The OCl^- ions are strong oxidizing agents that can destroy microorganisms.

In some water-treatment plants, calcium hypochlorite, $Ca(ClO)_2$, a salt of hypochlorous acid, is added to water to provide OCl^- ions. Similar treatments are used in swimming pools.

Nearly a hundred cities in the United States and thousands of communities in Europe use chlorine in the form of chlorine dioxide, ClO_2, as their primary means of disinfecting water. The main drawback to the use of ClO_2 is that it is unstable and cannot be stored. Instead, ClO_2 must be prepared on location by one of the following reactions involving sodium chlorite, $NaClO_2$.

$$10NaClO_2(aq) + 5H_2SO_4(aq) \longrightarrow 8ClO_2(g) + 5Na_2SO_4(aq) + 2HCl(aq) + 4H_2O(l)$$

$$2NaClO_2(aq) + Cl_2(g) \longrightarrow 2ClO_2(g) + 2NaCl(aq)$$

The expense of using ClO_2 makes it less desirable than Cl_2 in water-treatment systems unless there are other considerations. For example, the use of ClO_2 is likely to result in purified water with less of the aftertaste and odor associated with water purified by Cl_2.

Fluoride and Tooth Decay

In the 1940s, scientists noticed that people living in communities that have natural water supplies with high concentrations of fluoride ions, F^-, have significantly lower rates of dental caries (tooth decay) than most of the population.

In June 1944, a study on the effects of water fluoridation began in two Michigan cities, Muskegon and Grand Rapids, where the natural level of fluoride in drinking water was low (about 0.05 ppm). In Grand Rapids, sodium fluoride, NaF, was added to the drinking water to raise levels to 1.0 ppm. In Muskegon, no fluoride was added. Also included in the study was Aurora, Illinois, a city that was similar to Grand Rapids and Muskegon, except that it had a natural F^- concentration of 1.2 ppm in the water supply. After 10 years, the rate of tooth decay in Grand Rapids had dropped far below that in Muskegon and was about the same as it was in Aurora.

Tooth enamel is made of a strong, rocklike material consisting mostly of calcium hydroxyphosphate, $Ca_5(PO_4)_3(OH)$, also known as apatite. Apatite is an insoluble and very hard compound—ideal for tooth enamel. Sometimes, however, saliva becomes more acidic, particularly after a person eats a high-sugar meal. Acids ionize to produce hydronium ions, which react with the hydroxide ion, OH^-, in the apatite to form water. The loss of OH^- causes the apatite to dissolve.

$$Ca_5(PO_4)_3(OH)(s) + H_3O^+(aq) \longrightarrow 5Ca^{2+}(aq) + 3PO_4^{3-}(aq) + 2H_2O(l)$$

Saliva supplies more OH^- ions, and new apatite is formed, but slowly.

If fluoride ions are present in saliva, some fluorapatite, $Ca_5(PO_4)_3F$, also forms.

$$5Ca^{2+}(aq) + 3PO_4^{3-}(aq) + F^-(aq) \longrightarrow Ca_5(PO_4)_3F(s)$$

Fluorapatite resists attack by acids, so the tooth enamel resists decay better than enamel containing no fluoride.

When the beneficial effect of fluoride had been established, public health authorities proposed that fluoride compounds be added to water supplies in low-fluoride communities. Fluoridation started in the 1950s, and by 1965, nearly every medical and dental association in the United States had endorsed fluoridation of water supplies. In the past decade, however, that trend slowed as opposition to fluoridation grew.