O_3 Greentech

Presents

Useful Information

About

OZONE

Developments in the Ozone Technology

- Ozone has been used for disinfections of drinking water in the municipal water industry in Europe for over 100 years and is used by a large number of water companies, where ozone generator capacities in excess of 100 kg/h are common.

What is Ozone?

- Ozone is a molecule composed of three atoms of oxygen. Two atoms of oxygen form the basic oxygen molecule--the oxygen we breathe that is essential to life. The third oxygen atom can detach from the ozone molecule, and re-attach to molecules of other substances, thereby altering their chemical composition. It is this ability to react with other substances that forms the basis of manufacturers claims. Ozone (O3) is one of the strongest oxidizing agents that are readily available. It is used to reduce color, eliminate organic waste, reduce odor and reduce total organic carbon in water. Ozone is created in a number of different ways, including ultra violet (UV) light, corona discharge of electricity through an oxygen stream (including air), and several others. In treating small quantities of waste, the UV ozonators are the most common, while large-scale systems use either corona discharge or other bulk ozone-producing methods. Ozone is formed as oxygen (O2) is struck by a source of energy. The bonds that hold the O2 together are broken and three O2 molecules are combined to form two O3 molecules. The ozone begins to break down fairly quickly, and as it does so, it reverts back into O2. The bonds that hold the Ö atoms together are very weak, which is why ozone acts as a strong oxidant as readily as it does.

History of Ozone

- **1840** - Discovered by Schönbein

  1893 - Used as a disinfectant in drinking water
- **1909** - Used as a food preservative for cold storage of meats
- **1939** - Was found to prevent the growth of yeast & mold during the storage of fruits

OZONE PROPERTIES

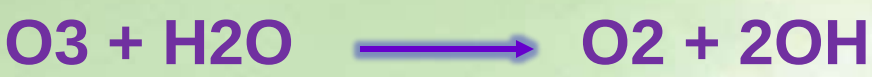
Property	Ozone	Oxygen
Molecular Formula	O_3	O_2
Molecular Weight:	48	32
Color	Light Blue	Colourless
Smell	-clothes after being outside on clothesline - photocopy machines - smell after lightning storms	Odorless
Solubility in Water (@ O-deg C)	0.64	0.049
Density (g/l):	2.144	1.429
Electrochemical Potential, V:	2.07	1.23

How Ozone works?

Ozone offers real advantages over chlorine bleach and other disinfectants used in the dialysis field because of its strong oxidizing power that inactivates pyrogenic lippopolysaccharides (endotoxin) and destroys total organic carbon (TOC). Additionally, ozone has a higher lethality coefficient than chlorine and other disinfectants against most organisms and readily destroys viruses. The action of ozone is through the agency of free radicals produced by the incorporation of ultraviolet radiation. The covalent bond connecting two atoms consists of the mutual sharing by these atoms of two bonding electrons. This valence may break in two ways: In one process, one of the atoms may acquire both bonding electrons, leaving the other with none. This type of bond cleavage gives rise to ions. The electron being the seat of negative electricity, one atom possesses more than its original share of negatively charged electrons, or an anion. The other atom is deprived of its normal complement of electrons and becomes positively charged, or a cation.

The covalent bond may also rupture, leaving each of the constituent atoms with one of the bonding electrons. These atoms are now free radicals, which require combinations with other free radicals to form stable molecules. Alternatively, a free radical may form a linkage with a molecule and abstract an atom and a bonding electron. This action stabilizes the free radical, but in the process forms a new free radical. A series of free radical attacks upon molecules results in a free radical chain. Eventually the free radical chain terminates. Free radicals have half-life durations whose length are inverse expressions of their stabilities. Thus, the more unstable the free radical, the more avid its need to bond, the shorter its half-life.

Also, the more unstable the free radical, the broader the spectrum is of molecules it can interact with Hydrogen abstraction from carbon atoms, as well as carbon-carbon bond cleavage to create free radical chains can be initiated by the hydroxyl free radicals caused by the action of the ozone upon water:



Hydroxyl free radicals are generated by ozone in water in a several step reaction. Carbon dioxide is the final product of the oxidative free radical chain.

Ozone Generation

Nearly all commercial ozone generators employ the corona discharge principle. Properly dried air, or oxygen itself, is passed between a high-voltage electrode and a ground electrode separated by a dielectric material. Considerable electrical energy is required for the ozone producing electrical discharge field to be formed. In excess of 80% of the applied energy is converted to heat that, if not rapidly removed, causes the ozone to decompose, particularly above 35° C (95° F). Proper cooling of the ozone generator is crucial to maintaining ozone yields. Some units include a composite mixing tank that mixes the fluid stream with ozone via a venturi side-stream. The side-stream venturi injection method is recognized by some as more efficient than the fine bubble diffuser type for transferring ozone to water. Electrolytic generation of ozone results in the formed ozone being rapidly dissolved in water. However, the small quantity of ozone containing water involved must be dispersed throughout the water being treated. The use of static mixers, storage tanks and distribution loops serve this purpose.

Ozone Generators

The power of ozone generators is estimated in two ways ie - the production of ozone per hour or yield (g/H or grams per hour) and quantity of ozone in weight per unit of volume of the bearer gas (mg/L) or concentration. O_3 Greentech designs and manufactures OZONE GENERATORs caters to a range from 100 Mg/Hr to 5000 Gm/Hr. A swimming pool of Olympic size would hardly require 20 grams of ozone per hour from high concentration machines, but over 60 grams from low concentration air fed generators. The reason is that the solubility of Ozone in water is proportional to the concentration of ozone in the bearer gas.

Oxidizing Potential of Various Reagents

Oxidizing Reagent	Oxidizing Potential
Ozone	2.07
Hydrogen Peroxide	1.77
Permanganate	1.67
Chlorine Dioxide	1.57
Hypochlorous acid	1.49
Chlorine Gas	1.36
Hypobromous acid	1.33
Oxygen	1.23
Bromine	1.09
Hypoiodous acid	0.99
Hypochlorite	0.94
Chlorite	0.76
Iodine	0.54

Ozone vs Chlorine

The US Government for 8 HOURS installation rates ozone as toxic at 100PPT level only.	Chlorine is not only toxic; it is also a poisonous gas
Ozone is generated on the premises and not stored or transported.	Chlorine is stored in high pressure containers on the premises and is hazardous.
Ozone degrades all organic substances to make them into harmless ashes and does not leave any other by-products than Oxygen.	Chlorine, on the other hand, when mixed with body fluids and perspiration, will form chloramines that will cause eye irritation and are carcinogenic by nature.
Ozone has become less expensive due to an increase in efficiency and lower energy consumption	The cost of chlorine is constantly increasing and it has become quite expensive
Ozone does not require pH control, but some other chemicals use may require such control.	Chlorine needs pH control (7.0 to 7.4 pH) for reliable results.
-Tests have proven that ozone is 600 to 3000 times more active in the destruction of bacteria and viruses than Chlorine in the same concentrations. Ecoli is killed within 5 seconds by ozone at a concentration of 1 mg/l. Even the cyst and spores cant resist ozone.	But to be killed by chlorine Ecoli required 15,000 seconds at a concentrations of 1 mg/l
-Ozone is an excellent deodorizing agent for many substances, such as hydrogen sulfide, ammonia, smoke, cooking smells, paint, etc. Whereas, Chlorine is not a deodorizing agent. -Ozone is effective against decomposition of wastes, mildew, and fungus and can be used to eliminate "locker room" odor in dressing room.	Chlorine doesn't have such effect.

Ozone is the strongest oxidant on the market !

Ozone vs. Chlorine

Action in Water		Chlorine	Ozone
Oxidation Potential (Volts)-		1.36	2.07
Disinfection:	Bacteria	Moderate	Excellent
	Viruses	Moderate	Excellent
Environmentally Friendly		No	Yes
Color Removal		Good	Excellent
Carcinogen Formation		Likely	Unlikely
Organics Oxidation		Moderate	High
Micro flocculation		None	Moderate
pH Effect		Variable	Lowers
Water Half-Life		2-3 hours	20 min.
Operation Hazards:	Skin Toxicity	High	Moderate
	Inhalation Toxicity	High	High
Complexity		Low	High
Capital Cost		Low	High
Monthly Use Cost		Moderate-High	Low

Industrial Applications of Ozone

Using ozone in industrial applications does not produce any by-product to contaminate the ecological system further. In the conventional methods, there would be by-products created in the process and this creates problems in one way or the other. However, Ozone leaves only pure oxygen and inert oxides as by-products. There is a vast potential for applications in sewage treatment industry, as there is a lot of opportunities for detoxifying, de-coloring and deodorizing. As OGs were capital intensive, it is not favourable in these industries and in the midst of recession. The support from the government such as decreasing taxes, offering other encouragements, higher depreciation or other benefits is lacking.

However, Ozone has more potential applications in other industries such as hospitality industry, fish farms, cooling towers beverage manufacturers, and mineral water plants.

One of the important future applications is the replacement of Auto-Claves, an apparatus to sterilize surgical instruments, being developed for the first time in the world. In the conventional method, surgical instruments were boiled and pressurized in Autoclaves. In addition to being a laborious process, it also consumed a lot of energy. This can be easily replaced by ozone-based disinfectors with high concentration of ozone circulating in a stream of water and dipping the instruments to become sterilized almost instantaneously and using less energy.

Other important niches for Ozone are: the cooling waters, (Keeping the cooling water sparkling without any chemical build-up and hence, no need of blow-down and zero-pollution,) fish ponds, (for the same reason) sewage water treatment plants and also to remove the stench, and generally a host of applications where the liquid fire of high concentration Ozone, will oxidise unwanted molecules which otherwise resist all other treatments, such as the pesticides, DDT, Deldrin, Arsenic, Aldrin, and other toxic or poisonous substances.

More About Ozone

The Universal Disinfectant

- Disinfection by **3-atomic oxygen** called OZONE takes place by rupture of the cell wall - a more efficient method than Chlorine that depends upon diffusion into the cell protoplasm and inactivation of the enzymes. Ozone level of 0.4 ppm for 4 minutes has been shown to kill any bacteria, virus, mold and fungus.

- When the effectiveness of Ozone as a disinfectant was measured, up to a certain dosage there was little or no disinfection. At higher levels the sanitizing effect increased greatly. For complete disinfection there has to be a surplus of **residual Ozone** in the solution to assure that every living microorganism has been contacted.

- In the area of **viruses** there is yet to be discovered an antibiotic that is truly effective. There are indications that DNA viruses such as Herpes are implicated in human cancers, since they organize the genetic material of the host cell to produce new viruses. Ozone will inactivate viruses on contact even at very low residual concentrations. In case of polio only 0.012 ppm removes all viruses in less than 10 seconds.

- **Mold** and **mildew** are easily controlled by Ozone in air and in water. Giardia and Cryptosporidium **cysts** are susceptible to Ozone but not effected by normal levels of Chlorine. Mold and **mildew** are easily controlled by Ozone in air and in water. Giardia and Cryptosporidium **cysts** are susceptible to Ozone but not effected by normal levels of Chlorine.

TASTE & ODOR CONTROL

- Most tastes and odors in water supplies come from naturally occurring or manmade organic material contamination. Bacterial decomposition of humic material imparts taste to surface water, also the action of algae and actinomycetes give rise to objectionable tastes. Chlorination of humic material leads to chlorophenols that are far stronger odor and taste antigonists than the original phenol and the Chlorine. Most of these odors are removed by treatment with Ozone. Even some sulfur compounds such as hydrogen sulfide, mercaptans or organic sulfides can be oxidized to Sulfates with Ozone.

REMOVAL OF HEAVY METALS

- Ozone oxidizes the transition metals to their higher oxidation state in which they usually form less soluble oxides, easy to separate by filtration. e.g. iron is usually in the ferrous state when it is dissolved in water. With ozone it yields ferric iron, further oxidized in water to Ferric Hydroxide that is very insoluble and precipitates out for filtration.
- Other metals: Arsenic (in presence of Iron), Cadmium, Chromium, Cobalt, Copper, Lead, Manganese, Nickel, Zinc - can be treated in a similar way. At Ozone levels above 4 ppm however, Manganese will form soluble permanganate, showing up as a pink color.

COLOR REMOVAL

- Surface waters are generally colored by natural organic materials such as humic, fulvic and tannic acids. These compounds result from the decay of vegetative materials and are generally related to condensation products of phenol like compounds; they have conjugated carbon/carbon double bonds. When the series of double bonds extend upwards of twenty, the color absorption shows up in the visible spectrum. Ozone is attracted to break organic double bonds. As more of these double bonds are eliminated, the color disappears. Surface water can usually be decolorized when treated with 2 to 4 ppm of Ozone.

OZONE vs. CHLORINE

In comparing disinfection efficiency, Ozone is effective 25 x more than Hypochlorous acid (HOCI), 2,500 x more than Hypochlorite (OCI) and 5,000 x more than Chloramine (NH_2CL). This is measured by comparison of CT constants - the Concentration & Time needed to kill 99.9% of all microorganisms. Chlorine reacts with organic materials to form Chlorine containing organics such as Chloroform, Carbon Tetrachloride, Chloromethane and others, generally known as Trihalomethanes (THMs).

Ozone reacts with Organics to break them down into simpler compounds. These (e.g. Oxalic Acid) do not readily break down all the way to Carbon Dioxide with just Ozone, but if subjected to bacterial degradation on activated charcoal, they will be removed. This water can be later treated with a low level of Chlorine say 0.2 - 0.3 ppm to maintain sanitation in the distribution system. This way no THMs will be formed. The THMs have been implicated as carcinogens in the development of Kidney, Bladder and Colon Cancer. The regulatory authorities are again decreasing the levels of THMs that can be in Community water systems. At the present time the limit is 0.05 ppm.

Ozone does not react significantly with THMs as they are more resistant to oxidation - it takes a very long time to achieve full oxidation. Some THMs are removed by the aeration action of the ozone/air mixture.

ALGAE REMOVAL

Ozonation of a water contaminated with Algae oxidizes and floats the Algae to the top of the reservoir. The ozone will also oxidize the metabolic by-products of the Algae and remove the undesirable odor and taste.

IMPROVED COAGULATION & TURBIDITY REMOVAL

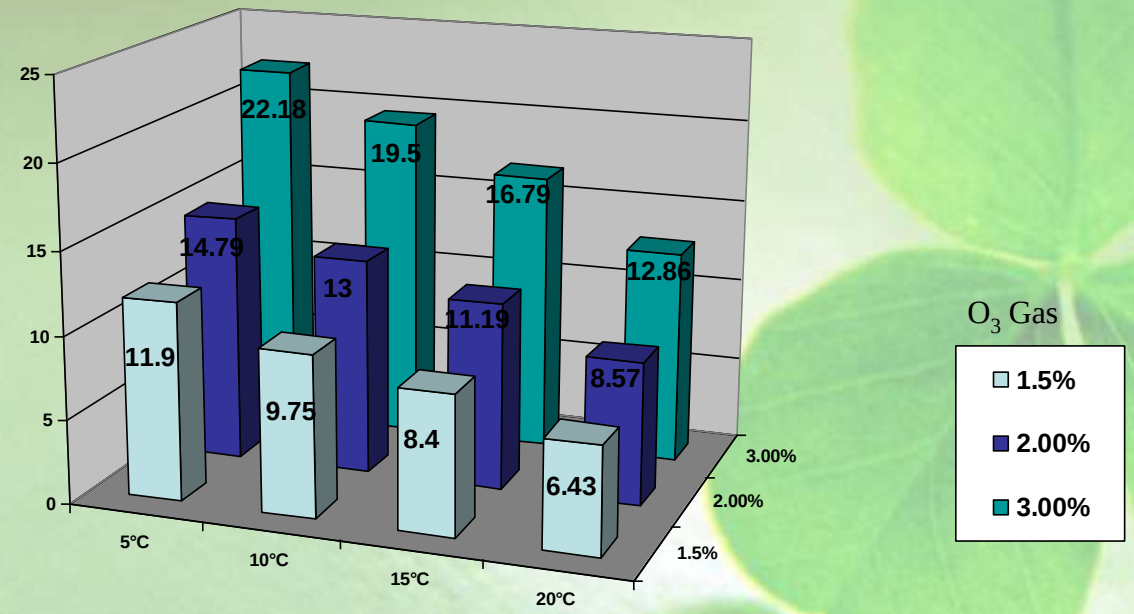
Oxidation of dissolved organic materials by Ozone results in polar and charged molecules that can react with Polyvalent Aluminum or Calcium to form precipitates. Treatment of a surface water with up to 0.5 ppm of Ozone results in a decrease in turbidity, improved settleability and a reduction in the number of particles. Referred to as **pre-ozonation** this treatment destabilizes the colloid with a resultant reduction of the amount of coagulant needed to produce a clear filtrate.

OZONE REACTIONS TO ORGANICS

- Ozone reacts rapidly with most simple aromatic compounds and unsaturated aliphatic, such as Vinyl Chloride, 1,1-dichloroethylene, trichloroethylene, p-dichlorobenzene, Benzene, etc. But it reacts slowly with complex aromatics and saturated aliphatic. Ozone will degrade many organic compounds, such as sugars, phenols, alcohols, and as it degrades these materials it returns to Oxygen.
- **Coupling Ozone with Hydrogen Peroxide** will cause the formation of very active Hydroxyl ions which cause a nucleophilic attack on organic compounds. This can cause displacement of Halogens and other functional groups such as Amines and Sulfides. Coupling Ozone with Hydrogen Peroxide will cause the formation of very active Hydroxyl ions which cause a nucleophilic attack on organic compounds. This can cause displacement of Halogens and other functional groups such as Amines and Sulfides.

OZONE SOLUBILITY

- The solubility of Ozone depends on the temperature of water and concentration of Ozone in the gas phase.



	5°C	10°C	15°C	20°C
1.5%	11.9	9.75	8.4	6.43
2.00%	14.79	13	11.19	8.57
3.00%	22.18	19.5	16.79	12.86

If oxidizable chemicals are present in the water, even more Ozone will dissolve to satisfy the demand. One limiting factor is the efficient of the mass transfer device used. In case of a pump and Bubble Diffuser, the water column should be at least 16ft. high. Higher concentrations of Ozone in water cause more vigorous oxidation of even resistant organic compounds.

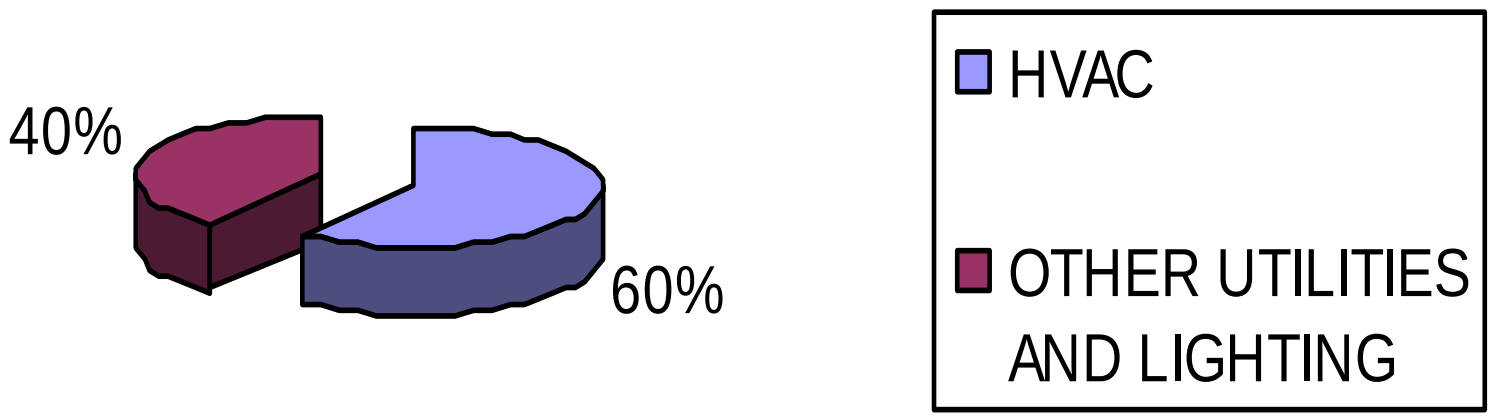
AIR TREATMENT

- Ozone reacts rapidly with most odors, oxidizing them to less harmful elements or all the way to harmless Carbon Dioxide.

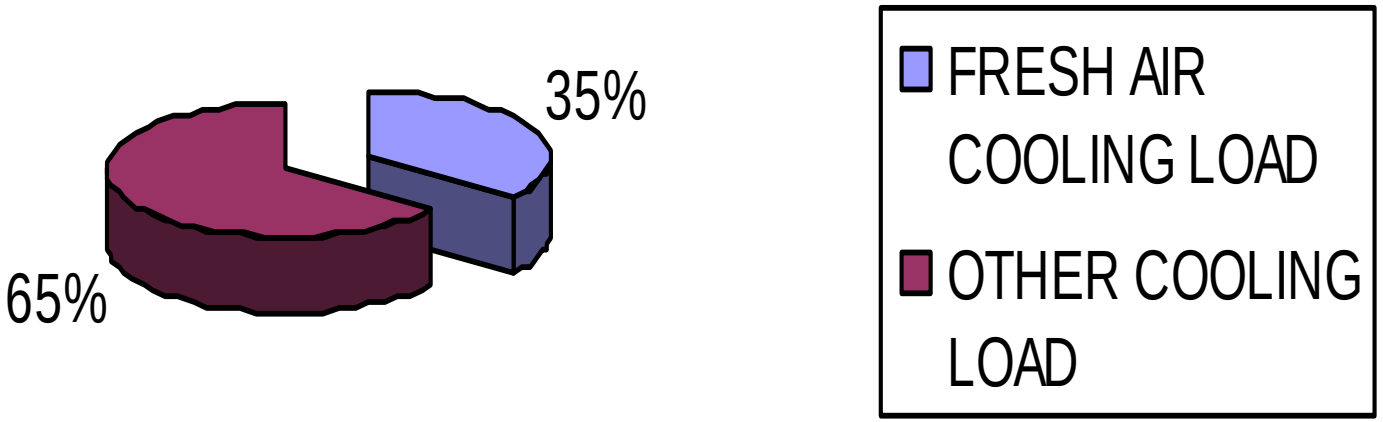
- More and more of our furnishings and floor coverings are made from synthetic materials. Under the stagnant air conditions which prevail because of the lack of ventilation, decomposition products and solvents leach out of these synthetic materials and fill the indoor space. Much has been said about the "**sick building syndrome**" and this usually refers to institutional building. But they have basically the same problems as the private home. When odors are inhaled, they increase the demand for oxygen in the human body thus depleting the body of oxygen.

- Ozone in natural settings is around 0.02 ppm, but it can be as high as 0.10 ppm. At this level it is capable of keeping pathogens in check and yet at this level ozone is not harmful to higher life forms such as fish, birds, animals or man. Ozone is not causing harm to the nature. Only a prolonged exposure to very unnatural high levels of ozone may lead to discomfort, later headache and coughing, telling you to leave the space and seek better air.

ENERGY CONSUMPTION IN COMMERCIAL BUILDINGS



COOLING LOAD BREAK UP FOR HIGH OCCUPANCY APPLICATIONS - MALL,MULTIPLEX,IT AND SOFTWARE OFFICE ETC.



WHY DO WE NEED FRESH AIR ?

TO REDUCE THE VOLATILE ORGANIC COMPOUNDS (VOC)

TO REMOVE ODOURS

TO DILUTE CO2

IN SHORT FRESH AIR IS REQUIRED TO IMPROVE THE INDOOR AIR QUALITY

HOW DOES FRESH AIR IMPROVE INDOOR AIR QUALITY ?

- THE OXYGEN IN THE FRESH AIR OXIDISES THE VOC AND ODOURS
- THE OXYGEN IN THE FRESH AIR ALSO DILUTES THE CO_2

IN SHORT , OXYGEN IN THE FRESH AIR DOES THE WORK

ASHRAE VENTILATION CODE NO 62-1999

MINIMUM 15 CFM PER PERSON

30 CFM PER PERSON IF SMOKING IS ERMITTED

ENERGY CONSUMED BY FRESH AIR

150 CFM OF FRESH AIR IN MUMBAI WILL REQUIRE 1 TON OF COOLING LOAD

THIS WILL CONSUME APPROX. 1 KW ENERGY FOR A WATERCOOLED SYSTEM OR 1.3 KW OF ENERGY FOR AN AIRCOOLED SYSTEM

HOW CAN WE MINIMISE THIS ENERGY WASTAGE ?

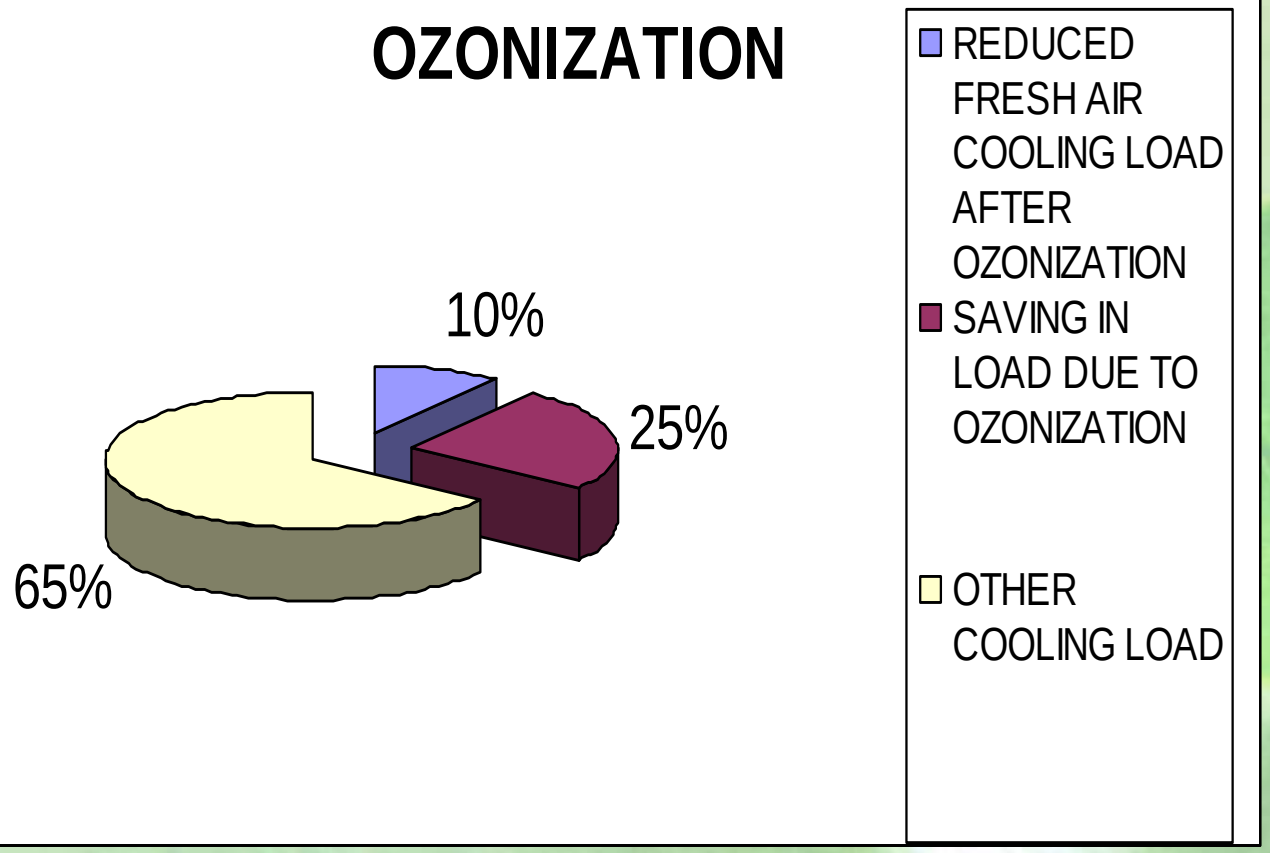
1. AIR QUALITY IMPROVES DRAMATICALLY.
2. OXYGEN IS THUS REQUIRED ONLY TO DILUTE THE CO2 . THIS IS A MUCH SMALLER REQUIREMENT.
3. THUS FRESH AIR CAN BE MODULATED RATIONALLY DOWN TO 5 CFM OR LESS PER PERSON.

HOW CAN WE MINIMISE THIS ENERGY WASTAGE ?

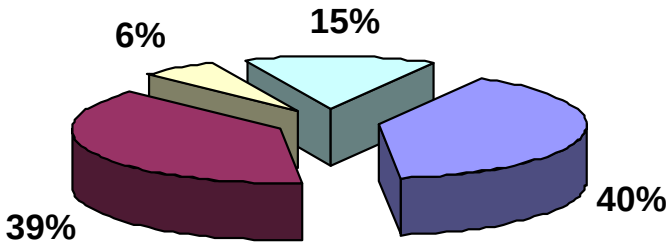
THIS WILL REDUCE THE

OVERALL PLANT CAPACITY BY UP-TO 25 %

SAVING IN HVAC LOAD DUE TO OZONIZATION



SAVING IN OVERALL ENERGY CONSUMPTION (HIGH OCCUPANCY APPLICATION)



- ENERGY CONSUMED BY LOAD OTHER THAN HVAC
- ENERGY CONSUMED BY HVAC NON FRESH AIR LOAD
- ENERGY CONSUMED BY REDUCED FRESH AIR AFTER OZONIZATION
- SAVING IN ENERGY DUE TO RATIONAL MODULATION OF FRESH AIR

PERMISSIBLE OZONE CONCENTRATION

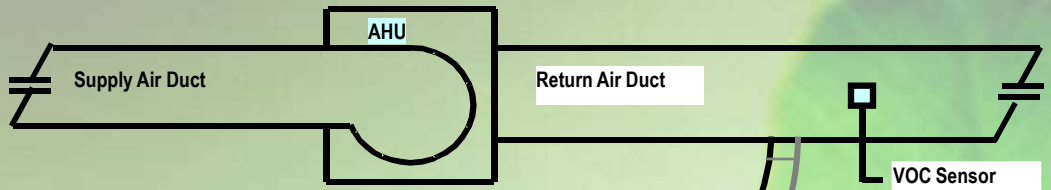
If residual concentration exceeds, Ozone is a toxic gas.
maximum Permissible Concentration in Occupied space:

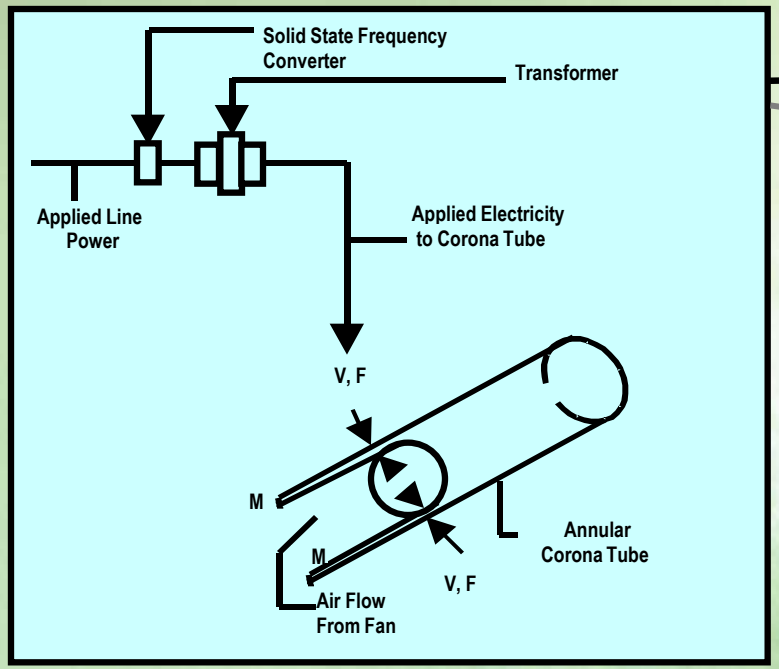
OSHA: 0.1 ppm (100 PPB)
Exposure of 8 Hr /day, 5 days a week

ASHRAE: 0.05 ppm (50 ppb)

FDA: 0.05 ppm (50 ppb)
Continuous exposure 24 hr/day
365 Days a year

ANNULAR CORONA GENERATOR





Ozone Injection Tube to HVAC Duct

M = MASS FLOW OF AIR OVER CORONA TUBE
V = APPLIED VOLTAGE ACROSS DIELECTRIC
F = APPLIED FREQUENCY ACROSS DIELECTRIC

Ł = QUANTITY OF OZONE PRODUCED

L M
L V
L F

ANNULAR CORONA GENERATOR

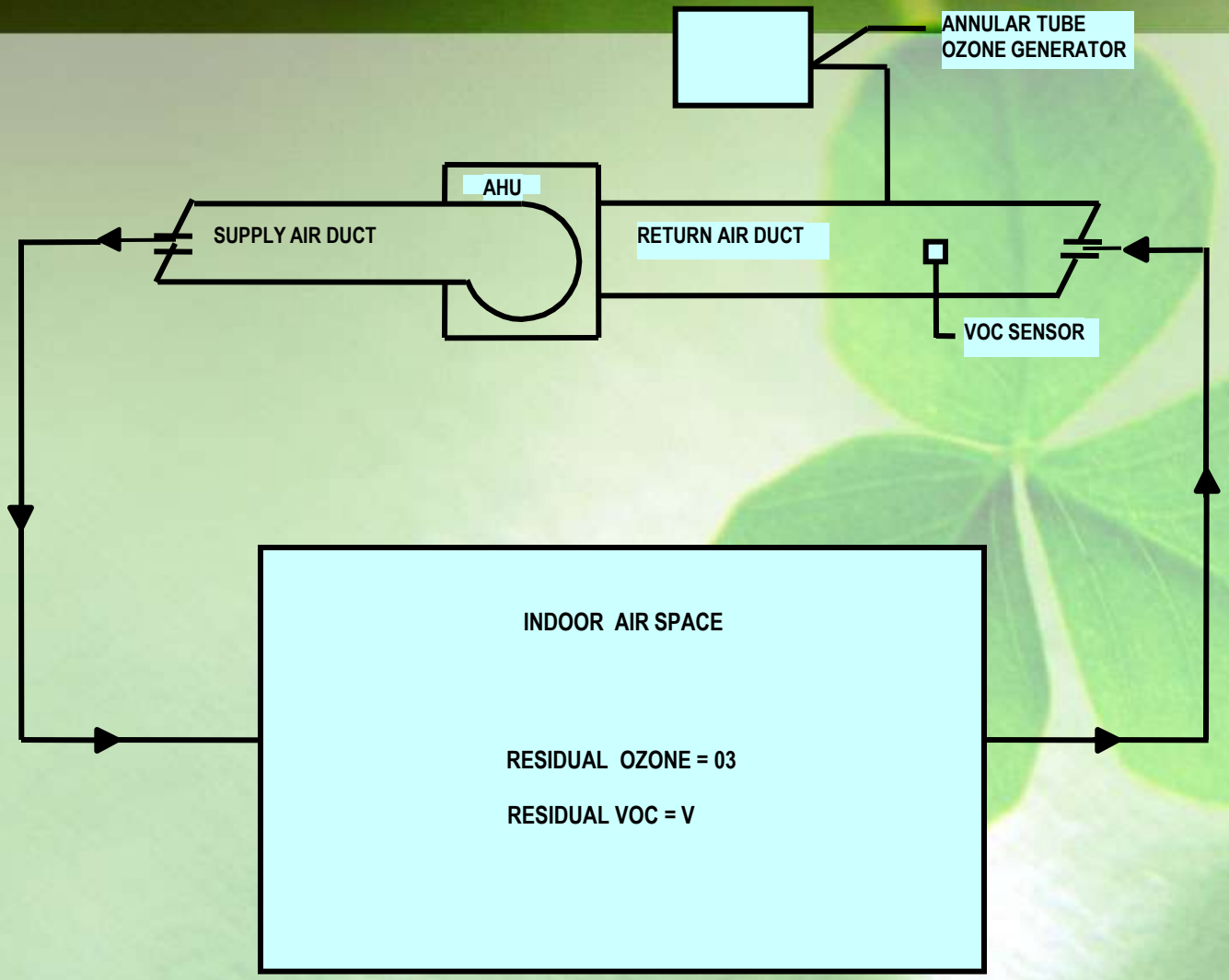


FIG 2

CONCLUSION

- Benefit of OZONE SYSTEM
- ACHIEVES Dramatic reduction in build up of HC,Toxic Gases, and VOC

- ✓ Dramatic Reduction in Odor
- ✓ Near Total Elimination of Cigarette Smoke.
- ✓ Depletion of Microbial Colonies (Fungi) in Ducts and AHU cooling coils. Eliminates duct cleaning
- ✓ Depletion of Microbial (Fungi) Indoor

CONCLUSION (CONTD)

ECONOMIC BENEFITS

DIRECT ECONOMIC BENFITS OF OZONE SYSTEMS

1. **CAPITAL COST SAVINGS**
2. **Reduced size and capacity of HVAC systems.**
3. **Cost of O_3 Greentech Ozone System is often lower than Savings in HVAC plant reduction**
4. **Net Result: REDUCED CAPITAL COST**

CONCLUSION (CONTD)

ENVIRONMENTAL BENEFITS

- Reduced Fungi and Microbes in Ducts, Cooling Coils and Indoor
- Reduced Allergy Related Disorders
- Cleaner Indoor, Cleaner Ducts

ECONOMIES

- Ozone is effective against a large variety of water treatment problems. In general, the more problems in the water to be treated with ozone, the less an ozonation system costs when compared to other more conventional treatment methods.
- When one is comparing the cost of an ozonation system to other treatment systems there are some key factors to consider; here are a few:

- ✓ There is no need to purchase, ship or store chemical oxidants or disinfectants
- ✓ There is no labor for handling.
- ✓ Many health and safety concerns are reduced or eliminated.
- ✓ Because ozone reacts so much more quickly there is opportunity for substantial savings in space requirements for the treatment system.
- ✓ Because ozone treatment design is flexible, one of the variety of installations can be adapted to any fit any design circumstance.
- ✓ It is likely that much of your existing treatment facilities are adaptable to an ozone based treatment system.
- ✓ The pay back of your investment can be surprisingly short.

Venturi Injector

Venturi Injectors (Injectors) work by forcing water through a conical body which initiates a pressure differential between the inlet and outlet ports. This creates a vacuum inside the injector body, which initiates ozone suction through the suction port.

Characteristics

- Very high ozone mass transfer rate (up to 60 to 70%)
- Requires water pump to initiate suction
- Efficiency rarely decreases over time
- No moving parts

Bubble Diffuser

Bubble Diffusers work by emitting ozone through hundreds of bubbles beneath the waters surface.

- **Characteristics:**

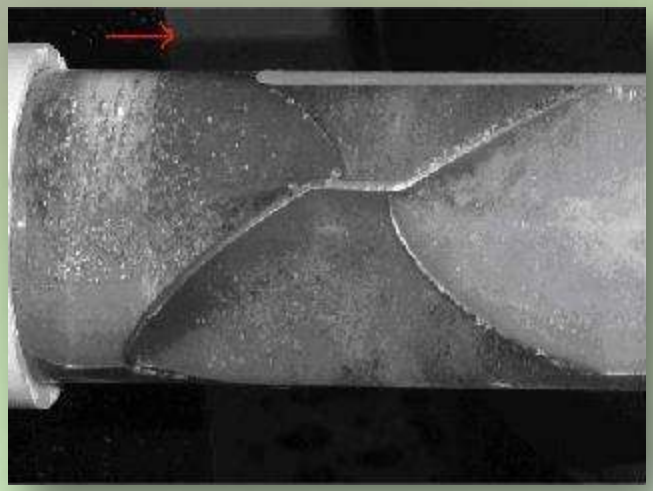
✓ Low ozone mass transfer rate (typically around 10-15%)

✓ Efficiency increases with increased water depth

✓ Requires air-pump to transfer oxygen below surface

✓ Diffuser holes become fouled decreasing transfer efficiency

What Happen Inside Static Mixer



If you think a venturi injector is good enough, think again. Venturi injectors do attain fairly good mass transfer, but using a static mixer can greatly improve your mass transfer efficiency up to 90 to 95%.

Notice how the bubbles are made into a fine mist as they move from left to right resulting in significantly greater ozone mass transfer than using a venturi alone. Pipe size is 1-1/2" diameter.

Ozonation for Drinking Water

Applications:

- Destruction of bacteria and viruses
- Oxidation of iron and manganese
- Heavy metal precipitation
- Colour destruction
- Taste improvement
- Algae and protozoa destruction
- Hardness reduction
- Hydrogen sulphide and mercaptans elimination

Ozone chemical free treatments & applications

- Domestic/Municipal
- Pulp & paper
- Mining (Cyanide, Arsenic)
- Pharmaceutical (Phenol)
- Textile
- Leather
- Petroleum/Petrochemicals
- Electroplating
- Heavy metal precipitation
- Landfill leacheates

- Cooling towers treatment
- Boiler water treatment
- Chilled water treatment
- Cutting fluids recycling
- Barn disinfecting (air/water)
- Hydroponics
- Animal waste treatment
- Water dripping treatment
- Animal drinking water
- Irrigation water disinfecting

Ozone chemical free treatments & applications

- Drinking & water bottling
- Food Grain disinfecting
- Fruit & vegetable storage
- Meat storage
- Slaughter house disinfecting
- Fruits & vegetable wash
- Food containers sterilizations
- Wine/Beer SO2 replacement
- Chicken egg wash
- Ozonated meat grinders
- Smoke & odour treatment
- Semiconductor wafers clean
- Laundry water recycling
- Med. instrument sterilization
- Hospital air sterilization
- Aqua-culture
- Paper pulp bleach
- Sour gas desulphurization
- Zebra mussels treatment
- Rubber recycling

The measure of an oxidiser and its ability to oxidise organic and inorganic material is its oxidation potential (measured in volts of electrical energy). Oxidation potential indicates the degree of chemical transformation to be expected when using various oxidants. It gauges the ease with which a substance loses electrons and is converted to a higher state of oxidation

Theoretically the substance with the lower oxidation potential will be oxidised by the substance with the higher oxidation potential. A substance can only be oxidised by an oxidiser with a higher potential. The oxidation potentials of common oxidants and disinfectants associated with water and wastewater treatment are all of a lower oxidation potential than ozone. There is only one element with a higher oxidation potential than ozone and that is fluorine.

Oxidation potential does not indicate the relative speed of oxidation nor how complete the oxidation reactions will be. Complete oxidation converts a specific organic compound to carbon dioxide and water. Oxidation reactions that take place during water treatment are rarely complete, due to the large quantity of contaminants and relatively short durations of time in which to oxidise the water pollutants.

Although the relative position of an oxidant is indicative of its ability to oxidise other materials, it does not indicate how fast one material will be oxidised by another, nor how far toward completion (to carbon dioxide and water) the oxidation reaction will proceed.

Continue.....

Post-Ozonation Requirements

The ozonation treatment step is usually followed by :

Clarification: to precipitate oxidised organic and inorganic matter.

Filtration (nano, sand, charcoal): to remove precipitants. The use of activated carbon filters has the added advantage of adsorbing the excess unreacted, unrecycled ozone and allows it to convert back to oxygen.

This increased understanding of ozone oxidation has lead to the broadening of its applications making it the one of the fastest growing market segments within the drinking water and waste water treatment industry. Other industries employing ozone treatment include the agricultural, food, pharmaceutical, and electronic industries. Lower ozone production costs have allowed this material from the past to have modern applications.

Disclaimer: The articles about ozone are collected from several sources from the internet and does not necessarily reflect O3 Greentech applications and experience

Imagine your pool and spa with no chlorine.

Yes, imagine yourself sitting in your spa with sparkling clean water, no smell of chlorine irritating your nose. Your bathing suit is not slowly disintegrating from the chlorine in the water.

Yes, imagine you and your children swimming in a pool filled with sparkling water. Enjoy all the pool fun with out red burning eyes. The blond swimmers don't get green hair. Your skin is smooth and silky, no rash or itchiness here.

The first concern of pool owners should be the safety of the water in your pool. OZONE is one of the strongest oxidizers available. Only fluorine is stronger. Chlorine is a weaker oxidizer. Ozone water treatment system has a quicker kill time of organisms and kills more types. OZONE is used to purify Olympic pools. In fact the athletes in the LA Olympics refused to swim in a pool purified by chlorine.

We guarantee NO CHLORINE NEEDED EVER. Instead bromine is used. The bromide combines with the OZONE to form bromine. The bromine then reacts with the algae. Bromide is then released as a byproduct. The cycle begins again!! Bromides needs only to be added to replace that removed by water splashing out of the pool or exiting on the bodies of swimmers.

An added advantage as you can see, is that there are no harmful byproducts. Ozone breaks down into oxygen. Chlorine on the other hand breaks down into trihalomethanes, which have been shown to increase the incidence of kidney, bladder and colon cancer. Another byproducts of chlorine plus urine and or perspiration are chloramines, which cause eye and skin irritation.

THOUSANDS THAT TREAT THEIR POOLS THE BEST WAY DOES

THIS SOUND TOO GOOD TO BE TRUE ?? THIS TIME THE TRUTH IS GOOD

Ozone was first used in swimming pool water treatment in the 1950's. Since then its use has widely grown. There are over 30,000 swimming pools in Europe that are treated with ozone. The swimming pools for the Olympics have been treated with Ozone at least since 1986 for the Los Angeles Olympics. Most recently the Sydney Aquatic Center pool water was treated with Ozone.

Well known water facilities using ozone to treat their water:

- ✓ Disneyland and Disney World for all their water features
- ✓ Mirage Resort, Las Vegas
- ✓ San Diego Zoo, San Diego, CA for their marine and Aquatic habitats
- ✓ Vancouver Aquarium, Vancouver, Canada -for their Sea mammal support systems
- ✓ Universal Studios, Jurassic Park, "The Ride“
- ✓ Many YMCA's and hotels
- ✓ Waterparks and aquatic centers

WHAT HAPPENS IN YOUR SWIMMING POOL ?

EACH swimmer brings into the pool:
300-400 million bacteria
0.5 gr. of organic matter
30-50 cc of urine

Ozone water treatment system can take care of it!

Ozone kills bacteria, viruses, spores, and mold and does it fast. Ozone pierces the cell wall of bacteria and viruses killing them 3000 times faster than chlorine. Ozone was used to treat the water in the swimming pool that the AIDS infected blood of Greg Louganis contaminated. No one else contracted AIDS from that incident.

Ozone water treatment system advantages

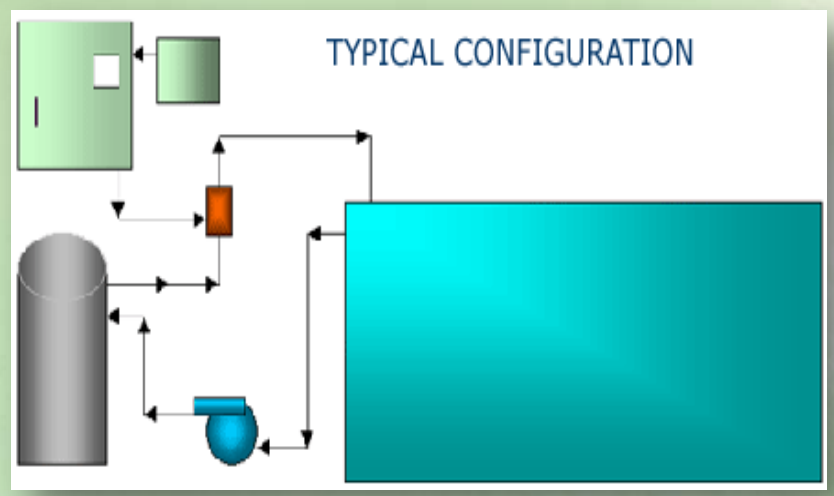
- ✓ OZONE is produced on site-no storage or transport of dangerous chemicals
- ✓ OZONE kills all bacteria, viruses, fungi and parasites
- ✓ OZONE prevents calcium carbonate scaling and removes existing
- ✓ OZONE not used up slowly decomposes to oxygen up to the saturation point of oxygen in water this gives sparkling clean pool water
- ✓ OZONE use in the water does not cause discharge liabilities
- ✓ OZONE is not affected by pH of water, nor does it affect the pH of water
- ✓ OZONE causes increased flocculation of organic wastes, thus increasing the effectiveness of the sand filtration system of your pool.

ARE YOU SURE IT WON'T NEED CHLORINE EVER ?

YES, we are sure except sometimes for chock treatment in cold climates at the beginning of the season. We use bromides instead of chlorine for residual disinfection and algae destruction. The bromine reacts with algae and turns to hypo-brmous acid. The hypo-bromus acid recombines with the ozone to reform bromine. This starts the cycle over again. Bromide is added in the beginning and additional bromide is needed only as water leaves the pool by splashing or on a swimmer's body as he/she exits and that for once in 3 month average depends on bather load.

There are several models you can choose from depending on the size & usage of your pool.

The following are general guide lines



Pool Volume	O_3 G/hr
10,000 Liter	2.0 to 3.0
30,000 Liter	6.0 to 7.0
5,000 liter	10.0 to 12.0
1,00,000 Liter	20.0 to 25.0
5,00,000 Liter	100.0 to 125.0

Disclaimer: Table indicate value are in general term. It may very base on Turn over Cycle, Bather load and Filtration system.

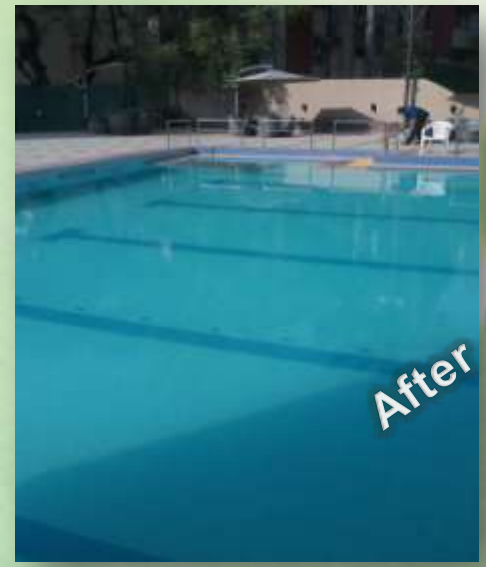
Chemical free Pool water treatment with Ozone

No Chlorine EVER!!!!

Ozone can replace partially or totally Chlorine in the pool. It is many times more effective in getting rid of bacteria & viruses then Chlorine.

It will maintain a very clean water without the use of the many chemicals used to disinfect, to adjust the PH, Alkalinity...

By comparison to the Chlorine , **Ozone water treatment system for pool** is virtually maintenance free. All what you need is to install Ozonator, add the Ozone fix and enjoy.



120 Gm/hr Ozone Generator

Commercial Ozone Generator

Qmax
O, Greentech

O_3 Greentech

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Thank You for being
With Us.....