

Dutchess County Health Department

OZONE FUNDAMENTALS

By Robert J. Maswick

I recently attended an AWWA Professional Development Seminar entitled "Ozone Essentials" in Andover, MA. The seminar was a combination of lectures, workshops and tour of a 24-MOD WTP utilizing ozonation as a pretreatment method. The Andover WTP was generating approximately 143 lbs. of ozone, applying it at a dosage of 1.9 ppm. This paper will provide a synopsis of the key points raised and also act as a short primer on the use of ozone.

Ozone can be used for a variety of reasons. The primary reason is disinfection, particularly for Giardia and Cryptosporidium inactivation. USEPA allows "direct" and "CT" credits for inactivation based on site-specific parameters. Secondary benefits include color removal, oxidation of metals, sulfides, and taste and odor reduction. It is important to accurately determine the primary need for and the secondary benefits of an ozone system. These findings will guide many of the design parameters. Ozone can be applied as a pretreatment method, before coagulation/flocculation/settling or in an intermediate step, before filtration. Some WTP's utilize a two stage approach, ozonating before and after coagulation/flocculation/settling.

Ozone (O₃) is produced by forcing a feed gas through a high voltage electrical field. Heat is produced as a byproduct of ozone generation. This reaction takes place inside of a water-cooled stainless steel vessel known as an ozone generator. Voltages in the generator range from 8,000 to 20,000 volts. Varying the applied voltage regulates the amount of ozone produced. The most common feed gases used are either conditioned ambient air or oxygen. Ozone yields from the generator can range from 1% to 10% by weight. Control of an ozone system is complex - a high degree of instrumentation reporting back to a programmable logic controller or computer.

There are a few varieties of generators on the market, but the configuration most commonly seen is a horizontal tube, medium frequency water-cooled unit. A series of stainless steel tubes are welded to end plates; these end plates are affixed inside the generator vessel. The steel tubes act as the ground electrode for the voltage that is applied. A 10-foot long glass tubular electrode (dielectric tube) is placed in the steel tube, resting on small (0.5 - 3.0 mm) circular spring spacers. The feed gas is pumped into the generator and flows around the glass tubes. When voltage is applied to the dielectric tube an electron flow is developed, ionizing the oxygen molecules and ozone is produced.

Ozone is piped as a dry gas to a concrete ozone contact chamber where it passes through fine bubble diffusers and is transferred to the water. A typical ozone contactor design calls for 18-20 feet of water over the diffusers, sized for 5-30 minutes of contact time (40 minutes for Cryptosporidium inactivation). The chamber, which is operated under a vacuum, is typically baffled ("over/under" design) into stages, with ozone applied at the bottom of each stage. Contactors usually have 2 to 4 stages, depending on the treatment objective. An induced draft fan pulls the off gas through a thermal gas destruction unit; its exhaust is then vented to the atmosphere.

There are four (4) variations of oxygen feed gas systems. The liquid oxygen (LOX) system is the most widely used - a pressurized tank of liquid oxygen provides a steady flow of feed gas to the generator. Compressors, heat exchangers, refrigerated dryers, and desiccant dryers are not used. Although LOX is more expensive to purchase, there can be significant savings on the capital, operational and maintenance costs. A LOX system also provides a much higher concentration of oxygen (by weight) to the generator, which yields a correspondingly higher concentration of ozone.

Electrical operating costs for the ozonation systems at Andover are approximately \$1.46 per pound of ozone, based on a \$0.10 kilowatt-hour cost. Based on my conversations, Ozone is currently enjoying widespread use. Ozone is an alternative that seems to be the answer to a number of treatment concerns.