Disclaimer: The attached articles about ozone are collected from several sources
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OZONE GENERATORS

Sterilization and purification of water by the use of ozone has been used for may years in drinking water and waste water treatment plants throughout the world. Ozone is very reactive form of oxygen that can destroy and enormous variety of liquid waste materials and toxins. In the aquarium, it offers a simple, highly effective agent capable of killing a wide variety of microorganisms. Viruses, bacteria, spores, and some chemical impurities, etc., are attacked and destroyed by ozone. Additionally, toxic materials treated with ozone are nearly always converted into less toxic compounds, enhancing their absorption by bacteria, algae and /or activated carbon.

Ozone promotes the formation of stable foaming compounds from otherwise non-foaming components, noticeably increasing the efficiency of protein skimmers in the marine aquarium. When ozone is used with a protein skimmer, complex waste materials not removed as foam are further broken down to simpler component parts and passed off to the atmosphere, nitrates are broken down into materials readily consumed by the bacteria and algae in the aquarium. We recommend that protein skimmers always be used with ozone.

Afer 24-48 hours of protein skimming with ozone, the water in the aquarium will seem to disappear as the small particles and colored materials are removed from the water. The clarity of the water is quite simply unequaled by and system.

Ozone should be applied to the aquarium water via a dedicated reaction chamber such as a protein skimmer. Ozone should not be arbitrarily introduced to the aquarium of a reservoir because sufficient contact time is essential to its effectiveness.

The amount of ozone required is directly related to the amount of organic matter in the water to be treated. (e.g. A heavily stocked 50 gallon aquarium will require more ozone than a sparsely stocked 50 gallon aquarium) Generally, the amount of ozone required in the average aquarium can be calculated as approximately 3.5mg of ozone per hour per 10 gallon of water to be treated.

The ozonizer should be connected between your air pump and the airstone of your protein skimmer or connected to the venturi port in venturi operated models. Air that enters the ozonizer exits as a mixture of ozone and air.

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Article 2:

Blood treatment with Ozone

In 1785 Martinus Van Marum noted it's odor and oxidating properties. In 1840 Schonbein named it ozone, from the Greek "ozein", meaning odorant.

In the latter part of the nineteenth century, ozone was found to oxidize certain organic compounds, and interact with double bonds. Using these properties, Harries discovered the structure of natural rubber.

Because ozone can destroy toxic or foul smelling pollution, as well as bacteria in sewage, Wiesbaden (W. Germany) began purifying drinking water with it in 1901. Now, Zurich (Switzerland), Florence (Italy), Brussels (Belgium), Marseille (France), Singapore, Moscow, and other major cities do the same.

Oxygen atoms exist in several forms:
A free atom that's unstable and will react readily.
O2 Oxygen - colorless as a gas, and pale blue as a liquid.
O3 Ozone - blue as a gas, and dark blue as a solid, is a powerful oxidant.
O4 A very unstable, pale blue gas which readily turns into two molecules of oxygen (O2)

It is important to note that ozone interacts with tissue and blood. This is the method generally used in ozone therapy. Remove the patient's blood, mix it with ozone, and return it to him. This mixture reacts with the fatty (lipid) structures, and forms lipid peroxides. [Today "rectal insulflation" of ozone is becoming a popular, painless method.

There are a number of lipid (fat based) components in whole blood. Among these are: cholesterol, phospholipids, triglycerides, and freefatty acids. Ozone can react with all of these, creating many different end products. Our bodies buffer this lipid peroxidation with vitamin E, uric acid, and enzymes such as S.O.D. (superoxide dismutase), catalase, and the glutathione peroxidase system.

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The main compounds derived from the lipid peroxidation are, free radicals, singlet oxygen, hydrogen peroxide, hydroperoxides, hydroperoxide ozonides, carbonyls, alkanes, and alkenes. The hydroperoxides attack viruses, and then in turn are broken down into alcohols by the enzyme glutathione peroxidase.

In 1915, A. Wolff is credited with using ozone as a local treatment for wounds. The cups and bags used to apply it were made from natural rubber. They broke down too quickly, causing ozone to fall into disuse.

Our modern Teflon and other plastics last much longer, and deliver more precise dosages. For example, a burn area can now be treated without touching the site through use of an ozone inflated bag.

Ozone is used on wounds, burns, staph infections, fungul and radiation injuries, herpes, and gangrene. The dosage is tailored for each condition. A treatment lasts from 3 to 20 minutes, and the concentrations vary from 10 to 80 ug per milliliter. The maximum is 5 parts ozone to 95 parts oxygen. High concentrations are used for disinfection and cleaning, and low concentrations promote skin growth and healing.

In 1935, Payr, and Aubourg in 1936 introduced ozone into the rectum, and by this method treated colitis and fistulae. This method is now used in hemorrhoids and anal infections. It promotes healing, and the balance of friendly bacterial cultures.

As an example; for colitis, it is applied daily in increasingly higher concentrations until equilibrium is reached. Then the dosages are lowered in subsequent treatments to promote healing. This method may be found to be optimum in AIDS related bowel infections.

Major Blood Treatments:</B>

Major Blood treatments are also known as autohemotherapy (AHT) (See Medizone).
50 to 100 milliliters of blood are drawn out of the patient, mixed with ozone/oxygen mixture, and reintroduced into the body. This produces oxygenation, kills viruses, and enhances circulation. We do not know exactly how it effects all the body systems, or how long it remains. Some people have reported being able to faintly tast ozone after it's reintroduction. Blood ozone treatment's have been used to treat virus infections, including: AIDS, hepatitis, flu, some cancers, diabetes, and arteriosclerosis. More exacting studies need to be done. Some patients report feeling of well being after ozone treatements, lasting from a few minutes to a few hours.

Minor Blood Treatments:</B>

This method involves drawing 10 milliliters of venous blood, mixing it with ozone/oxygen and injecting it into the muscles. This method has treated asthma, acne, and some allergies."

Today, we continue on the history and current usages of Ozone, I am writing excerpts from the book "Oxygen Therapies", by Ed McCabe on "Dr. Sunnen's Paper on Historical and Current Ozone Usage", pp 100-102:

Intravenous Treatment: </B>

Now rarely used, this method of direct injection (without first mixing the blood with ozone outside the body), was used by Lacoste in 1951 on gangrene. It is rarely used because of the potential of accidents due to too rapid an injection. He found that up to 10 ml of pure ozone/oxygen could be directly injected into the leg artery, or a vein, without getting dangerous bubbles in the blood, since both gases are readily soluble in blood.

Muscular Injection: </B>

Used with blood treatment, this is an added cancer therapy. Up to 10 ml of the pure mixture is injected into the muscles.

Ozonated Water: </B>

Ozone is about 10 times more soluble in water than oxygen. Used mostly in dental surgery, it improves the local oxygen supply, and inhibits bacteria. Ozone water has also been used on peridontal disease, swallowed for treatment of gastric cancer, and applied as a wash in intestinal or bladder inflammation.

<B>Ozone Ointments: </B>

Mixed with olive oil, this mixture gives a low strength, long term dose of ozone and lipid peroxidases to the tissues. Used on fungal growths and skin ulcers.

Ozone Baths: </B>

Ozone bubled through warm water irrigates the skin, to disinfect and treat eczema and skin ulcers.

Blood Purification:</B>

An exciting possibility, all the world's blood supplies may possibly be made viral free! Treating 500 ml of whole blood with 100 ml of ozone/oxygen mixture (40-50 ug/ml) is reported to render it virus free without injuring any healthy cells. One particular study tested ten thousand treated samples and found no hepatitis. In the future, this technique may also be used in removing the AIDS virus.

One preliminary unpublished study indicates this to be so.

Effects of Ozone: </B>
>

Most studies, up to this point, have only focused on proving how breathing ozone was toxic, or name it as air pollution. Pure ozone, applied in the proper say, is quite a different story. The studies where animals have inhaled it do not equal the response of the human lungs, because there are so many differences in the anatomy and physiology. Mice have the most trouble with it, and birds the least. Inhaling very low dosages increases enzyme activity, while overdosage can result in bleeding in the lungs. We see again the window concept, and refer you to what "Merlin" found out.

Due to the danger of breathing in too much ozone, modern treatment machines are designed to prevent any leakage into the treatment roo, as well as catalytically converting excess ozone to oxygen during administration. some studies, however, point to beneficial effect of low dosage ambient ozone.

Bactericical, Virucidal, and Fungicidal Action: </B>

We have known ozone kills and inhibits pathogens since the nineteenth century. What we haven't done is the tests proving exactly why it has

these effects. Only a few microgreams per liter provide germ killing action. It works even faster on viruses than bacteria, at lower dosages, and is influenced by pH, temperature, and other nearby organic compounds. Different viruses have different susceptibility to destruction by ozone, for example, the polio virus is forty times more resistant than other viruses.

Ozone's popular reputation as a bactericide centers on it's ability to destroy the pathogen's outer fatty/protein shell. In one study it actually penetrated the cell's membrane and changed the DNA. Higher organisms have enzymes that can restabilize disrupted DNA & RNA, where

lower forms do not. This could be why ozonem, at proper levels, will kill a virus (a lower lifeform), and leave a person's (higher lifeform) cells unharmed.

One study showed the ability to destroy candida fungi to be dependent on their stage of growth. Budding cells were the most sensitive. Another study showed a low dose increasing the growth
of two other fungi.

Viruses are genetic parasites, and can be separated inito families, based on structure. Those containing lipids are the most sensitive: herpes, mumps, measles, flu, rabies, HIV/AIDS. In some, the shell is

damaged, in others they remain whole, but unable to reproduce. Often the ozone is used up in a blood reaction, and the products of that reaction cause the destruction or inactivation of the pathogens. Although unlikely to be outright curative by itself, when combined with other therapies, ozone may lessen clinical severity or duration.

Article 3

Effect of Hatching Cabinet Sanitation Treatments on Salmonella Cross-Contamination and Hatchability of Broiler Eggs

ABSTRACT

Four trials were conducted to evaluate the efficacy of hatcher air sanitation utilizing ultraviolet light (UV), ozone, or hydrogen peroxide on bacterial populations, the spread of Salmonella, and hatchability of broiler eggs. The UV light (254 nm, 146 µW/s) and ozone (0.2 or 0.4 ppm) treatments were continuously applied through the last 3 d of hatch, the hydrogen peroxide treatment (2.5%) was administered 1 or 2 min of each 10 min at rates of 500 or 100 mL/h.
<p>
Hatchability was not significantly reduced by sanitizing treatments

when compared with the untreated control (94 vs 95.6%). As compared to controls, all sanitizing treatments reduced 75 to 99% of the total bacteria, Enterobacteriaceae, and Salmonella in the hatching cabinet air samples. The use of hydrogen peroxide resulted in greater reduction of bacteria than ozone or UV light. Only hydrogen peroxide significantly reduced Salmonella levels on eggshell fragments. Significant reductions in the number of Salmonella-positive chicks occurred using the ozone and hydrogen peroxide treatments. Hydrogen peroxide significantly reduced the magnitude of Salmonella colonization in chicken ceca. These trials demonstrated that the spread of bacteria can be effectively reduced in the hatching cabinet by air sanitization using UV light, ozone, and hydrogen peroxide. The potential to reduce bacterial cross-contamination in the hatcher is achievable without depressing hatchability.

Article 4

Ozone as a Biocide

Traditionally, chlorine has been used as biocide in drip irrigation systems to prevent emitter clogging due to organic material. However, questions are now being raised about the detrimental effects of chlorine on the environment and alternative biocides are being investigated. One alternative is ozone. Ozone has been used as a safe and effective biocide in other commercial applications, such cooling towers, municipal water treatment, and swimming pools. Ozone attacks bacteria and algae by rupturing the cell wall. In addition to the added safety aspects of using ozone, bacteria and algae do not develop ozone resistance, as they do to chlorine.

Additionally, there is an environmental liability with chlorine that isn't present when using ozone.

This paper discusses a study that compared the use of ozone with traditional chlorine treatments as an effective biocide to control organic clogging in a subsurface drip irrigation system. Source water and tube samples were taken and analyzed for bacteria counts. Additionally, tube samples were analyzed for algae build up. An ozone treatment of greater than 700 oxygen reduction potential (ORP) was compared to a check treatment and three chlorine treatments:

20 ppm and

10 ppm shock treatments and a 1 ppm continuous injection. Initial results showed that the ozone more effectively controlled bacteria growth in the tubing when compared to the 10 ppm and 1 ppm chlorine treatments and the check. Further study on a larger scale will be required to test ozone's effectiveness and economic viability.

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Article 5

Using Ozone to Treat Drinking Water From Dugouts

Any illnesses can be transmitted by surface water. As a result, reducing the risk of illness is the most important consideration when choosing the best water treatment system for you..</P>

<P>Ozone has been used in water treatment for more than 80 years. It is a powerful oxidizing agent that can reduce levels of many impurities in water, including colour, taste and odour. Ozone can also be used as a disinfectant and is a good alternative to chlorine for some applications.</P>

<P>In the summer and fall of 1993, staff from Alberta Environmental Protection conducted field trials on the use of ozone to treat drinking water from farm dugouts.</P>

<P>A trailer-mounted water treatment system was set up at two sites in Alberta's Peace Country. In a series of experiments, ozone was applied to dugout water at and above the rates that are used in most of the home ozone systems currently being marketed in Alberta. Even when ozone was applied at well above typical rates, it failed to disinfect the test waters. This demonstrates that most home ozone systems would be inadequate to disinfect water from similar dugouts, without severe restrictions in the water flow rate.</P>

<P>Comparable laboratory tests on samples collected from Lethbridge area dugouts showed lower ozone requirements than the northern dugout waters. Disinfection of these dugout waters should be possible using controlled water flow rates and available ozone generators.</P>

<P>All of the dugouts used in this study were well-maintained, and of comparable di-mensions. The regional variation is due to differences in filling practice. The southern test dugouts are filled from nearby irrigation systems. The northern test dugouts receive controlled runoff from nearby grass areas or fields.</P>

To remove microbes from dugout water, it is necessary to use several barriers.
 It is recommended that both filtration and disinfection be used
<P>Variations in dugout water quality limits the use of standard ozone system sizing. The only practical way to ensure a proper dosage is to measure dissolved ozone in the water. Residual ozone has to be present, and should remain in the water several minutes downstream of the ozone injection point to reliably disinfect drinking water.</P>

<P>Here are two examples of ozone treatment on dugout water. Both cases use an ozone generator with a maximum capacity of 0.5 g/hr on air service (considered a "large" model on the local market):</P>

<LI>A well-maintained farm dugout near Spirit River is filled by controlled runoff from a grass area. More than 15 mg/L of applied ozone is probably required to provide a safe residual ozone level of 0.4 mg/L. To achieve 15 mg/L, the full generator output would have to be dissolved in a water flow of less than 0.5 L/min (1/10 USgal/min).
<LI>A well-maintained farm dugout in the Lethbridge area is filled with water from southern Alberta's irrigation system. The required ozone dose to achieve the same 0.4 mg/L residual is a fraction of the Peace Country case, at around 3 mg/L. To accomplish this dose, water flow should be limited to 2.8 L/min (3/4 USgal/min).

<P>Ozonation technology boasts a very impressive list of capabilities, however it is not a magic bullet for all situations. Ozone has to be applied at the right dosage and given proper allowance for contact time to achieve disinfection.</P>

ARTICLE 6

Submarine Graywater Remediation Using Ozone Technology

Challenges: Voluntary compliance with environmental goals by year 2000. Shipboard graywater and blackwater treatment to reduce:<p>

environmental concerns
the need for significant potable water production
large tankage volumes<p>

Approach: To develop a system to mitigate impacts of graywater and blackwater through:<p>

re-use (graywater)
treatment (for overboard discharges)<p>

Goals

Mitigate environmental concerns with "clean" discharge

Reduce use of potable water and operating frequency of distilling system by at least 50%
Reduce onboard stowage of detergents by at least 50%
Develop tech demo of submarine size equipment
Show feasibility of voluntary compliance by 2000<p>

Program Team<p>

NAVSEA SEA 92R - Program Management (Ms. M. Payne POC - 703-602-1703)
Newport News Shipbuilding - Shipboard Integration
International Ecoscience (IES) - Laundry System Design and Manufacture
Penn State/Applied Research Laboratory (PSU/ARL) - Ozone Wastewater Treatment System Modeling, Characterization, and Development<p>

Areas of Investigation

Develop recycling capability for dish washing and laundry using ozone technology, utilizing existing science and technology funding in SBIR program. (IES & NNS)
Develop ability to treat remaining graywater (galley, sink, shower, deck drains, etc.) with ozone to re-use as flushing water or for unrestricted discharge. (PSU/ARL & NNS)
Develop the ability to treat blackwater with ozone technology to permit unrestricted discharge of some or all of the effluent. (PSU/ARL & NNS)
Produce Technology Demonstration Model to Verify Technology in an SBIR Phase II Effort (end of FY97)
TEMPALT Installation on a SSN688 Class Submarine For Installation of Proven System on USS Memphis (Navy 6.4 RDT&E) Funded) (FY98)
Conduct At-Sea Demonstration (FY98+)
Full Scale Development (Navy 6.4 RDT&E, planned) TBD<p>

Ozone Laundry Water Recycling System Schematic<p>

See source document.<p>

Graywater Remediation Using Ozone Technology

Other Applications:

Surface Fleet & Naval Facilities

Laundry water recycle
Graywater/oily waste reduction
Hazardous waste reduction thru ozone-based cleaning (ex. shop rags) and site remediation<p>

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Other DoD Activities With Similar Challenges

Dual-Use Commercial Applications

Large scale commercial laundry (currently prototyped)
Graywater reuse/reduction<p>

Generation
Ozone (O3)

Nature produced properties, oxygen (O2)

Lightning
Sunlight (UV)<p>

Most effective oxidizer
available 100 years old (discovered 1840)
pH neutral, water chemistry minimal<p>

Primary Function Nature<p>

Purify air
Screen from harmful rays<p>

Manufactured<p>

Dry air (-60 F dew point) exposed to high frequency electric discharge<p>

O2 disassociates and reassemble as O3<p>

Half life: approximately 20 minutes<p>

Reverts back to O2<p>

Ozone<p>

Triatomic form of oxygen<p>

Colorless gas at room temperature<p>

1 1/2 times as dense as air<p>

Strong oxidizer, only excessed by florine, hydroxyl radicals, and atomic oxygen<p>

Very effective bactericidal and viralcidal agent<p>

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Ozone is formed reaction of monatomic oxygen with dimolecular O2<p>

See source document.<p>

Hydrogen peroxide (H2O2)<p>

Hydroxyl (OH)

Radical
Non-selective oxidant

2 to 3 orders of magnitude<p>

Silent Arc Discharge (Corona Discharge)<p>

O3 obtained by passing air between two plates electrodes connected to an alternating current source (KVs)<p>

Configuration

Electrodes can be flat, tubular etc.
Dielectric material, glass, ceramic, etc.
Voltage frequency of gap distance and dielectric material<p>

Health and Safety

Exposure Level Air - 0.1 ppm<p>

Symptoms - Detectable hay-like smell, like after thunderstorm<p>

Exposure Level Air - 0.1-1 ppm<p>

Symptoms - Headache, burning eyes, dry throat<p>

Exposure Level Air - 1-100 ppm<p>

Symptoms - Appetite decreases, asthma like symptoms<p>

Exposure Level Air - 100 ppm<p>

Symptoms - Hemorrhaging pulmonary edema<p>

Article 7

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Commercial Laundry Ozone Application

<p>Large commercial laundry companies and institutions such as
hotels are just beginning to discover the benefits of using ozone
treated water in the washing process.</p>
<p>Ozone vastly enhances the cleaning capabilities of most
detergents. As a result, colder water and less detergent can be
used. The length of wash cycles can be reduced and sanitizing
capablilities can be enhanced.</p>
<p>The savings to laundry companies are substantial through lower
utility costs, lower costs for detergents and manpower, and
reduced disposal costs for detergent laden water discharged into
public sewer systems.</p>
<p>Cyclo<sub>3</sub>pss' powerful and compact ozone generating
system is easily adaptable to laundry applications of any size.</p>
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Article 8

Medical-toxicological opinion on the ozone disinfection treatment of eggshells

Eggshells often contain pathogenic bacteria (1). Since eggshells are permeable to microorganisms, they probably contain bacteria found in the hen's digestive system, such as Salmonella, Shigella, various Streptococci, Pseudomonas and others.

The effectiveness of ozone as a general disinfectant.

Ozone (O3), a highly effective disinfectant for two main reasons: It has a high oxidation capability, and good permeability through bacterial cell membrane and cell walls (2). Unlike other disinfectants, ozone very quickly kills not just bacteria but also viruses.

A further advantage of ozone as a disinfectant is its very short life-span.

Under normal humidity and temperature conditions, ozone decomposes within minutes to form ordinary oxygen (O2), which constitutes about 20% of the air on the planet.
Safety of using ozone as an egg disinfectant The egg is particularly suitable for external disinfection by ozone because of its layered structure. The external shell contains calcium and is covered with a layer of cuticula (a mainly protein material). The shell allows bacteria to penetrate through its pores. Under the shell are two membranes made of protein and protein complexes.

Next is a relatively thick layer of albumen (the white of the egg) which encloses the yolk consisting mainly of protein and fat.

The protein layer has a chalaza system whose function is to maintain the yolk at the center of the egg.

The thick layer of protein (which quickly converts the ozone into ordinary oxygen) under the eggshell prevents the ozone, during the suggested disinfection operation, from reaching the yolk at the center of the egg (3).
</OL>

Ozone serves as a disinfectant for drinking water in the USA (California) as well as in Europe (France, Switzerland).
It is known that a short time after ozone is introduced into water it decomposes to become ordinary oxygen.
In various countries (e.g. Japan), ozone is used to disinfect vegetables as well as fish, on the assumption that ozone only disinfects the external area and does not penetrate deep inside (4).

Reservations about using ozone stemmed from the fact that ozone is known as an ecological air pollutant.
Long exposure to ozone harms the airways, especially the bronchioles, and causes small airway disease.

However, the ozone disinfection procedure implemented under conditions suggested by Health Eggs Ltd., leaves no ozone residue at all on the treated egg, since within a few minutes after the end of the disinfection process, the ozone turns into ordinary ambient oxygen.
There can, therefore, be no danger of exposing egg consumers to ozone.

The suggested disinfection procedure at a concentration not exceeding 100 parts per million (ppm) for one hour C*T (concentration x time) = 6000, seems to me extremely safe, and is certainly preferable to disinfection with chlorine or formaldehyde which leave residue on the egg that could produce harmful effects.

OZONE DISINFECTION OF EGGSHELLS WITHOUT LEAVING TRACES

Ozone kills all microbial pathogens, including bacteria and viruses.
The main advantage of ozone is that, unlike most common disinfectants, this gas does not leave any toxic residue on the treated eggs and does not pollute the environment.
Since ozone is extremely unstable, it decomposes spontaneously within a short period to become regular oxygen.
In tests conducted on edible eggs and hatching eggs, we found that ozone causes an almost total sterilization of the eggshell within a relatively short time
and does not cause a build-up of new smells or flavors on the egg.
Ozone does not even harm the developing embryos, the percentage of hatching or the rate of chick development, or any other parameters up to the marketing age.

The scope of the problem
Eggshells are contaminated with various pathogenic microorganisms even when the eggshell seems to be clean.
The resulting danger to public health depends on the level of contamination, i.e. the number of pathogens found on the eggshell, especially the Salmonella bacteria.
The penetration of various bacteria, including Salmonella enteritidis, normally takes place from outside the eggshell and through it into the egg (1).
As regards the prevalence of Salmonella in eggs, in sample tests conducted in our labor

atory on edible eggs that had been purchased in various supermarkets, we found that up to 25% of all eggshells were contaminated with Salmonella (in general, without defining which species).
In the case of "farm eggs" (organic), all the eggs in our sample were infected by this genus of bacteria.
In recent years, reports have been published of rare cases where the inside of an egg, especially the outer layer of the yolk, has been contaminated with a violent strain of Salmonella enteritidis.
Clearly, in such a case disinfecting the eggshell would not be effective.

DISINFECTING EGGSHELLS

Formaldehyde disinfection of eggshells
An accepted procedure today is to disinfect hatching eggs by exposing them to formaldehyde.
This is an easy method to implement, it is effective in destroying pathogens, and it is cheap.
However, it has a number of obvious disadvantages, especially the fact that formaldehyde has been proved to be carcinogenic (3).
In addition, exposure to formaldehyde fumes creates bad irritation in the eyes and mucosity of the respiratory system (especially the nose).
Because of these disadvantages, hatchery owners
ying to avoid using this procedure.
Its use will probably be stopped eventually, since formaldehyde disinfection endangers the health of hatchery personnel.
This procedure has never been used to disinfect edible eggs, mainly because of the unpleasant smell that emanates from formaldehyde-treated eggs long after treatment is over, and because of the public health danger involved.

Disclaimer: The attached articles about ozone are collected from several sources
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Despite the problematic nature of disinfecting eggshells, this treatment is very important since eggshell bacteria could penetrate inside the eggs and harm the developing embryos (4). With regard to edible eggs, disinfecting the eggshells could be very important because eggshell contamination is the main reason for Salmonella contamination in eggs.

Since the refrigeration of an egg contaminated with Salmonella will not prevent the bacteria from reaching the consumer (2), (5), it is important to disi
ggs as early as possible.

Ozone disinfection of eggshells

Ozone (03) is a highly active oxidizing agent that can break down most organic materials and even some inorganic compounds, especially in the gaseous phase.

Ozone is extremely effective for treating and disinfecting air and other gases (as well as liquids and solids), for removing unpleasant smells, for breaking down toxic and irritating substances, and for killing bacteria and other microorganisms of all kinds, including germs and viruses.

In this, ozone has an advantage over other kinds of treatme

disinfection (6). Moreover, ozone treatment does not leave any toxic or corrosive residue on the treated products, unlike treatment with other disinfectants (such as chlorine and its derivatives, ethylene oxide or sulphur dioxide), since ozone is unstable and decomposes entirely shortly after the end of treatment, to become regular atmospheric oxygen (O2) (7).

Ozone is also not accumulated in materials or in the facilities where ozone treatment takes place, since it decomposes spontaneously and very rapidly.

Ozone is, in fact, the only disinfectant that does not leave any residue whatsoever on the treated material.

The scientific literature contains several papers on the experimental use of ozone in disinfecting eggs.
Whistler and Sheldon reported that they had succeeded in achieving extremely high effectiveness in destroying all microorganisms that are to be found naturally on the shells of hatching eggs.
In their study, they achieved an effectiveness similar to that produced using formaldehyde (3), but the hatching percentage of eggs treated with ozone using their method was much lower than with eggs treated ormaldehyde.
In our opinion, the ozone treatment procedure used by Whistler and Sheldon (3) was not correct.

Recently, attempts have been made to use hydrogen peroxide for disinfecting fertilized eggs, but the disadvantage of this method is that this involves wetting the eggshell, which damages the natural coating (cuticula) found on the eggshell.

Experiments conducted by us

The ozone treatment method that we used was produced by Ozonetech Ltd., Israel (8). The experiments were conducted in Israel at commercial hatcheries on a kibbutz (collective farm) and on a moshav (cooperative village), in the special rooms that serve those hatcheries for formaldehyde treatment.
Each experiment was conducted three times, each on a different date.
The kibbutz experiments included some 4,500 eggs in each experiment, with one third being treated with ozone, one third with formaldehyde, and one
third with hydrogen peroxide.
The formaldehyde and hydrogen peroxide treatments were conducted in the same way usually employed by the hatcheries.
In the moshav experiments (including 4,200 eggs for each experiment), half were treated with ozone and half with formaldehyde.
Similarly, each treatment included groups of other eggs that had been contaminated with fresh chicken manure, or had been deliberately contaminated with a large number of bacteria of various types (each type for a separate group of eggs).
These bacteria included Salmonella typhimurium, Pseudomonas aeruginosa, Salmonella enteritidis, and Escherichia coli, which were received from the bacteria collection of the Israel Ministry of Health in Jerusalem.

This last group of eggs was also treated with ozone together with the other eggs that were earmarked for ozone treatment in each experiment.
The parameters for assessing the success of each treatment were:

The number of bacteria on the eggshell before and after each treatment (random checks);

The percentage of hatching and the quality and performance of the chicks after hatching (all the eggs and all the chicks were examined).

In the experiments with edible eggs, the natural microorganisms on the eggshell were examined (general count), as well as the types of bacteria with which the deliberately contaminated eggs had been inoculated, before and after the ozone treatment, as explained above (re: hatching eggs).

Further experiments conducted by the Dutch Ministry of Agriculture in cooperation with Dr. Ron Meijerhof, showed similar results to those obtained in the experiments conducted in Israel.

Results and conclusions

In all experiments, both with hatching and edible eggs, whether the treatment was conducted under laboratory conditions or at the hatcheries, the ozone treatment destroyed at least 99% of the microorganisms on the eggshells and in most cases up to 99.99%.
Similar results were observed with eggs that had been contaminated with chicken manure, and also eggs that had been deliberately contaminated with the above mentioned pathogens.
These results were not statistically significantly different from those observ
ed with formaldehyde-treated eggs.

Regarding hatching results, in both hatcheries, the main observations summarized in the following table prove that the hatching percentage of ozone-treated eggs was similar to that of formaldehyde-treated eggs.
There were no significant differences in the percentage of chicks classified as "Class B", in the percentage of defects in the chicks, or in the mortality rate in the first five days of hatching and in the last three days before hatching.
Hatching results of ozone or formaldehyde treated eggs in two hatcheries (in %)

Fertilized eggs in experiments conducted in Kibbutz Bet Haemek.
The effectiveness of the ozone treatment in destroying natural microbial contamination that was deliberately placed on the eggshells (average values for four experiments, each one run 5 times).
The treatment time was 30 minutes.
The concentration is expressed in the total number of bacteria from that type on one egg.
Summary of experiments under laboratory conditions on the efficiency of ozone in destroying specific bacteria that were deliberately placed on eggshells from the bacteria collection of the Ministry of Health (average values for 6 experiments, each one run 12 times).
The treatment time was 15 minutes.
The concentration is expressed as the total number of bacteria from that type on oneh egg.

Disclaimer: The attached articles about ozone are collected from several sources from the internet and does not necessarily reflect Ozomax applications and experience

Conclusions:</B>

Ozone treatment allows disinfection that is no less efficient than formaldehyde or hydrogen peroxide treatments.

Ozone treatment does not harm the unborn chicks.

In the treatment process described here, the ozone does not harm the inside of the egg.
We can therefore conclude that consumption of ozone-treated eggs is safe.

Ozone treatment is easy to implement.
It is efficient, it does not leave any residue on the egg, and it is environment-friendly.

ARTICLE 9

Ozone Compatible Materials Chart

****

Material rating codes

Disclaimer: The attached articles about ozone are collected from several sources from the internet and does not necessarily reflect Ozomax applications and experience

Excellent = E , Very Good = V.G , Good=G , Poor = P

Material	Rating	Material	Rating
ABS	V.G	CPVC	E
Hytrel	G	LDPE	G
Noryl	G	Nylon	P
Polycarbonate	E	Polypro	V.G
Teflon	E	PVC	V.G
PVDF	E	Buna	P
EPDM	E	Hypalon	E
KEL-F	E	Rubber	P
Neoprene	G	Silicone	E
Viton	E	304 St-steel	V.G
316 St-Steel	E	Aluminium	V.G
Bronze	V.G	Copper	E

Disclaimer: This table is based on information collected from Cole Palmer compatbility material chart catalogue 1997-1998.All data was either provided by material suppliers of above trade marks or experimental results by researchers.At no time Ozomax ltd will be held liable/responsable on data provided above.
This table was prepared in good faith & best information available at time of publishing which is January 1997.

Article 10

Facts About Ozone

Ozone is a form of Oxygen in which three atoms combine to form a molecule, instead of the normal two atom structure. In this "trivalent" state, Ozone is a powerful oxidizing agent and an effective antiseptic.

Ozone is created in one of two different ways - electrically and photochemically. Electrically created Ozone is a blue gas with a pungent odor in high concentrations.
Ozone that is produced photochemically is found in two distinctly different parts of the atmosphere. In the upper stratosphere Ozone is created when UV light from the sun converts normal Oxygen to Ozone. This Ozone layer protects us from harmful radiation from the sun. Ozone is also created in the troposphere when exhaust from internal combustion engines is photochemically degraded. If held close to the surface by thermal inversions, this low-lying Ozone begins mother nature's process of oxidation which eventually converts the components of smog to natural, breathable air.Ozone is magnetically attracted to other chemicals. When it comes in contact with another chemical it "oxidizes" or converts the target
chemical into harmless byproducts.
Ozone has a very short life span. In ambient temperatures, Ozone will only last for 10 to 20 minutes before it returns to "normal" oxygen.
Ozone has been in commercial use for over 100 years. Water treatment, Sewage treatment, Fire deodorizing, Spas and pools, Food storage, Medical science, and more.

Ozone reduces airborne and surface bacteria by 71%
Ozone reduces airborne and surface molds and fungus by 83%
Ozone is 3,000 times more germicidal than chlorine
Ozone is 160 times more bactericidal than sulphur dioxide
Ozone is 37 times more bactericidal than formaldehyde
Ozone is 1.7 times more bactericidal than hydrocyanic acid

According to the AMERICAN INSTITUTE OF TOXICOLOGY:</STRONG>
"The use of Ozone as a disinfectant, deodorizer and air purifier represents a safe, effective and less costly alternative to other more conventional methods."

"Toluene, Xylene and Ethyl Benzene are aromatic hydrocarbons and are readily oxidized by Ozone. Methyl Ethyl Ketone is also readily oxidized in the presence of Ozone."

"Ozone is an inhibitor of mold and bacteria growth."

"Ozone has been recommended for purifying air with high concentrations of carbon monoxide."

"Ozone is particularly useful for the oxidation of formaldehyde, the final products of the reaction are carbon dioxide, oxygen and water."

"Although all chemicals including Ozone can be harmful at exposures that are too high, the <STRONG><EM>Inter+Sept</EM></STRONG> product is designed to produce Ozone in the room air at levels similar to those found in fresh outdoor air. In addition, our ability to smell Ozone at levels far below those associated with even minor harmful effects helps make Ozone very safe to use."

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ARTICLE 11

WHAT IS OZONE

Ozone is "active oxygen,"
nature's special element. <I>It is a natural purifier, created by combining
three oxygen molecules.</I> DEL Industries manufactures ozonesystems that
for purification of water and air - greatly reducing or eliminating the use of chemicals. These systems produce ozone molecules which are very unstable powerful oxidizers that kill bacteria and viruses over 3,000 times
faster than chlorine. Ozone does not leave contaminants in the water that
smell, look or taste bad nor does ozone leave potentially hazardous by-products
such as chloramines that can irritate your eyes, dry out your skin, fade swimwear, and damage pool and spa or water storage equipment. In fact, unused ozone reverts back to life-giving oxygen. </FONT></FONT></B></P>

Ozone is not new. It was first
discovered in the 1840's. By combining the ultraviolet rays from the sun with the air we breathe, ozone is naturally generated - (it's clean, fresh
scent is often noticed after a heavy rain). In 1906, the city of Nice, France, built the first municipal water purification plant using ozone. Today, there are over 2,000 plants worldwide using ozone to purify drinking
water.

Some ways ozone is used:

Bottled Water Treatment - Used by Many Bottled
Water Plants

Municipal Drinking Water

Pool and Spa Water Purification - Commercial
and Residential Applications

Life Support and Aquaculture Systems for Mammals
and Marine Life

Air Purification - Eliminate bacteria, virus,
mold and mildew odors

Agriculture - Washing fruits and vegetables
for longer shelflife
Industrial - Cooling Tower water, Ultra Pure
Water

Home Water Purification - Point-of-Use and
Whole House Water Treatment Systems

Odor Elimination in Commercial Facilities
Some familiar places using ozone system

San Diego Zoo, San Diego, California, U.S.A.
for marine and mammal aquatic habitats Disney World, Florida and
California, U.S.A.
- All water features -City of Los Angeles, California, U.S.A. -
municipal drinking water systems
Olympic Swimming Pools
Vancouver Aquarium, Canada - sea mammal life
support systems.

Many YMCA's and Hotels

Waterparks and Aquatic Centers
Universal Studios - Jurassic Park exhibit

In the United States, ozone is beginning to be used more often to purify pools and spas. It is used in hundreds of thousands of residential and commercial pools and spas all over the world. The International Bottled Water Association (IBWA) recommends that all bottled water be treated with ozone. This provides disinfection for the water, the bottle, and the cap, leaving no residual taste, odor, or harmful byproducts. Ozone is also used to purify waste water. It even has the capability of bringing life back to "dead /stagnant"
contaminated lakes and ponds.

Why Ozone is Better Than Chlorine

Ozone is faster - over 3,000 times - to purify water

Unlike chlorine, ozone leaves
no harmful chlorinated byproducts in the water - ozone quickly reverts back to pure oxygen if unused.

Chemical water treatment leaves
long-term chemical effects on the environment - some of which are negative.

Ozone does not.

Ozone is the strongest, fastest,

commercially available disinfectant and oxidant for water treatment. Ozone
oxidation reactions take place several thousand times faster than those of chlorine for destruction of bacteria, viruses, yeast, molds, cysts, mildew, and most other organic and inorganic contaminants. Ozone in appropriate
doses can treat all water-borne pathogens, while chlorine cannot (given practical, safe doses.)

Ozone can be generated on site and does not require storage.

You cannot over-dose with ozone
as unused ozone escapes out of the water and reverts to oxygen.

Ozone disinfection qualities
are not dependent on pH, nor does the addition of ozone affect the pH of water.

Other events leading the way to ozone use include:
Concerns about water conservation
and water reuse

>More stringent EPA and Water Quality Guidelines

General water quality concerns
- what is in the water you drink and use daily

Advancement of ozone-based technology
to a safe, environmentally-friendly, state-of-the-art approach to water treatment has made the transition away from chlorine a comfortable

BENEFITS OF USING OZONE:

Ozone destroys bacteria, mold,
and mildew, eliminates spores, yeast, and fungus, and inactivates viruses and cysts.

Ozone oxidizes and destroys oils and other contaminants in water.

Ozone can significantly reduce
levels of harsh chemicals such as chlorine.

Ozone acts as a microflocculant
aiding in the removal of minerals such as iron and manganese.

Ozone leaves no unpleasant chemical taste or smell.

Ozone dissolved in water will not irritate skin, nose, or ears, nor will it dry out or leave a chemical
film on skin.

>Ozone can reduce chlorine or
bromine consumption to a minimum, saving money on maintenance.

Ozone is generated "on site".

Ozone's effectiveness can be
measured with a simple ORP meter.

Ozone does not affect the pH
balance of water like traditional chemicals treatment methods.

>Ozone is less corrosive than chlorine in water.

ARTICLE 12

TYPICAL SLURRY TREATMENT VIA OZONE PROJECTS

A, Pulp Paper Bleaching:

<P>
BAI has been providing consulting services to some of the major corporations involved in pulp paper bleaching and equipment suppliers for the pulp paper industry in the field of ozone technology and ozone mass transfer into low, medium and high consistency pulp during the past 15 years.

<P>
B, Medical and Hospital Waste Disinfection:

<P>
The medical and operating room waste when it is ground-up forms a slurry consisting of 5% solids (syringes, gauze, scalpels, blood, etc.) in water. BAI has provided consulting services for the pilot plant study and designed the first demonstration plant for the ozone disinfection of that waste slurry. BAI developed a ground breaking technology for the efficient mass transfer of ozone (up to 1000 mg/l) into the medical waste slurry. The design treatment capacity of the demonstration plant is 160 GPM slurry containing up to 5% solids (on the dry basis).

Disclaimer: The attached articles about ozone are collected from several sources
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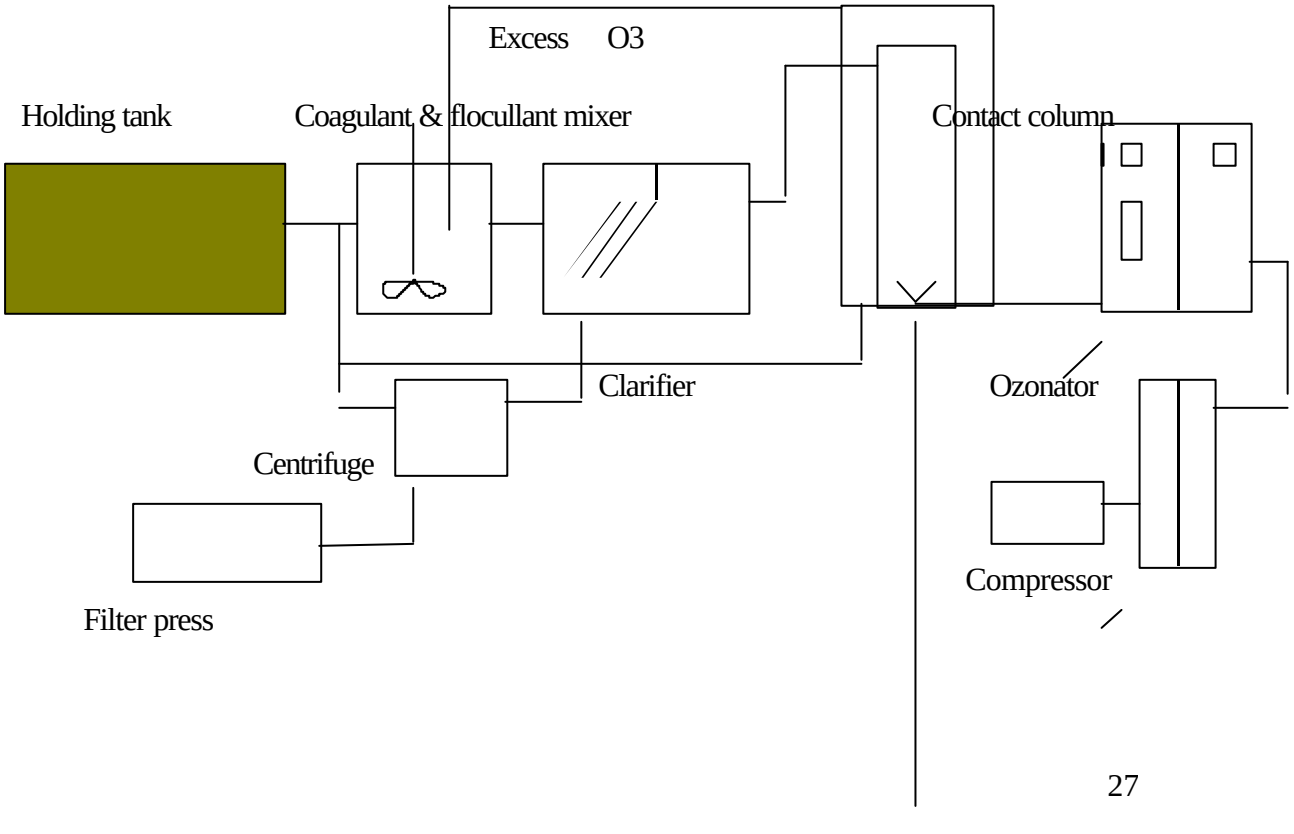
Article 13

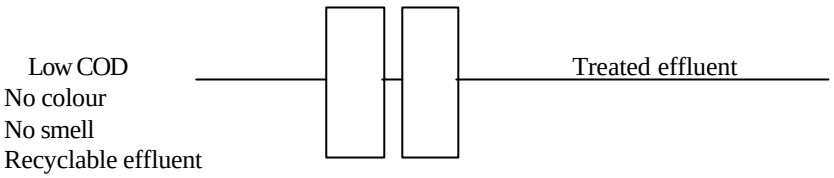
Pig manure Ozone treatment process



Disclaimer: The attached articles about ozone are collected from several sources from the internet and does not necessarily reflect Ozomax applications and experience

Oxygen generator

Sand filter



Article 15

Ozone Applications For Agricultural Products, Perishable Goods, Produce and Food Products

Ozone treatment has been used world wide to extend the storage life of fruits and other perishable food products. A summary review paper on this subject is available on request.

The bactericidal, fungicidal and the general disinfection effect and the oxidizing effect of the ozone treatment was used world wide to extend the storage life of various perishable food products prior to the general availability of refrigeration. It is still used commonly in some parts of the world where refrigeration is deemed expensive. We believe it can be used to a great advantage in combination with refrigeration also when processed perishables are stored.

<P>
In the US the current primary interest is in the disinfection effect of ozone treatment during the processing of food products. The two main areas of interest appear to be in:
<UL>
<LI>The processing of produce; vegetables, fruits and berries to assure sanitary conditions and the high quality of product.

<LI>The disinfection of poultry meat and meat products for the control of salmonella bacteria.

ARTICLE 16

Zebra Mussel Control by Ozone Treatment

The Zebra Mussel (Dreissena polymorpha) infestation of raw water intake pipes and structures can seriously limit the water flow into hatcheries, drinking water treatment plants and cooling systems of power plants. A mechanical removal of the mussels might be required to restore the original flow.

<P>
In order to prevent the Zebra Mussel infestation of raw water pipes, Bollyky Associates, Inc. (BAI) has undertaken a laboratory and pilot plant program to develop an environmentally safe process that will not leave or produce undesirable or harmful chemicals in the water.
Among the chemical treatments tested, ozonation showed the most promise.