By L. Joseph Bollyky, Ph.D., P.E., Bollyky Associates, Inc. and Brian Johnson, Pacific Ozone Technology

The Role of Ozone in Water Bottling

Ozone treatment is one of the most effective microbiological barriers that water bottlers can employ to protect consumers against microorganisms. Consumers are largely unaware, however, that many bottlers worldwide rely on ozone to provide a safe and good tasting product. Since the 1970s, ozone has played a critical role in helping the bottled water industry deliver a safe and aesthetically pleasing product. In fact, one could say that ozone saved the bottled water industry in its infancy, when bottled water wasn't always properly disinfected and was frequently criticized in television and newspaper investigative reports.

Today, a few bottlers in the United States may face a new challenge in applying ozone without exceeding the newly established disinfection byproduct (DBP) maximum contaminant level (MCL) for the bromate ion. Because of the relative and perceived ease of ozone treatment, many bottlers still don't use proven ozone process controls and monitoring technology. Thus, they're yet to assure precise ozone treatment, which is necessary when certain contaminants—such as bromide, from which bromate is formed—are present in the source water. The careful use of controls can result in bottled water of a higher quality.

Bottlers Rely on Ozone

Ozone treatment played a pivotal role early in the bottled water process that contributed to the healthy growth the industry has enjoyed for many years. In the early years, not all water bottlers used ozone treatment for disinfection. In addition, the water bottling process wasn't fully developed, nor was the bottled water always sealed properly. During the handling and squeezing of the bottle, air and airborne organisms could enter the product. Thus, after days or weeks of storage, often on supermarket shelves, the potential existed for the explosive growth of microorganisms, which could lead to undesirable taste and odor and health problems. Several well-publicized bottled water recalls took place during this time.

Shortly thereafter, under pressure from many state health organizations, disinfection processes for water bottling, with ozone as a key component, were developed. Required ozone dosages, contact times and closure requirements for the various types of bottles and waters were established. Ozone proved to be the magical oxidant that could disinfect everything—the water, bottling equipment, bottle and sealed cap—and then decompose to harmless oxygen and disappear without leaving a taste or odor.

Ozone disinfection enabled the water bottler to produce high-quality, storage-stable bottled water free of byproducts and the taste and odor associated with the use of chlorine for disinfection and oxidation. These characteristics and the claims of good-tasting, odor-free, pollution-free, healthy water led to the rapid growth of the bottled water industry through the '80s and '90s with overall public consumption growth consistently approaching or exceeding double-digit rates. (See Tables 1 and 2.)

Table 1. U.S. Bottled Water Market in Gallons and Dollars, 1990–2002

Year	Gallons (millions)	Change from Previous Year	U.S. Dollars (millions)	Change from Previous Year
1990	2,237.6	9.5%	$2,481.9	13.2%
1995	3,226.9	8.8%	$3,521.9	11.3%
1996	3,495.1	8.3%	$3,835.4	8.9%
1997	3,794.3	8.6%	$4,222.7	10.1%
1998	4,130.0	8.9%	$4,666.1	10.5%
1999	4,583.4	11.0%	$5,314.7	13.9%
2000	4,904.4	7.0%	$5,809.0	9.3%
2001	5,425.3	10.6%	$6,880.0	18.4%
2002	6,018.5	10.9%	$7,700.0	11.9%

Beverage Marketing Corp. New York, via IBWA website, www.bottledwater.org.

What Is Ozone?

Ozone (O_3) is a gaseous material made from oxygen in an electric discharge field (corona discharge) type ozone generator. Early ozone generators operated at 1 to 2 percent weight (% wt.) ozone. Today, the output of the ozone generator typically contains 3 to 10% wt. of ozone in the unreacted oxygen feed gas stream. This ozone gas stream is brought into contact with the water to be treated in a device called an ozone contactor. In the ozone contactor, the ozone is dissolved in the water and the undissolved ozone in the off-gas is discharged through an ozone decomposer and released at rooftop levels.

Ozone is a powerful oxidant and an exceptional chemical disinfectant.

Ozone's Role in Bottled Water

- Disinfection against all microorganisms.
- Disinfection of bottles prior to filling.
- Disinfection of wetted parts of bottling equipment.
- Disinfection of the bottle surface.
- Disinfection of the sealed cap.
- Disinfection against air-borne microorganisms in the air gap.
- Eliminate bad taste and odor.

About the Authors
L. Joseph Bollyky, Ph.D., is president of Bollyky Associates, Inc., Stamford, Conn., and a licensed professional engineer. He is a former chairman of the International Ozone Association and can be reached at 203-967-4223; fax 203-967-4845; ljbbai@bai-ozone.com. Brian Johnson is president of Pacific Ozone Technology, Inc., Benicia, Calif., and can be reached at 707-747-9600; fax 707-747-9209; brianj@pacificozone.com.

Table 2. U.S. Bottled Water Market
Volume and Growth by Segment, 1990–2000

Year	Non-Sparkling Volume	Non-Sparkling Change from Previous Year	Sparkling Volume	Sparkling Change from Previous Year	Imports Volume	Imports Change from Previous Year	Total Volume	Total Change from Previous Year
1990	1,987.7	8.0%	176.0	12.7%	73.9	32.9%	2,237.6	10.3%
1996	3,178.5	9.9%	159.0	–3.7%	111.8	15.1%	3,449.3	8.9%
1997	3,472.9	9.3%	153.8	3.4%	149.1	33.4%	3,775.8	9.5%
1998	3,839.1	10.5%	146.1	5.3%	160.8	7.8%	4,146.0	9.8%
1999	4,349.1	13.3%	146.0	0.1%	151.1	–6%	4,646.1	12.1%
2000	4,751.1	9.2%	144.2	–1.2%	137.8	–8.8%	5,033.2	8.3%
90–00	***8.2%***	***–1.8%***	***5.8%***	***7.6%***				

Beverage Marketing Corp. New York, via IBWA website, www.bottledwater.org.

The ozone treatment process is an integral part of the drinking water treatment plant operation in more than 3,000 municipal water installations worldwide. These plants supply water to the residents of many major international cities such as London, Paris, Budapest, Kiev, Moscow and Singapore. In the United States alone there are nearly 400 ozone drinking water installations including those in Los Angeles, Dallas, Milwaukee, Orlando and Atlanta, and more are coming to Boston and New York City.

Ozone for Bottled Water Treatment

The ozone/water contacting system serves two primary functions. First, it is used for the dissolution or mass transfer of the ozone gas from the output gas stream mixture of the ozone generator into the water to be treated. The balance of the ozone remaining in the off-gas is destroyed by an ozone decomposer unit so that any off-gas discharged into the atmosphere contains an ozone concentration less than 0.1 parts per million (ppm)—or milligrams per liter (mg/L)—of ozone.

Second, the ozone contactor is a reactor. It provides the reaction time—detention or contact time—to allow the desired disinfection and/or oxidation processes to occur in the water. Once the ozone is dissolved in the water it undergoes three simultaneous reactions.

Ozone's Effects

- **Disinfection.** The disinfection treats the water against bacteria, viruses and parasites such as *Giardia* and *Cryptosporidium*.

FYI: More on Ozone from IOA

Information on ozone, how it works, particular applications and other issues, can be found from the International Ozone Association (IOA). The IOA is a global educational and scientific organization dedicated to the collection and dissemination of information on all aspects of ozone technologies. Established in 1973, several of its members helped to develop some of t he good manufacturing practices for ozone that are being employed by bottlers today. The IOA is a nonprofit organization with a simple charter that all users of ozone can benefit from, which is to serve as the authoritative source of information about ozone production, measurement, application and control and its respective advantages and synergies with other oxidation and disinfection technologies.

What Do I Gain From IOA?

Membership in the IOA gives you

- A direct channel to a **clearinghouse** of ozone information.
- Access to 30 years of **research**.
- Access to the world's **top specialists** in ozone technology.
- **Ozone news** —Bi-monthly news and updates that include articles on the latest developments in ozone equipment, applications, developments and literature.
- ***Ozone Science and Engineering Journal*** —Bi-monthly journal containing peer reviewed scientific ozone studies and papers with detailed analyses of major research and developments.
- **Legislative reports** and information on government regulations.
- Periodic **monograms on applications** and special issues relating to ozone applications.
- Annual *Who's Who in Ozone* ***Membership Directory***.
- **Discounts** for technical meetings and seminars as well as an opportunity to participate in the biennial International Ozone World Congress.

For more information, contact the IOA at 203-348-3542; fax 203-967-4845; www.ozone-int-assoc.org.

While much more detail can be given (see *FYI* sidebar), suffice it to say that ozone is highly effective against all of the above microorganisms and more.

- **Chemical oxidation.** Ozone is a powerful oxidizing agent and is very effective against essentially all taste- and odor-causing organic materials and oxidizeable inorganics such as iron, manganese and sulfide ions. Again, additional details on the specifics of this reaction have been expanded on in other articles (see *FYI* sidebar).

- **Decomposition.** Ozone is an unstable material under room temperature and near room temperature conditions and decomposes to oxygen fairly quickly. Primarily, water temperature and pH influence the decomposition rate. The half-life of ozone at 20°C and pH 7.0 in potable tap water typically is 24 minutes.

Ozone's Objectives

The objectives of ozone treatment in water bottling include the following.

- Disinfection of water against all microorganisms that might be present in the water.
- Disinfection of bottles, especially reusable bottles in the wash prior to bottling.
- Disinfection of the wetted parts of the water bottling equipment and machinery.
- Disinfection of the surface of the bottle and the sealed cap of the bottled water.
- Disinfection against the airborne microorganisms that may be present in the air above the water in the bottle.

Ozone treatment is a unique and valuable process. It can accomplish all the aforementioned treatment objectives without leaving a taste or chemical residual behind when accurately applied and controlled. Ozone is an exceptionally powerful disinfectant and oxidant. It does its job and disappears. With appropriate pretreatment and careful monitoring and controls, it can leave water relatively free of disinfection byproducts as well. WQP

HIGHLIGHTS

Reverse Osmosis System

The MS Series reverse osmosis systems are designed to provide high-purity water under the demands of continuous operation and harsh environments. This unit, suitable for most commercial and industrial applications, is available with optional operational and control features for ancillary equipment, allowing systems to be completely customized.

Sanitaire Water Equipment Technologies, West Palm Beach, FL **Write in 1139**

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