Application Note AN-OZ1

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Ozone Monitoring in a Municipal Drinking Water Treatment Plant

Ozone is becoming a common means of addressing disinfection concerns in municipal drinking water facilities. It is a powerful oxidant and disinfectant. As such, it not only deactivates biologic activity in water, but also controls nuisance problems such as odor, taste, and color. Ozone has been used for nearly 100 years to improve the safety and aesthetics of drinking water. Nice, France has been using ozone for disinfection since 1906*.

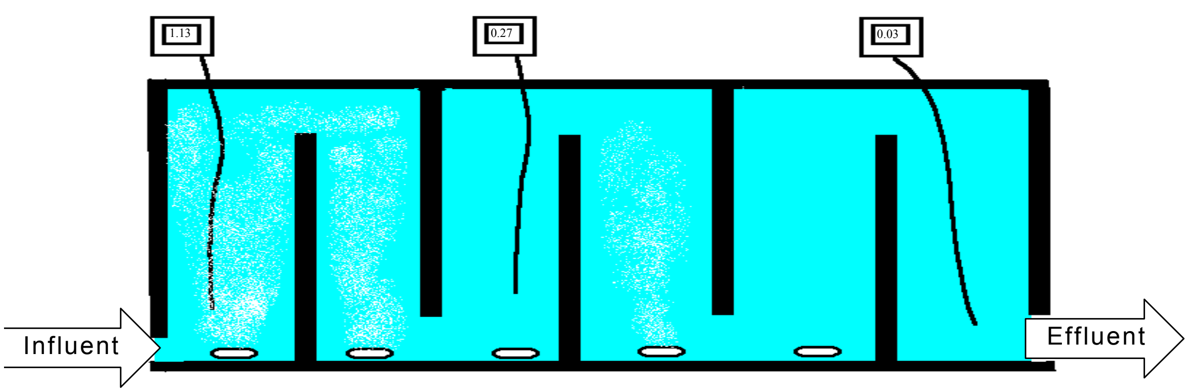
Ozone generation and control has historically been a major stumbling block for efficient, cost-effective ozonation of drinking water. Efficiencies in the generation of ozone have improved and the technologies for monitoring the gas have progressed.

Typical Installation for Disinfection

Chlorine is the most common method for disinfecting drinking water. It carries a residual throughout a distribution system, thus enabling water managers to assure the constant disinfection capability of their water. However, new regulations in the drinking water industry are aimed at reducing the exposure to undesirable compounds formed by chlorine when it reacts with natural organics. These compounds, called THM's (trihalomethanes), are suspected human carcinogens. By using ozone as the primary disinfectant, a system can provide biologically safe water while treating with less reactive forms of chlorine called chloramines. (Chloramines are formed when ammonia is added to chlorinated water.) Chloramines are measurable and effective disinfectants, but because of their lower reactivity, they do not produce THM's in the higher quantities that free chlorine produces.

Ozone monitoring in a drinking water plant assures that an adequate contact time (CT) is achieved. Ozone is very reactive, and decays rapidly in water. By constructing baffled chambers, ozone levels can be monitored as the decay takes place (see Figure 1). The goal is to achieve as long a contact time as possible, without discharging ozone into the distribution system. In many installations, a deozonation process takes place after the appropriate CT has been achieved. Deozonation or quenching can be achieved with hydrogen peroxide (H_2O_2), sodium bisulfite or ultraviolet light. Along with raising the pH of the water, these processes can create hydroxyl radicals (O_2^-), which also help control odor and tastes.

Figure 1 Typical Ozone Contact Chamber Monitoring



* Ozone, an Effective and Affordable Choice for Small Water Systems", GDT Corporation, Presented at the 1999 AWWA Annual Conference, Chicago, Illinois.

Advantages of Ozone Treatment

There are many advantages to ozonation of drinking water:

- Ozone is a very powerful disinfectant. Its oxidation potential is 2.07 volts. By comparison, the oxidation potential of hypochlorite is 1.49 volts while chlorine is only 1.36 volts (Towles, 1997).
- Ozone does not create negative residuals such as THM's unless bromine is present.
- Ozone harmlessly degrades back to oxygen when its reaction is complete.
- Ozone addition does not affect the pH of the water, so corrosion control programs are not adversely effected.
- The CT for ozone disinfection is shorter than for chlorine compounds and it forms a microfloc upon contact, thus improving coagulation and reducing the dosage of coagulant.
- Ozone reduces taste, color, and odor problems by oxidizing the algae and humic material often responsible for them.

Table 1 shows the CT values for ozone, chlorine, and chloramines. Note how pH and temperature effects these times.

Table 1: CT Values for Disinfectants to Inactivate 99.99% (3-logs) of Giardia Lamblia Cysts USEPA Guidance Manual to the SWTR[1]

Disinfectant	pH	<1°C	5°C	10°C	20°C	25°C
Free Chlorine at 2 mg/l[2]	6 7 8 9	165 236 346 500	116 165 243 353	87 124 182 265	44 62 91 132	29 41 61 88
Ozone	6-9	2.9	1.9	1.43	0.72	0.48
Chlorine Dioxide	6-9	63	26	23	15	11
Chloramine (performed[3])	6-9	3800	2200	1850	1100	750

1. These CT values for free chlorine, ozone, and chlorine dioxide will guarantee greater than 99.99% inactivation of enteric viruses.
2. CT values will vary depending on concentration of free chlorine. Values indicated are for 2.0 mg/l of free chlorine. CT values for different free chlorine concentrations are specified in the Guidance Manual (U.S. EPA, 1990).
3. Obtaining 99.99% inactivation of enteric viruses with preformed chloramines requires CT values greater than 5,000 at temperatures of 1, 5, 10, and 15°C.

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