CHAPTER 7
DISINFECTION AND OXIDATION PRODUCTS

7-1. GENERAL.

Historically, chlorine has been the primary disinfectant used in swimming pools, although bromine has also been widely used. Both chemicals are commonly referred to as halogens, a chemical term used to describe four related elements in the atomic table: chlorine, bromine, iodine, and fluorine. Although iodine has shown promise as a pool disinfectant and is currently the subject of considerable experimentation, its use has not become widespread enough to be included in this discussion. Algicides are used to assist the disinfection process and are therefore included. All pool chemicals must be handled and stored in accordance with the manufacturer's instructions. NOTE: Never mix chemicals together outside of the pool; rather use the pool as a buffer in the actual application.

7-2. CHLORINE PRODUCTS.

Chlorination, as the term implies, is the practice of introducing chlorine to pool water after it leaves the equipment either in its elemental form or as a chlorine-bearing compound. Regardless of the product used or the method of application, the goal is to achieve a chlorine residual possessing strong oxidizing and disinfecting properties. There are four chlorine sources that are commonly accepted as disinfection products.

7-3. ELEMENTAL CHLORINE.

a. Elemental chlorine is a greenish gas at room temperature. Packaged under pressure as a liquid in metal bottles, it is fed into the recirculation system by specially designed equipment. If the chlorine gas escapes from the container or feeder apparatus, it will aggressively attack virtually all surroundings, especially if water or moisture is present. It is also highly toxic to man. Because of the hazardous nature of chlorine gas, its proper handling must be thoroughly understood by those responsible for handling containers and operating feeding devices.

b. Normally, the cost of elemental chlorine is considerably less than the cost of commercial chlorine-bearing compounds. It is therefore the most commonly used chlorine sources in the large swimming pools where feed rates and consumption are high. The cost of the extra soda ash required for this type of chlorine must be taken in account in making any cost comparison.

7-4. CALCIUM HYPOCHLORITE.

a. Calcium hypochlorite is a relatively stable compound of chlorine and calcium, commercially packaged either as a coarse powder or in tablet form. It is a safer material than chlorine gas with respect to handling and feeding, but it may present serious problems if spilled or scattered in a moist or wet environment or if oxidizable material is introduced to the container. When applied to swimming pool water calcium hypochlorite reacts much the same as chlorine gas. It tends to release free chlorine from the stabilizing agent and the resulting hydrolysis produces varying chlorine reactions. Due to the relatively compact nature of the package material, calcium hypochlorite is a popular chlorine source in small-/medium-sized swimming pools. Although it is a more costly source than gaseous chlorine (in net yield), this disadvantage is somewhat offset by the relative ease and safety of handling, storage and feeding. The most commonly used calcium hypochlorites will yield 70 percent available chlorine by weight.

b. Calcium hypochlorite can be manually fed directly into the pool from hand-held containers to either facilitate super chlorination or as an alternate feed in the event of equipment failure. Normally, however, it is mixed with water in tanks or feed crocks and the clear liquid is fed to the recirculation system by mechanical feeders. Such feeders are adjustable to control rates of continuous or intermittent feed.

7-5. SODIUM HYPOCHLORITE.

a. Sodium hypochlorite is a liquid compound of chlorine, water and sodium which is usually packaged in carboys or drums. If properly stored, it will yield 10 percent to 15 percent net chlorine depending upon its method of manufacturer and the age of the material. Like calcium hypochlorite it is relatively safe and easy to handle and feed, but it is also a hazardous product to spill. Applied to pool water the hydrolysis reactions are essentially like those of other chlorine sources.

b. Because of the weight and bulk involved, sodium hypochlorite normally is used to chlorinate smaller pools ranging in size up to 75,000 gallons. For disinfection purposes its use with respect to pool size is limited.

c. Mechanical feeding is accomplished in the same manner and by the same type of equipment used to feed the mixture of calcium hypochlorite and water.

Sodium hypochlorite need not be premixed with water. It is a feedable liquid in its packaged form when the proper feeder is used.

7-6. LITHIUM HYPOCHLORITE.

Lithium hypochlorite is another of the dry chlorine compounds. It is a free-flowing granular sanitizer containing 35 percent available chlorine. The product is an inorganic material with the chlorine immediately available as in the other inorganic chlorine vehicles. It is completely soluble in pool water or may be made up in a solution and dispensed through a chlorinator. Stable under all normal storage conditions, it may be stored for extended periods without appreciable loss of available chlorine. It is an acceptable product for swimming pool sanitation and has all the attributes common to the other hypochlorites.

7-7. CHLORINATED CYANURATES.

a. Chlorinated cyanurate is a relatively new pool disinfection product and is not widely used in swimming pools.

b. Chlorinated cyanurate is available commercially in both white powder and tablet form. The most commonly marketed cyanurates contain from 60 percent to 85 percent available chlorine. The physical appearance, handling precautions, and techniques of feeding, etc., of this group of chlorine-bearing compounds are the same as calcium and sodium hypochlorite. The important product differences involve the chemistry of hydrolysis. The cyanurates provide chlorine residual which is relatively more stable and therefore longer lasting in pool water than that provided by elemental and hypochlorite forms. Although such stability reduces disinfection and oxidation properties, it may be desired for other reasons. Cyanurates are an advantage when chlorination is accomplished by intermittent hand feeding rather than by continuous mechanical application.

7-8. ELEMENTAL BROMINE.

a. Pure elemental bromine is a heavy, red liquid and, like chlorine, is an aggressive oxidizing agent. Bromine is a dangerous chemical in untrained hands. If spilled from its container, bromine will attack virtually all surroundings. Even the fumes from an uncapped container can injure people and damage surroundings. Any person exposed to bromine fumes should be checked by the base health department.

b. As a disinfection product, bromine has been demonstrated to be equal to chlorine in bactericidal efficiency, although the chemistry is somewhat different. The hydrolysis of bromine produces hypobromous acid which, like the hypochlorous acid product of chlorination, is the agent which destroys bacteria and oxidizes undesirable soil.

c. Commercially, elemental bromine is packaged in glass jugs specially crated to guard against shock damage and breakage in shipment and handling. The material is fed to the recirculation system through a brominator which dissolves the liquid bromine in a crock of water near the point of injection. Elemental bromine is more costly for equivalent disinfection values than gas chlorine, and normally more expensive than the hypochlorites and cyanurates.

7-9. ORGANIC BROMINE.

a. In recent years bromine has become available commercially for pool sanitation in bromine-coating organic compounds commonly referred to as hydantoin or “stock” bromine. In such forms bromine can be compared with hypochlorites and cyanurates except it is twice as heavy as chlorine but not as volatile in the pool atmosphere. Such products are more costly than elemental bromine and therefore less likely to be used in large swimming pools. They are far less hazardous to handle than elemental bromine, however, and therefore possess distinct advantages in dosing small- and medium-sized pools where cost is a lesser consideration.

b. Organic bromine is more costly than most of the disinfection products discussed here. It is a slowly dissolving solid which is normally fed to the recirculation system from a pressure vessel by the washing action of the recirculating stream of water. As a practical matter, the organic bromine compounds may be less adaptable to precisely controlled feed rates unless metered by positive displacement devices. The method has been systematically effective, however, in disinfection of private pools. Also, claims have been made that longer swimmer immersion can be effected, which is a factor for competitive and training pools.

7-10. ALGICIDES.

If the pool water takes on a greenish or mustard-colored cast or black or dark green spots appear on the surface finish, algae is probably present and an algicide should be used. An algicide is a chemical additive used to kill and prevent the growth of algae in swimming pool water. Algicides are formulated for their specific toxicity to algae as an aid to disinfection chemicals. Although algae growth can be inhibited by disinfection chemicals alone, there seems to be increasing acceptance and use of the algicides for reasons of economy because their use reduces chlorine demand. Since mercurials have been banned by The Environmental Protection Agency (EPA), phenol mercuric acetate cannot be used. Quaternary ammonium halides are not recommended as they may cause foaming, absorb on filter media, and increase chlorine demand. Copper compounds are ineffective

against some algae. Copper sulfate can cause skin rash and turn hair green at high concentrations as well as cause milky or inky precipitates in highly alkaline or sulphur-containing waters. Other copper salts can be considered safe to use if manufacturer's instructions are strictly followed.

7-11. PRODUCTS.

Unlike the relatively unstable hypochlorous acid product, algicides are highly stable and residuals can therefore be sustained by hand dosing once or twice per week. The most commonly used commercial algicides are compounds containing copper or quarternary ammonium chloride, or phenol mercuric acetate.

7-12. SILVER.

Silver has been used experimentally in the purification of water for many years but has never gained acceptance among public health authorities. There are many limitations which need not be discussed here. The primary shortcoming is the relatively prolonged "contact time" required for bacterial kill. It is also noted that silver has very limited oxidizing properties which, as discussed previously, are essential to overall treatment of pool water.

7-13. ULTRAVIOLET LIGHT.

Ultraviolet light has been discredited as a disinfection process for pool water. Although the ultraviolet light rays will destroy bacteria in a single exposure at a single location, there is no known way to disperse this germ-killing residual throughout the pool, bathers run the risk of infection. Ultraviolet light disinfection would require a continuously virtual floodlighting of the entire pool. Such a practice would involve risks greater than those of bacterial infection.