TerranearPMC Safety Share

Week of March 10, 2014 – OZONE

Since the 1970s, ozone has been a topic of conversation. It was during this time that scientists reported information that the ozone layer was being depleted. Of course the vast majority of people didn't know what the ozone layer was, let alone ozone, but this was the beginning of an environmental awareness that today has taken center stage with regulations designed to protect people and limit the use of many substances that are associated with destroying the ozone layer.

The ozone layer resides in the stratosphere, which begins 5-11 miles above the Earth's surface (depending on the specific location) and continues for another 30 miles. The amount of ozone in the stratosphere is actually not that large, making up less than 10 parts per million. Ozone was first recognized as a distinct chemical substance in 1840 by Christian Friedrich Schonbein, who named it after the Greek verb ozein, meaning "to smell," due to its peculiar odor in lightning storms.

Ozone is a molecule made up of three oxygen atoms. It is colorless or a slightly bluish gas (blue when liquefied), slightly soluble in water and much more soluble in inert non-polar solvents such as carbon tetrachloride or fluorocarbons as well as bromine and chlorine-containing compounds, where it forms a blue solution. As a result of this solubility, these substances have been targeted with restrictions while being banned in many products. The reasoning is due to these volatile materials rising up, into the stratosphere where they can "scrub out" ozone, resulting in a reduced amount of ozone. Such products are aerosol spray products (hair sprays, deodorants, degreasers, etc.), halon-containing fire extinguishing products, and polyurethane products.

OK, so we are have a diminished amount of ozone up there in the stratosphere. What's the problem? As it turns out, ozone in the ozone layer filters out ultraviolet (UV) radiation from sunlight wavelengths, ranging from about 200 nanometers (nm) to 315 nm, with ozone peak absorption at about 250 nm. Therefore the ozone way up in the sky removes all of the UVC and just about all of UVB (a small amount does penetrate the stratosphere and result in human exposure). The small unabsorbed part that remains of UV-B after passage through ozone causes sunburn in humans, skin cancer and direct DNA damage in living tissues in both plants and animals. This same wavelength band is also responsible for the production of vitamin D in humans. UVA wavelength are unaffected by the filtering properties of ozone and therefore, enter the earth's surface. While UVA does cause skin damage, specifically increases the aging process, UVA does not present the same concerns (i.e. skin cancer) as UVB.

In addition to ozone's presence in the stratosphere, which protects us from excessive UVB-ray exposures, down here on planet Earth, ozone does exist through numerous sources, *AND* can be quite harmful. There is a great deal of evidence to show that ground level ozone can harm lung function and irritate the respiratory system. Exposure to ozone and the pollutants that produce it is linked to premature death, asthma, bronchitis, heart attack, and other cardiopulmonary problems.

Long-term exposure to ozone has been shown to increase risk of death from respiratory illness. A study of 450,000 people living in United States cities showed a significant correlation between

ozone levels and respiratory illness over an 18-year follow-up period. The study revealed that people living in cities with high ozone levels such as Houston or Los Angeles, receive an increased risk of over 30% from dying from lung disease. Both the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established airborne exposure concentrations of ozone as a protective measure to workers that are assigned tasks involving ozone. The OSHA permissible exposure limit is 0.1 ppm, while ACGIH has varying degrees of exposure limits based on a persons' workload (i.e. heavy, moderate, light) ranging from 0.05 ppm (for heavy work) to 0.1 ppm (light work), with an additional work exposure limit for all workloads of 0.2 ppm when the exposure period is 2 hours or less. These values are quite stringent, indicating that both OSHA and ACGIH acknowledge the serious health consequences due to ozone inhalation.

Yet under controlled conditions ozone does have many uses. The largest use of ozone is in the preparation of pharmaceuticals, synthetic lubricants, and many other commercially useful organic compounds, where it is used to sever carbon-carbon bonds. It is a reagent in many organic reactions in the laboratory and in industry. Ozonolysis is the cleavage of an alkene to carbonyl compounds. Ozone can also be used for bleaching substances and for killing microorganisms in air and water sources. Many municipal drinking water systems kill bacteria with ozone instead of the more common chlorine. Ozone can form the suspected carcinogen bromate in source water with high bromide concentrations. Where electrical power is abundant, ozone is a cost-effective method of treating water, since it is produced on demand and does not require transportation and storage of hazardous chemicals. Once it has decayed, it leaves no taste or odor in drinking water.

Many hospitals around the world use large ozone generators to decontaminate or disinfect laundry and operating rooms between surgeries. The rooms are cleaned and then sealed airtight before being filled with ozone which effectively kills or neutralizes all remaining bacteria.

Ozone's odor is sharp, reminiscent of chlorine, and detectable by many people at concentrations of as little as 10 ppb in air. Exposure of 0.1 to 1 micro-mole per mole produces headaches, burning eyes and irritation to the respiratory passages. At 161 K (−112 °C; −170 °F), it condenses to form a dark blue liquid. It is dangerous to allow this liquid to warm to its boiling point, because both concentrated gaseous ozone and liquid ozone can detonate. At temperatures below 80 K (−193.2 °C; −315.7 °F), it forms a violet-black solid.

Ozone gas attacks any polymer possessing olefinic or double bonds within its chain structure, such as natural rubber, nitrile rubber, and styrene-butadiene rubber. Products made using these polymers are especially susceptible to attack, which causes cracks to grow longer and deeper with time. The rate of degradation depends on the load carried by the product and the concentration of ozone in the environment. Therefore, many types of personal protective equipment, such as gloves and coveralls degrade in the presence of ozone, reducing their protective qualities and useful life.

Many a trip continues long after movement in time and space have ceased.

John Steinbeck