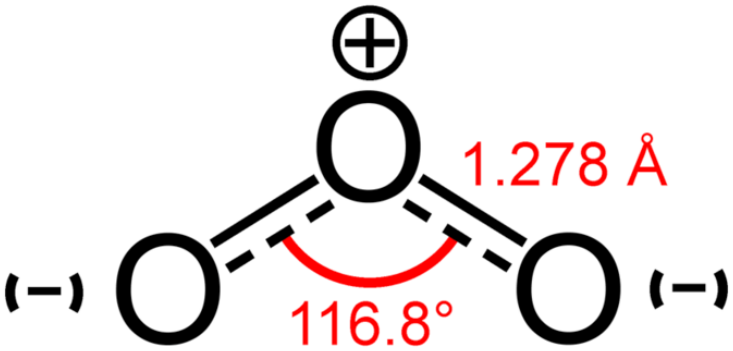
New Uses for an Old Source: Lab Sterilization with Ozone



Ozone Quick Facts:

- Ozone is a ubiquitous part of the atmosphere, created when electric discharges meet oxygen
- An inherently unstable molecule, ozone binds to hydrocarbons and other molecules, breaking them apart
- Ozone's properties make it an ideal sterilization agent; the FDA classifies it as GRAS, and US OSHA sets low limits for safe use

What is Ozone?

Ozone, or O3, is a naturally occurring part of the earth's atmosphere. It is created when oxygen (O2) reacts with ultraviolet light or high-voltage electric discharges such as lightning. It also can be created by crashing waves and waterfalls, as well by photons from the sun breaking apart the pollutant nitrous oxide.

While O2 is a very stable molecule, ozone is not. When these electrical or ultraviolet interactions occur, they break apart oxygen into individual atoms, which are strongly negatively charged. These lone, charged atoms will combine with an oxygen molecule (O2), which creates an unstable ozone molecule (though one that is more chemically stable than an individual oxygen atom.

When this "extra" oxygen atom is attached to another molecule, the oxygen molecule is reverted back to its most stable form (O2).

Ozone's Mechanism

Ozone will attach to any molecule. As a strongly charged molecule, it is a powerful oxidizing agent. Through its strong oxidation activities, ozone can break apart organic molecules, rendering them inert or non-toxic, create holes in the cell walls of bacteria and other microorganisms, and chemically alter heavy metals, making them more easily filtered.

This strong oxidation property makes ozone an excellent choice for sterilization processes, since it can kill cells, break apart large molecules or prepare any sample for more effective filtration.

Once ozone is attached and begins its oxidative activity, it is chemically reduced to its more stable form: oxygen. Thus, unlike other oxidative chemicals like ethylene oxide, there is no hazardous residue left from the oxidation process.

Ozone and Sterilization

Ozone was first identified as a sterilization agent for blood in the 1870s. It was first used therapeutically in the 1880s, and was initially used to treat anemia, cancer, diabetes, influenza, morphine poisoning, and whooping cough. It also was used during World War I to treat wounds, trench foot, gangrene and poison gas. The first ozone water treatment plants were opened in the late 1890s and early 1900s in the Netherlands and the United States. Today, ozone is being used to:

- Sterilize electronics instruments at low temperatures
- Sterilize minimally invasive surgical tools that are reused and cannot be autoclaved
- Sterilize plastics and other lab ware that would melt in an autoclave

Ozone breaks apart large molecules, punctures cellular walls and sends metals to a different oxidative state: all of these activities make sterilization feasible using ozone. It can be used in aqueous form, or as a gas.

How Safe is Ozone?

The U.S. FDA has declared ozone as GRAS (generally regarded as safe), and the U.S. Occupational Safety and Health Administration (OSHA) has set exposure limits to 0.1 ppm for individuals, well above effective concentrations as a disinfectant.

It is safer than many other oxidative agents: ethylene oxide, for example, requires detectors and monitors because it is odorless even at dangerous exposure levels. Ozone, however, has a distinct smell that is apparent well before hazardous concentrations can build up.

Unlike other disinfectants/oxidizing agents, ozone does not leave harmful residues. The only molecule left over from ozone sanitation is oxygen.

Ozone Myths and Misconceptions

Myth: Ozone is a component of smog.

Answer: Ozone is not smog. While the mixture of hydrocarbon particulates, CO2, CO, and SO2 are the true combinations of molecules that react with UV radiation to create smog, they are commonly, and mistakenly, referred t as "smog." O3 is not a component of this pollutant mix. Ozone, however, is often used as a measure of smog, since its levels coincide with smog component levels. However, ozone acts to break down these harmful pollutants.

Myth: Chlorine can work better than ozone.

Answer: Ozone is far superior to chlorine as killing bacteria, fungus and other microorganisms. It also can mor effectively remove color stains and odors. While it requires more complex equipment to apply than chlorine, it is a mor cost-effective solution, has a much shorter half-life and is less harmful to the environment.

Myth: Ozone creates carcinogenic compounds like bromate.

Answer: Ozone can react with bromide ions to create bromate, which products tumors in rat kidneys, thyroid glands and other organs. However, at usual doses, only formaldehyde is produced, and at levels far below the WH limit of 900 μg/l.