Technology Update

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Ozone for Bottled Water

Advances in Ozone Generation Technology Yield Big Benefits for Bottled Water Industry

The proliferation of bottled beverages worldwide and an increased awareness of consumer health issues have beverage suppliers rethinking how to keep their liquids safe for consumption. One challenge they face is the need to deliver a product that is free of bacteria and provide extended shelf life. Because of its powerful disinfectant properties, environmentally clean treatment process and its ability to remove unwanted tastes and odors, ozone quickly has become the technology of choice among water bottlers worldwide.

A Powerful Performer

Ozone (O_3) is a low molecular weight molecule composed of three oxygen atoms in a triangular arrangement. Its high chemical reactivity results from its unstable electron configuration that seeks electrons from other molecules. During its reaction with other molecules ozone is destroyed and the organic material is oxidized. Compared with other disinfectants, the byproducts of ozone reactions ecologically are benign. Since ozone rapidly converts back into molecular oxygen—with a half-life of about 20 minutes—there's no need to worry about disinfection residuals in the end product.

Although ozone was "discovered" in the mid-19th century, it is only during the last several decades that its numerous applications and benefits have become evident. Ozone is used in water treatment for its oxidative qualities. With 52 percent more oxidizing power than chlorine, ozone will oxidize both organic and inorganic substances; remove unwanted taste, odor and color; and provide effective disinfection. Ozone is extremely efficient as a bactericide, fungicide and virucide, killing even chlorine-resistant *Cryptosporidium*. It also can be used for oxidation and removal of iron and manganese.

Ozone for Bottled Water

Municipal water companies have used ozone technology to treat large quantities of water for many years because of its effectiveness in purifying and conditioning water. Because ozone can be added at the point of water treatment and naturally reverts back to oxygen, it can keep water sanitized throughout a facility.

In the bottled water market, maintaining an optimum level of ozone at the filler is critical. If the ozone level is too high, plastic bottles may develop an aftertaste. If the level is too low, bacteria spores hidden in the water, inside the plastic walls or closure device could recover and easily contaminate the entire product.

The International Bottled Water Association (IBWA) recommends that ozone be applied in the 1.0 to 2.0 milligram per liter (mg/L) range for a period of four to 10 minutes contact time to safely ensure disinfection. Application at this level helps maintain a 0.1 to 0.4 ppm residual ozone level at the time of bottling. This provides an additional safety factor because the bottles can be disinfected and sanitized while filling it with product.

Water charged with ozone also is suitable for rinsing and cleaning bottles and disinfecting production equipment. This reduces the potential for bacterial growth in unchlorinated water found within the distribution system. It also reduces the amount of clean-in-place (CIP) required to keep the operation disinfected. Many plants have started incorporating an ozonated cap and bottle rinsing system.

Ozone is particularly effective when used in conjunction with other water treatment processes. By using reverse osmosis and nanofiltration or ultrafiltration, organic precursors and inorganics such as bromide can be removed from water before ozone is used. With this configuration, 99 percent of naturally occurring organic materials such as lignin, humic and fulvic acids can be removed, reducing the amount of ozone necessary to disinfect the water. Another benefit is that ozone will not lead to the formation of harmful trihalomethanes (THMs), which are formed when chlorine is added to raw water containing humic materials.

Commercial Ozone Production

Unlike other chemicals, there is no natural resource to tap for ozone. It is created using an ozone generator. Ozone is generated by accelerating electrons between two electrically charged plates in a process called "corona discharge." This process occurs when electrons flow at sufficiently high electrical potential through a gas such as oxygen-enriched air. The two electrodes are separated by an air gap. A dielectric material is inserted in the gap with sufficient voltage potential existing between the two electrodes to cause current to flow through the dielectric material and the gas.

Because ozone is a gas, it needs to become soluble within the water. This requires proper mixing within the system to convert it from a gas phase into a liquid phase. The objective is to get as much of the ozone gas as possible dissolved into the water. Therefore, ozone contacting is one of the most crucial elements in designing an efficient ozonation system.

Historically, tall-tower designs using gas diffusion have been the most widely used contacting method. In recent years, venturi injection has become the preferred contacting method. Venturi injection uses an eductor—a device similar to ejectors for mixing two fluids. Eductors work on the Venturi Principle: Water is channeled through a short tube with a constriction in the middle, which causes an abrupt decrease in fluid pressure and a corresponding vacuum. The resulting suction draws ozone into the flow stream and efficiently mixes the ozone with the water. The water enters a contact vessel at the top and is drawn off the bottom where it travels through the eductor and mixes with the ozone.

It then is reintroduced into the bottom of the tank through a dispersion grid. Some designs also will preozonate the raw water entering at the top of the contact tank. The eductor venturi injection method is a much more efficient gas transfer mechanism, allowing the use of short contact tanks and, most importantly, giving you excellent control of residual ozone levels in the product water.

New Technology Expands Capabilities

Ozone generators are available in a range of sizes and configurations including air-feed and oxygen feed units, with ozone dosage concentrations ranging from 1 to 10 percent or higher. Among the latest technology enhancements are new flat plate dielectric designs that are being incorporated into smaller generators used in bottled water applications.

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Compared to traditional generators, which use glass tubular or cylinder style, dielectric's flat plate designs provide a more uniform surface area, resulting in more consistent and reliable ozone output.

Ozone output can be controlled by adjusting the amount of gas that flows through the system or by changing the amount of electricity that is applied across the plates. Surface imperfections found in traditional cylinder-type dielectrics often result in wide variations and frequent inconsistencies in ozone output. This makes it difficult to deliver precise, controlled dosages and can lead to excessive amounts of ozone in the water. New flat plate designs, along with today's advanced solid-state electronics, allow users to fine-tune voltages, resulting in a more linear, controlled ozone output.

Ozone generators with flat plate dielectrics also are capable of producing ozone at higher concentrations (up to 10 percent by weight) and offer users wider production ranges (60 to 70 percent turn down capability) for greater operating flexibility. With higher ozone concentrations, less feed gas is required, leading to lower operating costs.

As more people turn to bottled water for a clean and safe alternative to drinking tap or well water, bottled-water suppliers will have to look harder for water sources free from external contamination. Meanwhile, ozone continues to offer a safe, reliable and cost-efficient solution for treating a wide variety of water treatment problems. WQP

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