand pools each week.

In the late 1990s extensive scientific studies were conducted to investigate the effects of gas chlorine service on residential swimming pools.

## **STUDIES**

Two nationally recognized experts, considered to be the foremost authorities in the fields of chemistry and engineering in water treatment and sanitation headed up the team. The Dr. Jerome F. Thomas and George Clifford White studies included consideration of chlorine availability, oxidation states, reaction in water, chlorine demands, oxidizing agents, organic debris, biocidal bacteria, enzymes, proteins, ammonia, toxicity levels and contaminants. In addition, readings from electronic probes placed in various locations and depths throughout the pool, during chlorine injection to record chemical levels, dispersion, and reactivity were reviewed.

### **Dr. Jerome F. Thomas, Ph.D.**

Dr. Thomas has a B.S. in Chemistry from De Paul University, and a Ph.D. in Physical Organic Chemistry from the University of California, Berkeley. He is a Professor Emeritus of Sanitary Engineering at the University of California and was the former Chairman of the Division of Sanitary, Environmental, Coastal and Hydraulic Engineering.

Dr. Thomas authored a book on industrial water chemistry, published more than one hundred scientific journals and authored a white paper on chemistry related to swimming pool linings and chemistry related to pool waters.

### **George Clifford White**

George Clifford White, CE, ME. is the author of the *Handbook of Chlorination and Alternative Disinfectants*, the essential source book on disinfectants for water purification.

For more than two decades, George Clifford White's handbook has been known as one of the most vital references on all aspects of chlorination, de-chlorination, and the use of alternative disinfectants, such as chloramines, ozone, bromine and ultraviolet radiation. His latest edition (Fourth Edition) is a key resource for researchers, designers, regulatory agencies and technicians.

### **James R. Brownell, Ph.D.**

Dr. Brownell has a B.S., M.S., and Ph.D. in Geobiochemistry from the University of California, Davis.

Dr. Brownell supplemented the studies conducted by Dr. Jerome Thomas and George Clifford White. He supervised the collection of water samples from gas chlorinated pools by university students. The samples were then tested at the University of California, Fresno, laboratory and at the Fresno County Health Department laboratory. Dr. Brownell also conducted tests on the affects of chlorine gas injection on a vinyl pool liner.

### **CONCLUSIONS**

White says a pool must be properly treated for three primary purposes: health, safety and aesthetics. The pool must be disinfected to prevent transmission of disease. The water should be non-irritating and free of objectionable odors and tastes. The combination of adequate chemical treatment and the removal of particulate matter by filtration make achievement of these objectives possible.

According to George Clifford White, Free Residual chlorine (HOCL) has the greatest germicidal efficiency of all the chlorine compounds. Free available chlorine is formed by dissolving chlorine gas in water. It is the best disinfectant for pool water treatment, notwithstanding the claims for bromine, iodine and ozone. It is a taste and odor-free compound in the quantities used for pool treatment purposes. It is not known to be an eye irritant. Because of its oxidizing powers, it has the capability of destroying organic matter, resulting in super clarity, giving the pool water a polished look.

White found the gas injection treatment system will not cause any kind of stain or deposit on the pool containment structure, nor will it damage the pool plaster, plumbing or equipment.

White emphasized, "The most important feature of this system is a stable biological condition at all times. It is the only system that can unconditionally guarantee this stability and provide the pool user a pure wholesome, sparkling clear water on a continuous basis."

Professor Jerome Thomas stated that chlorine gas is introduced by direct injection using a dispersion device placed at the pool's bottom. The gas is released as minute bubbles creating a roiling reaction, resulting in a very rapid and even distribution of the chemical through the body of water and rapid neutralization by the buffer system. Studies measuring pH have shown no unfavorable drop in pH around the dispersion device, including the under surface of the device which is in contact with the pool lining.

Thomas emphasized that "a major advantage of direct injection of chlorine gas is that it insures that no ammonia buildup is ever possible, and that the kill of chlorine-resistant microorganisms readily occurs."

According to Dr. James Brownell, a piece of vinyl was blasted with chlorine gas, equivalent to the effects of several years of treatment on a vinyl pool liner, with no measurable impact. Neither gas chlorine or pH in the range of 2.5 to 9.5 had any effect on the vinyl. There was no visible loss of pattern or bleaching of the basal color.

Plaster, marcite, fiberglass, vinyl and pebble pool linings cannot be adversely affected by chlorine levels maintained in solution even if the chlorine levels were taken many times higher than those levels that are achieved by use of gas on swimming pools.

These findings were given support by Douglas Noh, manager at Farmers Insurance Group located in San Jose, California, who stated, "Over the past 16+ years my agency has insured 60 to 70 companies, that service residential swimming pools using chlorine gas. To date, I have never had any claims concerning chlorine gas damage to any pools or equipment."

Safe and healthy swimming pool water must be crystal clear, sweet smelling and good tasting. This requires chlorination and filtration. The better the sanitation and the more adequate the filtration, the safer and more comfortable the pool water will be for your family.

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*Rudolph S. Caparros, Sr., has over forty years experience in the chlorine industry. He has made great technological advances in chlorine plant packaging technology. In addition, he is the creator and patent holder of containment systems for chlorine cylinders, ton containers, bulk storage tanks, tank trucks, rail tank cars and barges.*