OZONE INFORMATION

Dispura

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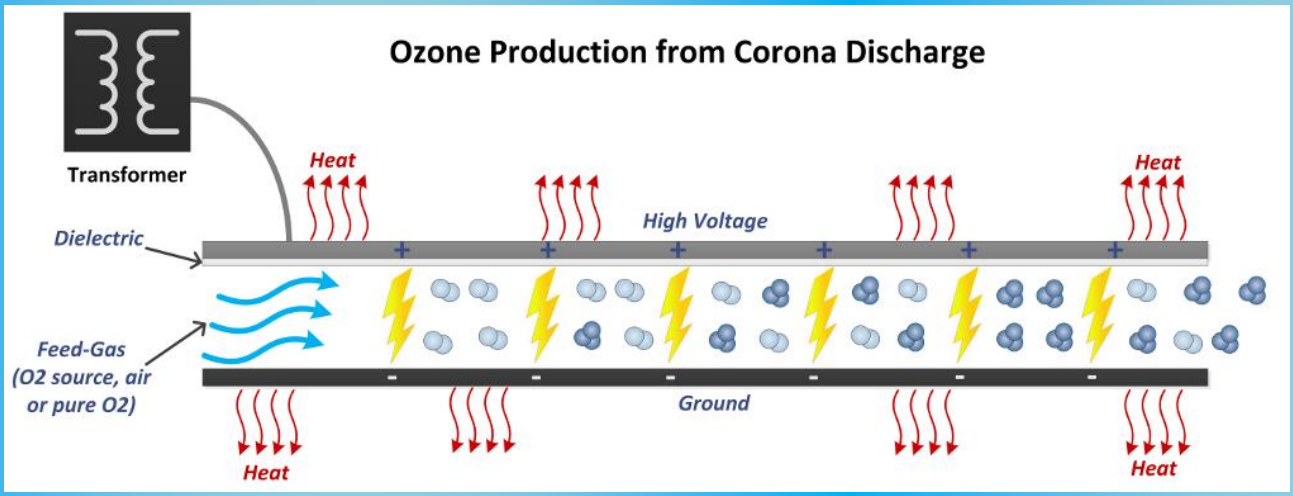
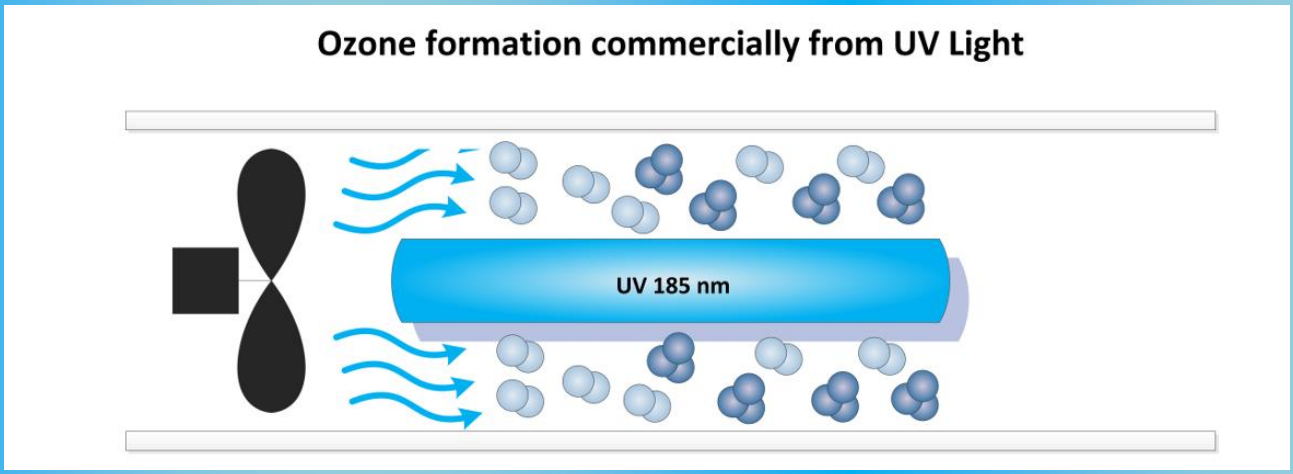
GUIDE FOR WASTE WATER

OZONE MANUFACTURE

- Corona – Air or Oxygen is drawn into a Corona tube and high voltage applied.
- UV – UV Light produced at a wavelength to produce Ozone.





ADVANTAGES OF OZONE

- Ozone is the most powerful oxidant for disinfecting water & surfaces.
- Ozone kills pathogens in seconds as against minutes.
- Ozone is one of the strongest oxidants of organics.
- Ozone decomposes into Oxygen.
- Ozone, by itself, does not affect pH.
- Ozone cannot be stored, thereby negating storage of large volumes of oxidant.
- Ozone is excellent at oxidising Iron & Manganese.
- Ozone enhances flocculation & coagulation of organics – increasing efficiency.
- Ozone can be effective in partially oxidising in water to biodegradeable compounds which can be removed by biological filtration.

OZONE PROPERTIES

- Symbol: O_3
- Atomic weight: 48
- Melting Point: -192.5°C
- Boiling Point: -119.5°C
- Density relative (in air): 1.7kg/m^3

OZONE – TYPICAL HALF LIFE VERSUS TEMPERATURE

GASEOUS

TEMP (°C)	HALF LIFE	TEMP (°C)	HALF LIFE
-50	3 months	20	3 days
-35	18 days	120	1.5 hours
-25	8 days	250	1.5 seconds

WATER

TEMP (°C)	HALF LIFE	TEMP (°C)	HALF LIFE
15	30 minutes	30	12 minutes
20	20 minutes	35	8 minutes
25	15 minutes	>40	Ineffective

OXIDISING POTENTIAL

Oxidiser	Potential
Ozone	**2.07**
Hydrogen Peroxide	1.77
Permanganate	1.67
Hyporchlorous Acid	1.49
Chlorine Gas	1.36
Hypobromous Acid	1.33
Oxygen	1.23
Bromine	1.09
Hypoiodus Acid	0.99
Chlorine Dioxide	0.95
Hypochlorite	0.94
Chlorite	0.76
Iodine	0.54

PATHOGEN EFFECTIVENESS

Bacteria

Pathogen	Dosage
Bacillus Bacteria	Destroyed by 0.2 m/l within 30 seconds
Bacillus Anthracis	Ozone susceptible
Bacillus Cereus	99% destruction after 5-min at 0.12 mg/l in water
Bacillus Subtilis	90% reduction at 0.10-PPM for 33 minutes
Candida Bacteria	Ozone susceptible
Clostridium Bacteria	Ozone susceptible
Diphtheria Pathogen	Destroyed by 1.5 to 2 mg/l
Eberth Bacillus Typhus Abdomanalis)	Destroyed by 1.5 to 2 mg/l
Escherichia Coli Bacteria (from feces)	Destroyed by 0.2 mg/l within 30 seconds in air
E-coli (in clean water)	99.99% destruction at 0.25 mg/l for 1.6 minutes
Endamoebic Cysts Bacteria	Ozone susceptible
Klebs-Loffler Bacillus	Destroyed by 1.5 to 2 mg/l
Legionella Pneumophila	99.99% destruction at 0.32 mg/l for 20 minutes in distilled water
Mycobacterium Avium	99.9 with a CT value of 0.17 in water
Mycobacterium Foruitum	90% destruction at 0.25 mg/l for 1.6 minutes in water
Penicillium Bacteria	Ozone susceptible
Proteus Bacteria	Very susceptible
Pseudomonas Bacteria	Very susceptible
Salmonella Bacteria	Very susceptible
Salmonella Typhimurium	99.99% destruction at 0.25 mg/l for 1.67 minutes in water
Schistosoma Bacteria	Very susceptible
Staph Epidermidis	90% reduction at 0.1-PPM for 1.7 minutes
Staphylococci	Destroyed by 1.5 to 2.0 mg/l
Streptococcus Bacteria	Destroyed by 0.2 mg/l within 30 seconds
Virbrio Cholera Bacteria	Very susceptible

Viruses

Pathogen	Dosage	Pathogen	Dosage
Bacteriophage F2	99.99% destruction at 0.41 mg/l for 10-seconds in water	Hepatitus A Virus	99.5% reduction at 0.25 mg/l for 2-seconds in a phosphate buffer
Coxsackie Virus A9	95% destruction at 0.035 mg/l for 10-seconds in water	Herpes Virus	Destroyed to zero level in less than 30 seconds with 0.1 to 0.8 mg/l
Coxsackie Virus B5	99.99% destruction at 4.1 mg/l for 2.5-minutes in sludge effluent	Poliomyelitis Virus	99.99% kill with 0.3 to 0.4 mg/l in 3-4 minutes
Echo Virus 29	The virus most sensitive to ozone After a contact time of 1 minute at 1 mg/l of ozone, 99.999% killed	Poliovirus Type 1	99.5% destruction at 0.25 mg/l for 1.6 minutes in water
Enteric Virus	95% destruction at 4.1 mg/l for 29 minutes in raw wastewater	Rhabdovirus Virus	Destroyed to zero level in less than 30 seconds with 0.1 to 0.8 mg/l
Encephalomyocarditis	Virus Destroyed to zero level in less than 30 seconds with 0.1 to 0.8 mg/l	Stomatitis Virus	Destroyed to zero level in less than 30 seconds with 0.1 to 0.8 mg/l
Enterovirus	Destroyed to zero level in less than 30 seconds with 0.1 to 0.8 mg/l	Vesicular Virus	Destroyed to zero level in less than 30 seconds with 0.1 to 0.8 mg/l
GDVII Virus	Destroyed to zero level in less than 30 seconds with 0.1 to 0.8 mg/l		

Mold

Pathogen	Dosage	Pathogen	Dosage
Aspergillus Niger (Black Mount)	Destroyed by 1.5 to 2 mg/l	Fusarium Oxysporium F Sp. Melonogea	99.99% destruction at 1.1 mg/l for 20 minutes
B. Cereus (Spores)	99% destruction after 5-min at 2.3 mg/l in water	Luminescent Basidiomycetes	Destroyed in 10 minutes at 100-PPM
Botrytis Cinerea	3.8 mg/l for 2 minutes	Mucor Piriformis	3.8 mg/l for 2 minutes
Clavibacter Michiganense	99.99% destruction at 1.1 mg/l for 5 minutes	Phytophthora Parasitica	3.8 mg/l for 2 minutes
Cladosporium	90% reduction at 0.10-PPM for 12.1 minutes	Verticillium Dahliae	99.99% destruction at 1.1 mg/l for 20 minutes
Clostridium Botulinum (Spores)	0.4 to 0.5 mg/l threshold value	Vicia Faba Progeny	Ozone causes chromosome aberration and its effect is twice that observed by the action of X-rays
Fusarium Oxysporium S Sp. Lycopersici	1.1 mg/l for 10 minutes		

MATERIAL COMPATIBILITY

Rating Scale

A = Excellent (no effect)	B = Minor effect (slight corrosion or discolouration	C = Fair – Moderate effect/not recommended for continuous use	D = Severe effect/not recommended

Material	Rating (Cole-Palmer) O_3 Concentration not specified	Material	Rating (Cole-Palmer) O_3 Concentration not specified
ABS plastic	B	Magnesium	D
Acetal (Delrin®)	C	Monel	C
Aluminum	B	Natural rubber	D
Brass	B	Neoprene	C
Bronze	B	NORYL®	N/A
Buna-N (Nitrile)	D	Norprene	A
Butyl	A	Nylon	D
Cast iron	B	PEEK	A
Chemraz	A	Polyacrylate	B
Copper	B	Polycarbonate	A
CPVC	A – does get brittle	Polypropylene	C
Durachlor-51	A	Polysulfide	B
Durlon 9000	A	Polyurethane, Millable	A
EPDM	B – Dry Ozone/C – Wet Ozone	PPS (Ryton®)	N/A
EPR A	A	PTFE (Teflon®)	A
Epoxy	N/A	PVC	Ozone in water – A Ozone in air – B Does get brittle
Ethylene-Propylene	A	PVDF (Kynar®)	A
Fluorosilicone	A	Santoprene	A
Galvanized Steel	Water – C/Air - A	Silicone	A
Glass	A	Stainless steel - 304	B
Hastelloy-C®	A	Stainless steel - 316	A
Hypalon®	A	Steel (Mild, HSLA)	D
Hytrel®	C	Titanium	A
Inconel	A	Tygon®	B
Kalrez	A – up to 37.7°C	Vamac	A
Kel-F® (PCTFE)	A	Viton®	A
LDPE	B	Zinc	D

CALCULATIONS FOR OZONE IN AIR

Temperature and Pressure Standard:

273.3 K (O^0 C, 32^0 F) and 1013.25 mb (14.706 psi)

Ozone in Air by Volume (Low concentrations such as work place safety)

1 g O_3/m^3 = 467 ppm by volume
1 ppm O_3 (volume) = 2.14 mg O_3/m^3
.1 ppm O_3 (volume) = 214 ug/m^3 (used more often in Europe)
1 ppm = .00214 ug/ml 1 ug/ml = 467 ppm (used in medical ozone)
1 ppm = 100 pphm (used in rubber testing)

Concentration by volume, v/v = C (g/m^3) X 1733 X T/P = 467C at STP

Ozone in Air by Weight (High concentrations such as at the outputs of corona discharge generators)

1 g O_3/m^3 = 782 ppm by weight
100 g O_3/m^3 = 7.82% O_3 in air
1% O_3 (by weight) = 12.8 g/m^3 in air
Conc. by weight, G (or w/w) = C X .29 X T/P = .0782C at STP, C = Conc. in G/M^3

Ozone in Oxygen (High concentrations by Weight)

1 g O_3/m^3 (of O_2) = 699 ppm by weight
100 g O_3/m^3 (of O_2) = 6.99% O_3 in O_2

OZONE IN WATER CALCULATIONS

Calculate Ozone Dosage Requirements in Water

Flowrate (lph) x Ozone dosage (ppm) = Ozone production (mg/hour)/1000 = g/hr Ozone
Example:
10000 (lph) x 2ppm = 20000 mg/h = 20 g/hr

Calculating Ozone Output

Flowrate (lpm) x Ozone concentration (g/m^3) = Ozone production (mg/h)
Example: Ozone concentration exiting Ozone unit: 120g/m^3 at 5 lpm of Oxygen flow
5 l/min x 120 g/m3 x (1 m3/1,000 l) = 0.60 g/m x 60 = 36 gph

Iron & Manganese Oxidation

Iron Oxidation – 0.43mg Ozone to 1mg Iron
Manganese Oxidation – 0.88mg Ozone to 1mg Manganese

WASTE WATER TREATMENT GUIDE

COD removal with Ozone

- Complete oxidation from inert COD to CO_2
- Cracking of COD → inert organic molecules are cracked into smaller molecules which consequently become biodegradable

COD_{TOTAL}= COD for Total Organic + COD for Inorganic

High Ozone dosage – COD oxidised to CO_2 – 2g to 5g Ozone/1g COD removed
Low Ozone dosage – COD transformed into BOD – 0.7g – 1.5g Ozone/1g COD removed

Ozone in Waste Water Treatment

Pre-ozonation

Pre-treatment to remove toxic substances like Phenols, Cresols,etc.

Sludge treatment

To improve sludge disintegration and improve sludge reduction

To eliminate filamentous bacteria and reduce SVI (Sludge Volume Index)

Final ozonation

Removal of endocrine disruptors

Elimination of inert COD

Color/odor removal

Disinfection

Removal of other substances like Phenols, etc.

Please note this is a guide only and is not to be used for definitive purposes without consultation

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