Spartan Environmental Technologies, LLC
Air and Water Treatment

Ozone Water Treatment and Advanced Oxidation Systems

Spartan Environmental Technologies

Spartan Supplies Solutions to Water and Wastewater Treatment Challenges Where Disinfection and Oxidation are Required

- **Treat Objectives**
  - Disinfection
  - COD/TOC Reduction
  - Destruction of Specific Organic Compounds, e.g. phenol, MTBE, etc.
  - Removal of inorganic compounds such as H_2S, Mn, Fe, CN, etc.
  - Color Removal
  - Taste and Odor Removal
- **Markets/Applications**
  - Drinking/Bottled Water
  - Cooling Water
  - Industrial Wastewater (pretreatment and surface discharge
  - Groundwater Remediation (pump and treat)
  - Industrial process water treatment, recycling and reuse

Spartan Supplies Both Skid Mounted Integrated Disinfection and Oxidation Systems and Individual Equipment Components

- Technologies
  - Ozone
    - Generators, Gas Preparation, Mixers/Diffusers, Instruments
  - UV
    - Closed Reactors
  - Peroxide
    - Metering
- Systems
  - Integrated Skid Ozone Injection System
  - Conventional and Standard Advanced Oxidation Processes
  - Turn Key Peroxide Systems with Chemical Supply

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Spartan Provides Support Services for Supplied Systems Either Directly of Through Our Partners

- **Laboratory Testing**
  - Treatability Studies
- **Pilot Testing**
  - Process Testing on Site
- **Engineering Support**
  - Design and integration
- **Applications Consulting**
  - Process Selection
- **Equipment Servicing**
  - After Sales

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Spartan Supplies a Complete Range of Ozone Generator Systems, Components and Services

- Ozone Generators
- Instruments
- Ozone Injection Systems
- Ozone Destroyers
- Turn Key Ozone Water Treatment Systems

Benefits of Ozone: Inactivation of a Wide Range of Pathogens

CT = residual concentration (mg/L) x time (min)

E. coli	0.02 - 0.06 mg-min/L = CT (2-log)
Streptococcus faecalis	0.01 - 0.025 mg-min/L = CT (2-log)
Legionella pneumophila	0.3 - 1.1 mg-min/L = CT (2-log)
Total Coliform	0.19 mg-min/L = CT (6-log)
HPC	0.19 mg-min/L = CT (3-log)

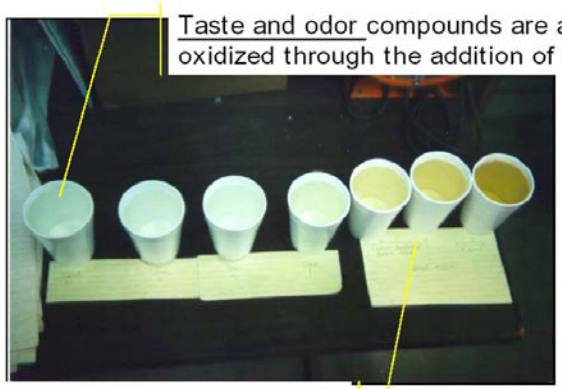
Benefits of Ozone: Superior Rate of Disinfection (CT) Versus Other Agents

	Free Chlorine (pH 6 to 7)	Chloramine (pH 8 to 9)	Chlorine Dioxide (pH 6 to 7)	Ozone (pH 6 to 7)
Giardia	**122**	**2200**	**26.0**	**1.9**
Virus	**8**	**1988**	**33.4**	**1.2**

CT values for various chemicals at 5 degrees C

Benefits of Ozone: Selective Oxidant with Limited Toxic Byproducts Formation

- Inorganic Oxidation:
  - Fe and Mn (complexed, wide pH range),
  - H2S,
  - CN (free and most complexes)
- COD/TOC Reduction
- Color Removal
- Taste and Odor Control
- Specific Organic Molecules (e.g. phenol)
- Enhances Biodegradability (less toxic compounds, pretreatment to biological processes)
- Limited Formation of Toxic Compounds
- Oxidation with Simultaneous Disinfection



Ozone performs its work through oxidation reactions.

Large Ozone Water Treatment Systems

- Spartan is the US/Canada Distributor for Ozono Elettronica Internazionale (OEI):
  - Based Near Milan Italy
  - Thirty (35) Years of Ozone Experience in Highly Developed European market
  - Applications Include Drinking Water, Municipal Wastewater, Industrial Wastewater, Odor Control, Bottling Plants Among Others
  - Over 700 Installations Worldwide

OEI Offers a Full Range of Generators

- **OEI MCP/TPF Series Ozone Generators Have the Following Characteristics:**
  - Production Rates 50 to 750 lbs O3/day.
  - Horizontal Tube, Water Cooled, Medium Frequency Corona Discharge
  - Can Work with Oxygen or Air Feed

OEI Ozone Generators are Designed with Features that Insure High Reliability

- Thirty Five Years of Continuous Improvement has Resulted in a Proven System that Provides Long Term Value to the Client
- Key Features
  - Modular Design
  - Redundancy in Instruments and Controls
  - Superior Materials of Construction
  - High Quality Components
- ISO 9000 Compliant Quality Systems

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Municipal Water Installations Examples

Arguenon, France 7 MGD

Chauvon, France 3.8 MGD

Daon, France 1.6 MGD

Bombarde, France 3 MGD

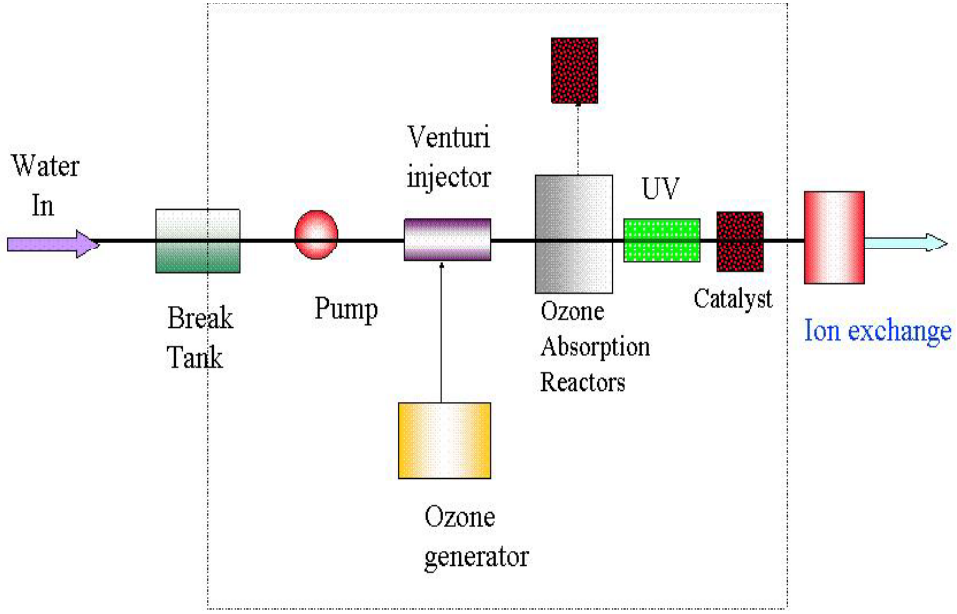
Graon, France 7 MGD

Ozone Industrial Wastewater Examples

Color Removal Applications – Two Textile Plants in Northern Italy

Advanced Oxidation Systems

- **Spartan Represents ESCO International in the US/Canada**
  - ESCO Engineers and Designs Advanced Oxidation Processes
  - System include convention advanced oxidation systems such as UV/Ozone, UV/peroxide, Ozone/Peroxide, etc.
  - Proprietary catalytic systems are also offered such as CATADOX. In many cases the proprietary systems offer lower costs.



AOP Applications

- Reclaim, Recycling and Reuse of process and wastewater, examples include Semiconductor Fabrication and TFT-LCD production
- Ground Water Remediation
- General Industrial Wastewater Treatment
- Gas Effluent Scrubbing and Treatment

Advanced Oxidation Process Example Installations

- Electronic Manufacturer
  - Location: China
  - Treatment objective: TOC reduction
  - Water quality: Process water
  - Flow rate: 300 m3/h (1,325 gpm)
- Electronic Manufacturer
  - Location: Taiwan
  - Treatment objective: TOC reduction
  - Water quality: Process water
  - Flow rate: 25 m3/h (110 gpm)
- Electronic Manufacturer
  - Location: China
  - Treatment objective: TOC reduction
  - Water quality: City water
  - Flow rate: 600 m3/h (2,650 gpm)
- Semiconductor Manufacturer
  - Location: Singapore
  - Treatment objective: TOC reduction
  - Water quality: Process water
  - Flow rate: 45 m3/h & 65 m3/h (200 gpm & 287 gpm)

Benefits of Advanced Oxidation Processes (AOP)

- AOP use a combination of ozone, UV and hydrogen peroxide to decompose organic contaminants, in some cases to CO_2 and salts
- AOP can deal with compounds that can not be treated with conventional biological treatment or simple oxidation processes.
- Unlike physical (e.g. membranes/filtration) or biological processes, AOP doesn't produce additional by-products or sludge that requires further handling and disposal.
- AOP systems can be adapted for a wide variety of applications and can be fully automated to reduce labor and other operating costs.

Packaged Ozone Water Treatment Systems

- **Spartan Supplies Integrated Ozone Water Treatment Systems which include:**
  - Oxygen Concentrators/Compressors for Gas Preparation
  - Ozone Generators
  - Back Flow Protection
  - Ozone Injection Systems with Venturi and Booster Pump
  - Allen Bradley PLC Process Control
  - Optional Equipment include Dissolved Ozone Monitors, Degas Valves, Off Gas Ozone Destruction, Water Phase Ozone Destruction

Application of Small Packaged Systems

- Small Community Drinking Water Systems
- Bottled Water Plants
- Cooling Towers
- Industrial Wastewater Treatment and Pretreatment Systems
- Pilot Systems for Larger Applications