

Hydro-Peroxide for Indoor Air Quality!

A new advanced Oxidation Technology utilizing “Photocatalytic Ionized Hydro-Peroxide”

is brought to the HVAC industry for indoor Air Quality!

By Dr. James Marsden

Oxidation is technically defined as the losing or the giving up of an electron. It can involve very complex reactions between molecules and the oxidizers that are produced. For this article we will keep it simple and only look at some of the interactions between oxygen molecules and the different substances that they may contact. Controlled oxidation is an excellent way to destroy organics such as odors, viruses, bacteria, VOC's and mold. Unfortunately, uncontrolled oxidation can also destroy living tissue. Fire is an



example of rapid oxidation. Rust is an example of slow oxidation. As in many things, too much of a good thing can be dangerous. Some oxidizers are classified as “friendly”; which means when these oxidizers react they revert to water, hydrogen, or oxygen. Friendly oxidizers are always oxygen based. They include hydroxyl radicals, low level ozone, hydrogen peroxide, and oxygen.

Table 1

Oxidizing Agents Redox	Potential (v) ⁽¹⁾	Government Safety Limits ^{(1) (2) (3)}
1. Fluorine (F)	2.87	Not recommended
*2. Hydroxyl radical (OH)	2.86	Too fast to measure
*3. Ozone (O ₃)	2.07	.04 ppm
*4. Hydrogen Peroxide (H ₂ O ₂)	1.78	1.0 ppm
5. Chlorine (CL)	1.36	.5 ppm
*6. Oxygen (O ₂)	1.23	19.5-23.5%
*Friendly Oxygen-Based Oxidizers		

Hydroxyl radicals are almost theoretical in that they are so reactive that they are created and decomposed almost instantaneously. They are typically confined to the reaction surfaces of the catalyst where they are made. They can be difficult to control, and accordingly are not always practical to use for indoor air treatment systems.

Ozone was discovered in the late 1800s in France and has been used extensively for water and food purification. Unlike America, Europe prefers ozone over chlorine for water purification. In the 1980s, ozone began to appear in air purification primarily as a way to destroy various odors including smoke.

Commercial ozone generators are still very popular with

fire and flood restoration companies. The use of ozone as an indoor air quality method for occupied spaces quickly was picked up by Sharper Image with a product called “Ionic Breeze”, basically an ion generator that produced ozone. Numerous State Attorney Generals filed suit against Sharper Image for false and misleading advertising which ultimately forced the company into bankruptcy.

Ozone is an effective oxidizer, but it carries a health warning at a relatively low dosage. A look at Table 1 of oxidizing agents shows ozone as number 3, just below fluorine and the hydroxyl radical, which are far too dangerous to consider.

Chlorine (CL) is a chemical that creates a byproduct of trihalomethanes that are known carcinogens linked to cancer in humans. Oxygen (O₂) is good, but by raising oxygen levels, fire hazards are created.

This leaves us with Hydrogen Peroxide (H₂O₂), number four on the list, just below ozone, hydrogen peroxide is a compound of two parts hydrogen and two parts oxygen ⁽²⁾, simply water (H₂O) with one extra atom of oxygen. Sounds safe enough! Hydrogen Peroxide has been used by the medical community for 170 years, mostly for disinfection purposes. In the 1920s, the British cut the mortality rate for pneumonia from 80% to 48% using Hydrogen Peroxide therapy. Hydrogen Peroxide (H₂O₂) is considered the safest oxidizer available (after oxygen). It is widely used today in toothpaste, mouthwash and household



Hydrogen peroxide products

cleaners. An old household remedy for children with respiratory problems is to put a tablespoon of hydrogen peroxide in a vaporizer.

Why not use it to disinfect the indoor air we breathe? We know it works in high concentrations as tested by the EPA for use in disinfecting HVAC ducts for Anthrax spores.^{(3) (4)} Should we have another terrorist Anthrax incident or a contaminated hospital, vaporized Hydrogen Peroxide (H₂O₂) has been successfully tested.

Some will say that Hydrogen Peroxide (H₂O₂) in levels over 1 ppm can be a health hazard. This is probably true, but high levels of almost everything can be a health hazard. After all, too much oxygen can cause oxygen toxicity or poisoning, which will lead to cell damage and death.⁽³⁾ Even consuming too much water can be fatal.

Hydroperoxides are known as Mother Nature's natural, envi-friendly cleaning agent. Maybe mother did know best when she said "Go play outdoors, it's healthier". Ionized hydrogen peroxides are responsible for the air smelling so clean after a thunder storm. The combination of ions from lightning, water and sun increase the natural level of hydrogen peroxide, thereby cleaning the air. Typical outdoor levels of hydroperoxides run between .01 to .03 ppm. The Government safety ⁽²⁾ guideline on hydroperoxide gas is 1.0 ppm, .02 ppm (typical outdoor levels) is 1/50 or well below the Government safety limits.

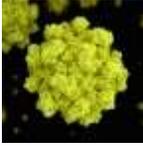
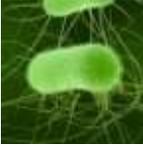


Hydroperoxides outdoor levels --
 .01 ppm to .03 ppm ^{(7) (8) (10)}
 Hydroperoxides inside house unit off --
 .00 ppm ^{(9) (10)}
 Hydroperoxides inside house unit on --
 .01 ppm to .02 ppm ^{(9) (10)}

Now, .01 ppm may not sound like a lot, but there are approximately 177,000,000,000,000,000 hydroperoxide gas molecules in a single litre of air, which means they are close to one micron apart. So, bacteria, odors, viruses, VOCs, mold, etc. do not have to go far to be hit with one and destroyed. Hydroperoxide gas at levels of .01 ppm are now recognized by the EPA as an effective infection control and microbial treatment technology.

A technology developed in the late 1990s used by Oxyzone Enterprises creates hydroperoxides from moisture in the air within an HVAC system, almost like misting the indoor air with a weak hydrogen peroxide solution. Photo catalytic hydroxyl ionization, a patented ionized hydroperoxide technology used in the Bioblaster Hydroxymax™ simulates the natural hydroperoxides in the outdoor air. The technology works on a rare metal catalyst and a hydrating agent activated by a broad spectrum ultraviolet light reacting with ambient moisture in the air creating hydroperoxides. A later development, allows for the ionization of the hydroperoxides, basically super charging them. The concept is a proactive, aggressive method of indoor air sanitation instead of a contaminant or microbe being trapped or killed in a filter system. Hydroxymax™ systems kill microbes at the source, in the room before you can come in contact with them. Hundreds of independent studies and lab tests have proven photo catalytic hydroionization to be a very effective and safe method of controlling airborne organics. A byproduct of this technology actually lowers ambient ozone levels, as when an ozone molecule reacts with the catalyst it is used in the conversion to a hydroperoxide molecule. Other advantages are very low energy consumption, about 12 watts, which is about the same as the light in your refrigerator making it a green product and there is no air flow restriction or back-press on the hvac blower! The air is so clean that you can actually smell the difference as a wide variety of odors are reduced from 55% to 98%⁽¹²⁾.

Typical Test Results Photocatalytic Hydroperoxide levels of .01-.02 ppm

	Virus	99%
	Bacteria	99%
	Odors	55% - 98%
	Mold	97% - 98%
	VOCs	80% - 99%
	Smoke	70%

Sneeze Study⁽⁹⁾



Many of these studies and lab tests were done on airborne contaminants as well as surfaces. This is important because, as with the Norwalk Virus, much of the spread of the virus was from touching contaminated surfaces. The photocatalytic ionized hydroperoxide molecules settle on surfaces and continue to kill microbes.

Photocatalytic oxidation technology has been extensively employed by the food industry for the last 17 years. Also, medical facilities have embraced it to reduce rates of H1N1, SARS, C-Diff ⁽⁹⁾⁽¹¹⁾, MRSA, etc. Schools use it as it can reduce absenteeism of students and teachers. One photocatalytic validation study was to destroy the microbes of a sneeze, which it did-99% at three feet.⁽⁹⁾

Photocatalytic oxidation has been tested and approved by the military and homeland security. Hundreds of cruise ships have installed photocatalytic technology throughout the ship, which has helped eliminate the Norwalk Virus problem plaguing that industry for years. Thousands of hotel rooms, chain restaurants and hospitals also utilize photocatalytic oxidation technology.

One of the best features is, with well over one million photo catalytic oxidation cells in use worldwide over the past 15 years, hydroxyl uses have a perfect safety record!

Footnotes

- (1) Infection Control Today, May 2008
- (2) Health Guidelines for Hydrogen Peroxide, US Dept. of Labor, OSHA
- (3) Oxygen Toxicity, Wikipedia. org
- (4) Peroxide of Hydrogen as a Remedial Agent (Journal of the American Medical Association, March 4, 1988)
- (5) Vaporized Hydrogen Peroxide, Wikipedia.org
- (6) Purified Hydrogen Peroxide, U.S. EPA
- (7) Atmospheric Hydrogen Peroxide, Peking University, Beijing, China 2008
- (8) Measurement of Atmospheric Hydrogen Peroxide, North Carolina State University
- (9) Kansas State University testing results of photocatalytic technology, 2000 to 2012

(10) Katz Analytical, 2010

(11) Study by Kansas City Public Health Dept., 2010, Dr. L. Franken

(12) Photo catalytic odor testing C&W Engineering 2008

Authors:

Dr, James Marsden, Distinguished Regents Professor at Kansas State University, who has conducted research on Advanced Oxidation Technology for the past 15 years. He has authored numerous articles and holds many patents.