

TS SERIES

COMPACT TURNKEY OZONE GENERATOR

MODEL: TS-20

INSTALLATION & OPERATIONS MANUAL



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CONTENTS

| | | | |
|--|---|---|-----------|
| Introduction | 4 | IV. ADDITIONAL INFORMATION | |
| Theory of Operation | 4 | Warranty | 8 |
| I. SAFETY | | Specifications | 8 |
| Precautions..... | 4 | Contact Information | 9 |
| Personal Safety | 5 | APPENDIX A - MAINTENANCE..... | 11 |
| II. COMPONENTS | | APPENDIX B - TROUBLESHOOTING..... | 12 |
| Diagram | 6 | APPENDIX C - SAFETY DATA SHEET | 13 |
| Descriptions..... | 6 | | |
| III. INSTALLATION AND OPERATION | | | |
| Requirements..... | 7 | | |
| Initial Start-up..... | 7 | | |
| Operator Instructions..... | 8 | | |
| Flow Meter corrected Flow | 8 | | |

IMPORTANT SAFETY INSTRUCTIONS, READ AND FOLLOW ALL INSTRUCTIONS.
Read this manual completely before attempting installation.
SAVE THESE INSTRUCTIONS.



INTRODUCTION

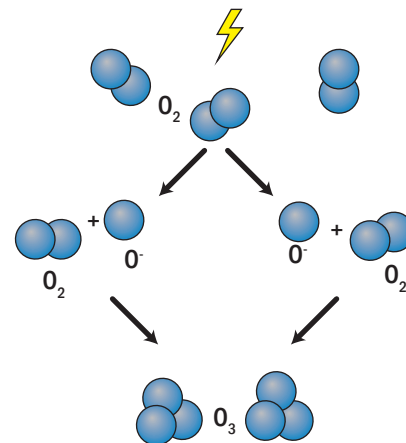
The TS Series Ozone Generators are a complete air preparation and ozone generation system that includes an integrated air compressor, oxygen sieve's, and ozone generator. No external oxygen supply is required. The TS Series Ozone Generators are designed to produce ozone from oxygen under pressure. While maximum ozone production (by volume) will be achieved at high pressures and flows. These turnkey systems use oxygen from the oxygen sieve's to achieve prime ozone production at pressure up to 20 PSI.

THEORY OF OPERATION

The TS Series Ozone Generator produces ozone via corona discharge. This process uses an electrical spark to split the molecular bond of natural diatomic oxygen to form the atomic O^{\cdot} form of oxygen. These O^{\cdot} atoms then bond to other O_2 molecules to form O_3 (ozone).

The spark inside the TS Series is a controlled corona. This spark, an intense corona, is produced by forcing a high voltage source through a dielectric and a small air gap. These actions take place in a chamber called the corona cell.

The spark occurs at a higher-than-line voltage and much higher-than-line frequencies. These changes in voltage and frequency are accomplished with the circuit board and transformer inside the generator. The oxygen feed is forced through the small air gap along the dielectric and intense corona. This process splits the oxygen molecule and generates ozone. (See diagram on the right.)



1. Air Compressor takes in ambient air & delivers it to the oxygen sieve's.
2. Compressed air enters the oxygen sieve's in an alternating sequence.
3. The oxygen sieve's remove nitrogen from the air using pressure swing adsorption, leaving 90-95% oxygen. Effluent nitrogen is then vented to the atmosphere.
4. 90-95% Oxygen leaves the oxygen sieve's at up to 15 PSI pressure. Pressure & flow are regulated by an internal needle valve downstream of the ozone generator.
5. Oxygen enters the ozone cell where it is utilized to produce high concentration ozone under pressure.
6. A needle valve will allow adjustment of flow from the TS Series Ozone Generator.
7. Ozone exits the TS series via the OZONE OUT port

I. SAFETY

PRECAUTIONS

Ozone is a powerful oxidizing agent. Observe strict operating procedures while using ozone equipment. It is imperative that only ozone compatible materials are used in conjunction with the ozone system.

NOTE: If the operator has asthma, he or she must not enter an airspace that has a significant ozone concentration. Ozone can induce an asthma attack.

Carefully review and familiarize yourself with the following important safety information concerning the Ozone Generator:

- Ozone is an extremely aggressive and powerful oxidizer. The Occupational Safety and Health Administration (OSHA) 8-hour exposure limit is

0.10 PPM. The OSHA 15-minute exposure limit for ozone is 0.3 PPM. Above 0.3 PPM, there is the risk of damage to respiratory tissues.

- People who have no sense of smell should not operate this equipment.
- Never attempt to verify ozone production by directly breathing or smelling the ozone outlet.
- The Ozone Generator contains high voltages. Tampering can result in serious injury or death. For service instructions, contact Ozone Solutions.

Oxygen itself is not combustible, however it greatly accelerates the burning of combustible materials. Therefore, precautions should be taken to avoid a fire in the area of the generator

- Smoking should not be permitted in the area where the system is located.
- All oxygen connections and hoses should be kept clean and free of grease, oil and other combustible materials.
- Valves controlling oxygen flow should be opened and closed slowly to avoid the possibility of fires or explosions that can result from adiabatic compression.
- When bleeding a tank or line, stand clear and do not allow oxygen to embed itself within clothing. A spark could cause the oxygen embedded clothing to ignite.

High pressure gasses may be present within the system. Valves should be opened and closed slowly, and safety glasses and hearing protection should be worn at all times while gasses are being vented.

Do not attempt to modify or enhance the performance of a generator in any way.

PERSONAL SAFETY

Flushing ozone from the system

Safety warnings regarding ozone gas are found at the beginning of this manual. The Ozone System produces a large amount of ozone, which can be inadvertently “stored” within the Ozone Generators, manifolds, and ozone lines.

Eventually the ozone (even while in the system) will safely revert back to oxygen, but in the right conditions the ozone can remain in the system for 24 hours or even longer. In the event that maintenance must be performed on the components in contact with ozone, the following is recommended for reducing the possibility of exposure to the ozone.

Whenever possible it is recommended that the machine run with maximum permissible air and oxygen flow for at least 10 minutes with the Ozone Generator OFF in order to flush out most residual ozone.

In most circumstances, a very small amount of ozone will be contained within the system after shutdown; therefore, exposure will be minimal.

If the machine cannot be operated prior to maintenance or repair, a waiting period of 12 to 24 hours (if ozone has been produced recently) is recommended to allow the ozone to decay by reverting back into oxygen.

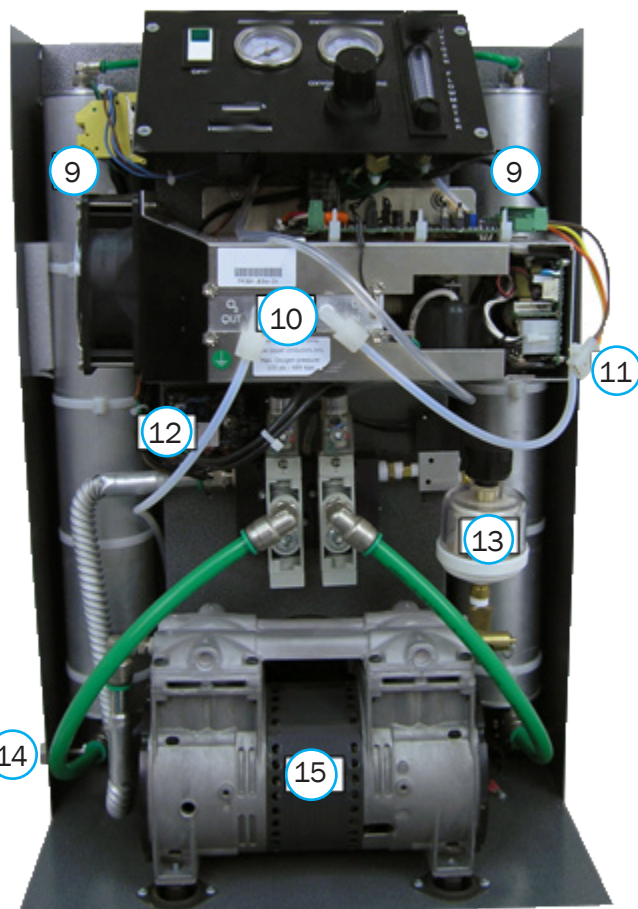
Isolating energy sources

The Ozone Generator has electrical and mechanical hazards, and maintenance or repair should not take place unless all energy sources have been turned off, disconnected, and/or drained. Energy sources include, but are not limited to:

- Electrical power
- Oxygen Concentrator sieve beds
- Ozone Generator internal capacitors

II. COMPONENTS

DIAGRAM



DESCRIPTIONS

- | | |
|------------------------------|-------------------------------|
| 1. Power Switch | 8. Ozone Production Light |
| 2. Air Pressure Gauge | 9. Sieve Beds |
| 3. Oxygen Pressure Gauge | 10. Ozone Generation Cell |
| 4. Hour Meter | 11. Connection for Ozone Dial |
| 5. Oxygen Pressure Regulator | 12. Timer |
| 6. Flowmeter | 13. Inlet Air Filter |
| 7. Ozone Output Control | 14. Ozone Outlet |
| | 15. Air Compressor |

III. INSTALLATION AND OPERATION

REQUIREMENTS

Location

Ensure that the Ozone Generator is in a well-ventilated area. This system is not weather proof; therefore a dust-free, non-condensing, enclosed environment is required for operation.

There are ventilation openings on the sides and bottom of the cabinet, which provide filtered air into the cabinet and exhaust out of the cabinet. A minimum of eight (8) inches of clear space should be provided to the left and right sides of the unit, and two (2) inches from the bottom. The cabinet door must be able to fully swing open for future maintenance and service.

If mounting the machine, ensure the wall or support system can withstand the weight of the unit.

Temperature & Humidity

Water must not be allowed to condense in or on the machine. For best performance, the operating temperature should be between 40°F and 95°F with a maximum relative humidity of 85%. The storage temperature should be between -20°F and 170°F.

If humidity levels are expected to exceed 85%, it is recommended that a quality air dehumidifier should be installed in the area of the generator.

Note: Operation outside of specified temperature and humidity ranges will not be warranted.

Ventillation

Proper ventilation is necessary to ensure safe conditions for workers around the machine. As the oxygen concentrator operates, it purges nitrogen into the area around the system. For systems installed in confined spaces (less than 2000 cubic feet), approximately three (3) air changes per hour is recommended.

Mechanical Connections

The TS series unit can provide gaseous ozone out of the 1/4" Swagelok tube compression bulkhead on the left side of the enclosure. Only use ozone compatible tubing and fittings to direct the flow of ozone to the final point of use.

Electrical

The system requires 110V, 60Hz, 15 amp power. A power cord is attached and stored on the right side of the enclosure. The power cord can be omitted if direct wiring is desired. It is required that a 15 Amp circuit be dedicated to each unit. Additionally, the unit must be plugged into this circuit using only the supplied power cord, and without additional extension cords.

INITIAL START-UP

Once the unit has been installed in a suitable location in accordance with this manual, it is ready to run. Complete the following instructions to start up the system and prepare it for your process.

1. Set the variable output knob to the "0" position so that ozone is not produced.
2. Ensure that all electrical connections and ozone tubing connections are complete.
3. Set the system switch to on. The compressor and oxygen concentrator on board the system will start.
4. The oxygen pressure gauge on the TS system will indicate increasing pressures as the oxygen concentrator starts.
5. Check all external ozone tubing connections for possible leaks or restrictions. Leaks can be detected by using a spray bottle to apply soapy water to fittings.
6. Observe the oxygen flow and oxygen pressure on the system while it is running. Ensure that any ancillary equipment connected to the system is also running. Pressure will decrease slightly (1-2 PSI) after the ozone generator has run for about 10 minutes, as the air compressor warms up. Adjust flow via needle valve in order to maintain 1-10 liters per minute of flow and 10-15 PSI oxygen pressure.
7. Once flow is properly adjusted, the air pressure gauge will continuously cycle between 15 and 40 PSI. This is due to the cycling of the oxygen concentrator, and is normal expected operation.
8. Turn the variable ozone output knob to the "2" or "3" position to start producing a limited amount of ozone. After 2-3 seconds, the ozone indicator lamp should illuminate.

9. Once ozone is being produced and the system is behaving properly, the ozone output can be slowly increased to the level required by your process.

OPERATOR INSTRUCTIONS

For local operation, the system can be started by activating the switch on the door of the machine. The 0-10 knob can be used to vary the ozone production level. An indication lamp on the door will light up when power is supplied to the cell and ozone is being produced. For further instruction, please refer to the initial start-up procedure.

If desired, the production of ozone can be controlled from a remote location. Contact Ozone Solutions to set up remote connections to the unit.

FLOW METER CORRECTED FLOW

The oxygen flow meter indicates the flow rate of oxygen leaving the oxygen concentrator and passing through the ozone generator. This flow meter indicates volumetric flow of the fluid (oxygen) through it. Since the oxygen is under pressure, the indicated flow needs to be mathematically adjusted to determine actual flow at atmospheric pressure.

The following equation can be used to determine the actual flow through the system:

$$(\text{adjusted flow}) = (\text{measured flow}) \times \sqrt{\frac{\text{oxygen pressure} + 14.7}{14.7}}$$

The TS series operates as given below:

| | |
|-----------------|-------------------|
| Air Pressure | 15-40 PSI |
| Oxygen Pressure | 15-25 PSI |
| Oxygen Flow | 6 LPM (indicated) |

Lower than normal air pressure or oxygen pressure is usually a sign of improper system setup (too much oxygen/ozone flow) or air compressor wear. The oxygen concentrator will rarely cause low pressure issues. For more information on low pressure issues see the "Maintenance and Troubleshooting" section of this manual.

IV. ADDITIONAL INFORMATION

SPECIFICATIONS

| TS-Series | O ₃ Production (g/hr) | Flow Rate (lpm) | Power (watts) | Current (amps) | Output Connection | Dimensions - WxDxH (inches) | Weight (lbs) |
|-----------|----------------------------------|-----------------|---------------|----------------|-------------------|-----------------------------|--------------|
| TS-20 | 20 | 0-10 | 760 | 15 | 1/4" Compression | 17x10x28 | 85 |

WARRANTY

Ozone Solutions warrants all equipment assembled, manufactured, and sold to be free from defects in material and workmanship under normal use and service for a period of one (1) year after date of sale to the original purchaser.

Some products may have a specific warranty period other than what is outlined in this document. For such products, the manufacturer warranty will supercede this warranty. Ozone Solutions will honor the manufacturer's warranty, but if and when advised

by the manufacturer, may have the customer deal directly with the manufacturer. This warranty covers all parts that are not outlined in a product maintenance schedule. This warranty will be void if any piece of the equipment is used in a manner other than what is explicitly outlined in the product manuals.

If any part of the equipment manufactured by Ozone Solutions proves to be defective during the warranty period, please call Ozone Solutions at 712.439.6880, or email service@ozonesolutions.com.

Prior authorization is required before working on or shipping a product back to us. Failure to get prior authorization may result in denial of your claim. Once authorized, you may return the defective equipment to Ozone Solutions with the transportation charges prepaid. If Ozone Solutions finds the equipment to be defective, it will be repaired or replaced at our discretion, free of charge, to the original purchaser (F.O.B. factory).

This warranty shall not place any liability on Ozone Solutions for any transportation charges, labor, or cost for, or during the replacement of any parts. The replaced part(s) or product will then continue the original warranty duration. The replaced parts will not start a new one (1) year coverage period. The purchaser by acceptance of the equipment will assume all liability for the consequences of its use or misuse by the purchaser, employees, or others. This warranty shall not apply to any piece of equipment, or part thereof sold by this company which has been subject to any accident caused in transit, alterations by unauthorized service, negligence, abuse, or damage by flood, fire, or act of God.

This warranty shall constitute the entire warranty and/or agreement between Ozone Solutions and the original purchaser, and in lieu of all other warranties, expressed or implied, either oral or written, including the warranty of merchantability and fitness for a particular use and of all other obligations or liabilities on our part. Ozone Solutions neither assumes nor authorizes any other person or entity to assume for us any liability associated with the sale of its products or equipment.

The term "original purchaser," as used in this warranty, means whom the product was originally sold to by Ozone Solutions or by an authorized dealer. Ozone Solutions reserves the right to make changes in its products without notice. Because of this, Ozone Solutions is not obligated to replace warranty defective part(s) and/or product with the same original part or product.

CONTACT INFORMATION

Ozone Solutions, Inc.
451 Black Forest Road
Hull, IA 51239 USA

Phone: 712.439.6880
Fax: 712.439.6733
Email: sales@ozonesolutions.com
Website: www.ozonesolutions.com

APPENDIX A - MAINTENANCE

Please contact Ozone Solutions with any questions or concerns regarding the maintenance and servicing of this system.

Maintenance Table

| Component | Action | Time Period | Part Numbers |
|-----------------------------|-------------------------------------|-----------------------|----------------------------|
| Compressor Inlet air filter | Replace filter element | 3 months/as needed | CP-Filter-4: Repl Element |
| Pressure Regulator+Filter | Replace filter element | 3 months/as needed | PR-8+Filter: Repl Element |
| Coalescing Filter | Replace filter element | 3 months/as needed | CF-8: Repl Element |
| Carbon Filter (if equipped) | Replace | 3 months/as needed | Carbon Element Replacement |
| Air Compressor | Rebuild Compressor | 2 Years/4000-8000 hrs | |
| Oxygen Concentrator | Replace O ₂ module sieve | 5 Years* | OG-15 Sieve Beds |

*Replacement may be necessary earlier if operated in dirty or humid conditions, or if the compressed air supply contains oil or water. **NOTE:** *The Ozone Generator will produce less ozone and have erratic oxygen pressures when the sieve beds are nearing the end of their useful life.*

APPENDIX B - TROUBLESHOOTING

| Symptom | Possible Cause | Repair |
|-----------------------|---|---|
| System does not run | No Power | Check and repair incoming power |
| Dusting of Sieve Beds | High pressuring of machine | Replace concentrator sieve beds |
| Valves Sticking | Dusting of sieve beds | Replace concentrator sieve beds |
| | Filters have reached end of useful life | Remove valve block from machine and clean valve and spools completely |
| Low oxygen flow | Low oxygen pressure | See “Low oxygen pressure” |
| | Flow restriction | Open needle valve or dislodge restriction |
| | Damaged oxygen regulation valve | Replace regulation valve |
| | Damaged oxygen concentrator | Replace concentrator |
| Low air pressure | Air leak inside ozone generator | Find and repair air leak |
| | Pressure regulator requires adjustment | Adjust pressure regulator |
| Low oxygen pressure | Oxygen or ozone leak | Find and repair leak |
| | Low Air Pressure | See “Low air pressure” |

APPENDIX C - SAFETY DATA SHEET



SAFETY DATA SHEET FOR OZONE FORMERLY MSDS

1. PRODUCT IDENTIFICATION

PRODUCT NAME: Ozone

COMMON NAME / SYNONYMS: Triatomic Oxygen, Trioxygen, O₃

OZONE GENERATOR MANUFACTURER / SUPPLIER: Ozone Solutions
451 Black Forest Road / Hull, Iowa 51239
712.439.6880 / www.ozonesolutions.com / tinfo@ozonesolutions.com

PRODUCT USE: This SDS is limited to ozone produced in gaseous form on site by an ozone generator, in varying concentrations, in either air or aqueous solutions, for the purposes of odor abatement, oxidation of organic compounds or antimicrobial intervention, in a variety of applications.

2. HAZARD IDENTIFICATION

GHS CLASSIFICATIONS

| PHYSICAL | HEALTH | ENVIRONMENTAL |
|---------------|---|---------------|
| Oxidizing Gas | Skin Irritation - Category 3 Eye Irritation - Category 2B Respiratory System Toxicity - Category 1 (Single & Repeated) | Severe |

WHMIS CLASSIFICATIONS (WORKPLACE HAZARDOUS MATERIALS INFORMATION SYSTEM, CANADA): C, D1A, D2A, D2B, F
Source: CCOHS CHEMINFO Record Number 774

3. COMPOSITION

| | |
|----------------------------|-----------------------------|
| CHEMICAL NAME | Ozone |
| COMMON NAMES | Triatomic Oxygen, Trioxygen |
| CHEMICAL FORMULA | O ₃ |
| CAS REGISTRY NUMBER | 10028-15-6 |

4. FIRST AID MEASURES

| ROUTE OF ENTRY | | SYMPTOMS | FIRST AID |
|-----------------|-----|---|---|
| Skin Contact | Yes | Irritation | Rinse with Water |
| Skin Absorption | No | NA | NA |
| Eye Contact | Yes | Irritation | Rinse with Water, Remove Contacts |
| Ingestion | No | NA | NA |
| Inhalation | Yes | Headache, Cough, Heavy Chest, Shortness of Breath | Remove to Fresh Air, Provide Oxygen Therapy as Needed |

For severe cases, or if symptoms don't improve, seek medical help.

5. FIRE FIGHTING MEASURES

Ozone itself is not flammable. As a strong oxidant it may accelerate, even initiate, combustion or cause explosions. Use whatever extinguishing agents are indicated for the burning materials.

6. ACCIDENTAL RELEASE MEASURES

Turn off the ozone generator and ventilate the area. Evacuate until ozone levels subside to a safe level (<0.1 ppm).

7. HANDLING AND STORAGE

Ozone must be contained within ozone-resistant tubing and pipes from the generation point to the application point.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

| | |
|--|---|
| OSHA PERMISSIBLE EXPOSURE LIMIT | 8 hour TWA 0.1 ppm |
| ANSI / ASTM | 8 hour TWA 0.1 ppm, STEL 0.3 ppm |
| ACGIH | 8 hour TWA 0.1 ppm, STEL 0.3 ppm |
| NIOSH | ELCV 0.1 ppm Light; 0.8 ppm Moderate; 0.5 ppm Heavy; Light, Moderate, Heavy Work TWA <=2 Hours, 0.2 ppm Immediately Dangerous to Life or Health 5.0 ppm |

RESPIRATORY PROTECTION: Use full face self-contained breathing apparatus for entering areas with a high concentration of ozone.

ENGINEERING CONTROL: Use ozone destruct unit for off gassing of ozone.

9. PHYSICAL AND CHEMICAL PROPERTIES

| | | | |
|----------------------------|---|---------------------------|----|
| PHYSICAL STATE | Gas | pH | NA |
| MOLECULAR WEIGHT | 48.0 | Decomposition Temperature | NA |
| APPEARANCE | Clear at Low Concentration, Blue at Higher Concentration | Evaporation Rate | NA |
| ODOR | Distinct Pungent Odor | Flash Point | NA |
| ODOR THRESHOLD | 0.02 to 0.05 ppm; Exposure Desensitizes | Auto-Ignition Temperature | NA |
| MELTING POINT | -193° C / -315° F | Relative Density | NA |
| BOILING POINT | -112° C / -169° F | Partition Coefficient | NA |
| VAPOR PRESSURE | > 1 atm | Flammability | NA |
| VAPOR DENSITY | 1.6 (Air = 1) | Explosive Limits | NA |
| SOLUBILITY IN WATER | 570 mg / L at 20° C 100% O ₃ ; 0.64 at 0° C | Viscosity | NA |

10. STABILITY AND REACTIVITY

Ozone is highly unstable and highly reactive. Avoid contact with oxidizable substances. Ozone will readily react and spontaneously decompose under normal ambient temperatures.

11. TOXICOLOGY INFORMATION

| | |
|--|--|
| ROUTES OF EXPOSURE | Inhalation, Eyes, Skin Exposure |
| EFFECTS OF ACUTE EXPOSURE | Discomfort; including headache, coughing, dry throat, shortness of breath, pulmonary edema; higher levels of exposure intensify symptoms. Possible irritation of skin and / or eyes. |
| EFFECTS OF CHRONIC EXPOSURE | Similar to Acute Exposure effects, with possible development of chronic breathing disorders, including asthma. |
| LC₅₀ | Mice 12.6 ppm for 3 hrs / Hamsters 35.5 ppm for 3 hrs |
| IRRITANCY OF OZONE | Yes |
| SENSITIZATION TO OZONE | No |
| CARCINOGENICITY (NTP, IARC, OSHA) | No |
| REPRODUCTIVE TOXICITY, TERATOGENICITY, MUTAGENICITY | Not Proven |
| TOXICOLOGICALLY SYNERGISTIC PRODUCTS | Increased susceptibility to allergens, pathogens and irritants |

12. ECOLOGICAL INFORMATION

The immediate surrounding area may be adversely affected by an ozone release, particularly plant life. Discharge of ozone in water solution may be harmful to aquatic life. Due to natural decomposition, bioaccumulation will not occur and the area affected will be limited.

13. DISPOSAL CONSIDERATIONS

Off-gassing of ozone should be through an ozone destruct unit which breaks ozone down to oxygen before release into the atmosphere.

14. TRANSPORT INFORMATION

NOT APPLICABLE, as ozone is unstable and either reacts or decomposes and must be generated at the location and time of use.

15. REGULATORY INFORMATION (Source: EPA List of Lists)

| | |
|---|--------------------------|
| SARA TITLE III SECTION 302 EHS TPQ | 100 lbs |
| SARA TITLE III SECTION 304 EHS RQ | 100 lbs |
| SARA TITLE III SECTION 313 | > 10,000 lbs used / year |

16. OTHER INFORMATION

Half-life of ozone in water at 20° C = 20 minutes; in dry still air at 24° C = 25 hour; decreases significantly with increase in humidity, presence of contaminants, air movement and / or increase in temperature.

Preparer: Tim McConnel and Stacey Eben, Ozone Solutions 5/1/2012 (layout revision (2/13/2018))

DISCLAIMER: Ozone Solutions provides this information in good faith, but makes no claim as to its comprehensiveness or accuracy. It is intended solely as a guide for the safe handling of the product by properly trained personnel, and makes no representations or warranties, express or implied, of the merchantability or fitness of the product for any purpose, and Ozone Solutions will be responsible for any damages resulting from the use of, or reliance upon, this information.

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