Extension FactSheet

FSE-5-07

Food Science and Technology, 2015 Fyffe Road, Columbus, Ohio 43210-1007

Ozone Technology

Fact Sheet for Food Processors

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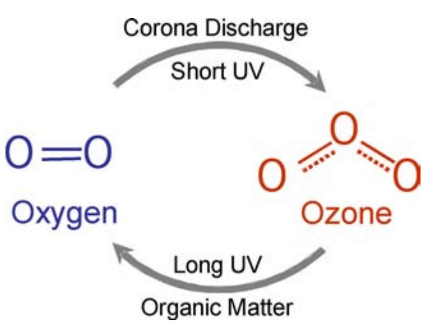
1. What is ozone and where can it be found?

Ozone is a highly reactive form of oxygen, consisting of three oxygen atoms (O_3). It is a potent oxidant/disinfectant that quickly decomposes to diatomic oxygen (O_2), while reacting with targeted organic matter or microorganisms. Ozone is naturally generated in the stratosphere, the upper atmospheric layer that protects us from harmful radiation. Gaseous ozone is formed also in the atmosphere during lightning discharges, and on the earth's surface by photochemical reactions, UV sterilization lamps, and high voltage electric arcs.



2. Significance of ozone in food processing.

Ozone is a potent antimicrobial agent. It can effectively kill viruses, bacteria, fungi, and parasites, including those causing food spoilage or human diseases. Efficacy of ozone, however, depends on the target microorganism and the treatment condition. Commercial applications of ozone include purification of drinking water, sterilization of containers for aseptic packaging, decontamination of fresh produce, and food preservation in cold storage. Ozone also is useful in deodorizing air and water.

3. How is ozone generated industrially?

Ozone is commonly generated by electrical discharge. In this method, dry air or oxygen is passed between two parallel or concentric electrodes that are coated with a dielectric material. Oxygen molecules are broken down to charged oxygen atoms, which recombine to form ozone molecules. Depending on the feed gas, ozone production rate varies from 1–3% (w/w) to 6–16% (w/w) for air and pure oxygen, respectively.

4. How does ozone kill microbes?

Ozone destroys microorganisms by reacting with oxidizeable cellular components, particularly those containing double bonds, sulfhydryl groups, and phenolic rings. Therefore, membrane phospholipids, intracellular enzymes, and genomic material are targeted by ozone; these reactions result in cell damage and death of microorganisms.

5. How is ozone different from other chemical treatments?

The strong antimicrobial character of ozone is partially related to its oxidation-reduction potential (2.07 V), which is higher than that of chlorine (1.36 V). Ozone has many advantages over chlorine and other antimicrobials. Ozone destroys microorganisms instantly and effectively, without leaving harmful residues in treated food or processing water. Therefore, ozone is safer and environmentally friendlier than most other antimicrobials. Ozone gas should be produced on-site and it cannot be stored or transported. Although this may sometimes be considered a disadvantage, a desirable feature is that only air or oxygen is needed to produce the sanitizer.

6. Is ozone safe to use in food processing?

Ozone is a colorless gas at ambient conditions, and is readily detectable by the human nose at 0.01–0.05 ppm. At low concentrations, ozone has a characteristic pleasant odor, similar to that of fresh air after a thunderstorm. High concentration of ozone gas in air is objectionable and could pose health risks. According to OSHA regulations, the permissible level of exposure to ozone in the workplace environment is 0.1 ppm during a normal 8-hour day (40-hour workweek). The short-term exposure limit is 0.3 ppm for exposure of less than 15 minutes (4 times per day). Therefore, the production and use of ozone in food processing should be controlled and monitored, and excess ozone should be removed by a commercial "ozone destruct" unit.

7. Current and potential applications of ozone in the food industry.

Ozone can be applied in an aqueous solution or gaseous phase to decontaminate food-contact surfaces, sanitize equipment, recycle wastewater, and decrease pesticide levels on fresh produce. The microbiological quality and shelf-life of vegetables, fruits, cheeses, eggs, nuts, and meats can be improved when these products are directly treated with ozone or stored in an ozone-containing environment. For fresh-produce processing, ozone can be used to sanitize processing water or to decontaminate the product itself. The use of ozone in the gaseous phase helps in controlling mold and bacteria, both in the air and on the surface of the product.

8. Commercial ozone-generation systems.

Gaseous or aqueous ozone generators are commercially available and relatively inexpensive instruments. Generators vary in production capacity from a few pounds to hundreds of pounds of ozone per day. It should be cautioned, however, that suitable treatment chambers, monitoring devices, and excess gas destruction units, should be designed and integrated with the ozone generators to produce functional food treatment systems.

9. Is the application of ozone approved by regulatory agencies?

In 1982, ozone was declared as Generally Recognized As Safe (GRAS) for treatment of bottled water. Since 2001, FDA approved its use as an antimicrobial agent in foods. Depending on the application, ozone use may fall under the guidelines of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), thus entering the jurisdiction of the Environmental Protection Agency (EPA). Food processors should confirm with ozone-equipment suppliers or directly with the EPA to determine if a particular ozone application will require a special pesticide registration under FIFRA. Ozone is also listed in the National Organic Program (NOP) final rule, which permits its use in processed products labeled as "organic" or "made with organic." There are no special labeling requirements for ozone-treated products.

10. Facility available for feasibility studies.

Many ozone equipment manufacturing and ozone treatment facilities are available worldwide. A simple search of the Internet can guide the reader to relevant and useful sites. The Ohio State University (OSU) food safety laboratory hosts ozone generators and product treatment chambers that vary in size, from bench-top to pilot-scale. At the OSU facility, ozone generators range in productivity from 1 to 16 lb/day and treatment chambers vary from 1 to 300 l-capacity. Some chambers were engineered to decontaminate fresh fruits and vegetables, or to produce Salmonella-free shell eggs. Pathogen-contaminated products can be treated at the OSU pathogenic pilot plant, a biosafety level-II facility.

For additional information, contact:

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http://www.fst.osu.edu/foodsafetylab/index.htm

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Support of USDA-CSREES National Integrated Food Safety Grant No. 2003-51110-02093, and USDA-Food Safety Inspection Service Grant No. FSIS-C-53-2005 is gratefully acknowledged.