

**Reactive**

**Gas**

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# Ozone Generators for Biopharm



## MKS Ozone Generators — The Green Alternative

Ozone is 3,000 times more efficient than chlorine when used as a disinfectant. It destroys bacteria, fungus, spores and parasites in water, especially chlorine-resistant microorganisms. Ozone also oxidizes organic contaminants and decomposes inorganic contaminants. Since ozone can be converted back to oxygen, it can be used in high concentration without residuals—making it a truly green solution.

MKS ozone generators are much more compact, reliable, and energy efficient than other ozone products on the market today. Equipment and system design, including air preparation and feed gas options, diffusion methods, monitoring, removal, off-gas handling and destruction are core competencies of MKS.

Ozonation is a chemical treatment method that must be produced at point-of-use. Therefore, it is necessary to address safety, materials compatibility, dosage rate, contact time, possible formation of byproducts, and protection of downstream components for proper process application.



SEMOZON® O<sub>3</sub>mega Integrated Ozone Delivery Subsystem

# Ozone for Biopharm

MKS offers a complete spectrum of ultra clean, highly reliable ozone generation, delivery and accessory products. The ozone product family includes compact, powerful ozone gas generators, high concentration, closed-loop controlled ozone gas delivery subsystems, state-of-the-art, high concentration dissolved ozone liquid delivery subsystems and ozone accessories for flow, mixing and ozone destruction.

Ozone is increasingly used in a number of Biopharmaceutical manufacturing steps including clean in place (CIP), biofilm removal, water treatment systems, sterilization in place (SIP), biowaste treatment and many other processing applications. Ozone is an environmentally friendly alternative to many process chemicals. It has a high redox potential, can be generated at the point-of-use and is easily converted back to oxygen, reducing energy cost as well as the cost to purchase, store and dispose of many chemicals.

## Biopharmaceutical Solutions

### Water Treatment Systems

Ozone is the strongest, commercially available oxidizing agent for use in water disinfection and tank maintenance. It eliminates bacterial growth and Biofilm build up, eliminates endotoxins and reduces TOC. Use of ozone reduces reliance on chlorine and other harsh chemicals vastly improving workplace and environment safety.

### Biofilm Removal

Biofilm is produced by clusters of microorganisms found in virtually every environment. Ozone provides a very powerful oxidant alternative to chlorine-based compounds for the removal of these pollutants.

### Biowaste Treatment

Treating wastewater and site effluent with ozone lowers operating costs by reducing energy consumption and chemical treatment. Existing treatment systems can be upgraded to include tertiary filtration and disinfection with ozone, improving performance at a fraction of the price of a complete new treatment system.

### Clean-In-Place (CIP) Systems

Clean-in-place is insitu cleaning of piping and production equipment in biopharm production and R&D facilities. Cleaning begins with an application of a surfactant followed by rinsing to remove organic debris. Ozone-enriched water is used to disinfect the pipe walls, tanks, and fillers. Disinfection with ozone is conducted at ambient temperature and excessive rinsing is not required making it both a cost effective and environmentally friendly choice. Ozone is a proven solution with multiple production and R&D facilities using ozone CIP disinfection systems today.

### Sanitization

Ozone generating sanitization, used for killing spores of various bacteria, is compact, easy to operate and cost effective. The process uses only oxygen and electricity making it a safe alternative to traditional methods—no toxic chemicals or harmful emissions are involved. Ozone sanitization is extremely efficient and generated at point-of-use. Standard destruction of 1 million cells can be routinely achieved.

## Applications

- Lyophilization and Fermentation
- Sterile Drug Manufacture
- Bioreactors and Skid Systems
- Plant Fluid Systems
- PAT (Process Analytical Technologies) Implementation

## MKS Offerings in the Biopharm Market

In addition to ozone, MKS offers a full line of instruments, controls, subsystems and analytical software products to support biopharmaceutical development and production.

- Mass Flow Controllers
- Pressure Measurement & Control Products
- Ozone Generating Subsystems
- Stainless Steel Filter Housings, Fittings, Flanges, Heaters & Traps
- FTIR/NDIR and Mass Spectrometer-based Gas Analysis Instruments
- Process Monitors and Controllers
- Multivariate Analysis Software

## Ozone Products

Working in our fully equipped ozone laboratory, and with leading industry research facilities, MKS' staff of scientists, expert in the use of ozone, support expanded applications for the use of ozone. Our applications expertise is augmented by our experienced system design engineers who understand the needs of biopharmaceutical manufacturing. The result is the most comprehensive, reliable, clean and effective ozone product offering in the industry.

### SEMOZON® Generators & Delivery Subsystems

Based on the silent discharge principle, SEMOZON® generators and delivery subsystems are the most compact and highest concentration ozone generators available. The patented MKS generator designs have high efficiency cooling for maximum ozone concentration and flow. Ultra-pure wetted materials maintain high concentration and ensure the cleanest ozone possible. The SEMOZON product family ranges from compact, rack mountable generators to fully interlocked, closed loop controlled, high output delivery subsystems.



SEMOZON® AX8407 Ozone Generator

### LIQUOZON® Ultra

The LIQUOZON® Ultra ozone injection system from MKS Instruments provides a clean, safe, and efficient water sanitization alternative to chlorine and heat in pharmaceutical applications. The LIQUOZON Ultra generates ozone, dissolves it into water and delivers degassed ozone-enriched water using less energy than heat systems and without the use of hazardous chemicals. With onboard instrumentation and control, the LIQUOZON Ultra delivers all the necessary data for validation. LIQUOZON Ultra is a compact skid-mounted purified water system for UPW & UHPW that is thoroughly tested at the factory to reduce installation time.



LIQUOZON® Ultra Ozone Injection System

### Ozone Accessory Products



Ozone Gas Destruct

Wherever ozone is used, safety measures have to be taken in order to protect personnel and equipment from unintended ozone exposure. One important safety measure is the destruction of excess ozone gas that is not used in a process. The OVS ozone gas destruct unit is designed to safely convert high levels of ozone into benign oxygen, reducing the ozone level down to detection limit, well below safety thresholds.

## Global Support

As a worldwide leader in the development and manufacture of advanced instruments, subsystems, software and controls, we can support your MKS products. Our service engineers average 7-10 years of industry experience. Service plans include extended warranty, contracts, calibration, 24/7 telephone support and state-of-the-art training. With 17 calibration and service centers in 13 countries around the globe, we are where you are.

## Why Use Ozone?

When most people think of ozone, they picture a thin layer of gas high above the earth's outermost atmosphere that protects us from the sun's ultraviolet rays. On earth however, ozone has a variety of uses. Ozone is an extraordinary sanitizing agent that's economically produced, environmentally friendly and is remarkably effective in cleaning and sanitizing.

Ozone, or O<sub>3</sub>, is generated in nature as a bluish or colorless gas. When oxygen (O<sub>2</sub>) and electricity interact, ozone is created. It is an unstable gas that readily reacts with organic substances and sanitizes by interacting with microbial membranes and denaturing metabolic enzymes.

Ozone will also attack microbial biofilms and degrade them, much as it would any other polysaccharide. Upon release of its oxidizing potential, ozone reverts back to the oxygen from which it was generated. Application of ozone does not leave a chemical residual. Under ambient conditions, ozone has a half-life of 10 to 20 minutes.

### Extensive Range of Applications

Scientific research shows that ozone is a broad-spectrum bactericide that kills bacillus and all known bacteria, viruses, mold, spores, yeast, mildew and fungus faster than hot water, steam or chlorine.

### Efficiency

Research shows that the sterilization speed of ozone far exceeds alternative methods of killing bacteria.

### Ozone Is . . .

- An effective disinfectant
- Generated at point-of-use; no transport or storage
- Cost effective to produce and use
- Chemical-free—NO toxic byproducts
- FDA approved for direct-food contact
- Environmentally friendly—byproduct is oxygen
- Safer than conventional chemicals
- More powerful than chlorine
- Strongest broad-spectrum microbial treatment



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