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The application of ozone technology in the food and beverage industries includes disinfection of process water, hard surfaces and work and storage area atmospheres.

Industry Sees Ozone Technology As the Latest Food Factor

Atmospheric treatment with ozone is effective in reducing post-harvest fruit and vegetable decay as well as ethylene production in cold storage rooms

There is renewed emphasis on safe quality food production in the industry, and ozone-based technologies have become part of the solution for various production issues, particularly after the GRAS (Generally Recognized As Safe) designation in 1997. The application of ozone technology in the food and beverage industries includes disinfection of process water, hard surfaces and work and storage area atmospheres. Recent data and test results show that atmospheric treatment with ozone is effective in reducing post-harvest fruit and vegetable decay as well as ethylene production in cold storage rooms.

Ozone is the triatomic form of oxygen. Its configuration is a very reactive molecule. The extra atom detaches itself from the other two and reacts quickly with surrounding materials. Ozone has approximately 150 percent of the oxidizing potential of chlorine.

The successful application of ozone technology can be simple or complex, depending on the situation. Disinfection of clean water is a well-established and simple application. Disinfection of fruit and vegetable processing water is more challenging. Developing a thorough understanding of the application environment is essential. It is important to characterize the range of water quality parameters including fluid volumes, temperatures, organic loading rates, pH, microbial loading rates and filterable solids. Filtration can be an important companion technology to ozone treatment since ozone readily attacks any organic matter present in processing solutions. Soluble and suspended organic matter can prevent efficient removal of microbial contaminants when present in large amounts.

For the treatment of processing waters having significant organic loading rates, a combination of ozone and hydrogen peroxide, which produces hydroxyl radicals, has shown promise. Hydroxyl radicals increase the oxidizing potential of ozone by 35 percent. A large number of process water applications exist where this technology may prove effective.

For atmospheric treatments in cold storage rooms, it's important to have knowledge of air volumes, room temperature, the percent of the room volume occupied by product and concentration of aerial particulates and gases in order to develop appropriate ozone dosage rates. The relative sensitivity of the product to ozone gas concentrations may also cause dosage rates to vary. It's also important to make sure hot spots do not occur within treatment rooms. The timing of ozone gas injections must be coordinated with room ventilation cycles to ensure even dispersal.

In recent long-term studies in controlled environments, ozone has shown promise as an economical alternative to methylcyclopropane in cold storage atmospheres for maintaining pear post-harvest quality. In one study involving pears,

'Ozone has approximately 150 percent of the oxidizing potential of chlorine.'

ozone treatment resulted in better fruit firmness, and post-harvest decay was reduced after several months of controlled atmosphere storage. Fungal spores were reduced significantly in the air, on the fruit and on the fruit bins. Other studies have shown similar results for apple and citrus fruits. This application of ozone technology is being evaluated currently for many commodities.

Ozone is an attractive option when compared to chlorine and other disinfectants because its handling does not require on-site transportation, storage, handling or discharge of toxic chemicals. It is produced on-site. Chlorinated process water can have disinfection byproducts including trihalomethanes (THMs), of which chloroform is a major component. THMs are not produced in processing waters treated with ozone. The presence of THMs in fruit and vegetable process water has not been addressed in the fruit and vegetable processing industry to date.

Properties of Ozone

Physical Constants of Ozone	
Molecular Weight, g/g-mol	48.0
Boiling Point, °C	-111.9
Melting Point, °C	-193.0
Gas Density, 0°C grams/liter	2.144
Critical Temperature, °C	-12.1
Critical Pressure, atm	54.6
Critical Volume, cc/mol	147.1

Comparative Oxidizing Potentials, 25°C Volts	
Fluorine (F_2)	2.87
Ozone (O_3)	2.07
Hydrogen Peroxide (H_2O_2)	1.78
Potassium Permanganate ($KMnO_4$)	1.70
Hyprobromous Acid (HOBr)	1.59
Hypochlorous Acid (HOCl)	1.49
Chlorine (Cl_2)	1.36
Chlorine Dioxide (ClO_2)	1.27
Oxygen (O_2)	1.23
Chromic Acid (H_2CrO_4)	1.21
Bromine (Br_2)	1.09
Nitric Acid (HNO_3)	0.94
Iodine (I_2)	0.54

Ozone generators can be configured for multiple remote application points from a central location for use in storage facilities having many separate rooms. Process water disinfection can also be administered for separate water systems using sidestream injection systems. Sophisticated process control systems are making these applications feasible. These types of applications will become more common in industries where physically separate processes need ozone treatment.

With any disinfectant application, safety is a consideration. OSHA's threshold exposure limit for worker exposure for ozone is 100 parts per billion (ppb) over eight hours. As an ideal management practice, all installation sites should include monitors that provide for system shutdown should exposure levels reach 100 ppb. Ozone is limited in its water solubility and can result in elevated gas concentrations around process waters. In facilities using ozonation of open flumes, injection concentrations should be controlled in a feedback loop to reduce gas exposure to areas where workers congregate. Ventilation should be provided at strategic points to assist in the dispersal of ozone gas where hot spots may occur.

Ozone treatment can be economical for minimizing water use for industrial processes. It is known to extend the usable life of process water and minimize waste. Ozone also does not leave residuals in waste process water. Its decomposition product is oxygen. In contrast, process waters containing chlorine need to be de-chlorinated prior to disposal to meet environmental standards.

The future of ozone application depends on the expertise of the companies now offering solutions to address the needs of the food industry. It's important for food processors to determine the ability of vendors to address their particular needs. There can be no substitute for proven results and hard data to back up claims of success. Vendors should also be aware of regulatory and third-party certification requirements, which can determine system design parameters. Companies bringing this type of broad expertise to the table can provide a partnering relationship to successfully apply ozone treatment solutions to the industry.

Just the Facts About Ozone Technology

- **The application of ozone technology can be simple or complex. Disinfection of clean water is a well-established application. Disinfection of fruit and vegetable processing water is more challenging.**
- **In a study involving pears, ozone treatment resulted in better fruit firmness, and post-harvest decay was reduced after several months of controlled atmosphere storage. In addition, fungal spores were reduced significantly. Other studies have shown similar results for apple and citrus fruits.**
- **Filtration can be an important companion technology to ozone treatment since ozone readily attacks any organic matter present in processing solutions.**
- **Ozone is an attractive option when compared to chlorine and other disinfectants because its handling does not require on-site transportation, storage, handling or discharge of toxic chemicals.**

Dr. Randy J. McLaughlin, Ph.D., is an applications engineer of Novazone Inc., 2575 Collier Canyon Rd., Livermore, CA 94551. He is responsible for the development, testing and refinement of ozone-based cold storage, disinfection and sanitization solutions for fresh produce and processed food. Prior to joining Novazone, Dr. McLaughlin was executive partner of Columbia Technical Associates, specializing in microbiological, chemical and statistical analyses for agriculture. He also held a variety of development and research positions for the USDA, Rutgers University, the University of Wisconsin and Texas A&M University. He has a doctorate and master's in plant pathology and a bachelor's degree in plant and soil sciences. Questions about this article can be addressed to him at rmclaughlin@novazone.com. Additional information is available at www.novazone.com or by calling 925-454-0303.