

# OZONE INFORMATION



DISPURA OZONE

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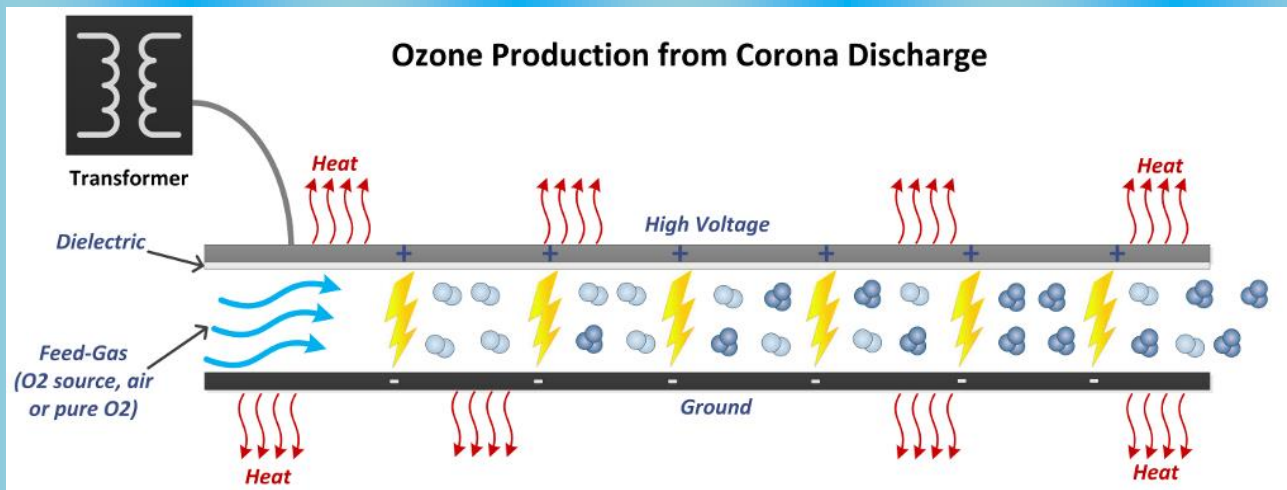
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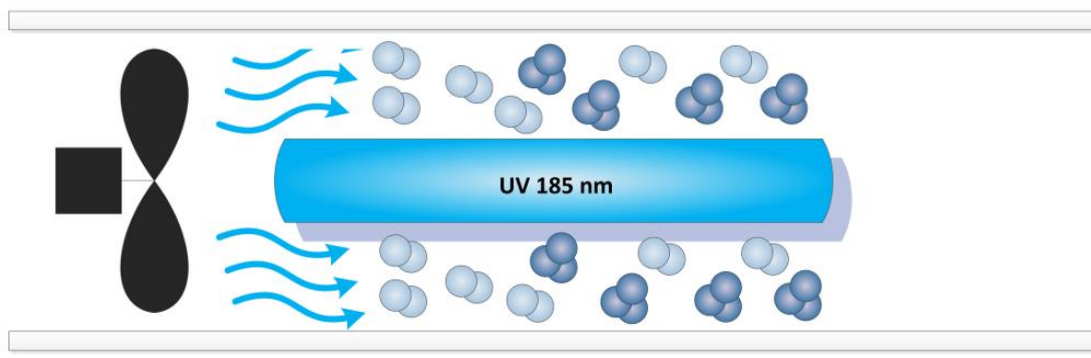
GUIDE FOR WASTE WATER

## 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.



## Ozone formation commercially from UV Light



## 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<sub>3</sub>
- Atomic weight: 48
- Melting Point: -192.5°C
- Boiling Point: -119.5°C
- Density relative (in air): 1.7kg/m<sup>3</sup>

### 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
<b>Ozone</b>	<b>2.07</b>
Hydrogen Peroxide	1.77
Permanganate	1.67
Hypochlorous Acid	1.49
Chlorine Gas	1.36
Hypobromous Acid	1.33
Oxygen	1.23
Bromine	1.09
Hypoiodous 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	Hepatitis 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
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Material	Rating (Cole-Palmer) O <sub>3</sub> Concentration not specified	Material	Rating (Cole-Palmer) O <sub>3</sub> 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
Hyrel®	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 (0° C, 32° F) and 1013.25 mb (14.706 psi)

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

1 g O<sub>3</sub>/m<sup>3</sup> = 467 ppm by volume  
1 ppm O<sub>3</sub> (volume) = 2.14 mg O<sub>3</sub>/m<sup>3</sup>  
.1 ppm O<sub>3</sub> (volume) = 214 ug/m<sup>3</sup> (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<sup>3</sup>) 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<sub>3</sub>/m<sup>3</sup> = 782 ppm by weight  
100 g O<sub>3</sub>/m<sup>3</sup> = 7.82% O<sub>3</sub> in air  
1% O<sub>3</sub> (by weight) = 12.8 g/m<sup>3</sup> in air  
Conc. by weight, G (or w/w) = C X .29 X T/P = .0782C at STP, C = Conc. in G/M<sup>3</sup>

### Ozone in Oxygen (High concentrations by Weight)

1 g O<sub>3</sub>/m<sup>3</sup> (of O<sub>2</sub>) = 699 ppm by weight  
100 g O<sub>3</sub>/m<sup>3</sup> (of O<sub>2</sub>) = 6.99% O<sub>3</sub> in O<sub>2</sub>

## 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<sup>3</sup>) = Ozone production (mg/h)

**Example: Ozone concentration exiting Ozone unit: 120g/m<sup>3</sup> at 5 lpm of Oxygen flow**  
**5 l/min x 120 g/m<sup>3</sup> x (1 m<sup>3</sup>/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<sub>2</sub>
- Cracking of COD → inert organic molecules are cracked into smaller molecules which consequently become biodegradable

$$\text{COD}_{\text{TOTAL}} = \text{COD for Total Organic} + \text{COD for Inorganic}$$

High Ozone dosage – COD oxidised to CO<sub>2</sub> – 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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