

Chlorination

Chlorine is the most widely used disinfectant because it is effective at low concentration, cheap, and forms a residual if applied in sufficient dosage. It may be applied as a gas or as a hypochlorite, the gas form being most common. The gas is liquified at five to ten atmospheres and shipped in steel cylinders. Pressurized liquid chlorine (99.8 percent Cl_2) is available in cylinders containing 100, 150, or 2000 lb of the liquified gas. The disinfecting ability of chlorine is due to its powerful oxidizing properties, which oxidize those enzymes of microbial cells that are essential to the cells' metabolic processes (Butterfield, C. T., Wattie, E., Megregian, S., & Chambers, C. W. 1943).

Reaction

Chlorine gas reacts readily with water to form hypochlorous acid, HOCl, and hydrochloric acid:

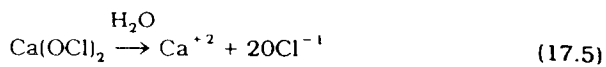


In dilute solution and with pH greater than 3, the reaction is appreciably displaced to the right and very little molecular chlorine gas will remain dissolved and unreacted. The hypochlorous acid produced then dissociates to yield hypochlorite ion:



The relative distribution of HOCl and OCl^- is a function of pH, as shown in Figure 17.3.

Hypochlorite salts are available in dry (calcium hypochlorite) or liquid (sodium hypochlorite) form. The dry form is cheaper but must be dissolved in water:



The OCl^{-1} will then seek an equilibrium with the hydrogen ions as indicated in Eq. (17.4), and therefore when hypochlorites are used in such applications as swimming pools, it is often necessary to add acid.

Although both hypochlorous acid and hypochlorite ion are excellent disinfecting agents, the acid form is the more effective (Engelbrecht, R. S.). They also react with certain inorganic and organic materials in water. One of the important reactions is with ammonia:

CL - 2

Figure 17.3. Relative Amounts of Chlorine as HOCl and OCl^- at 20°C versus pH

Adapted from "Behavior of Chlorine as a Disinfectant" by G. M. Fair, et al., *Journal of the American Water Works Association* 40, no. 10 (October 1948):1051. By permission. Copyright 1948, the American Water Works Association.

