Ozone Status Report

This safe gas offers key benefits for grain storage, handling, and processing.

This article is based on a presentation by Dr. Dirk Maier, head, Department of Grain Science and Industry, Kansas State University (KSU), Manhattan (785-532-6161), given at the 2011 International Association of Operative Millers (IAOM) Conference and Expo, May 2-6, in San Antonio, TX.

Food safety is a key concern to the grain-based food and feed industries.

In efforts to enhance food safety, ozonation is a technology that can be used to reduce microbial loads, control insects, and to remove off-odors in grain and grain products.

Ozone reduces a wide range of pathogenic and food-borne microbes by oxidizing their cell membranes.

Purdue University, West Lafayette, IN, started working with ozone during the early 1990s, when it was focusing on alternative, nonchemical methods of pest control and on stored-product insects. However, researchers also were aware that ozone had the potential to control microbial loads and even odor issues experienced with grain.

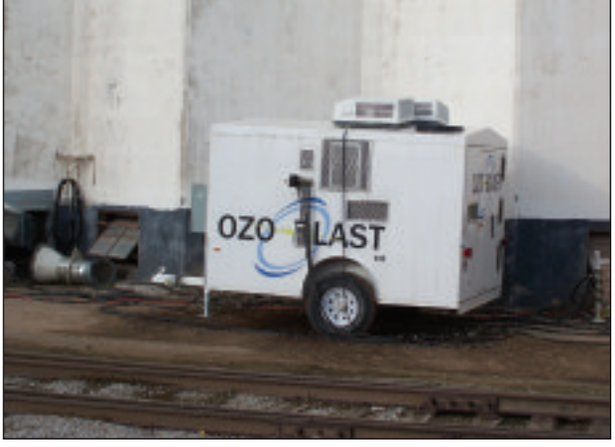
Further studies have shown that ozonation treatment decreases the biological toxicity of certain mycotoxins significantly in contaminated feeds and food grains. Such treatments help to ensure safety throughout the food supply chain. Recent advances in ozone generation and application technologies also have made ozonation treatment more effective and reliable.

Dirk Maier

What Is Ozone?

Ozone is a very natural product. For example, ozone is produced when lightning strikes and reacts with oxygen in the atmosphere. Even the electrostatic reaction caused by an operating copying machine will produce small amounts of ozone.

Ozone (O_3) is an allotrope of oxygen and exhibits strong oxidizing properties. It also is soluble in water at acidic pH levels.



Above is a mobile unit that can generate ozone gas on site using electricity. Photo supplied by O3Co.

At ambient temperatures, ozone is a bluish gas, but it is unstable and decomposes quickly back into its original state as oxygen.

For many years, it also has been used for sterilization purposes in the food, medical, and water treatment industries, including bottled water.

How Ozone Works

Ozone is a powerful oxidant that reacts readily with contaminants found on the surfaces of grain kernels and other food particles.

Due to its somewhat radical or unstable nature, ozone attacks numerous cellular constituents in cell membranes, such as proteins, unsaturated lipids, and enzymes and nucleic acids in cytoplasm. In enzymes, ozone acts as a general protoplasmic oxidant.

On bacteria, mold cells or fungi, ozone starts breaking down the cellular structures, until they die.

On insects, ozone will react and break up the outside of the exoskeleton's waxy layer causing asphyxiation and dehydration.

Generating Ozone

Another useful feature of ozone is that it can be produced on-site with electricity.

The passage of oxygen over capacitors will produce good ozone. For example, OzoBlast™, which is a commercially available mobile unit manufactured by O3Co., Idaho Falls, ID (208-542-5012), is equipped with an electrical generator that can produce about 1,000 grams of ozone per hour. There are units that can generate up to 4,000 grams per hour, but this usually involves a fifth-wheel trailer for transporting.

Plus, unlike other disinfectants, ozone leaves no harmful residue after application due to its short half-life.

Regulatory Status of Ozone

In June 2001, the U.S. Food and Drug Administration issued Generally Recognized As Safe (GRAS) status to ozone and approved it as an antibacterial agent that could used on grain and food products for sanitation and sterilization purposes.

In fact, according to the Material Safety Data Sheet, ozone is considered to be pure air.

The Environmental Protection Agency considers ozone a non-chemical and environmentally friendly alternative in the food processing industry.

Ozone even has been approved by the National Organic Standard Board under the category of "synthetics allowed" for use on organic crops (as an antimicrobial agent). In Japan, however, ozone hasn't been approved yet for the organic market. Consequently, some organic food exporters to Japan are not using ozone for this reason.

Additional Uses of Ozone

Ozonation treatment can be incorporated into grain storage, handling, ►

and processing systems as well as used to treat grain products, including flour.

Research has shown that ozone treatment can be effective, without reducing end-use quality.

Ozone also might serve as a substitute or potential replacement for phosphine fumigation treatments on grain.

For grain processing and storage companies, ozone is being used for odor removal and pest control.

Ozone's Impact on Wheat Quality

Some other uses:

• In the milling industry, ozone is being used instead of chlorination treatments for employee safety reasons.

• Through oxidation, ozone improves flour mixing and baking properties, such as bigger bread volume and spread of cookies.

• Ozone helps control bacterial contamination in flour, such as E. coli.

• In some research studies, tempering wheat with ozonated water was found to reduce bacteria counts.

• In other studies, ozone was found to reduce mechanical energy for first break by affecting the aleurone layer.

According to a 2007 master's thesis by KSU graduate student Julien St. Paul, when used at various concentrations, ozone had a positive impact on wheat quality.

For example, in whole wheat, ozone treatments resulted in greater sodium carbonate retention, which proved useful for long fermentation products such as sourdough.

• Greater lactic acid retention, which allows more cookie spread.

• Increases maximum viscosity and volume of bread. However, it was found to be detrimental to volume and symmetry of cakes.

• In flour, ozone promoted greater sucrose retention, which is good for high-ratio sugar formulas, and greater lactic acid retention, which increases break and cake volumes. However, it decreases alpha amylase activity.

Through oxidation, ozone improves flour mixing and baking properties, such as bigger bread volume and spread of cookies.

- Dirk Maier,
Kansas State University

In pest control tests involving stored wheat, according to Purdue University research studies, ozone's effect on grain quality showed no differences in breadmaking properties (hard red winter wheat) or milling performance (soft and hard wheat), when applied at a concentration of 51 parts per million (ppm) for 30 days and 50 ppm for 72 hours in laboratory and field trials, respectively.

Consistency in Expressing Concentration

In moving forward, there is a need for better and more uniform consistency in how ozone treatments or concentrations are defined.

Presently, concentrations often are reported in grams or milligrams per cubic meter, or in percentages, or in parts per million.

Better comparisons of ozone treatments would be possible by following the concentration x time (Ct) measurement, which commonly is used in fumigation calculations.

Karl Ohm, associate editor