OZONE TECHNOLOGY - GROWING WITH THE BOTTLED WATER INDUSTRY

An article for Water Technology Magazine - October 1999
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A trip to the grocery store will tell you that the bottled water industry is on the move. Growing an estimated 10-15% annually over the last decade, water can now be purchased from vending machines, at stores and restaurants, or conveniently delivered to your home. It is available in almost every imaginable flavor and from a variety of exotic sources, from Canadian glaciers to French springs.

This recent industry growth is fueled by the American consumer's apparent desire for healthy, natural products. Health consciousness is at an all-time high while the perception seems to be that the safety and quality of public water services is at an all-time low. Today, "natural" and "safe" are the most important descriptions of the food we eat and the water we drink as we seek healthier alternatives to the caffeine, alcohol and sodium found in other beverages. The bottled water industry has responded by providing refreshing, good tasting, quality products.

To better understand what is "natural" from a water processing perspective, bottled water can be generally divided into two categories - natural water and drinking water. The International Bottled Water Association (IBWA) Model Bottled Water Code states that "natural water" cannot be changed by adding or removing dissolved solids. It may not, by definition, be derived from a public water service and cannot be treated by reverse osmosis, distillation or deionizaton. Typical sources for natural water include springs, wells and artesian wells.

Drinking water, on the other hand, is usually taken from a public water supply and treated by the bottler. Also referred to as "purified water," it cannot be sold as "natural."

How Ozone Fits In

The bottled water industry has been utilizing ozone for more than 30 years and its use is gaining popularity in many agricultural applications because ozone rapidly oxidizes contaminants while leaving elevated dissolved oxygen levels and no chemical residues. For water bottlers, ozone is a powerful sanitizer and disinfectant. It easily and completely oxidizes organic contaminants, lowers total organic carbon (TOC) levels by reducing bacterial debris to carbon dioxide and water, and precipitates undesirable inorganics such as iron, manganese, sulfate and nitride. In addition, ozone is generated on-site so no chemical storage is required, and the equipment is easily integrated into the bottling process.

Since the chemical composition and purity of water varies so dramatically from region to region and from source to source, the ozone demand can be vastly different. For example, natural water (spring, well or artesian well water that has not been treated by RO, distillation or deionization) will have a greater ozone demand and will therefore require a higher dosage rate.

In contrast, the ozone demand for drinking or purified water is considerably less because this type of water normally comes from public sources and has been processed by RO, distillation or deionization. These waters have usually been softened to remove "hard" minerals (such as calcium and magnesium) prior to distillation or reverse osmosis. The result is a very high quality water with mineral contents at or below 10mg/l. It is the absence of dissolved solids or mineral content that significantly reduces the ozone demand. If not properly stored, waters of this purity are subject to rapid bacterial growth. A small residual of ozone applied to stored drinking water will maintain water purity without adding chemicals which can adversely affect taste and odor.

A .1 to .2 PPM ozone residual is an effective operating level for most bottling facilities. A .4 PPM residual is the absolute maximum level, due at least in part to the recent disinfection by-products rules. Bromide oxidation is a concern; some bottlers may have to reduce their ozone residual levels and use supplemental disinfection methods to comply. Regardless, recent concerns over bromide oxidation suggest that ozone is not the only disinfection method used in a bottling operation.

The Process

Ozone is an extremely effective disinfectant and oxidizing agent. It is produced by disassociating or "splitting" oxygen (O_2) molecules and reassembling as ozone (O_3). As an unstable gas, ozone's "half life" is comparatively short as it quickly reverts back to stable oxygen. It's half life (the time it takes to become oxygen again) can last only a few minutes when introduced to some natural waters and as long as 6-8 hours in higher purity drinking water.

Because of ozone's characteristically short half life, the process of efficiently dissolving ozone in the water and then allowing it to contact the water for a period of time is critical. Two methods of ozone contacting are generally employed in the water bottling process - static (also called atmospheric) or closed (also called in-line) systems. While both types of systems can serve a broad range of plant sizes, static contacting has historically been used in the majority of automated bottling plants. Closed ozone contacting systems are gaining popularity with smaller, lower volume facilities.

Figure 1 represents a static or atmospheric system for use with a bottler with it's own pressurization system. This configuration can be utilized for ozone amounts ranging from 2 Grams/Hour to several pounds per day to be delivered at 10-30 PSI. Ozone is introduced from the bottom of large stainless steel contact vessel(s) through ceramic diffusers (sometimes called air spargers). The contact vessels are usually between 8 and 18 feet in height and 10 inches to 4 feet in diameter. The water is contacted as it descends through the ozone bubbles rising from the ceramic diffusers.

The critical element in this type of system is the size of the bubbles produced by the diffusers. It must remain small, from 100 to 300 microns. Mass transfer efficiencies (physical act of solubilizing a gas in water) are directly linked to bubble diameter and the height of the contact vessel. Also, periodic cleaning of the diffuser is required as oxidized contaminants will precipitate on diffuser surfaces. Since natural water has not been treated by RO, distillation or deionization, the need for diffuser cleaning is even more important in plants producing natural water products than in purified drinking water facilities.

Atmospheric tanks also require a level control system interfaced with a storage transfer pump. A second pump is also necessary to pressurize the entire bottling system. This arrangement is especially easy to integrate into package bottling plants as they normally have an existing pressurization system.

As a safety precaution, these contact vessels should either be vented to atmosphere or to some type of ozone destruct device. An ozone monitor should also be employed in conjunction with the ozone destructor if it has not been vented well away from any possible human exposure.

The second type of ozone contacting system is the closed or on-line contactor. Illustrated in Figure 2, this process utilizes a pressure/delivery pump, a baffled or multiple pass contactor and a venturi type ozone injector. These systems are inherently safer than atmospheric contactors because they use vacuum type ozone generators and closed contactors. Ozonators that operate on vacuum do not allow ozone gas to escape should a delivery line leak or break. Also, since the ozone injection is controlled by the pump and venturi injector, these systems are very simple.

In closed contactor systems, the pressure/delivery pump draws water from the storage vessel then pushes it through the ozone injector and contactor, pressurizing the bottler. A small vessel made of stainless steel or a composite material will help by providing pressure sensing for pump pressure control.

The increased mass transfer efficiency provided by the venturi injector (up to 98% under ideal conditions), combined with the closed nature of the contactor allows for more precise ozone dosing and reduces the volume requirements of the contactor. The ozone gas actually becomes a part of the water solution at the venturi, traveling through the contactor without exposure to air or atmospheric pressure. This adds to the efficiency of the system by allowing for greater ozone saturation. An automatic, stainless steel vent controls the contactor ozone off gas, which is directed to atmosphere or to an ozone destruct unit.

ORP monitoring equipment on the contactor water outlet greatly enhances both static and closed contacting systems. The ORP controller can be interfaced with a low ozone alarm or a chart recorder to track bottling residuals. An ozone generator interface should also be included, capable of interrupting ozone delivery at high and low setpoint pressures (in a static system) as well as high and low ORP levels.

ORP control is the bottler's assurance that he is maintaining the highest water quality standards. Using the 1972 Drinking Water Standard of 650 millivolts ORP (minimum) established by the World Health Organization (WHO), superior water quality is a certainty through instantaneous viral inactivation and complete disinfection. With ORP's ability to establish and accurately maintain IBWA residual levels, the bottler may be confident that his products are receiving proper ozone dosages for maximum safety and shelf life.

Summary

Ozone plays a vital role in the growing and changing bottled water industry. Properly dosed and efficiently applied, ozone effectively sanitizes and disinfects both natural and treated drinking waters. Combined with other filtration or treatment processes, ozone adds to product longevity by providing bacteria control, bottle sterilization and oxidation of unwanted oxidizable contaminates. Ozone also enhances the taste and odor of bottled water products by selectively removing such undesirable constituents as iron, manganese and sulphide, and by increasing the dissolved oxygen levels.

Whether the water bottler's product is "natural" or "purified" (drinking) water, his market can be expanded with the use of ozone. Shelf life can be increased and new markets reached through improved longevity during transport. Even more importantly, today's water bottling professional can be assured that his products are safe for his customers.