MAKING FOOD AND WATER SAFER THAN EVER BEFORE WITH OZONE

By Michael Cutler, M.D. for Pacific Ozone

The method of sanitizing America's water supply is becoming a hot topic—especially for the city of Los Angeles, California. On December 15, 2005 the Metropolitan Water District of Southern California announced their official move to replace its chlorination water treatment system with a massive ozone system, to the tune of $3.5 billion.

The use of ozone has penetrated the food industry as well. By law, every grocery store, restaurant, bar, and all other commercial food suppliers are obligated to disinfect food sources from harmful bacteria, viruses, and a host of parasitic microbes before they sell it. Ozone is proving to be the best technology available and is gradually replacing older methods for many cleaning applications.

This paper explains what ozone is, its safety in health and medicine, and what organisms it effectively kills. Then the details of how ozone is used to purify our public drinking water and susceptible foods are explored. A brief comparison of ozone to chlorination is presented. Then, relatively new research showing ozone's ability to neutralize hazardous environmental chemicals is revealed. You'll learn how industry has discovered the secrets of reproducing this amazing natural cleaner for our more common daily uses.

What is Ozone?

You've no doubt heard of the stratosphere, also called the 'ozone layer' in our earth's atmosphere. That's where potentially harmful ultraviolet light is dampened—where certain shorter wavelengths of sunlight are filtered out for our safety. Ozone, found plentifully at 50 to 75 miles above the earth's surface, is a naturally occurring molecule, which also cleanses the atmosphere as it recycles particulate matter around the earth. It is a colorless gas at room temperature and has an odor like fresh rain on the earth.

But what is it chemically? Ozone is nothing more than three oxygen molecules electrically bound together. Unlike the stable oxygen you breathe (O2), ozone is unsteady and very ready to react to germs, viruses, and a host of microbes that are known to cause illness.

Ozone is generated naturally from oxygen in the air by electrical discharges such as lightning and by high-energy electromagnetic radiation. However, in order to harness this natural cleaning agent for commercial uses, ozone must be produced on-site when it is needed. It cannot be conveniently purchased by the gallon or by the pound. It is generated in small tanks or large robust generators when oxygen (O2) is charged with high voltage electricity. This is because ozone lasts only about 20 to 30 minutes in distilled water at 20 degrees Centigrade, and less time if contaminants are present.

The primary process used commercially today to make ozone is called electrical discharge, or corona discharge. This is the preferred method for the water treatment industry. In this process, a high voltage electrical spark is fired across a gap (like a spark plug) to turn oxygen into ozone. The other products formed in the process must be destroyed through various mechanisms, all of which are done safely and efficiently as part of the ozone generation process.

Once ozone has done its damage to impurities, it naturally converts back to O2, or stable oxygen. It is now clearly proven to be a powerful yet refreshing cleaning agent with end products that supply the earth with the oxygen we breathe—without carcinogenic chemical residues as occurs with chlorination. The fact is ozone is the strongest of all molecules available for disinfection in water treatment.

How safe is ozone?

For many years the ozone was feared because it was used in high concentrations and safety measures were quite loose. Some studies were aimed at portraying ozone as a dangerous substance; they showed how breathing it constantly could cause a chronic bronchitis effect. But today's safety standards have made ozone generators extremely safe and desired for sanitation by nearly every food and water-related industry. In fact, ozone is health promoting, such that it is even being used in medicine for several applications. It reduces the immune hypersensitivity of asthma while promoting the healing effect of natural anti-oxidants, according to an article in the September 2005 *Archives of Medical Research*.

Another use in medicine is that is has been shown to be superior to antibiotic treatments for infected diabetic foot ulcers. The authors of this medical journal article reported in the September 2005 *European Journal of Pharmacology* pointed out that not only was its efficacy superior to antibiotic treatment, it also proved to be without adverse effects—something antibiotics certainly can't claim. And because it has an oxygenating effect, ozone is able to aid in the reversal of cancer and therefore is being used along with chemotherapy and radiation therapy, according to a pilot study published in the June 2004 issue of *Evidence Based Complementary and Alternative Medicine*. To emphasize ozone's beneficial effect in medicine, one researcher at the University of Siena, Italy stated in his commentary in 2004 that "During the past decade, contrary to all expectations, it has been demonstrated that the judicious application of ozone in chronic infectious diseases, vasculopathies (blood vessel disorders), orthopedics and even dentistry has yielded such striking results that it is deplorable that the medical establishment continues to ignore ozone therapy."

What Microorganisms can Ozone treat?

Water safety problems that have formerly been addressed with acid, peroxide, chlorine or other oxidants are now prime candidates for ozone treatment. And if ozone cannot effectively treat a water quality problem, it's likely that no other available oxidant could do the job either. There is quite a long list of microorganisms that ozone effectively kills without hurting the food or surface where they reside.

But to summarize the list, the following are categories of contaminants that can all be treated with ozone:

- Bacteria—all known
- Fungi and yeast—all known
- Protozoa (including parasites and amoebae)—all known.
- Its effectiveness against Cryptosporidium has some limitations, yet is still the most effective of all known sanitation agents for this organism.

In general, ozone is used commercially to:

- Disinfect water before it is bottled
- Kill bacteria, yeast and protozoa on food-contact surfaces such as fresh fruits, vegetables, grains, seeds, nuts, legumes, and all animal meats
- Kill yeast and mold spores that float in the air in food processing plants
- Chemically attack (oxidize) impurities in water such as iron, arsenic, hydrogen sulfide, nitrites and organic clumps
- Oxidize and degrade many organic pollutants including pesticides, herbicides and other persistent environmental chemicals as explained below

Ozone to Disinfect Food and Water

Did you know that ozone has been used by the European food industry as a standard for decades, and as a sanitizer for their public water for over a century? As newer studies are asserting its superior disinfecting capability, the U.S. is adopting ozone in a wide variety of uses. Take Los Angeles, California for example. On December 15, 2005 the Metropolitan Water District of Southern California officially announced it is replacing its chlorination water treatment system with a massive ozone system—to the tune of $3.5 billion. The first two of five water treatment plants have already made the switch, with plans to complete the others by 2010. Soon, the entire city of Los Angeles will be dumping its current chlorination system and sanitizing its water instead with ozone.

Not only does ozone have superior qualities over chlorination for water treatment, its application for cleaning and sanitizing foods of many types deserves discussion here. For disinfecting foods, ozone is used to sanitize surfaces of vegetables, fruits, and other agricultural products. In June 2001 the Food and Drug Administration's final ruling published in their Federal Register, approved ozone as an additive to kill food-borne pathogens "as an antimicrobial agent on food, including meat and poultry." This also included the use of ozone on the treatment, storage, and processing of foods and even the preparing, packing, or holding of raw agricultural commodities for commercial purposes. This came almost as an imperative from the FDA, as ozone has been compared in government reports to other less favorable methods of food cleaning such as the use of hydrogen peroxide, UV light irradiation, peracetic acid, and bromination.

In order to disinfect organisms, ozone must come in physical contact with them. But it only takes ozone a few seconds of contact time to destroy pathogens. In fact, no pathogen can survive 1.5 milligrams of ozone per liter for 5 minutes at normal drinking water pH and temperatures.

Consider how many uses ozone has on fruits and vegetables. It is ideal for cleaning and sanitizing fresh produce directly plus it can be sprayed on all the equipment and surfaces where foods are packaged or processed. It can then be sprayed on walls and floors of storage areas and active processing areas to kill and remove bacteria or other organic matter. And because ozone has such a short half-life it does not build up on surfaces the way detergents can if they are not removed by proper rinsing. Ozone air is even used to blow dry food products to eliminate cross-contamination in the air, and ozone refrigeration is used to eliminate mold build-up.

Another important consideration is the preservation of fresh produce. Studies of fruits and vegetables indicate that cooling fruits and vegetables as soon as possible after harvest is a critical factor to extending product shelf life. So by adding ozone to the chilled air and water applied to fruits or vegetables after harvest, both decontamination and cooling can occur in one step.

Fortunately, ozone does not appear to injure vegetable and fruit tissues during contact with them. Several fresh-cut processors now equipped with ozone currently have preliminary results indicating that bacterial counts are lower as compared to chlorinated systems. Produce such as shredded lettuce exhibits a longer shelf life with less browning when washed with ozone than when chlorine is used, and has a noticeably better flavor.

Ozone is also ideal for cleaning and sanitizing beef, pork, poultry, seafood and other fish directly, as well as all the equipment and surfaces where they are packaged or processed. Vacuum packaging, using ozone gas is then used to ensure decontamination into the package.

Some additional benefits of ozone in the food preparation industry are that it:

- Extends the shelf life of food products
- Is much safer for employees than any conventional chemicals
- Eliminates all chemical usage and is chemical-free, without the chemical by-products of chlorination
- Eliminates the use of hot water and conventional sanitizer
- Is generated on site, thus eliminating the transporting, storing and handling of otherwise hazardous materials
- Is very inexpensive to produce once a generator is in use
- Permits recycling of wastewater

Comparing Ozone to Chlorine

Safety

Chlorine has traditionally been the sanitizer of choice in the food processing industry, but experts share a growing concern about the widespread use of chlorine. According to a 2004 article in the *Journal of Environmental Science and Health*, when chlorine reacts with naturally occurring substances such as decomposing plant and animal materials in water it produces known carcinogenic compounds called trihalomethanes and haloacetic acids. These by-products of chlorination are formed in drinking water and therefore have been constantly monitored in water treatment facilities supplying our nation's water. Because certain cancers are now clearly correlated with chlorinated drinking water consumption, the U.S. President's Council on Environmental Quality stated, "there is increased evidence for an association between rectal, colon and bladder cancer and the consumption of chlorinated drinking water." Bladder cancer is the most prominent cancer because harmful water-soluble molecules always end up in the bladder before being eliminated. Yet proving chlorination causes cancer has been difficult because of the many confounding factors. These factors include other known cancer promoters found in paints and solvents, inks, some metals, polycyclic aromatic hydrocarbons, combustion products, and diesel exhaust fumes.

Ozone has its own potential safety drawback that deserves mentioning. If ozone at very high concentrations and very long contact times is used in water that has a broad range of organic compounds, it can produce a variety of by-products. The by-products that are of concern and that are constantly being monitored are the formation of aldehyde, bromate, and other organo-bromine compounds. Fortunately, water treated with ozone can be filtered, settled or given a light chlorination following ozone treatment.

Cost

Many cost comparisons between ozone and chlorine have been conducted for a variety of applications. An exhaustive comparative analysis between these two methods is beyond the scope of this paper. Worth mentioning is that depending on the particular use and application, chlorine is generally less expensive. But as newer applications are being discovered and a greater need for safety and quality, ozone becomes less expensive overall with superior results. For example, one must consider the inherent costs of chlorine's transport, cleanup and storage of potentially hazardous toxic chemicals. In contrast, ozone is generated onsite without storage requirements and is made from harmless oxygen. Depending on the application, chlorination may be less or more expensive than ozone treatment.

Efficacy

Ozone is highly reactive molecule, killing bacteria and other microbes 3,000 times faster than chlorine. Because it is so highly reactive, ozone is also effective at removing organic contaminates that grow on food processing equipment.

Pesticides, herbicides, fungicides and industrial chemicals

A developing national issue with our foods is the widespread use of pesticides, herbicides and fungicides on our crops. The use of these chemicals has unquestionably enhanced farmer's crop yields. These chemicals have also assisted your grocery store to carry fresher produce—another benefit few would want to lose. Yet with these benefits comes a peaking national concern about the harmful effects of these chemicals. This has led to the now huge organic food movement, aimed at making our produce safer for health.

Paralleling this organic foods movement is the concern over the known dangerous chlorine waste by-products we call Priority Hazardous Substances. These chemicals that also are showing up in our water and food supplies in alarming amounts are better known as dioxins, polychlorinated biphenyls (PCBs) and a host of similarly hazardous industrial by-products. These carcinogenic substances are currently regulated in drinking water by the EPA.

But if you are health conscious you likely know the dangers of chronic consumption of foods tainted with these harmful chemical compounds. The good news is that ozone is proving to be a viable answer to this growing concern. In addition to flushing away infectious microbes from your raw meats, dairy and fresh produce, ozone can oxidize and eliminate many chemical residues from your food.

Ozone is being reported in scientific literature to oxidize a number of pesticides, herbicides, fungicides, and other Priority Hazardous Substances. This can often be done by ozone alone. However, even better results occur when ozone in combined with ultraviolet light, hydrogen peroxide, or titanium dioxide. This is an effect that is certainly not found with chlorination.

One example of a more stubborn and dangerous herbicide that ozone has a useful effect against is atrazine. Atrazine is widely used, as indicated by its 29 trade names or synonyms. It was estimated to be the most heavily used herbicide in the United States prior to 1993, although its effects persist in our drinking water nationwide. Its long term exposure at levels above the EPA's maximum containment goals in water is known to cause the following adverse health effects: heart damage, retinal degeneration, muscle degeneration, and cancer.

Researchers in Spain found that ozone was the most effective against atrazine when ultraviolet radiation was added, while within a year of this, in the December 2000 publication in the *Journal of Hazardous Materials*, German scientists reported their study in *Water Science Technology* that by combining ozone with UV light or hydrogen peroxide they were able to get a 90% degradation of atrazine.

It is also found that ozone alone is a promising method of efficiently removing pharmaceutical drugs that are known to persistent in drinking water. Swiss researchers used ozone on five prescription medications known to persist in water and found these drugs to be completely transformed two to three times faster than atrazine is transformed.

Side Bar

Herbicides: from the farmer's fields to your body's tissues

The current industry standard is not enough. Chlorination, for example, is not necessarily the food sanitizer of choice anymore when there are superior methods. The food industry will settle for government standards because they can. But they're not telling you about food surface residues of pesticides, herbicides and chemical detergents that remain even after current food cleaning methods.

But do these chemicals actually affect us, or is this just a hypothesis? Theo Colborn, Ph.D., who is highly published in peer-reviewed scientific literature, found that the herbicide 2,4 D (the most widespread herbicide) was detected in 50 percent of semen samples from a group of Canadian men ages 20-59 and that the pesticide CPF was detected in 82 percent of urine samples tested.

But Dr Colborn's research doesn't just stop there. His work demonstrates that over 60 percent of the poundage of all agricultural herbicides and up to 90 percent of a pesticide product is capable of disrupting animal (and therefore human) endocrine and/or reproductive systems. This matches what is occurring with astonishing prevalence in America—a clinical picture of cell membrane receptor-site disruption and resistance to the active hormone as is found in hypothyroidism and type II diabetes. Additionally, these toxic chemicals are fat soluble compounds, which we know store nicely in human fatty tissues of the skin and deeper organs such as the brain, 60 percent of which is composed of fat.

Summary

The simple but powerful molecule ozone is naturally used by the earth to clean the atmosphere. Thankfully, it can now be safely and efficiently generated for many food-grade cleaning purposes. Ozone is becoming the preferred method for disinfecting water supplies for many reasons, primarily effectiveness and health safety. Ozone has now been recommended by the U.S. Food and Drug Administration for sanitizing food supplies of all types. Ozone is even being shown to evaporate pesticide, herbicide and other persistent chemical residues from produce surfaces resulting in a new generation of healthier and safer foods.