Odorox® System Effect on Microorganisms

General

Atmospheric hydroxyl radicals are continuously produced by the action of the sun's radiated energy on water vapor in our atmosphere. There are, on average, two (2) million hydroxyls in each cubic centimeter of ambient outdoor air during daylight hours. They are the main driving force behind the daytime reactions with hydrocarbons in the troposphere and neutralize most natural and man-made pollutants including greenhouse gases like methane, hydrogen sulfide and ozone.

Atmospheric hydroxyls are also proven to kill bacteria, virus, and mold because they are able to react with the lipids and proteins in the cell membrane and disrupt their structure. The interior contents of the cells leak and the organism is destroyed. Conversely, humans, animals and plants have tougher, much more complex exterior surfaces that are essentially impervious to the effect of free radicals and have developed symbiotically with atmospheric hydroxyl radicals and thrive in their presence. Atmospheric hydroxyls are a critical component of nature's dynamic ability to provide environments that are free of harmful chemicals and pathogens. (D. E. Heard, "Analytical Techniques for Atmospheric Measurement", Blackwell Publishing, 2006 – professor at the University of Leeds, UK).

Hydroxyl Radical Sanitization Process

The HGI Odorox® irradiation process is fundamentally very simple. Multi-nanometer spectrum UV irradiation of various wavelengths interacts with the oxygen which generates a variety of reactive oxygen species, which remove a hydrogen atom from water vapor to generate atmospheric hydroxyl radicals (HO·). Ozone, one of the reactive oxygen species formed in the reaction chamber, is rapidly decomposed by UV energy to also generate hydroxyl radicals. Therefore ozone is both created and destroyed in the HGI process. HGI's Odorox® optics reaction chamber design and active process controls result in an effective commercially viable production of atmospheric hydroxyls within the same range as those found in nature.

The HGI Odorox® hydroxyl radicals are highly reactive and excellent radical transfer agents. They rapidly react with microorganisms and with nearly every organic chemical available. They remove a hydrogen atom and form a cascade of organic radicals that is further oxidized to form peroxy (R-C-O-O·) and oxy (R-C-O·) free radicals, which are also good oxidizing and sanitizing agents. These by-products are stable enough to circulate under the influence of high velocity fans to completely sanitize air, surfaces and porous fabrics in even exceptionally large spaces.

Atmospheric hydroxyl radicals and their by-products are unstable species which do not linger in the air or on surfaces. As long as the Odorox® system is running, the chain reactions persist. When the system is shut off, the hydroxyl radicals and other free radicals dissipate within seconds.

Effect on Microorganisms and Germination

HGI Industries has completed a number of microbiological studies to evaluate the speed and effectiveness of their systems to eliminate a broad range of pathogens on non-porous / porous surfaces and on plant material. Results from a licensed testing laboratory, using pathogens commonly tracked by the EPA as representative of their type, indicated that substantially all of the following microorganisms were killed on stainless steel, glass and cotton fabric respectively, within the specified times summarized below.

- C. difficile – 99.8% and 98.6% within 48 hours
- Listeria – 94.7% and 98.6% within 48 hours
- Aspergillus niger – 99.9% and 97% within 48 hours
- Porcine Reproductive Respiratory Syndrome (PRRS) virus – 97.9% within 6 hours
- Pseudomonas aeruginosa – 91.9% within 4 hours
- Influenza A virus – 99.98% and 99.9% within 6 hours
- Methicillin Resistant Staph. Aureus (MRSA) – 65.1% and 94.4% within 48 hours

Recent studies on the reduction of bacterial and fungal pathogens on plant material from raw and sprouted barley processing were also conducted. Random samples of raw barley and fresh barley sprouts (removed in the processing of sprouted barley) were exposed to Odorox® atmospheric hydroxyls and their by-products from an MVP14™ unit over a period of 2 to 96 hours. Kill rates in excess of 99.9% were measured by a licensed testing laboratory for the following pathogens. No fungal growth was isolated on any samples after 6 hours of treatment with respect to the raw sprouted barley product.

Sprouted Barley Product: (plant material was stirred every two hours and appeared unchanged)

- Aspergillus niger
- Candida krusei
- Trichosporum beigelii
- Rhodotorula glutinous
- Acinetobacter baumannii
- Enterobacter agglomerans
- Enterobacter clocae
- Bacillus sp.

Raw Barley product: (plant material was not stirred)

- Pantoea Agglomerans
- Acinetobacter Baumanni
- Bacillus SP
- Psuedomonas Fluorescens
- Penicullium Citrinum, Mucor SP
- Fusarium SP
- Afusarium SP
- Aspergillus Flavus Group (GRP)
- Aspergillus Niger GRP
- Syncephalastrum SP (Zygomycete)
- Pithomyces SP

Note that the hydroxyl radical does not react with carbon dioxide and would thus not interfere with normal plant respiration. Hydroxyl radicals would however, react rapidly with plant respiration by-products like ethylene and neutralize them, which is beneficial.

Safety

As a category, the FDA does not regulate or require premarket 510(k) approval for UV irradiation air cleaning devices – such as HGI's - since they irradiate ambient air and sanitize in a manner similar to that found in nature.

The safety standard of systems that preferentially produce atmospheric hydroxyls was established in 2005 when NASA developed a hydroxyl generating system using a titanium dioxide catalyst for use on the space shuttle that was subsequently commercialized as the Abracair system. They obtained approval to use the system for the reduction of aerosolized mold and bacteria in hospitals, nursing homes and medical facilities – including neonatal nurseries, hospitals and operating rooms – without formal 510(k) premarket approval (510k #K052732, Abracair Models QTZ300-60 and -24, notification in compliance with the Safe Medical Device Act of 1990, CFR, Part 807.92 , Feb. 7, 2006, www.fda.gov/cdrh/industry/support/index.html).

The National Institute of Environmental Health Sciences searched the NIH files, PubMed and the National Library of Medicine and "cannot find any hard science or research indicating that hydroxyl radical generation is harmful to human health. That applies to both atmospheric and man-made generation" (Colleen Chandler, NIEHS Office of Communications and Public Liaison, 8-5-10).

Further, at HGI's request, the CDC, FDA, OSHA and NIH researched their databases and did not find any data indicating that atmospheric hydroxyls were unsafe. None of these agencies indicated that their approval was required for commercial use. Hydroxyl systems have been in use for over ten years and no adverse effects have been reported.

Extensive toxicology studies conducted by HGI at an independent testing laboratory, using the FDA's rigorous testing protocol called Good Laboratory Practices (GLP), has shown that exposure to hydroxyl radicals and the associated oxidation by-products is safe. The study results indicated that the test animals tolerated the exposure well with no abnormal clinical observations.