

# KEEPING FRESH FRUIT FRESH

Powerful, Safe, and Efficient  
Technology to Maintain a  
Healthy Environment  
for Fresh Cuts Storage

# MOLD DAMAGE

- ❑ USDA - Green Mold destroys 5% of CA fresh citrus
- ❑ Airborne Mold can be effectively killed by intense ultraviolet (UV) and photocatalytic oxidation (PCO)



# ETHYLENE GAS

## ❑ What is it?

- ❑ A hormone that off-gasses from fresh fruits, vegetables, and floral, and creates stress, initiating ripening, and senescence
- ❑ Ambient concentrations of as little as 1 part per million (ppm) start the ripening reactions, sometimes even less (kiwis, floral, etc.)

# ETHYLENE DESTRUCTION

- ❑ Comparison of Technologies Marketed to Remove Ethylene (and also to “purify air”, killing mold, bacteria, VOCs, etc.):
  - ❑ Activated Carbon and Potassium-impregnated zeolites
  - ❑ Ozone or “Activated Oxygen” (O<sub>3</sub>)
  - ❑ Photocatalytic Oxidation (PCO)

# LIMITATIONS ON ACTIVATED CARBON AND ZEOLITES

- ❑ Have trouble in reducing to  $< 10$  ppm of organics
- ❑ Affected by High Relative Humidity, since water vapor is co-adsorbed
- ❑ “Favored” molecules take precedence over lighter molecules, such as Ethylene
- ❑ Need continual “physical” monitoring to determine saturation levels
- ❑ Constantly “throwing” away media

# LIMITATIONS ON ACTIVATED CARBON AND ZEOLITES (cont'd)

- ❑ Adds dust to room
- ❑ Carbons can grow bacteria and mold since it is a "food" source
- ❑ If there is a significant drop-off in Ethylene concentration, i.e., removing bananas from room, the Ethylene will tend to de-sorb, since it is an "equilibrium" process

# PRECAUTIONS WITH OZONE

- ❑ Ozone can adversely affect fresh fruit (source: [UC Davis](#))
- ❑ Half-Life, i.e., conversion to oxygen is affected by humidity and can take a long time to disappear
- ❑ EPA warns against the use of Ozone for Indoor Air Quality and has sued Ozone Generator Equipment Companies for such practices (Alpine Industries)
- ❑ Considered a Toxic Substance by OSHA and its use may be governed by intense Safety Management Programs

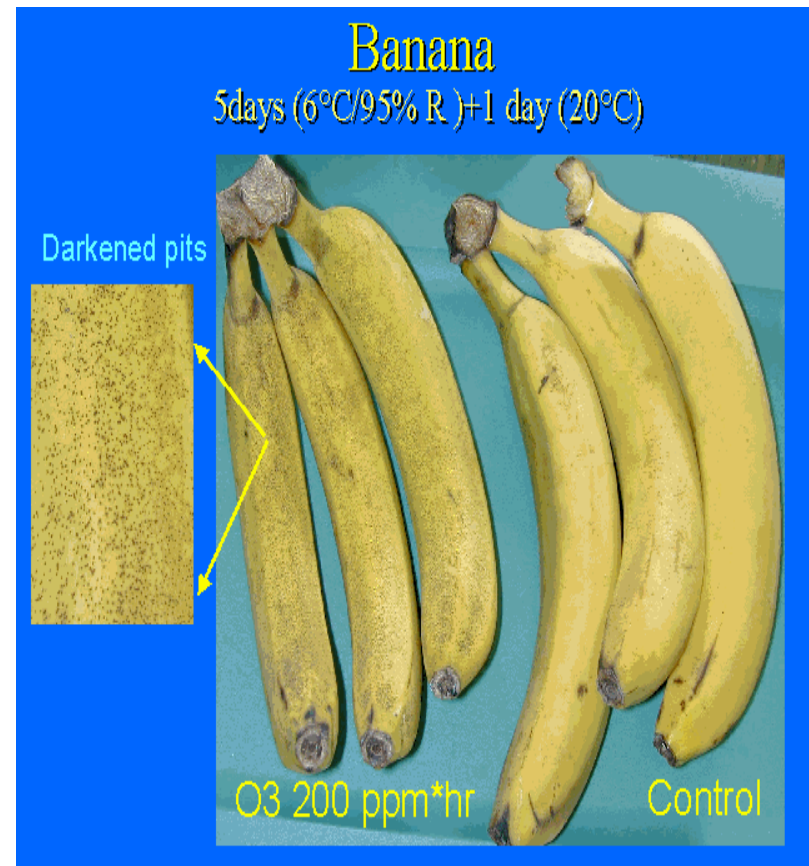
# OZONE DAMAGE

- ❑ Ozone apparently has initiated oxidation of the skins of the bananas, after 1 day of exposure
- ❑ Photo is from a research report conducted by UC Davis



# OZONE DAMAGE (cont'd)

- ❑ Ozone has apparently significant affect on the bananas, after only 5 days of exposure
- ❑ Photo is from a research report conducted by UC Davis

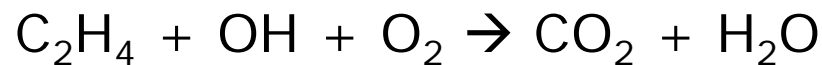


# NOTE ON OZONE IMPACT ON BANANAS (previous slides)

- Data is based on 200 ppm\*hr of ozone exposure
- The Immediate Dangerous or Health Limit (IDLH) for Ozone is only 5 ppm (ref. NIOSH Pocket Guide)

# PHOTOCATALYTIC OXIDATION (PCO)

- ❑ A technology used for past decade for destroying pollutants such as TNT and pesticides in wastewater
- ❑ Can easily reduce Ethylene concentrations in air according to the following Reaction



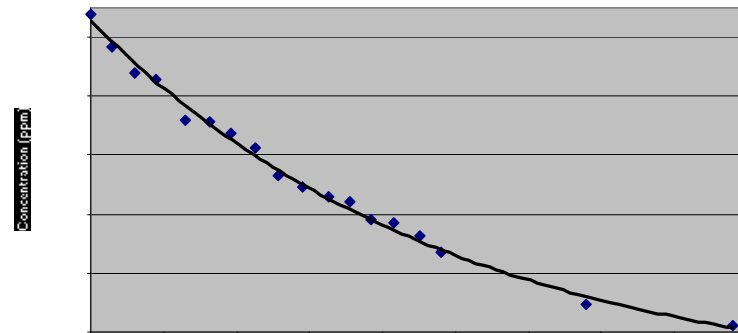
- ❑ No harmful chemicals or “throw-away” media needed; catalyst is continually being “cleaned”, and has a long life

# CATALYX TECHNOLOGIES EXPERIENCE WITH PCO

- Patented PCO Configuration for Air and Water Applications (also removes VOCs, combustion products, and pathogens such as anthrax, small pox, etc.)
- Showed pilot demonstrations in reducing 100-ppm levels of acetone and isopropyl alcohol
- Demonstration ability to reduce 10,000-ppm levels of an anesthesia gas
- Pilot and Real-Life work in reducing Ethylene in Cold Room Environments

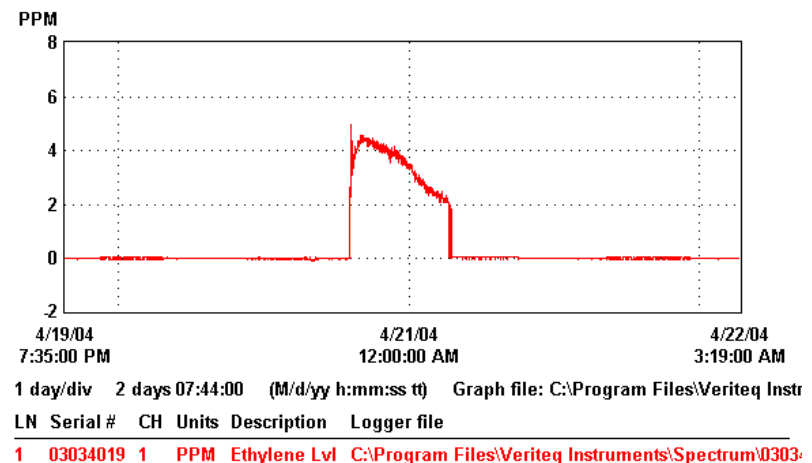
# ETHYLENE REDUCTION CURVE

- ❑ Patented filter/UV lamp configuration
- ❑ Pilot used for Design
- ❑ Curve: Taking 600 ppm of  $C_2H_4$  to < 100 ppm in under 3 hours



# REAL-LIFE CASE STUDY

- ❑ Reduced  $C_2H_4$  at a rate of 0.3 ppm per hour in a 45,000-ft<sup>2</sup> banana holding room
- ❑ Powerfull 800-cfm system, providing one complete turnover per day of the air volume



# WHAT IS A PCO SCRUBBER?

- ❑ PCO Scrubbers are “reactors” that use Ultraviolet (UV) Lights inserted into a catalytic bed or filter configuration
- ❑ The UV light “activates” the photocatalyst to generate the hydroxyl radicals that reside on the filter surface and react with organics and microorganisms

# WHAT IS A PCO SCRUBBER? (cont'd)

- ❑ Oxidizing Strength of Hydroxyl Radical >> Ozone and Chlorine
- ❑ Hydroxyl Radicals are comparable, and even create Hydrogen Peroxide, the key ingredient in the OxyClean® products to reduce Ethylene

# PHOTOCATALYTIC AIR SYSTEM

- ❑ 800-CFM  
(unit used in  
45,000 ft<sup>2</sup>  
banana holding  
room)
- ❑ Patented filter/UV  
lamp  
configuration
- ❑ Self-cleaning PCO  
Filter traps and  
oxidizes  
pathogens and  
gases



# PHOTOCATALYTIC AIR SYSTEM (cont'd)

- ❑ Internal View of PCO Filter
- ❑ Centrally placed UV lamp irradiates radially the entire filter face, when pleated
- ❑ UV Lamps range from 8 to 24" in length, depending upon power level



# SYSTEM DESIGN

- Each Application is carefully reviewed and designs are performed, based on the client's needs and limitations for installation and operation
- Typical Units are sized from 100-cfm to 1,000-cfm, and can be designed/built for higher airflows
- Operating voltages are 220V/1-ph or 460V/3-ph
- Optional PLCs, and Ethylene and UV output sensors can provide monitoring, self-diagnostics, alarms, and auto shutdown as needed

# VALUE ENGINEERING

- Taking airborne and surface swab samples to determine microbiological population
- Setting up portable Ethylene Sensors to trend Ethylene production
- Walk down facility to observe for best locations, taking into consideration; airflow patterns, electrical power, layouts, etc.
- Add in remote monitoring capability and O&M services

# PCO SCRUBBER COMPARISON

Parameter	KES	Catalyx
Airflow to be Treated	15 – 16 cfm	100 – 1,000 +
Available Models	2	Customizable, based on 4 Lamp Designs
Cost per CFM	\$220-260	\$30

# PCO DETAILS

- Catalyx uses the highest quality photocatalyst produced worldwide
- Photocatalyst has won distinction by receiving the SITPA Award, only given to those companies that passed stringent testing
- Photocatalyst was proven to reduce sulfur, organic, and ammonia compounds
- Microbiological testing indicated > 99.9% kill of E. Coli with minimal UV light activation

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