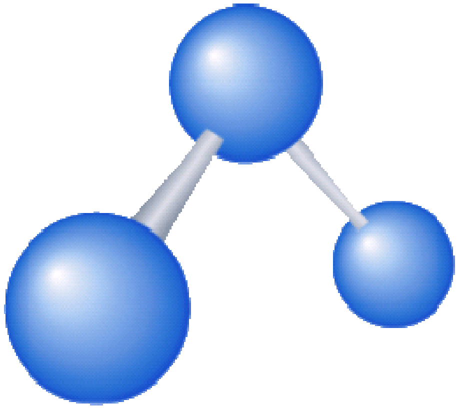
Ozone Technology for Winery Applications

presented by
DEL Ozone



Ozone History

1976 EPA Approves Ozone as an Antimicrobial

1982 IBWA Bottled Water Specifications Approve Ozone as an Antimicrobial for Product and Disinfectant for Filler Lines

1999 EPA Lists Ozone as Safe for Surface and Ground Water

2001 FDA/USDA Approve Ozone as an Antimicrobial Food Additive

2001 FDA/USDA Approve Ozone as a Food Contact Surface Disinfectant

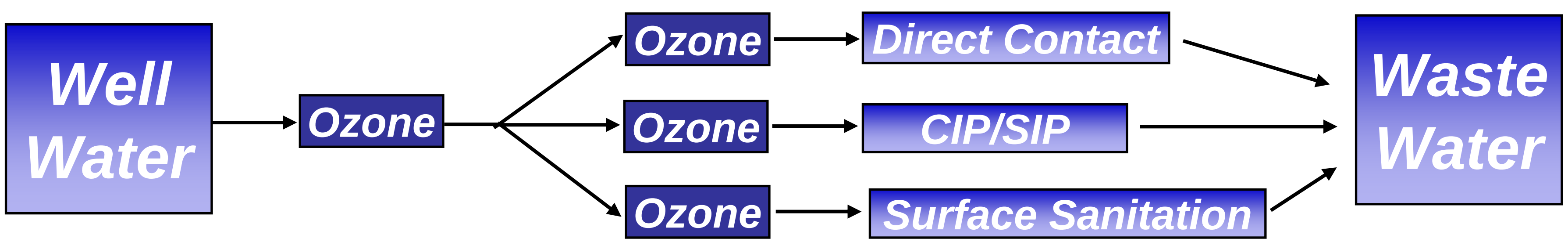
2002 USDA National Organic Program Allows Ozone as an Antimicrobial Food Additive and Food Surface Disinfectant

Movement to Ozone Anti-Microbial Technology in the Winery Industry

- Need for Wineries to remove as many chemicals as possible from the facility in an effort to protect wine quality
- Need to improve employee safety and workplace safety with reduction in chemicals
- Need to reduce operating costs – ozone can provide a speedy ROI vs. Thermal or Chemical Sanitation ROI
- Advancement of ozone technology to a safe, environmentally friendly and user friendly approach to sanitation treatment

Movement to Ozone Anti-Microbial Technology in the Winery Industry

- Trend to reduce chlorine/chemical-contaminated waste water use to comply with EPA DBPR; ozone is DBPR compliant
- Solution: ozonate source water (well water) in addition to ozonating at each application
- Ozone points of use in a HACCP facility:



Balancing Ozone Efficacy & Safety

Studies for Ozone Systems; All Should Comply

- Antimicrobial Efficacy
  - NSF conducts studies according to EPA established AOAC Official Methodology 961.02 & 960.09, Germicidal Spray Products as Disinfectants, and Germicidal & Detergent Sanitizing Action test procedures.
- Safety
  - NSF performs safety testing based on Hazard Communications Standard as promulgated through Occupational Safety and Health Act (OSHA) of 1970 and documented in the Code of Federal Regulations Title 29.

Balancing Ozone Efficacy & Safety

NSF studies of Ozone systems include EPA required:

- Antimicrobial efficacy data (Disinfectant Technical Science Section DIS/TSS - AOAC methods)
- Toxicologic profiles
- Environmental impact information
- Specific label information/technical literature that detail recommended use of applications and directions

Balancing Ozone Efficacy & Safety

NSF Anti-Microbial Third-Party Efficacy Evaluation

All Ozone Systems Should Comply

- Surface Sanitation Efficacy
  - Proven effective biocide against:
    - Bio-film
    - Bacteria
      - Salmonella
      - Staphylococcus
      - Pseudomonas
      - Campylobacter
      - Listeria
      - E. coli
    - Fungi
      - Aspergillus
      - Brettanomyces
      - Trichophyton

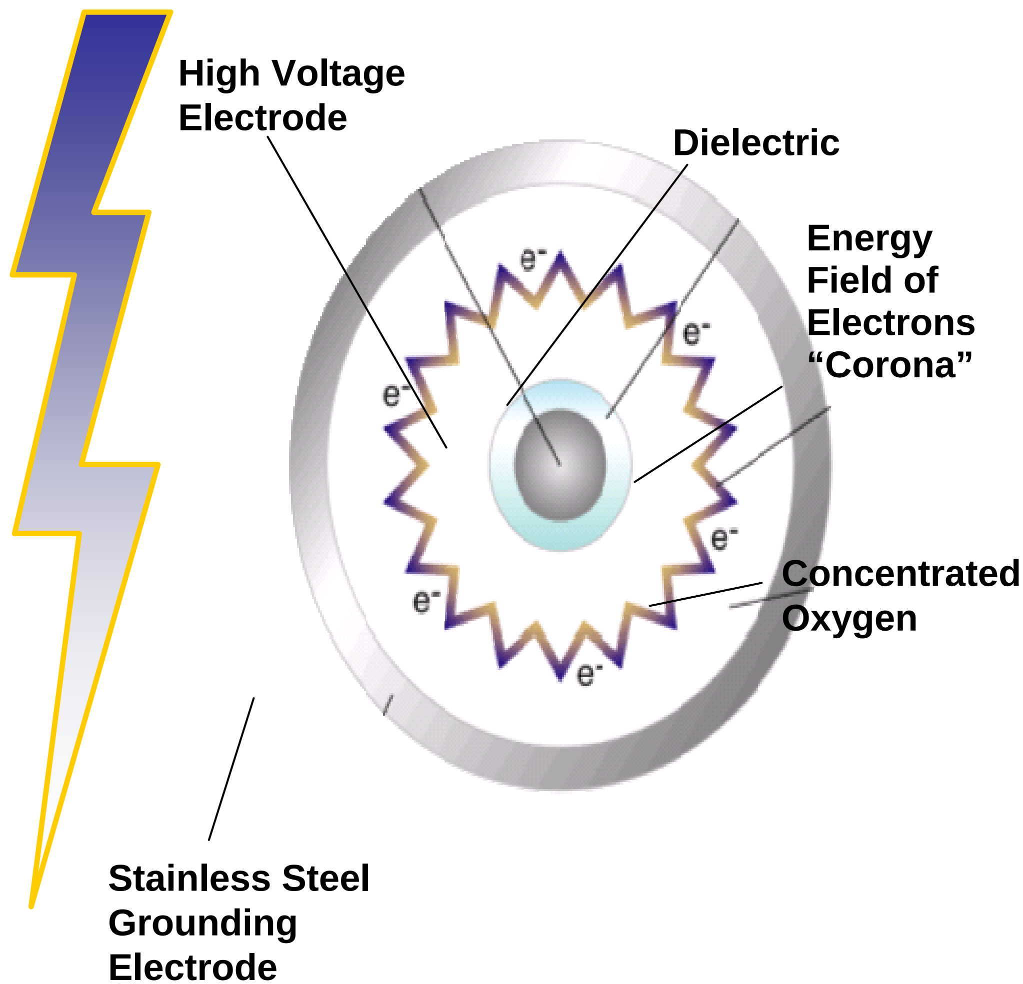
NSF REGISTERED

Organism	Reduction
Trichophyton mentagrophytes (ATCC 9533)	6 log (99.9999%)
Salmonella choleraesuis (ATCC 10708)	6 log (99.9999%)
Staphylococcus aureus (ATCC 6538)	6 log (99.9999%)
Pseudomonas aeruginosa (ATCC 15442)	6 log (99.9999%)
Campylobacter jejuni (ATCC 33250)	4 log (99.99%)
Listeria monocytogenes (ATCC 7644)	4 log (99.99%)
Aspergillus flavus (ATCC 9296)	4 log (99.99%)
Brettanomyces bruxellensis (ATCC 10560)	4 log (99.99%)
*Escherichia coli** (ATCC 11229)	5 log (99.999%)

Corona Discharge (CD) Ozone Production

High Voltage Electrical Energy

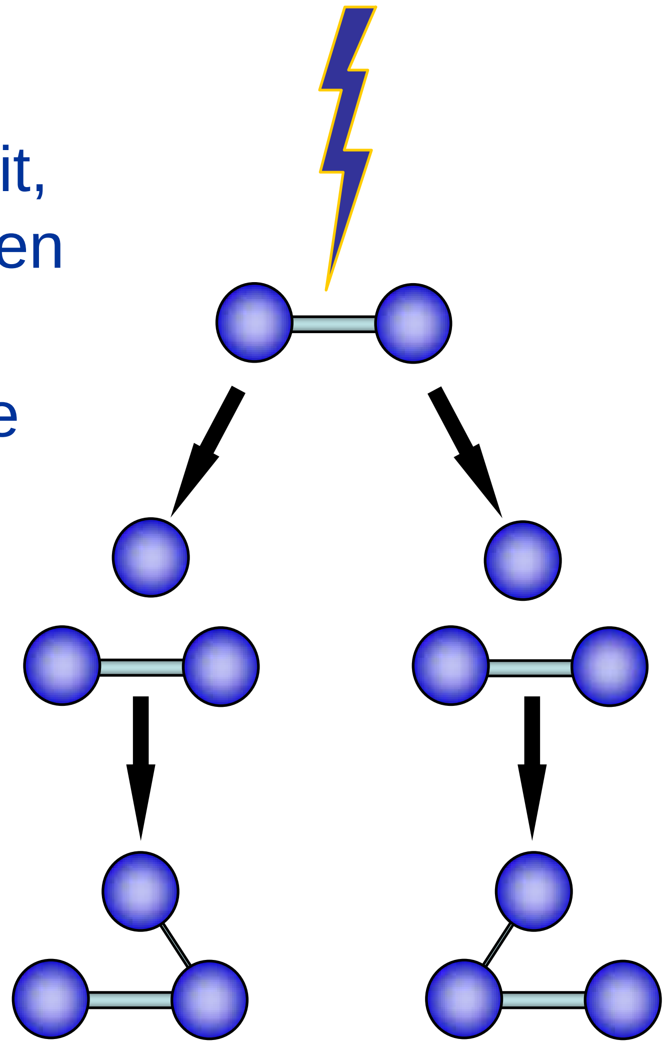
- **Electrically efficient to operate**
- **Typical Ozone concentration output 36,000 PPM (gaseous)**
- **Consistent ozone output**



How Ozone Is Made

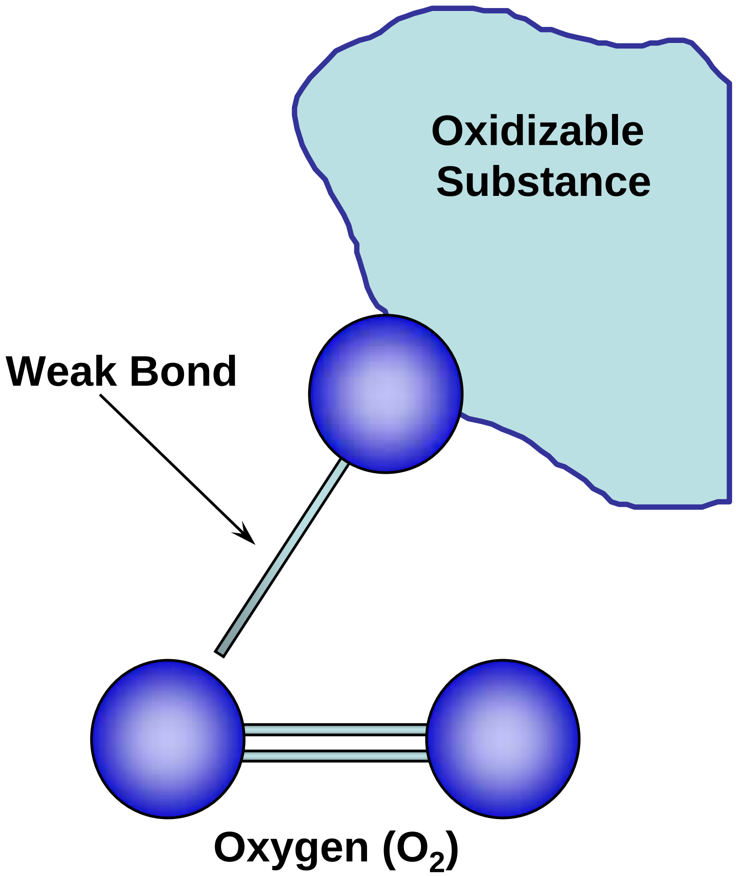
- Oxygen molecules (O_2) are split, resulting in two individual oxygen atoms (O_1).
- Oxygen atoms (O_1) + (O_1) unite with other oxygen molecules (O_2) to produce OZONE (O_3).
- Hence:

  $(O_1) + (O_2) = (O_3)$



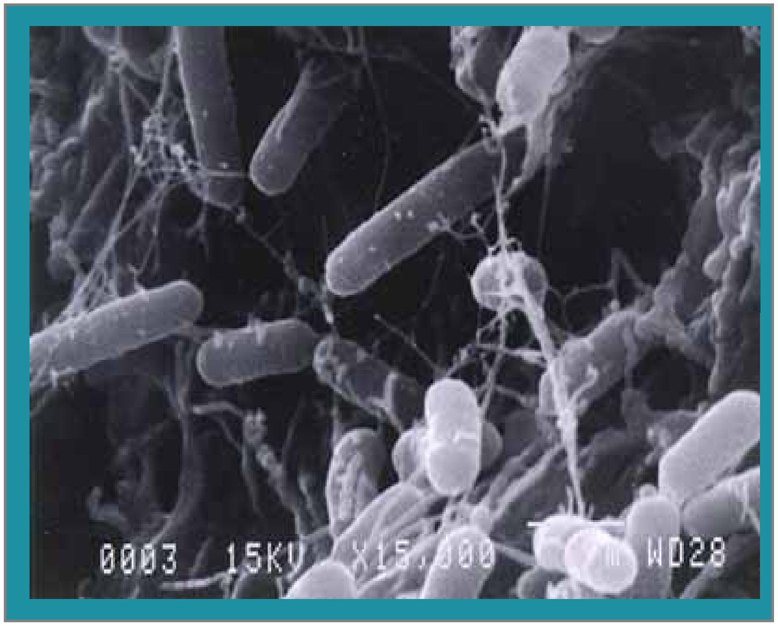
Ozone Oxidation Properties

- An oxidation reaction occurs upon any collision between an ozone molecule and a molecule of an oxidizable substance (i.e. bacteria, fungi (mold & yeast), viruses, iron & manganese, etc.)
- The weak bond splits leaving oxygen as a by-product
- During an oxidation reaction organic molecules are destroyed and dissolved metals are no longer soluble

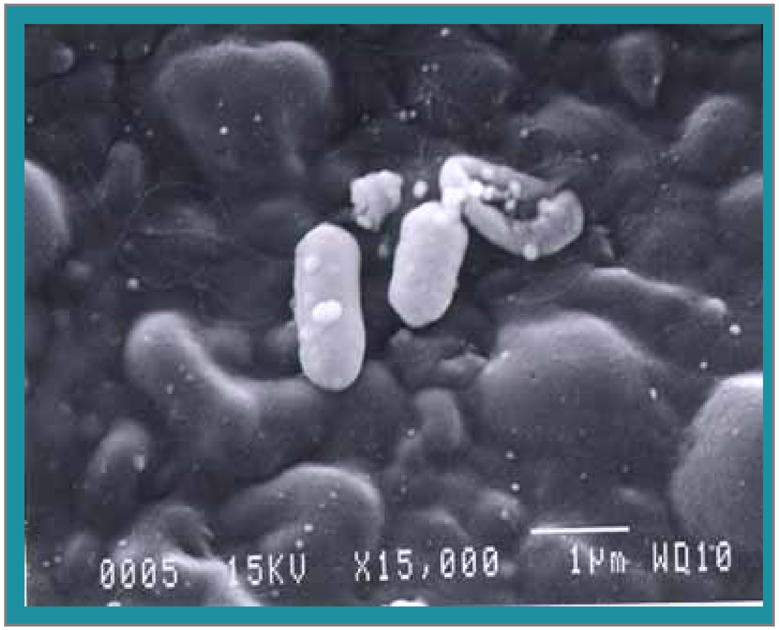


Ozone Biocidal Behavior

Before ozone treatment



After ozone treatment

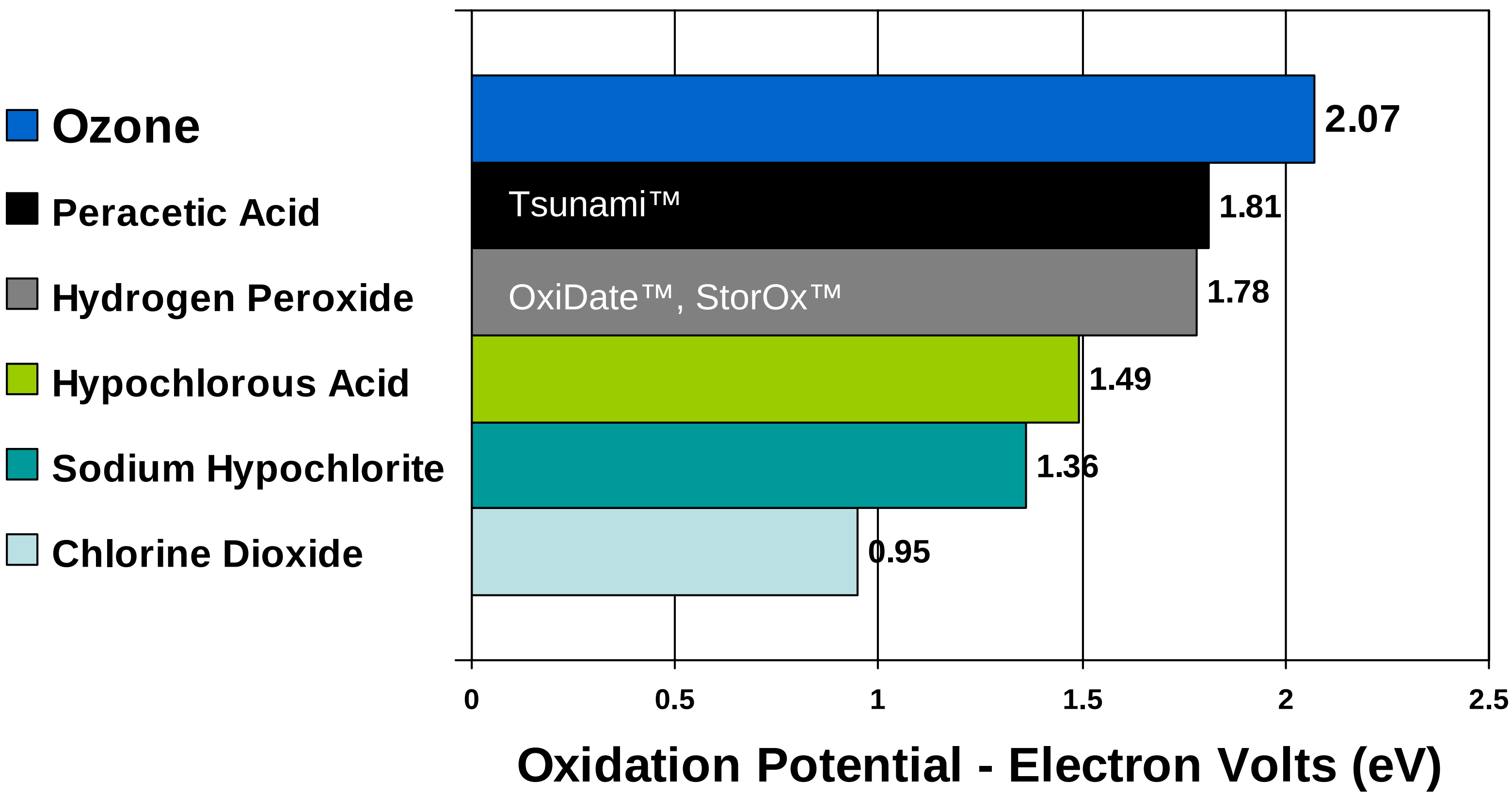


1. Ozone oxidizes cell membrane, causing osmotic bursting

2. Ozone continues to oxidize enzymes and DNA

Air Liquide America Corp., Chicago Research Center, James T.C. Yuan, Ph.D., year 2000

Strength Comparison



FDA CFSAN
(Center for Food Safety & Applied Nutrition)
Indirect Food Additive – Anti-Microbial Comparison

- CFR 178.1010 (b) (1, 3, 9, 30, 38)
  - "Category Three Certification": <15 cfu per cm for Yeast, Mold, Bacteria; No rinse
  - §178.1010 (b): "The solutions consist of one of the following, to which may be added components generally recognized as safe (GRAS) and components which are permitted by prior sanction or approval."
    - **(1) 200 PPM chlorine**
    - **(3) 25 PPM iodine (iodophore)**
    - **(9) 200 PPM quaternary ammonia compound**
    - **(30) 400-600 PPM hydrogen peroxide**
    - **(38) 128-156 PPM peroxyacetic acid**

  - **Ozone -** Relative Sanitizing Value
    - **Chlorine: 200 PPM**
    - **Ozone: 1.0 PPM**

Ozone Equipment Basics
Generate Ozone Safely

- On-board oxygen feed gas
- Ozone created and supplied under negative pressure
- Automatic generator shutdown due to loss of vacuum or other out-of parameter operation
- Interlocked sensors and regulating devices
- Door safety interlock
- Automatic operation (user friendly on/off)

Ozone Equipment Basics
Manage Ozone Safely (Control Off-Gas)

- Dissolve ozone in water via venturi injection
  - Attain and control >90% mass transfer
  - Obtain & maintain desired ozone dose rate
- Mixing / Degas
  - Remove undissolved (gaseous) ozone to prevent off-gas
- Destruct
  - Destroy undissolved ozone

OZONE SAFETY
MSDS Data

- **Ozone (Gaseous)**
  - **PEL: 0.1 ppm 8 hour**
  - **STEL: 0.3 ppm 15 min.**
- **Ozone (Aqueous)**
  - **PEL: none established**
  - **STEL: none established**
  - **Eye Contact: may cause mild irritation; not expected**
  - **Ingestion Hazard: not hazardous**
  - **Inhalation Hazard: not likely; exposure to aerosols could become irritating**
  - **Skin Contact: not hazardous**

Ozone Anti-Microbial Technology Application Review

Well Water

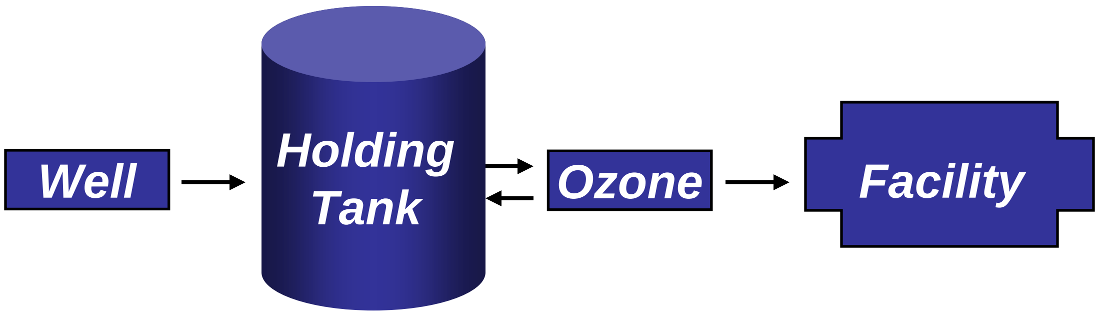
Clean In Place (CIP)

Surface Sanitation

Well Water

Micro-Flocculation, Oxidation, & Anti-microbial

- Ozone oxidizes these metals (known as micro-flocculation), enabling their removal via filtration:
  - Iron
  - Copper
  - Manganese
  - Zinc
  - Arsenic



- Ozone neutralizes "Nuisance compounds"
  - Most commonly hydrogen sulfide
- Ozone destroys microorganisms

Clean In Place (CIP)

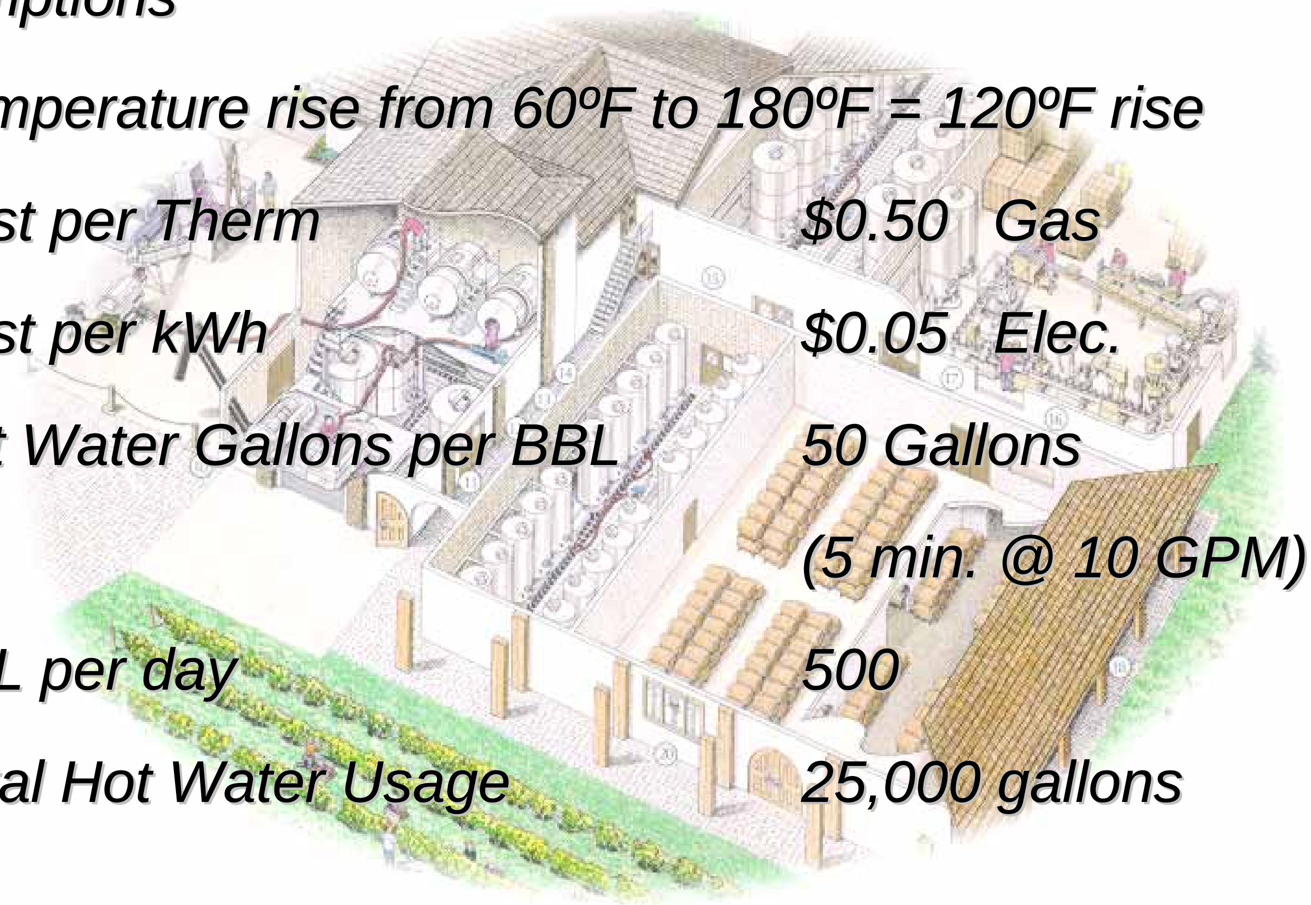
- Ozone can replace or reduce traditional chemical or thermal CIP disinfection methods
- Ozone disinfects more powerfully than traditional chemical disinfectants
- Ozone reduces chemical sanitizing costs
- Ozone improves uptime potential
- Ozone reduces water consumption
- No residual, no final rinse necessary
- Gentle to equipment
- Flow-through or recirculate

Surface Sanitation

- Ozone-enriched water can be sprayed directly on:
  - Floors
  - Drains
  - Walls
  - Wettable equipment
  - Tanks (externally or internally)
  - Clean rooms
- Leaves no residual
- No final rinse necessary

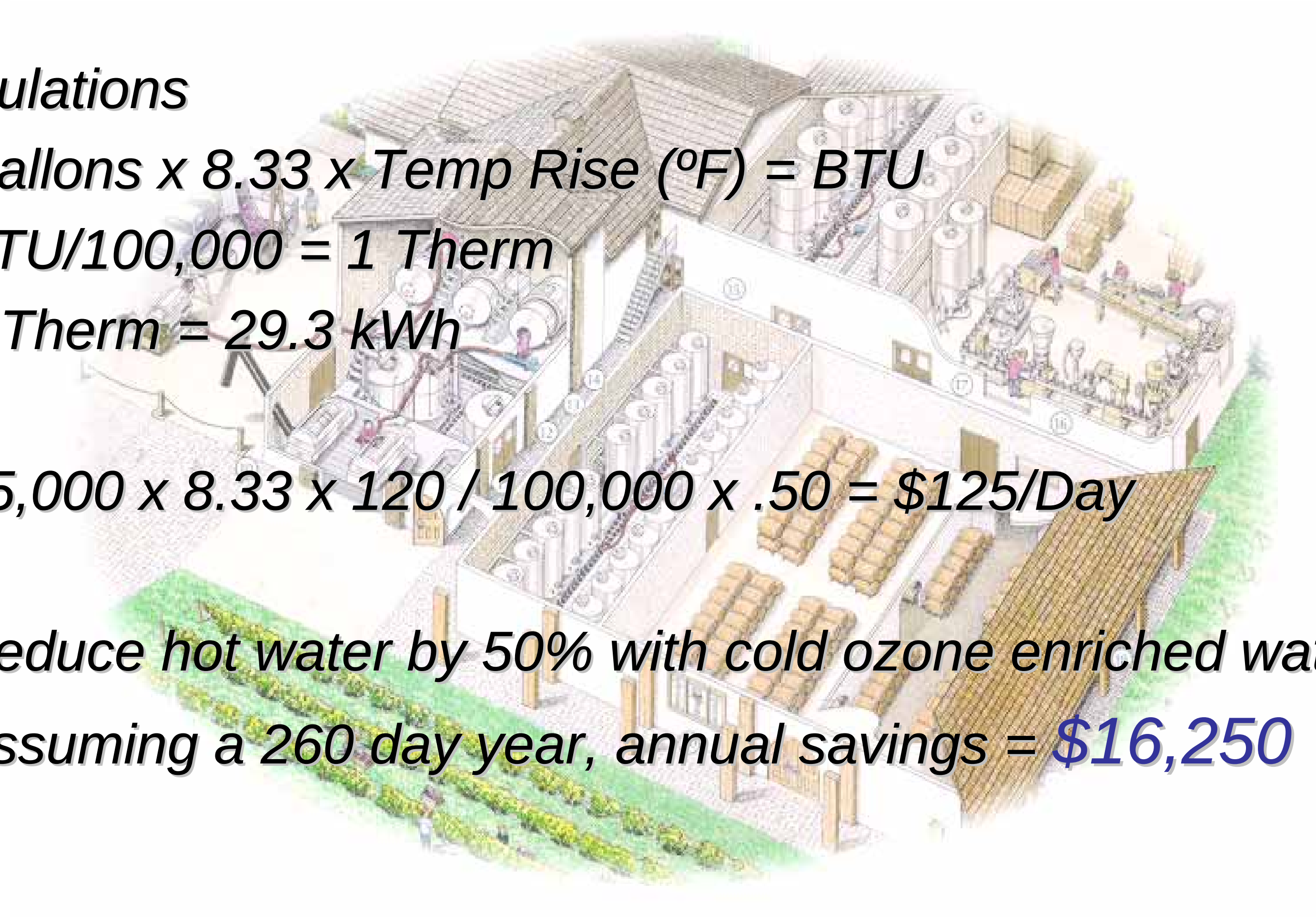
OZONE VS. THERMAL
Example of ROI in the Wine Industry

Assumptions



- *Temperature rise from 60ºF to 180ºF = 120ºF rise*
- *Cost per Therm* *$0.50 Gas*
- *Cost per kWh* *$0.05 Elec.*
- *Hot Water Gallons per BBL* *50 Gallons*
  (5 min. @ 10 GPM)
- *BBL per day* *500*
- *Total Hot Water Usage* *25,000 gallons*

OZONE VS. THERMAL
Example of ROI in the Wine Industry



Calculations

- *Gallons x 8.33 x Temp Rise (ºF) = BTU*
- *BTU/100,000 = 1 Therm*
- *1 Therm = 29.3 kWh*

- *25,000 x 8.33 x 120 / 100,000 x .50 = $125/Day*

- *Reduce hot water by 50% with cold ozone enriched water.*
- *Assuming a 260 day year, annual savings = $16,250*

Conclusions

- An effective ozone system design balances efficacious ozone dissolution in water with ozone off-gas management and employee safety.
- Ozone systems must offer:
  - Complete system consultation and design
  - Ozone generation, dissolution, and management
  - Regulatory compliance consultation