

Aug 16, 2011

Synopsis:

Recently, the EPA proposed to issue tougher new standards for ground level ozone, reducing the permitted concentration levels to the .6 to .7 ppb range. Although these standards have been postponed, the publicity associated with them once again raised the specter of “bad” ozone being a threat to human health.

The point of this brief whitepaper is to define the distinctions between “good” ozone and “bad” ozone so people can make informed choices about when and how to use ozone – and how to understand when it should be avoided. The central issue is about context: ozone is extremely beneficial, both in nature and in manufactured, controlled applications, in the proper context. Airborne ozone is dangerous only in high concentrations produced as the unintended byproduct of a process. In DEL Ozone applications, these potential byproducts are controlled well within limits established by OSHA, and are not hazardous.

Know the Difference: “Good” Ozone vs. “Bad” Ozone

Once again, ozone has been in the news, and people are frightened. Tougher EPA standards for ground-level ozone [were proposed](#) based on health concerns, and people understandably connected that “ozone threat” to ALL ozone under ALL circumstances. The agency later announced that the standards would be delayed, but the debate – and the confusion – has been going on for years, and will continue.

Unfortunately, many people conclude from this that even beneficial ozone applications are dangerous. In fact, DEL Ozone systems are safe, and are designed to be safe, for the important health and safety benefits they confer when installed and used properly. *DEL ozone is “good” ozone.*

An Important Distinction

Here’s the truth in two parts:

1. OZONE PROTECTS HUMAN QUALITY OF LIFE. The indisputable fact is that ozone benefits human life. In the upper atmosphere it shelters us from the harmful effects of UV radiation. On the earth’s surface, it is one of the most powerful, beneficial and environmentally friendly oxidation/disinfection agents known to protect human environments.
2. OZONE CAN BE A THREAT TO HUMAN HEALTH. **Airborne** ozone in a high concentration can cause human illnesses ranging from respiratory discomfort to life-threatening cardio-pulmonary disease. When the concentration exceeds .75 ppb (under current regulations) in the ground level atmosphere, an “ozone alert” is issued.

Making this simple distinction is not hard to understand, but it gets lost in the media-based mud wars over EPA regulations, health costs vs. business costs, and the “truth” of the science behind the regulations. Even though the EPA regulations under revision are intended to combat airborne ground-level ozone only, the beneficial applications of ozone are also caught in peoples’ concerns.

Get the Facts

Our aim in this paper is to give you some background about all this talk so you can form your own opinion grounded in a more objective context.

More specifically, we ask you to distinguish between the beneficial technologically sophisticated ozone disinfection systems like the ones DEL Ozone makes vs. the propagation of ozone in the lower atmosphere. The rest of this article describes the fact-based context of this distinction. We summarize the points here, and you may read on for detail.

Even the EPA knows the difference between “good” and “bad” ozone. The agency has issued regulations and guidance making a distinction between ozone in the upper atmosphere vs. at ground level. Ozone in the upper atmosphere is “good” ozone that is actively protected, while ozone at ground level can be “bad” ozone and should be reduced. *Ozone’s impacts depend on where and how it is used.*

The ground level ozone that the EPA regulates is a byproduct of burning fossil fuels in commercial, industrial and transportation processes. Ground level ozone in high concentrations can be dangerous to people with compromised respiratory systems, but ozone is not the causal agent in the process. Rather, it is one of many effects of burning fossil fuels. In some respects, regulating ground level ozone is a means to regulate the production of precursor chemicals like nitric oxide (NO) and volatile organic compounds.

DEL Ozone advanced sanitation systems are fitted with safety systems to prevent airborne ozone. DEL technologies do not create hazardous concentrations of ozone in the air, even in enclosed spaces where ozone generators typically operate, and they certainly do not contribute to ground level ozone in the atmosphere. Both through superior methods of ozone mass transfer into water (more complete dissolution of ozone in water) and through control of excess off-gassing in ozone destruct systems or automatic fail safe controls, DEL systems are safe to use. They meet or exceed all OSHA standards for airborne ozone in the workplace.

Even the EPA Distinguishes Between “Good” and “Bad” Ozone

Something lost in the flurry of words over EPA regulation of ground level ozone is that it also is [charged with protecting the ozone](#) in the upper atmosphere. The well-known hole in the stratospheric ozone layer over Antarctica was the trigger for the imposition of regulations on ozone-depleting chemicals.

This seeming contradiction stems from the [scientific fact](#) that ozone in the upper atmosphere helps to protect humans from excess ultraviolet radiation. UV light in excess amounts at the earth’s surface can lead to skin cancer, cataracts, and weakened immune systems in humans. It can also disrupt plant life cycles, resulting in lower crop yields. When ozone in the upper atmosphere is depleted, more UV radiation reaches the earth’s surface, increasing the threat.

The EPA response to these threats was to ban certain ozone depleting chemicals that were produced and/or released in certain industrial or residential processes. Perhaps the most commonly known examples have to do

with chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and other ozone destroying chemicals from substances used in refrigeration, solvents, and certain types of foams.

Today, industry has found alternative chemicals to supply the same functions in processes that do not threaten to deplete the ozone we need in the stratosphere. The EPA has estimated that the ozone hole in the Antarctic would recover by about 2050, all other things being equal.

Ground Level Ozone is the Byproduct, Not the Cause

People are trained to think that ozone is “bad” because they hear about it mostly when there is a significant pollution problem in the air where they live. The fact is that this ground level ozone is produced by the massive use of fossil fuels in energy production and is in no way connected to the beneficial applications of ozone. Controlled ozone generation for food safety, water disinfection, or spa and pool sanitation do not produce anywhere near enough airborne ozone to create hazardous conditions even within enclosed spaces where ozone generators might be installed (see below).

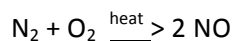
Ground level ozone is produced in large amounts under the right conditions. It is correlated with the production of photochemical SMOG because it results from the same chemical chain reaction that is started by fossil fuel exhaust. Since high concentrations of ozone can be dangerous to people who are elderly or have certain health conditions, an “ozone alert” is broadcast to tell them to avoid outdoor air, and on those same days, the SMOG level is usually also high.

Ground level ozone is a danger in and of itself, but it is not the causal agent in the process that results in SMOG. In some ways, it is singled out for attention because it is correlated with pollution and the resulting SMOG. Under atmospheric conditions that are conducive to producing SMOG, the only way to reduce the amount of ground level ozone is to reduce the amount of pollutants emitted in burning fossil fuels.

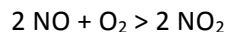
Therefore, regulating ozone achieves two objectives at once: first, it improves air quality for people who would be harmed by excess ozone, and second, it requires reducing the amount of pollutants emitted.

Generally, ground level ozone is the product of burning fossil fuels. We cannot reproduce the entire set of chemical reactions that result, but the basic path to high ozone concentration is straightforward.

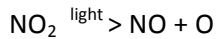
Nitrogen and oxygen do not ordinarily interact in the atmosphere at normal temperatures. However, in the high temperatures in the combustion chamber, these elements combine to create nitric oxide:



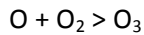
The nitric oxide emitted from an exhaust interacts with the O₂ in the air to form nitrogen dioxide:



Nitrogen dioxide dissociates when it is exposed to strong sunlight, yielding nitrogen oxide and free oxygen atoms:



A single oxygen atom is very unstable, and it easily bonds with an oxygen (O₂) molecule to form ozone:



This process will create enough ozone to trigger an “ozone alert” – and photochemical SMOG – only under specific conditions. These include the presence of exhaust gases in sufficient quantities (inversion layers can force the concentration in areas like the Los Angeles basin) and strong sunlight to energize the reactions. The stronger the sunlight and the more exhaust gases present, the higher the likelihood of creating high ozone concentrations and SMOG.

It is pretty obvious that the amount of ozone needed to produce dangerous concentrations in the lower atmosphere far exceeds the ability of all existing ozone generators. But, do ozone generators create a hazard in enclosed spaces where they are located?

DEL Ozone Systems Target Ozone Effectively and Safely

Once a person is conditioned to be wary of airborne ozone, he is more likely to worry about ozone concentrations from beneficial ozone applications. It is very important to know that DEL Ozone systems are designed in full awareness of the need to control ozone throughout its generation and injection. The upshot is that DEL Ozone systems meet or exceed OSHA standards for the amount of ambient ozone allowed in enclosed spaces. These systems are safe for workers and bystanders, day in and day out.

The crucial attribute of creating ozone for disinfection is that it is controllable. In an uncontrolled process like burning fossil fuels, ozone can be an unintended consequence with harmful effects. But in technically sophisticated applications like those developed by DEL Ozone, it is targeted at health threats in precisely controlled amounts. *In fact, the whole point of DEL Ozone systems is to generate, inject, measure, monitor and control ozone to achieve defined health and safety benefits without dangerous byproducts.*

- DEL systems produce very little off-gas in the first place. Through careful feed gas preparation and advanced techniques of ozone injection, DEL achieves a higher rate of “mass transfer” -- the dissolution of ozone into water – than other manufacturers.
- DEL engineering produces systems that do not deteriorate, thereby preventing unintended byproducts of ozone leakage due to corrosion.
- Many DEL systems, and all the larger ones, have safety devices and ozone destruct units to control the ozone production process, including the low probability that excess ozone off-gas is produced.

Ozone is one of nature’s most powerful disinfectants, and is probably the most useful one. This is due to its capability to oxidize an incredibly wide array of chemicals and contaminants, including dangerous

microorganisms that easily infect our essential water and food supplies. Ozone disinfection has the potential to improve human quality of life through greater health and safety.

DEL systems guard against an excess airborne concentration of ozone. Typically, ozone generators operate in an enclosed space – a food processing plant, a commercial aquatics equipment room, a health club or locker room, or the machine center of an on-premise laundry. In these applications, an excess concentration of airborne ozone could be dangerous to workers and customers, so DEL machines are designed to manage the ozone disinfection process to prevent it.

Here is more detail on how DEL systems manage ozone:

Feed gas preparation and ozone injection systems: One of the most important features of DEL systems is that they prevent off-gassing in the first place through superior ozone management. Although it is true that the complete design of the system is important, two elements stand out: feed gas preparation and mass transfer.

- Feed gas preparation is the foundation for the efficient generation of ozone without a high risk of introducing corrosion and other byproducts. DEL Ozone uses oxygen-enriched feed gas systems for reliable high quality ozone injection without the risks attendant with methods that result in a higher nitrogen content. See our paper on [ozone feed gas preparation](#) (pdf opens in new window).
- The mass transfer of ozone into water, either to purify the water itself or to use the water to purify something else, is an essential part of ozone disinfection. DEL technology achieves a high level of mass transfer without off-gassing, meaning that a high proportion of the ozone generated is dissolved in water, where it achieves the intended benefits without harmful byproducts. See our paper on [ozone mass transfer](#) for more detail (opens in new window).

Designing the exact capabilities for an application requires an understanding of its purposes (for example, what kinds of microorganisms are likely to exist in the target, and how much ozone is needed to kill them?) and experience with the technology to create the correct system. DEL Ozone's advanced sanitation solutions benefit from over 30 years of continuous development, and innovative industry leading technology worldwide.

Off-gas control / destruct systems: In enclosed spaces, and where the ozone systems are powerful, there is a small potential for off-gassing where some ozone injected into a body of water does not dissolve. Therefore, DEL systems are designed with integrated off-gas capture and destruct mechanisms that strictly control the amount of ozone that can escape to the environment. Again: all DEL systems meet or exceed OSHA standards for airborne ozone concentrations.

Automatic failsafe systems: Redundant automatic systems are incorporated in larger DEL products to monitor and detect excess ozone, or to prevent its generation, if specified conditions exist. These safety systems operate without user intervention. See our website for more information about the [DEL Ozone Safety Management System](#).

Corrosion resistant design and manufacture: Ozone is powerful. That includes its oxidation of some ordinary substances that might be used to channel or manufacture ozone in other circumstances. For example, ozone

will destroy latex and can corrode poorly made ozone generation chambers. The danger is that a failed component might allow ozone to escape to the environment. Therefore, DEL ozone systems are manufactured with ozone resistant materials like ceramics, stainless steel, and only plastics that are known to tolerate ozone.

Ozone Benefits Far Outweigh its Costs

In the real world, human well being and economic costs have to be balanced. DEL Ozone systems help owners and operators of many kinds of businesses to protect public health at a low cost over the life of the investment. These benefits should not be tossed out because unrelated and uncontrolled ozone production by pollution can pose a threat to some people. This would be a self-defeating action in failing to take advantage of controlled ozone in human-serving applications where clean is critical.