Air Purification by Oxidation in HVAC Systems

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Germicidal UV light, ozone, ions, hydroxyl radicals, catalytic oxidation and now enhanced catalytic oxidation. Confused? Who wouldn't be. Let's try to understand the facts:

Ozone has been around since the late 1800's and has been used extensively in Europe as a disinfectant. It is also widely being used in the United States for municipal potable water treatment, swimming pools and spas, odor and bacteria control, and many other airborne disinfecting functions. Ozone is widely used in the heating, ventilation, and air conditioning industry for duct cleaning and disinfection, where it is very effective against mold, mildew, odors, bacteria and Legionnaire's Disease. Municipal sewage plants use ozone to destroy sewer gases and odor control. The hotel industry has recognized its benefits as a room sanitizer, and its ability to permanently remove smoke odors. The food industry also utilizes ozone for mold, mildew, fungi and bacteria control on food products. All of the above uses of ozone have one thing in common, they are all commercial uses requiring operator training and caution on excessive dosages of ozone.

Several years ago, a few companies introduced ozone technology as an air purifier to be used in occupied homes. Ozone has been successfully used in residences for many years by professional cleaning services, duct cleaning and disaster restoration companies. These professionals utilize relatively high dosages of ozone to disinfect a sick house, destroy mold, mildew, fungi or smoke from fire damage. Dosages in the 1 to 5 ppm range are typically used for this purpose; however, with dosages this high, the house has to be evacuated. For many years, it was believed that ozone levels had to be over 1 ppm to be effective.[1] Recent research has found that while it is true that the level of 1 ppm to 5 ppm is necessary for sick buildings or professional disinfection, and at these levels the rooms must be evacuated, it is also true that low level, or passive ozonation, when combined with hydroxyl radicals (O_3OH^O), of indoor air can drastically reduce airborne contaminants such as bacterial, fungi and mold in addition to odor control. Let's digress and discuss the basics of ozone, UV light and hydroxyl radicals.

- Ozone, first discovered in 1840, received its name from the Greek work "Ozein", which means to smell.
- Ozone is produced when oxygen molecules (O_2) are split into two oxygen atoms (O_1) while in the presence of other oxygen molecules. These oxygen atoms (O_1) then combine with molecular oxygen (O_2) to yield ozone (O_3). Ozone is always present in the Earth's atmosphere.

Ozone is generated naturally by short-wave solar ultraviolet radiation, and appears in our upper atmosphere*(ozonosphere)* in the form of a gas. Ozone also may be produced naturally by passing an electrical discharge such as lightning through oxygen.

Ozone's third atom, the loosely held or "unstable" atom, has a strong tendency to break away and attach itself to other substances. While the original ozone molecule reverts back to O_2, the loose molecule attaches itself to a new host substance and oxidizes it.

Ozone has been, perhaps, the most misunderstood "tool" available to both the scientist and HVAC contractor. Partly due to the abuse of both the technology and the marketing, Ozone in the United States has not been properly deployed.

OSHA and the FDA have established limits or at least "levels" that are not only safe, but through extensive investigation, proven effective in the reduction of over 90% of airborne molds, bacteria, fungus and pathogens. UVc germicidal light as been used for decades in the medical and food industries to kill bacteria. While UVc light successfully kills bacteria, it only does so when it is in direct contact with the light rays, and UVc has little or no effect on odors. The combination of UVc light rays, moisture and ozone creates a hydroxyl radical, which is even more powerful and many times faster than ozone as an oxidizer. Extensive media investigations have shown that responsible deployment of ozone/hydroxyl radicals in occupied space (human and animal) will reduce the circulation and distribution of dangerous airborne contaminates. When ozone/ hydroxyl radicals was injected into a veterinary hospital[3] air conditioning system, noticeable reduction of "odors" and pathogens was the result.

In the injection of ozone/hydroxyl radicals in feline housing facilities, known as catteries, the instant serious reduction of "upper respiratory" diseases was resultant. It is suggested that all veterinary hospital and animal boarding facilities deploy the "injection" method to cover all air handling systems.

Ozone/Hydroxyl Radical injection is relatively simple. Depending on the application cubic area, a small 3" O_3OH^O injection tube, or as much as an 18" O_3OH^O injection tube is available. In a mixed application, requiring UVc and ozone/hydroxyl radicals, special "spliced" injection tubes are now developed. They provide both the UVc germicidal and ozone odor control benefits, safely and effectively. By selecting the correct injector tube, levels of ozone remain under the 0.04 ppm level prescribed by authorities for occupied areas.

A small 3" ECO tube can treat up to 2,500 sq. ft.

The combination of UVc, or germicidal UV combined with ozone and humidity, creates hydroxyl radicals, a faster and stronger oxidizer than ozone. In addition ions are emitted to aid in dust removal. This process is known as "catalytic oxidation". A recent discovery is the enhancement of the catalytic oxidation process with a target of Titanium Dioxide compounds. The ECO process (enhanced catalytic oxidation) has the ability to reduce ozone levels up to 50% while creating hydroxyl radicals and super oxide ions.

$$H_2O + O_3 + UVc = OH^O$$

The ECO process provides safe organic oxidation without elevated ozone levels. A soft ozone is created.

The ECO process injection technique is fully compliant with NFPA and NEC and local codes. A special electronic power supply is installed either in the electrical supply box, where the relays and HVAC controls are normally junctioned, or by mounting it to the outside of same. A CLASS 2, CAT 5 cable connects the low voltage side to the injector plate. Normally a 6' cord trails from the plate, and any distance up to 35' from the supply can be obtained by using *extender cords*. The injector unit is normally

affixed either by screw mount or foil tape. It should be mounted after the fan, in the plenum or the feeder duct.

With the ECO process injection system, it is easy to deploy more *probes* at any location additional support and treatment is needed.

A **B**

Indoor air pollution is now ranked as the nation's number one environmental health problem by the EPA and Congress. Sick building stories are commonplace, and asthma cases are increasing at an alarming rate. The need for safe, responsible indoor air purification technologies is real. Using soft ozone/hydroxyl radicals responsibly is one of the preferred technologies.

Summary

The use of safe, ECO Systems in occupied areas offers us the following benefits:

- Elimination of household odors.
- Less colds and flus, which are usually caught by indoor air transfer of germs and viruses.
- Lower incidents of food poisoning or food spoilage.
- Longer shelf life of foods.
- Reduction of indoor air pollution for better quality of air.

We breathe in approximately 23,000 times a day and intake 435 cubic feet of air per day. Wouldn't it be nice if it was clean air!

Footnotes

1Ozone Analytical Aspects and Odor Control, International Ozone Institute
Rice & Browning, 1976
2The Use of Passive Ozonation and Advanced Oxidation as a Food Preservative,
RGF Environmental Group, R. Fink, C. Willette & W. Ellis, 1997
3Use of Ozone/Hydroxyl Radical in Belvedere Animal Hospital,
Dr. Koons, 1999

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