NOSB NATIONAL LIST
FILE CHECKLIST

PROCESSING

MATERIAL NAME: **#18 Ozone**

✓ **NOSB Database Form**

✓ **References**

____ **MSDS (or equivalent)**

____ **FASP (FDA)**

✓ **TAP Reviews from:** **Joe Montecalvo, Rich Theuer**

NOSB/NATIONAL LIST
COMMENT FORM
PROCESSING

Material Name: #18 Ozone

Please use this page to write down comments, questions, and your anticipated vote(s).

COMMENTS/QUESTIONS:

---

1. In my opinion, this material is:
_____ Synthetic _____ Non-synthetic.

2. Should this material be allowed in an "organic food" (95% or higher organic ingredients)? _____ Yes _____ No
(IF NO, PROCEED TO QUESTION 3.)

3. Should this substance be allowed in a "food made with organic ingredients" (50% or higher organic ingredients)? _____ Yes _____ No

TAP REVIEWER COMMENT FORM for USDA/NOSB

Use this page or an equivalent to write down comments and summarize your evaluation regarding the data presented in the file of this potential National List material. Complete both sides of page. Attach additional sheets if you wish.

This file is due back to us by: Sept 8, 1995

Name of Material: Ozone

Reviewer Name: DR. JOE MONTECALVO

Is this substance Synthetic or non-synthetic? Explain (if appropriate)

If synthetic, how is the material made? (please answer here if our database form is blank) An oxygen supply is fed to the CARONA discharge system which is capable of producing O_3 in a more efficient manner. the solubility of O_3 decreases with increasing temperature of the water. Therefore its concentration in cool unchilled water is greater when the water is chilled (ie. 40-45°F)

This material should be added to the National List as:

✓ **Synthetic Allowed** ____ **Prohibited Natural**

or, ____ **Non-synthetic (Allowed as an ingredient in organic food)**

____ **Non-synthetic (Allowed as a processing aid for organic food)**

or, ____ **this material should not be on the National List**

Are there any use restrictions or limitations that should be placed on this material on the National List? NO

Please comment on the accuracy of the information in the file: - the information is 1970 - much more recent information : see OZONE in WATER TREATMENT, Application and Engineering Ed. by B. LANGLAIS, D.A. Reckhow and D.R. BRINK, Lewis Publishers, Ltd publication 1991

Any additional comments? (attachments welcomed)

Yes, O_3 has been shown to oxidize many organic compounds, it is not clear what the oxidized intermediates of ozonation are composed of or their concentration. Research is progressing in this area to determine if O_3 can serve as a replacement or substitute for chlorine

Do you have a commercial interest in this material? ____ **Yes;** ✓ **No**

Signature Dr. Joe Montecalvo **Date** 8/26/95

Please address the 7 criteria in the Organic Foods Production Act:
(comment in those areas you feel are applicable)

(1) the potential of such substances for detrimental chemical interactions with other materials used in organic farming systems;

Not Known

(2) the toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment;

not known

(3) the probability of environmental contamination during manufacture, use, misuse or disposal of such substance;

none

(4) the effect of the substance on human health;

to date there have been no standard 2 year rodent bioassays or other chronic toxicity tests on aqueous ozone or ozone disinfection by products in the scientific literature therefore not known

(5) the effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock;

O_3 is present in a suitable cold aqueous system is a powerful oxidizing agent therefore it may react with any form of organic material.

(6) the alternatives to using the substance in terms of practices or other available materials; and the only alternative is to use chlorine, and ironically, O_3's application is successful in the industry would allow perhaps gradual phase-out of chlorine compounds. since chlorine can also rx with hydrocarbons and other organic materials to form carcinogens

(7) its compatibility with a system of sustainable agriculture.

I believe, at this time, it is compatable..

TAP REVIEWER COMMENT FORM for USDA/NOSB

Use this page or an equivalent to write down comments and summarize your evaluation regarding the data presented in the file of this potential National List material. Complete both sides of page. Attach additional sheets if you wish.

This file is due back to us by: Sept 8, 1995

Name of Material: Ozone

Reviewer Name: _____

Is this substance Synthetic or non-synthetic? Explain (if appropriate)
SYNTHETIC

If synthetic, how is the material made? (please answer here if our database form is blank)
AS DESCRIBED

This material should be added to the National List as:

✓ **Synthetic Allowed** ____ **Prohibited Natural**

or, ____ **Non-synthetic (Allowed as an ingredient in organic food)**

____ **Non-synthetic (Allowed as a processing aid for organic food)**

or, ____ this material should not be on the National List

Are there any use restrictions or limitations that should be placed on this material on the National List?
NORMAL OSHA RESTRICTIONS: AMBIENT AIR MAXIMUM CONCENTRATIONS. OTHERWISE NONE

Please comment on the accuracy of the information in the file:
OK EXCELLENT

Any additional comments? (attachments welcomed)
I USE AN OZONE GENERATOR TO KEEP MY POOL WATER CLEAN + SPARKLING.

Do you have a commercial interest in this material? ____ **Yes;** ✓ **No**

Signature _____ **Date** 8/28/95

Please address the 7 criteria in the Organic Foods Production Act:
(comment in those areas you feel are applicable)

(1) the potential of such substances for detrimental chemical interactions with other materials used in organic farming systems;

NOT AN ISSUE

(2) the toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment;

EXCELENT, ESPECIALLY WHEN COMPARED TO CHLORINE. OZONE JUST OXIDIZES THINGS.

(3) the probability of environmental contamination during manufacture, use, misuse or disposal of such substance;

LOW - WORKER SAFETY MORE IMPORTANT

(4) the effect of the substance on human health;

HIGH AIR LEVELS ARE DANGEROUS

WATER CONCENTRATIONS DISSIPATE QUICKLY

(5) the effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock;

DISSIPATES RAPIDLY

NOT AN ISSUE

(6) the alternatives to using the substance in terms of practices or other available materials; and

OZONE IS FAR SUPERIOR TO CHLORINE – NO CHLORINATED HYDROCARBONS FORMED; KILLS CRYPTOSPORIDIUM ("THE BUG THAT MADE MILWAUKEE FAMOUS)

(7) its compatibility with a system of sustainable agriculture.

EXCELLENT

NOSB Materials Database

Identification

Common Name **Ozone**

Chemical Name

Other Names

Code #: CAS

Code #: Other

N. L. Category Synthetic Allowed

MSDS ○ yes ◉ no

Chemistry

Family

Composition O_3

Properties An unstable gas with a pungent odor. Oxidizing agent which kills bacteria and algae, with approximately 150% of the oxidizing potential of chlorine. Has a very short life (measured in minutes) before converting to oxygen. Ozone is sparingly soluble and is heavier than air and oxygen.

How Made Generated on site by either corona discharge of oxygen. In this method an ozone generator passes dry air between two parallel or concentric electrodes separated by a dielectric. The oxygen in the air is broken down and then recombine to form ozone. Ultraviolet light can also be used to produce ozone but it requires ten times as much energy to produce the same amount of ozone.

Use/Action

Type of Use Processing

Specific Use(s) Post harvest treatment for produce to retard spoilage in cold storage or in wash water. Disinfectant in water.

Action Ozone oxidizes the cell wall of the microorganism and then attacks the internal portion of the cell.

Combinations ozone reacts with ethylene to minimize its effect on fruit ripening.

Status

OFPA

N. L. Restriction

EPA, FDA, etc Recognized as a biocide by EPA but they have not issued a registration number. See attached.

Directions

Safety Guidelines Ambient ozone concentrations for exposure are limited by OSHA.

State Differences

Historical status allowed by OCIA in cold storage.

Internationl status

OFPA Criteria

2119(m)1: chemical interactions **Not Applicable**

2119(m)2: toxicity & persistence **Not Applicable**

2119(m)3: manufacture & disposal consequences

rapidly converts to elemental oxygen. Ozone generators also produce a small amount (about 1/2 of 1%) of Nitrogen Oxides as a byproduct of the conversion of O2 to O3. These may be a potential problem but are generally minimized by proper design of ozone generators.

2119(m)4: effect on human health

Exposure to high concentrations can cause irritation of eyes and respiratory tract.

2119(m)5: agroecosystem biology **Not Applicable**

2119(m)6: alternatives to substance

Chlorine-based oxidizers and cleaners.

2119(m)7: Is it compatible?

References

The Merck Index, 10th edition. 1983. Merck and Co., Inc., Rahway, NJ

Nagy, R., Application of Ozone in Control of Mold, Bacteria, and Odors, Advances in Chemistry Series 21, 1959.

Application of Ozone, 1970. Ozone Process Division of the Welsbach Corp., Refrigeration Service Engineers Society, Des Plaines, IL

Kirk-Othmer Encyclopedia of Chemical Technology, 3rd. Ed., 1982. John Wiley & Sons, NY.

TriOx

Division of TriNeos

6918 Sierra Court
Dublin, CA 94568
Tel: (510) 829-6300
Fax: (510) 829-8590

REGULATIONS GOVERNING THE GENERATION OF OZONE

Ozone is a gas that is generated on site by either corona discharge or ultraviolet light. The corona discharge method makes about 1000 times more Ozone than the ultraviolet light techniques. Ozone in these concentrations is considered a toxic gas capable of oxidizing many biological species and chemicals.

Ozone is used throughout the world as a biocide in the field of water disinfection. The use of Ozone is growing exponentially for several reasons. One of these reasons is that Ozone reverts to Oxygen within minutes and leaves no residual chemical presence. Ozone is not stored on site and there is no possibility of an Ozone spill.

The Environmental Protection Agency (EPA) does not have a registration number for Ozone. However Ozone is recognized as a biocide by the EPA. The EPA considers Ozone generators as pesticide devices. The manufacturer of these devices must record the yearly production of these devices and submit that number to the EPA with an estimate of the amount of devices to be produced the following year.

The EPA awards an establishment number to the manufacturer of Ozone generators. This number is used in all official documentation with the manufacturer by the EPA. In turn this number is printed on each Ozone generator by the manufacturer and must be visible to someone looking at the generator.

There are other limitations on the use of Ozone. Ambient Ozone concentrations to which people are exposed are limited by the Occupational Health and Safety Act (OSHA). The Uniform Fire Code (UFC) governs certain aspects of Ozone generator construction and installation. The local electrical code, seismic code, plumbing code, and fire code (as a hazardous material) should also be considered.

To date these are all the public regulations governing the use of Ozone. These regulations have not hindered the use of Ozone as a biocide. On the contrary, they have encouraged the thoughtful and well engineered application of Ozone.

This document has been reviewed for accuracy by the Environmental Protection Agency in Washington DC
July 1993

TriOx

Division of TriNeos

6918 Sierra Court
Dublin, CA 94568
Tel: (510) 829-6300
Fax: (510) 829-8590

OZONE WATER TREATMENT FOR AGRICULTURE

PROPERTIES OF OZONE

Ozone is an efficient treatment to maintain the post harvest quality of agricultural commodities.

Ozone is the strongest commercially available oxidant. One pound of ozone is comparable to 100 pounds of gaseous chlorine.

Ozone is an unstable gas with a short life measured in minutes, and it cannot be stored. Ozone is sparingly soluble. This combination of factors require that ozone be generated on site and effectively mixed in the water. The amount of ozone generated must be regulated to match the demand of the water. Meeting these conditions will ensure destruction of the decay causing organisms on agricultural commodities without leaving an ozone residual on the previously wetted surfaces.

DISINFECTION BY OZONE

Various studies have shown ozone to be far superior to chlorine, chlorine dioxide and chloramines at controlling mold, fungus, spores, and bacteria. Of particular interest is how ozone attacks a microorganism. Ozone oxidizes the cell wall of the microorganism and then attacks the internals of the cell. In contrast chlorine, as it is absorbed by the microorganism, poisons the cell. For this reason organisms that do not absorb nutrients from the environment during their dormant stage are not effectively destroyed by chlorine. Examples are spores and cysts.

Ozone offers the agricultural industry an environmentally acceptable alternative to conventional biocides. Apples, apricots, bananas, cherries and kiwis have all been successfully treated with ozone.

In related applications ozone gas destroys insects in stored grains, nuts and dried fruits.

BENEFITS

* More efficient processing of commodities.
* Ozone easily adapted to present processing methods.
* Safer and healthier working environment.
* Ozone treated commodities accepted, often at a more attractive price, where conventional biocides are undesirable.

Many other potential applications exist where ozone can be successfully applied within the agricultural/food processing realm. These include sanitizing equipment, work surfaces, piping and processing areas.

TriOx performs bench testing to determine the suitability of ozone to treat a variety of commodities.

For more information call:

TRIOX
(510) 829-6300

14

APPLICATION OF OZONE

Ozone Process Division, The Welsbach Corporation

INTRODUCTION

Our detailed discussion of ozone will include its applications in food preservation, odor control, sterilization and related areas. However, before discussing ozone and its applications, a brief review of its general characteristics and chemistry will be useful.

Occurrence of Ozone

Ozone, O_3, is a blue gas under normal conditions. It contains three atoms of oxygen compared to the standard two atoms in an oxygen molecule. Ozone is heavier than air or oxygen. At altitudes from 60 to 90 thousand feet ozone occurs naturally in concentrations from 10 to 20 parts per million by volume (ppm/v.) (1). At ground level or sea level, however, it exists in a greatly diluted state and is present in minute quantities (.001 to .003 ppm) as we breathe it.

Chemical and Physical Properties of Ozone

Ozone is one of the purest and most powerful oxidants and germicides known. Ozone's reaction is rapid with most materials as it is unstable and readily decomposes to ordinary oxygen. This decomposition is very slow at ordinary temperatures but is accelerated by heat and moisture. The decomposition is almost instantaneous at temperatures of several hundred degrees F. Ozone is also decomposed photochemically by the action of sunlight.

Ozone was first detected in 1785, but it was not until the 1800's that the first machine was constructed to generate ozone. The first commercially developed ozone generators were put into use in the early 1900's.

GENERATION OF OZONE

The most practical technique of generating ozone is the conversion of oxygen to ozone in an electrical or corona discharge. Ultraviolet light also produces ozone, but the energy required is ten times that of the discharge technique for the same quantity of ozone.

Ozone generators produce ozone by passing dry air between two parallel or concentric electrodes separated by a dielectric. The oxygen in the air is broken down to charged oxygen atoms, some of which recombine to form molecules of ozone. Ultraviolet lamps with glass that transmits some radiation below 2000 Angstrom units, produce some ozone from the oxygen of the air. Such lamps exert a double bactericidal action by ultraviolet irradiation and liberation of ozone(8). Figure 59F01 illustrates the electrical theory of ozone generation in the corona discharge.

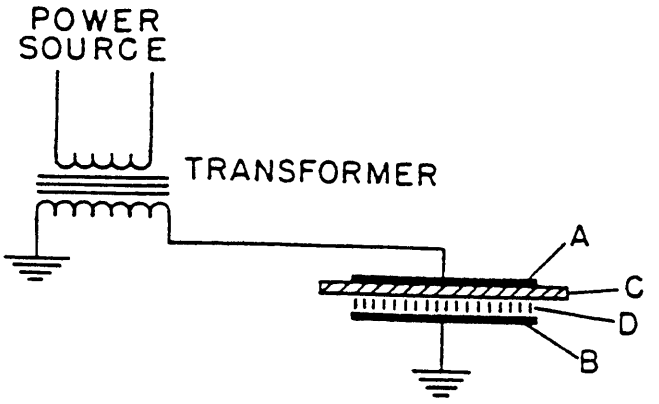


Figure 59F01

OZONE GENERATOR
(A and B. Metal Electrodes: C. Dielectric: D. Discharge Space).

The corona discharge can take place in ambient air at atmospheric pressure, or in dried air under pressure. Ambient air equipment is not as efficient in operation as dried pressurized air equipment. Ambient air equipment propuces low concentrations and small quantities of ozone in the air stream passing through the discharge. Ozonators operating on dry air and under pressure produce far greater quantities of ozone in much higher concentrations and at greater efficiency of operation (2). Both types of ozonator are used in commercial applications today. Each has its specialized area.

Figures 59F02A & B are illustrations of ambient air equipment. Figures 59F02C, D and E illustrate dry air pressurized equipment.

Existing commercial applications of ozone include:

Purfication of drinking water;

Production of chemicals, including synthetic fibers, jet lubricants and pharmaceuticals;

Treatment of industrial liquid wastes, such as cyanides and phenols;

Deodorization of sewage gases, rendering plant exhausts, and exhausts from other industrial processes;

Deodorizing air in inhabited areas;

Food and plant preservation in cold storage;

Sterilization of containers for aseptic packaging

Litho. in U.S.A. IMG 5-70

OZONE AND ITS USE IN FOOD PRESERVATION

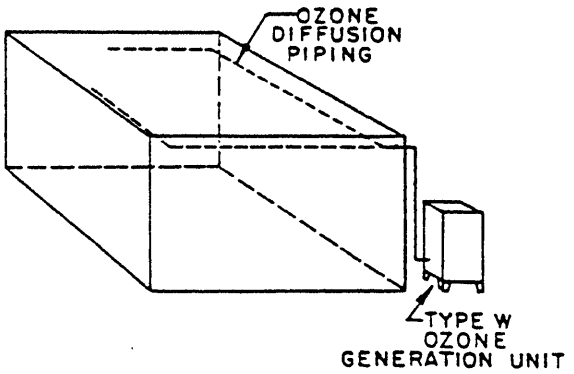
The use of ozone in food preservation is not new. For example, the American Society of Heating, Refrigerating and Air Conditioning (ASHRAE), in its Application and Equipment Guides, cites ozone's usefulness in cold storage warehouses, restaurants and supermarket coolers, and ships and trains, among other places. The ozone concentrations normally used are below 3 ppm/v., where prolonged storage is necessary and where prevention of spoilage, mold growth and transfer of odors between materials is desired. The principle of ozone's usefulness in food preservation involves its ability to check, reduce and eliminate the bacteria causing the majority of the spoilage problems, as well as its power to oxidize odors.

Materials successfully stored in ozone atmospheres include eggs, vegetables, apples, cheeses, citrus and other fruits, nuts, poultry and meats. Most of the present day application information is based upon work done by A. W. Ewell(3).

Let us now study the various materials normally stored and the criteria for storage.

Fruits

By far the most frequently used area of ozone application is in fruit storage. Ozone concentrations normally recommended range from 1 to 3 ppm/v. Several excellent papers on this topic have been presented by the U.S. Dept. of Agriculture (4). Ozone controls surface mold on packages and walls, and reduces scale developments and decay. As determined in the USDA tests, there is no difference in taste and other physiological properties between ozonized and non-ozonized apples.



TYPICAL STORAGE WAREHOUSE
USING OZONE
FOR FOOD PRESERVATION

Figure 59F03

Figure 59F03 shows a typical application with a Welsbach "W" series ozonator. In the work by Schoner of the USDA it was found that *intermittent use of ozone* would be satisfactory in preserving the quality of apples, preventing the growth of molds and eliminating or reducing other spoilage. This has been shown in a State of Washington warehouse where ozone is used only during evening hours.

> "Ozone has been recommended for use in the storage of apples and small fruits. Growth of surface molds, the mold spore count in the air, germination of spores and infection of the fruit were reduced and offensive odors were destroyed. A concentration of 1-2 ppm for a few hours a day was effective and not injurious to the fruit. Decay of apples that were already infected was not reduced by ozone.
>
> Concentrations of 3.25 ppm seemed to increase decay, causing pitting, and also caused a musty flavor to develop in apples of some varities."(8)

Other fruits, including strawberries, raspberries, currants, grapes, peaches and all types of nuts, can be stored in ozone atmospheres to reduce mold growth and extend the storage period. Fruits are kept fresh longer and losses during shipment are substantially reduced. In fact, some experiments show that the pleasant aroma from these fruits is even enhanced.

Egg Storage

The storage of eggs in large commercial warehouses calls for protective measures to prevent decay of the egg material. In egg storage the presence of high humidity is necessary to reduce shrinkage caused by loss of moisture through the permeable egg shell. Further, the high humidity necessary to prevent this is conducive to mold growth.

However, eggs stored in ozone atmospheres at a 90% humidity and 31 degrees F. temperature for up to 8 months are free of mold growth and indistinguishable from fresh eggs, raw or cooked. The recommended dosage to accomplish this is 1 to 2 ppm.

> "Ozone as a supplement to refrigeration is used in some storages to prevent mold on eggs. Mold is a serious problem in the storage of eggs because of the high humidities that are necessary to prevent loss of moisture and enlargement of the air cell. A continuous concentration of 1.5 ppm in the aisles assures 0.6 ppm of ozone in the center of the stack which is adequate to prevent mold growth in egg rooms at 31° F. and 90% RH if the eggs, cases and liners are clean when stored. Concentrations as high as 3.5 ppm for several months do not cause injury, but 10 ppm for five months causes off flavors." (8)

Cheese Storage

Another area of ozone usage is the storage of various types of cheese. The high humidity in the storage area contributes significantly to the development of mold spores on the surfaces of the cheeses during the curing stages. The presence of ozone in the atmosphere significantly reduces the occurrence of mold, so that one research report states: