# OZONE

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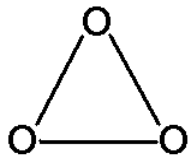
# Ozone Chemistry

- Formula – $O_3$
- Structure –



- Synonyms – Triatomic Oxygen, Trioxygen
- Molecular Weight – 48.0 grams

(NTP, 2001)

# Ozone Chemistry (cont.)

- Gas (25° Celsius, Standard pressure)
  - Melting Point - -193° Celsius
  - Boiling Point - -112° Celsius
  - Vapor pressure: 1 mm Hg @ -180.4° C
- Slightly water soluble
- Unstable, highly reactive, potentially explosive

(NTP, 2001)

# Sources of Ozone

- Naturally occurring stratospheric molecule
  - Created during thunder and lightning storms
  - Creation in the atmosphere by a catalyzed reaction of $O_2$ and 0
  - Provides barrier to ultraviolet radiation
- Photochemical air pollution in the troposphere
  - Produced as an indirect by-product of combustion
- Commercially produced material
  - Produced by passing air through charged electrodes

(NTP, 2001)

# Common Routes of Exposure

- Exposure occurs by respiration of ozone rich air pollution.
- Exposure to Ozone due to occupational exposure.
- Route of exposure is via the respiratory tract.
  - Accumulation of $0_3$ within the alveolar region of the lung
  - Volume reduced moderately by nasopharyngial region

(Costa, 2000;Vavra, 2000)

# Toxicokinetics

- Absorption
  - Some removal of volume due to nasopharyngial scrubbing
    - Mucous absorption
- Distribution
  - Target organ:  lung

(Santiago, 2000; Medinsky, 2000)

# Toxicokinetics (cont.)

- Metabolism
  - Ozone interferes with epithelial lining of the lung
    - $0_3$ seeks free electrons
    - Reacts with lipids in dissolved in lung fluids
    - Breaks down lipids imbedded in the cell membrane
    - Metabolites absorbed across the air-blood membrane
- Excretion
  - Exhaled during respiration

(Costa, 2000; Vavra, 2000)

# Ozone Interactions: Copollutants

- Multiplicative effect of ozone with other air contaminants
  - Reduced dose of air contaminants may suggest additive effect.
- $O_3$ and $NO_2$
- $O_3$ and $SO_2$
- $O_3$ and atmospheric acids

(Costa, 2000; Zeghnoun, 2001)

# Toxicity Thresholds

- NATIONAL AMBIENT AIR QUALITY STANDARDS
  - 1 hour (average): 0.12 parts per million (235 μg/m 3)
  - 8 hour (average): 0.08 parts per million
- OSHA
  - 8 hour (average): PEL - 0.1ppm
  - 15 minute (average): STEL – 0.3 ppm

(Costa, 2000)

# Toxicity Thresholds (cont.)

- Acute Effect

  (animal models and/or humans studies)

  - > 0.01 ppm - odor threshold
  - < .2 ppm – reduced respiratory volume
  - > .25 ppm – coughing, breathing difficulty
  - > 1 ppm – general irritation of respiratory tract, vomiting, lethargy, decreased lung function.
  - > 2 ppm - pulmonary edema (mice)

  – Increased mast cell proliferation

(Costa, 2000; Gong, 1998; Kleeberger, 2001)

# Toxicity Thresholds (cont.)

- Chronic Effects
  - Generally all effects are considered reversible
  - Exposures have a cumulative effect
  - Formation of tolerance
    - Occurs after 2 to 4 days continual exposure

(Costa, 2000; Gong, 1998; Kleeberger, 2001)

# Potential Health Outcomes

- Induces immune response
  - Activation of cytokine-mediated response
  - Increased permeability of the lung epithelium
    - Greater probability of infection while in ozone rich environment
  - Increased likelihood of an asthmatic response
    - Potential allergen
  - Increases quantity of Polymorphonuclear cells
    - May reduce level of antigen required for allergic response

(Cohen, 2001; Delfino, 1998; Holz, 2000; Shore, 2001; Petroeschevsky, 2001; Frischer, 2001)

# Potential Health Outcomes (cont.)

- Reduction in Forced Air Volumes
- Cardiac stress
- Formation of precursor emphysema tissue
- Exacerbated lung dysfunction by hyperthyroidism

(Costa, 2000; Gong, 1998; Huffman, 2001)

# Appropriate Treatment

- Removal from area of exposure
- Anti-inflammatory drugs to reduce effects of immune response
- Antioxidants to reduce decrease in lung function

(Costa, 2000; Trenga, 2001)

# Biomarkers

- Lavage Fluids
  - Increased concentration of immune related cells
- Exhaled gases
  - NO
  - Ethane, Pentane

(Costa, 2000; Graham, 2000)

# Regulatory Issues

- Multiple cities are in violation of mandated air quality standard.
  - Increased number of hospital visits during periods of high Ozone concentrations.
    - Economic burden on society.
    - Health burden on society.
- Benefits of reduction of air pollutants.

(Costa, 2000; Cifuentes, 2001, Burnett, 2000)

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