Ozone

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Properties and Occupational Uses

- **Ozone (O_3) presents as a colorless-blue gas with pungent odor, condenses to a dark blue liquid or blue-black crystals.**
- A chemical that is used in many industries.
- It can be used for purifying air and drinking water, decontamination, in industrial waste treatment, oil productions, bleaching and waxes, and even in order to make other chemicals.
- Ozone is both a natural and man-made chemical that occurs in the earth's upper and lower atmospheres.

Occupational Exposure

- Scenarios where workers are at risk of being exposed to ozone can include:
  - **Factory workers in paper and pulp mills**
  - **Workers in wastewater treatment plants**
  - **Fisheries workers who treat storage water**
  - **Outdoor workers in areas with high levels of ozone**

Toxicological Data

- The primary exposure of ozone occurs when workers breathe ambient air containing ozone in their occupational environment.
- **Ozone has a pungent odor, a strong irritant, and highly toxic by inhalation. It is a strong oxidizing agent and a dangerous fire and explosion risk when in contact with organic materials.**

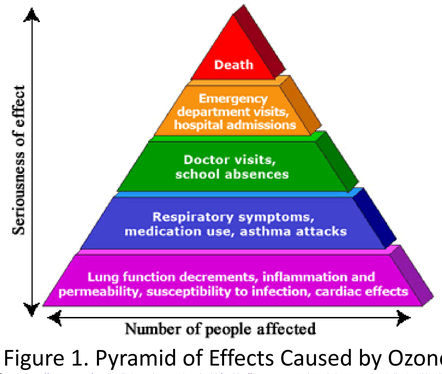

Figure 1. Pyramid of Effects Caused by Ozone

Source: https://www.epa.gov/ozone-pollution-and-your-patients-health/health-effects-ozone-general-population#:~:text=hospitalization%20or%20death.-,How%20are%20people%20exposed%20to%20ozone%3F,per%20minute%20(minute%20ventilation).

Epidemiological Studies

- Exposure to ozone may cause several adverse health affects; headaches, coughing, dry throat, shortness of breath, a heavy feeling in chest, and fluid in the lungs.
- **Higher levels of exposures of ozone can lead to more severe respiratory symptoms. Chronic exposure may lead to asthma.**
- The level of exposure depends upon the dose, duration, and work being done.

Sampling Methods

- The OSHA air sampling method for ozone consists of a calibrated sampling pump and **a two-piece polystyrene cassette containing two nitrite-impregnated glass fiber filters.**
- During monitoring, ozone will react with the nitrite on the filter collection device to convert to nitrate through oxidation. Using a flow rate of 0.5L/min with a sampling time of 180mins.

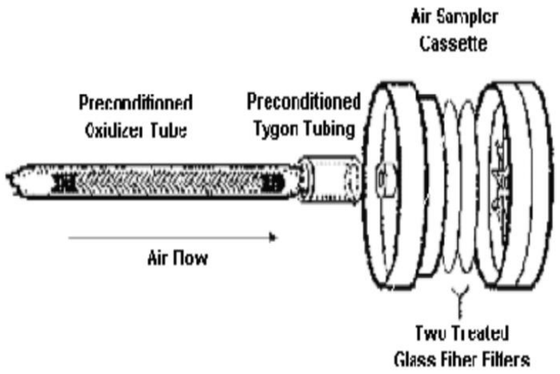

Figure 2. Ozone Sampler with Oxidizer Tube

Source: https://www.osha.gov/sites/default/files/methods/osha-id214.pd f

Analytical Methods

- **Ion Chromatography**
- The reaction product then gets extracted from thew filters using deionized water to be analyzed with ion chromatography using a UV-VIS detector (200nm wavelength).
- Analyze samples, standards, and blanks according to Standard Operating Procedures.

Occupational Exposure Limits (OELs)

- The current OSHA permissible exposure limit (PEL) and NIOSH limit for ozone averaged over an 8-hour work shift is **0.1 part of ozone per million parts of air**.
- OSHA regulates employee exposure to ozone gas through its Air Contaminants Standard, 29 CFR 1910.1000.
- The ACGIH recommended airborne exposure limits are for heavy work, 0.05ppm; moderate work, 0.08ppm; light work, 0.1ppm; and workloads of less than 2 hours, 0.2pp, averaged over an 8-hour work shift.

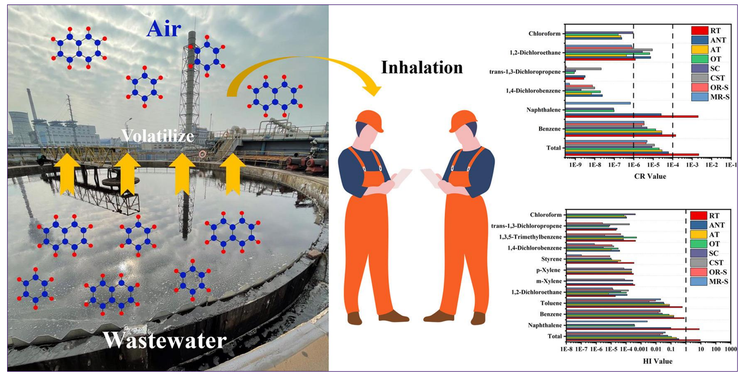

Figure 3. Ozone Formation with VOCs

Source: https://ars.els-cdn.com/content/image/1-s2.0-S0048969722079487-ga1_lrg.jpg

Case Study

- Metal Inert Gas Welding and Tungsten Inert Gas Welding are widely used in the basic metal industries, which results in the usages of ozone and nitrogen oxides.
- A total of 84 welders (43 MIG/TIG welders, 41 non-MIG/TIG other welders) were chosen, where concentrations of ozone and nitrogen oxide pollutants was measured in the breathing air of both workplaces.
- MIG/TIG Welders reporting pulmonary problems such as asthma, pulmonary inflammation, and higher susceptibility to infection.
- **It seems that exposure of welders to ozone have a cumulative effect on their health.**

Control Measures

- **Engineering Controls**: Elimination of ozone, if possible, increased local ventilation (not general), and ozone processes isolated/enclosed separately from work areas.
- **Administrative Controls**: Employee training on ozone as a hazardous substance, good work practices and maintenance to reduce exposures.
- **Personal Protective Equipment**: non-sorbent gloves and clothes, impact resistance goggles, full face respirator with gas cartridge approved for ozone.

References

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