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July 16, 2008

Clerk of the Board
California Air Resources Board
1001 I Street, P.O. Box 2815
Sacramento, CA 95814

Re: Comments on Proposed Air Cleaner Regulation

Dear Clerk of the Board:

We submit these comments on behalf of Ecoquest International, Inc. ("Ecoquest"), a manufacturer of indoor air cleaners.

As a starting point, Ecoquest supports the proposition that consumers should not be exposed to ozone concentrations that exceed the .05 ppm standard.

We incorporate by reference comments submitted on September 24, 2007. Those comments offered amendments to the regulation which would require detailed labeling and warnings (similar to countless other consumer products which are hazardous if not properly used) that would allow the use of air cleaning devices in unoccupied residential settings. Those comments were rejected.

Those comments also challenged the authority of the Air Resources Board under AB 2276 to effectively ban the use of air cleaning devices which are designed and intended for use in unoccupied spaces.

Given California's vulnerability to wildfires, the Legislature would not lightly have deprived consumers of the ability to purchase an air cleaning device for use in attacking smoke odors in their homes before re-occupying them, and yet that is how the Board has construed AB 2276.

Another application of low level ozone technologies is to attack microbes, including e coli, on cooking and other stainless steel surfaces. We attach a published (and peer reviewed) article from the December 2007 issue of Journal of Rapid Methods and Automation in Microbiology (published after the main hearing on the proposed regulations). The article assesses an Ecoquest-developed technology that produces ozone levels of 0.02 ppm and found it effective at reducing populations of environmental organisms.

In a bow to the usefulness of some ozone-generating devices for odor and smoke control, the Board grants a broad exemption for "industrial uses," including "odor and smoke control in the hotel industry, provided no people are physically present" (hotel rooms are defined as "occupied" even when people are not present, hence the need for the special exemption). Other special "industrial use" exemptions: "fire and smoke damage remediation, provided no people are physically present," and "mold remediation, provided no people are physically present."

At first blush these exceptions would seem to allow use of the devices for mold and smoke damage remediation in homes and apartments provided no people are physically present, but the regulation only allows the industrial use exemption for devices that "are marketed solely through industrial supply outlets or businesses." (Section 94803(a))

The effect is that a consumer, to gain the same benefits available to "industrial users," is forced to hire a professional smoke or mold remediation firm. Nothing in AB 2276 suggests that was the intent.

The Board has considered and rejected these arguments, but the Office of Administrative Law is charged with determining whether the regulation meets the "authority" and "consistency" requirements of the Administrative Procedures Act. Government Code section 11349 defines those terms as follows:

"(b)'Authority' means the provision of law which permits or obligates the agency to adopt, amend, or repeal a regulation."

"(c) 'Consistency" means being in harmony with, and not in conflict with or contradictory to, existing statutes, court decisions, or other provisions of law."

1. The core flaw in the regulation is the definition of "occupied space," which is not authorized by AB 2276 and, in banning devices while used in unoccupied spaces, is not in harmony with the intent of that statute and in fact conflicts with it.

The grant of authority in Health and Safety Code section 41986(a) is to adopt regulations "to protect public health from ozone emitted by indoor air cleaning devices...used in occupied spaces" (emphasis added). That phrase is repeated in the digest of the Legislative Counsel.

In an exercise of definitional fiat, the proposed regulation obliterates the statute's clear limitation to devices "used in occupied spaces" by defining "occupied space" to mean "an enclosed space intended to be occupied by people for extended periods of time, e.g., houses, apartments, hospitals and offices." This definition renders a space "occupied" regardless of whether it is in fact occupied and thereby creates a ban on the use of ozone technology in unoccupied residential, office or hospital settings.

This interpretation of "occupied space" is a radical departure from the ordinary meaning of the phrase and is contrary to the interpretation of "occupied" used elsewhere in California law.

Merriam-Webster's Collegiate Dictionary, Eleventh Edition, defines "occupy" as:

> **1** : to engage the attention or energies of
> **2 a** : to take up (a place or extent in space) <this chair is *occupied*> <the fireplace will *occupy* this corner of the room> **b** : to take or fill (an extent in time) <the hobby *occupies* all of my free time>
> **3 a** : to take or hold possession or control of <enemy troops *occupied* the ridge> **b** : to fill or perform the functions of (an office or position)
> **4** : to reside in as an owner or tenant

Merriam-Webster's defines "intended" as:

> **1** : to direct the mind on
> **2** *archaic* : to proceed on (a course)
> **3 a** : **SIGNIFY**, **MEAN b** : to refer to
> **4 a** : to have in mind as a purpose or goal : **PLAN b** : to design for a specified use or future

(Available online at http://www.m-w.com/.)

Based on dictionary definitions alone, the proposed definition means that an "occupied space" includes enclosed spaces that were designed for, or had the purpose or goal of, being taken up, filled, controlled, or held in possession by people for extended periods of time. The inclusion of the "intended to be" language has the effect of stretching the definition of "occupied space" from something akin to requiring actual presence into something that applies to virtually *all* enclosed spaces, occupied or not. This is due to the fact that there are few, if any, enclosed structures that were not designed for, or have the purpose or goal of being taken up, filled, controlled, or held in possession by people.

Courts have generally understood the term "occupied" to mean something closer to "actual presence" than the proposed definition would permit. For example, the California Supreme Court has stated, "[T]here is always the likelihood there will be a second person present in an occupied vehicle. (By definition, there will always be one person.)" (*People v. Ochoa* (2001) 26 Cal.4th 398, 462, emphasis added.) As such, California courts understand "occupied" spaces as requiring actual presence of at least one person; not merely spaces that were designed for or have the purpose or goal of being occupied by people regardless of whether or not people are actually present.

Oppositely, the proposed regulation appears to twist the definition of "occupied space" into something closer to "inhabited space." For example, in *People v. Tabios* (1998) 64 Cal.App.4th 1, 10, the court described an "inhabited dwelling house" as "one in which persons reside and where occupants are generally in or around the premises." (Emphasis added.) By including the phrase "intended to be" in the definition of "occupied space", the proposed regulation deviates from the judicial definition of "occupied" [at least one person (*Ochoa*)] and largely conforms to the judicial definition of "inhabited" [occupants are generally in or around the premises (*Tabios*)], which sounds closer to the regulation's phrase "…space intended to be occupied by people for extended periods of time."

The distinction might be largely inconsequential if the authorizing legislation, AB 2276, had empowered the Board to regulate ozone emissions in inhabited spaces. But that is not what the legislation authorizes the Board to do. It only authorizes the Board to regulate ozone emissions in occupied spaces, nothing less, nothing more.

California statutes further recognize that there is a difference between places that are intended be occupied, and those that are actually occupied. For example, Penal Code § 246 creates a felony for "[a]ny person who shall…discharge a firearm at an inhabited dwelling house, occupied building, occupied motor vehicle, occupied aircraft, inhabited housecar…or inhabited camper." Section 246 goes on to define "inhabited" as "currently being used for dwelling purposes, whether occupied or not." (Emphasis added.)

For our purposes, the implication of Section 246 is that California law recognizes a distinct difference between places that were designed for, or have the purpose or goal of being occupied (inhabited dwelling house, inhabited housecar, inhabited camper), and places that are actually occupied (occupied building, occupied motor vehicle, occupied aircraft).

Any attempt to define the term "occupied space" as both space that is actually occupied and space that is intended to be occupied blurs the distinction and deprives the word "occupied" of any real significance. This is a departure from the normal use of the word "occupied", as demonstrated in *Ochoa* and Penal Code Section 246; and creates inconsistency between the usage of "occupied" in the Penal Code (actual presence) and the Health and Safety Code as construed by the proposed regulation (possible presence).

There is no reason to think the Legislature meant the term "occupied" to be interpreted differently than in Section 246.

2. The proposed regulation is inconsistent with federal law.

Section 41986(a) of the Health and Safety Code, enacted by AB 2276, requires the state board to adopt regulations "consistent with federal law," and section 4198(e) expands on that mandate:

"(e) It is the intent of the Legislature that this section be interpreted and applied in a manner that is consistent with federal law. The regulations adopted by the state board pursuant to this section shall be consistent with federal law. The state board may, to the extent a waiver is required, seek a preemption waiver from the federal government to authorize the state board to adopt regulations that are more stringent than federal law." (Emphasis added.)

The federal regulation on this matter, recognized in AB 2276, is 21 CFR § 801.415, which declares that a device will be considered "adulterated and/or misbranded ... if it is used or intended for use under the following conditions:

"(3) To generate ozone and release it into the atmosphere and does not indicate in its labeling the maximum acceptable concentration of ozone which may be generated (not to exceed 0.05 part per million by volume of air circulated through the devices) as established herein and the smallest area in which device can be used so as not to produce an ozone accumulation in excess of 0.05 part per million." (21 C.F.R. section 801.415(c)(3)). (Emphasis added.)

This provision in essence is a labeling or warning obligation for devices which are capable of exceeding the standard if not properly used, as when the space is not occupied. The proposed regulation allows for no such exception for ordinary consumers and is therefore inconsistent with federal law and contrary to the specific requirement of subsection (e).

In our comments of September 24, we also pointed out the inconsistency of the regulations with federal and state workplace standards, which recognize a higher exposure limit (0.10 parts per million of ozone for an eight-hour period). Those standards apply to the workplace while occupied, whereas the proposed ARB regulation bans devices with a lower emission rate whether the space is occupied or not, unless one of the "industrial use" exemptions applies.

3. Flawed testing protocol.

The Board has adopted a testing protocol using the UL 867 standard, but as delineated in Section 1 on Scope of UL 867, that protocol was developed to cover electrostatic air cleaners intended to remove dust and other particles from the air (see attached statement of scope), which devices do not rely at all on ozone for any functional air cleaning purpose. The testing protocol for UL 867 to meet the .05 ppm ozone directive was developed to insure that an inadvertent level of excessive ozone is not produced in these specific devices, not in devices intended to use low amounts of ozone to remove other forms of air contamination. Neither the current or proposed revisions to the testing protocol are intended to cover testing of devices similar to those manufactured by Ecoquest where ozone meeting the .05 ppm ozone directive is intentionally produced.

The UL 867 requirement to measure ozone at 2" from the air outlet of the product will preclude the development and deployment of innovative air and surface cleaning technologies that still protect consumers from actual exposure above 0.05 ppm. In fact in a home environment, ozone that only marginally exceeds the 0.05 ppm at 2 inches would typically be barely detectable.

This is important from a legal standpoint because the statute adopts a .05 ppm standard defined as "the generation of ozone at a level in excess of 0.05 part per million by volume of air circulating through the device or causing an accumulation of ozone in excess of 0.05 part per million by volume of air when measured under standard conditions at 25 degrees Celsius (77 degrees Fahrenheit) and 760 millimeters of mercury in the atmosphere of enclosed space intended to be occupied by people for extended periods of time." (This is from 21 CFR 801.415 referenced above.)

The 2" rule, adapted from a protocol that only applies to electrostatic devices, will effectively preclude devices that actually meet the statutory standard.

The Board does not have statutory authority to do that.

4. Conclusion.

This regulation on its face acknowledges benefits of ozone but limits the benefits to "industrial use."

Such a limitation is neither authorized by nor consistent with AB 2276 (construing "occupied" according to its ordinary and legal meaning), nor is it consistent with federal law, as required by AB 2276.

The Office of Administrative Law should return these regulations for revisions which cure these legal flaws and restore the ability of California consumers to economically attack odors, smoke, mildew and bacteria in their own homes.

Sincerely,

Robert W. Naylor

cc: Peggy Jenkins

EFFICACY OF ECOQUEST RADIANT CATALYTIC IONIZATION CELL AND BREEZE AT OZONE GENERATOR AT REDUCING MICROBIAL POPULATIONS ON STAINLESS STEEL SURFACES

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ABSTRACT

The improvement of disinfection technology for contact surfaces in health care, food processing, schools and residential environments is critical for the control and prevention of disease-causing microorganisms. Historically, both ozone- and peroxide-based technologies have been used as disinfectants in numerous applications. This study determined the potential use of oxidative gases, including ozone and peroxide, generated by the EcoQuest Radiant Catalytic Ionization (RCI) cell for the inactivation of Escherichia coli, Listeria monocytogenes, Streptococcus pneumoniae, Pseudomonas aeruginosa, Bacillus globigii, Staphylococcus aureus, Candida albicans *and* Stachybotrys chartarum *on stainless steel surfaces. In addition, the EcoQuest Breeze AT ozone generator was evaluated for the inactivation of* C. albicans *and* S. chartarum *on stainless steel surfaces at diverse contact times in a controlled airflow cabinet. Results showed that oxidative gases produced by the RCI cell reduced all microorganisms tested by at least 90% after a 24 h exposure on stainless steel surfaces. The RCI cell was more effective at reducing microbial counts for shorter exposure times than was the Breeze AT ozone generator.*

PRACTICAL APPLICATIONS

The purpose of this study was to give an accurate evaluation of the Radiant Catalytic Ionization technology for disinfection of environmental contact surfaces. When used properly and safely, this technology can provide a cost-effective means for eliminating environmental microorganisms such as

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Bacillus globigii, *Staphylococcus aureus*, *Candida albicans*, *Stachybotrys chartarum*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Streptococcus pneumoniae* and *Listeria monocytogenes* in industries such as food processing and health care.

INTRODUCTION

Microbial contamination of indoor air represents a major public health problem and a potential source for sick building syndrome. For example, certain species of molds and bacteria may cause health concerns in homes, schools, offices and health care facilities (Hota 2004). In addition to being unattractive to see and smell, molds also give off spores and mycotoxins that cause irritation, allergic reactions or diseases in immune-compromised individuals (Banfleth and Kowalski 2005).

The term *nosocomial infection* refers to an infection that is acquired from the hospital or a health care facility (Chotani *et al.* 2004). Environmental contamination has produced devastating consequences in these facilities, resulting in the morbidity and mortality of tens of thousands of patients every year. Persons who visit hospitals, nursing homes or health clinics have a risk of acquiring an infection as a result of their stay (Tilton 2003). It is estimated that approximately one patient in 10 acquires an infection as a result of an extended visit in one of these health care facilities (Tilton 2003). Nosocomial-acquired infections are responsible for approximately 100,000 deaths with an annual cost approaching $29 billion (Kohn *et al.* 1999).

Nosocomial infections have a number of potential causes that promote the spread of diseases. Common health care surfaces such as countertops, beddings, bedpans and medical devices can all be used to transmit and spread diseases from one person to another (Hota 2004). Under hectic and stressful conditions, these surfaces can become easily contaminated, often by overworked employees. Cutbacks in staffing at health care facilities because of budget constraints have placed a greater burden on health care facilities to find ways to remediate contaminants with limited resources (Chotani *et al.* 2004). Older and poorly designed buildings may harbor contaminants that are not easily eliminated using conventional disinfection methods. Studies have shown that microorganisms such as *Staphylococcus aureus* and *Candida albicans* survive in environmental reservoirs found in health care facilities (Hota 2004).

Food and beverage industries face multiple issues when it comes to producing a safe, wholesome product. Food pathogens such as *Escherichia coli* 0157:H7, *Listeria monocytogenes* and *Salmonella* spp. have been a growing concern throughout the years. In addition, processors are concerned about spoilage microorganisms which shorten shelf life and cost companies millions of dollars every year in spoiled products. The areas impacted include the meat, seafood, poultry, produce, baking, canning and dairy industries. The United States Department of Agriculture has estimated the costs associated with foodborne illnesses to be about \$2.3 billion and \$4.6 billion a year for children and adults, respectively (USDA 2001), in addition to the billions of dollars lost every year because of spoiled products, which must be disposed of or sold at lower values. Reducing pathogens and additional microbial contamination on food contact surfaces decreases cross contamination, improving the quality and shelf life of food products (Kusumaningrum *et al.* 2003). Disinfection and microbiological control measures that efficiently eliminate or diminish microbial counts from every area of food plants are an unquestionable industry investment.

As a disinfectant, ozone has a remarkable ability to oxidize substances. When ozone comes in contact with organic compounds or bacteria, the extra atom of oxygen destroys the contaminant by oxidation. Ozone decomposes to oxygen after being used, so no harmful by-products result (Purofirst 2000). Ozone's oxidation potential is higher than chlorine, 2.07 and 1.36, respectively. Ozone disinfects substances such as water three to four times more effectively. As it oxidizes a substance, ozone literally destroys the substance's molecule leaving virtually no residue behind (Fink 1994).

Recent government approval of ozone for use with foods and food contact surfaces has opened the door to many more exciting possibilities for this technology. In June 2001, the Food and Drug Administration (FDA) approved the use of ozone as a sanitizer for food contact surfaces and for direct application on food products (FDA 2001, 2003). Previously, chlorine was the most widely used sanitizer in the food industry despite the fact that ozone may be more effective for disinfection of surfaces than chlorine. Chlorine is a common disinfectant used in meat processing and is effective and safe when used at proper concentrations. Chlorine, also known by its chemical name sodium hypochlorite, is a halogen-based chemical that is corrosive to stainless steel and other metals used to make food processing equipment. Chlorine can be a significant health hazard to workers when mixed in small amounts with ammonia or acid cleaners producing toxic chlorine gas that can cause massive cellular damage to the exposed nasal passages, trachea and lungs (Gunnarsson *et al.* 1998; Martin *et al.* 2003; Russell *et al.* 2006). In food plants, chlorine may react with meat forming highly toxic and carcinogen compounds called trihalomethanes rendering them lesser-quality products (Cunningham and Lawrence 1977). It can also result in the production of chloroform, carbon tetrachloride and chloromethane. On the other hand, ozone does not leave any trace of residual product upon its oxidative reaction.

An important advantage of ozone use in food processing is that the product can still be called organic. An organic sanitizer must be registered as a food contact surface sanitizer with the United States Environmental Protection Agency. Ozone has an FDA approval for its use as a sanitizer for food contact surfaces, as well as for direct application on food products.

The use of ozone in food processing has become widely accepted in recent years, and its uses have surpassed surface applications. The FDA (2004) stated, "ozone is a substance that can reduce levels of harmful microorganisms, including pathogenic *E. coli* strains and *Cryptosporidium*, in juice. Ozone is approved as a food additive that may be safely used as an antimicrobial agent in the treatment, storage and processing of certain foods under the conditions of use prescribed in 21 CFR 173.368."

The main aim of this study was to evaluate the application of oxidative gases, including low levels of ozone, generated by the EcoQuest Radiant Catalytic Ionization (RCI) cell and the EcoQuest Breeze AT ozone generator against environmental microorganisms such as *E. coli*, *L. monocytogenes*, *Streptococcus pneumoniae*, *Pseudomonas aeruginosa*, *Bacilus globigii*, *S. aureus*, *C. albicans* and *Stachybotrys chartarum* on stainless steel surfaces.

MATERIALS AND METHODS

Preparation of Cultures

The following bacteria and fungi cultures were used for the study: *B. globigii* (American Type Culture Collection [ATCC] #31028, 49822, 49760); *S. aureus* (ATCC #10832D, 25178, 11987); *C. albicans* (ATCC #96108, 96114, 96351); *S. chartarum* (ATCC #18843, 26303, 9182); *P. aeruginosa* (ATCC #12121, 23315, 260); *E. coli* (ATCC #27214, 19110, 67053); *S. pneumoniae* (ATCC #27945, 29514, 10782); and methicillin-resistant *S. aureus* (ATCC #33591). The cultures were revived using ATCC recommended instructions. *L. monocytogenes* (KSU #56 and 70).

Bacterial, yeast and mold species were independently grown in trypticase soy broth (Difco Laboratories, Detroit, MI) and yeast morphology broth (Difco Laboratories), respectively, to mid-exponential phase followed by a wash and resuspension in 0.1% peptone water. The microbial cultures were combined by species type to ca. 10^8 cfu/mL.

Preparation of Samples and Treatment

The microbial species used to validate the ozone generators were tested as microbial cocktails inoculated onto 6.3×1.8 cm, #8 finish stainless steel coupons (17.64 cm^2 double-sided area). Four stainless steel coupons were dipped per microbial inoculum and vortexed 15 s, optimizing microbial dispersion. Binder clips (Universal Brand, Des Plaines, IL), sterilized by autoclaving, were used to hang each stainless steel coupon from a cooling rack for 1 h until dryness in a laminar flow biohazard hood. The initial microbiological populations attached to the stainless steel coupons were in the range of 10^5–10^6 cfu/cm^2. The inoculated stainless steel coupons were transferred to a controlled airflow test cabinet (Mini-Environment Enclosure, Terra Universal, Anaheim, CA) at 26C, 46% relative humidity (ambient conditions) and treated using the EcoQuest RCI cell for 0, 2, 6 and 24 h. The EcoQuest Breeze AT ozone generator was evaluated separately for treatment periods of 0, 2, 6 and 24 h. During the evaluation of the EcoQuest Ozone Breeze AT ozone generator, ozone levels were monitored using a Model 500, Aeroqual (Auckland, New Zealand). The ozone levels in the chamber during treatment with the EcoQuest Ozone Breeze AT ozone generator were maintained at 0.02 ppm. Nontreated inoculated coupons were evaluated after 0 and 24 h as negative controls.

Sampling

At the end of the ozone contact time, the coupons were placed into 30 mL of 0.1% peptone water and vortexed for 30 s; the samples were serially diluted and plated on trypticase soy agar (Difco Laboratories) for bacterial recovery. Yeast and mold cultures were plated on potato dextrose agar (Difco Laboratories) and cornmeal agar (Difco Laboratories), respectively. The colony-forming units per square centimeter were estimated after 24 h (35C) or 5 days (30C) of incubation for bacteria, yeasts or molds, respectively.

RESULTS

Surface testing to evaluate nontreated control counts is shown in Fig. 1. Microbial reductions on negative controls after 24 h for *S. aureus* were 0.68 log cfu/cm^2, *E. coli* (0.27 log cfu/cm^2), *Bacillus* spp. (0.35 log cfu/cm^2), *S. aureus* (0.47 log cfu/cm^2), *Streptococcus* spp. (0.31 log cfu/cm^2), *P. aeruginosa* (0.52 log cfu/cm^2), *L. monocytogenes* (0.39 log cfu/cm^2), *C. albicans* (0.45 log cfu/cm^2) and *S. chartarum* (0.30 log cfu/cm^2). Reductions on nontreated controls after 24 h ranged from 0.3 to 0.6 log cfu/cm^2.

Reductions in microbial counts on #8 finish stainless steel coupons produced by the EcoQuest RCI cell after 0, 2, 6 and 24 h exposures are presented in Fig. 2. Exposure to ozone levels of 0.02 ppm reduced all microbial populations tested by at least 0.7 log cfu/cm^2 in all microorganisms tested after just 2 h. Longer exposure times resulted in greater reductions with the greatest

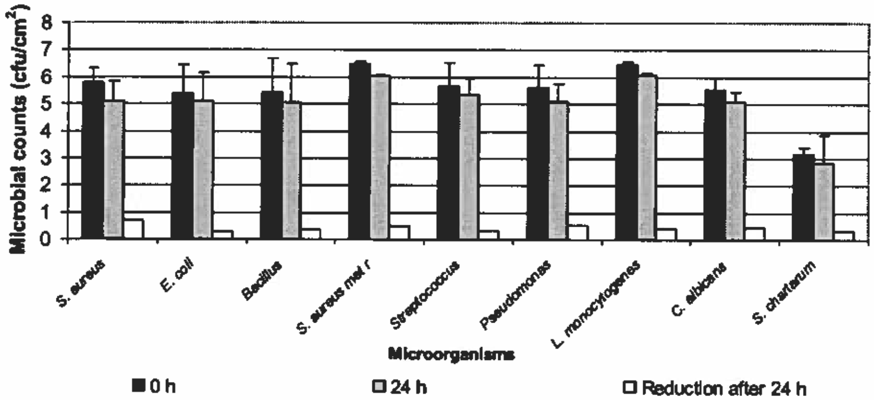

FIG. 1. MICROBIAL SURVIVAL AFTER 24 H INOCULATION ON STAINLESS STEEL COUPONS

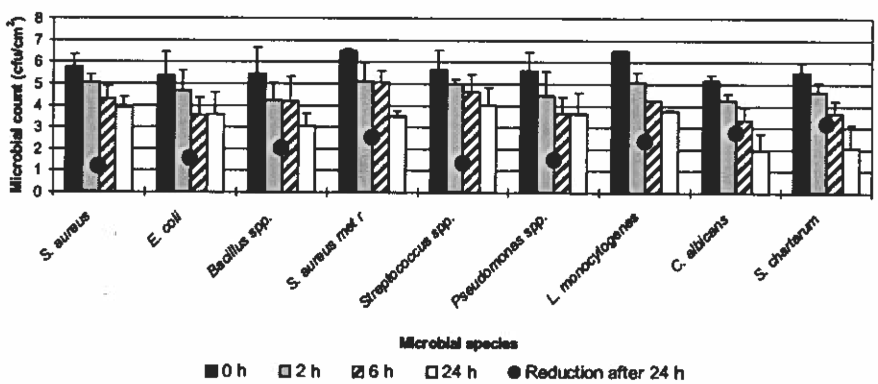

FIG. 2. DECONTAMINATION OF HIGHLY POLISHED STAINLESS STEEL SURFACES USING THE ECOQUEST RADIANT CATALYTIC IONIZATION CELL

reductions found after 24 h exposure. The microbial total reduction mean counts after 24 h exposure for *S. aureus* were 1.17 log cfu/cm^2, *E. coli* (1.53 log cfu/cm^2), *Bacillus* spp. (2.02 log cfu/cm^2), methicillin-resistant *S. aureus* (2.50 log cfu/cm^2), *Streptococcus* spp. (1.33 log cfu/cm^2), *P. aeruginosa* (1.48 log cfu/cm^2), *L. monocytogenes* (2.35 log cfu/cm^2), *C. albicans* (2.75 log cfu/cm^2) and *S. chartarum* (3.16 log cfu/cm^2). Reductions were calculated by taking 0–24 h counts + reduction after 24 h negative controls.

Results of microorganisms tested against the EcoQuest Breeze AT ozone generator are shown in Fig. 3. Exposure to ozone levels of 0.02 ppm resulted in reductions of at least 0.2 and 0.4 log cfu/cm^2 after 2 and 6 h of ozone

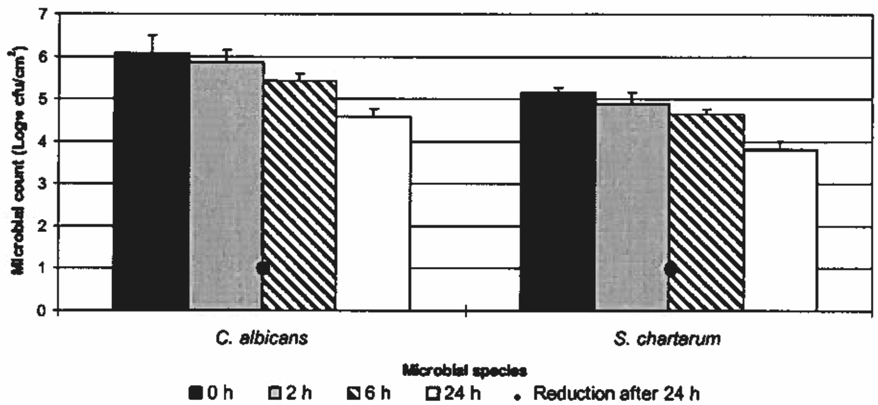

FIG. 3. OZONE DECONTAMINATION ON HIGHLY POLISHED STAINLESS STEEL SURFACES USING THE ECOQUEST BREEZE AT OZONE GENERATOR

exposure. After 24 h of exposure (calculated as described earlier), the *C. albicans* and *S. chartarum* reduction means were 1.02 and 1.01 log cfu/cm^2, respectively.

DISCUSSION

Oxidative gases such as ozone have been used by industry for many years and in numerous applications such as odor control, water purification and as disinfectants. Ozone can oxidize organic substances such as bacteria and mildew, sterilize the air and destroy odors and toxic fumes (Mork 1993). An area where ozone technology may be utilized more in the future is in removing environmental contaminants. It has been reported that ozone levels of less than 9 ppm are all that is needed to remediate sick buildings or for professional disinfection (Khurana 2003). In this study, levels of 0.02 ppm and less were found to have an affect at reducing populations of environmental microorganisms.

The application of this type of technology may be most beneficial in areas where environmental contamination is of growing concern such as in health care. Fear of nosocomial infection in chronic care facilities is a problem because of the extended time patients are exposed to the risk of infection. The anticipated increase in the elderly population in the next several decades makes prevention of infection in long-term care facilities a priority (Nicolle 2001).

Ozone applied in the food industry has proven to be a powerful, broad-spectrum antimicrobial agent that is effective against bacteria, fungi, viruses, protozoans and bacterial and fungal spores. A study by Kim *et al.* (1999) found that an ozone rinse of just 1.3 ppm for 5 min produced a greater than 99.9% reduction in psychrotrophic and mesophilic bacteria on lettuce. The ozone technology evaluated in this study would give processors a resource for controlling environmental contaminants, adding to their overall sanitation program.

To our knowledge, it is the first time a study has been conducted to test microbial reductions on stainless steel surfaces by exposure to oxidative gases and gaseous ozone. In this study, a low concentration of ozone (0.02 ppm) reduced all microorganisms tested by at least 90% after a 24 h exposure on stainless steel surfaces.

Short exposure times (2 h) to ozone levels of 0.02 ppm reduced all microbial populations tested by at least 0.7 log cfu/cm^2 in all microorganisms tested. It has been reported that the antimicrobial activity of ozone is based on its strong oxidizing effect, which damages the cell membrane (Pope *et al.* 1984). Ozone kills bacteria within a few seconds by a process known as cell lysing. Ozone molecularly ruptures the cellular membrane, disperses the cell's cytoplasm and makes microbial survival impossible. Because of these actions, microorganisms cannot develop ozone-resistant strains, eliminating the need to change biocides periodically (Pope *et al.* 1984).

The EcoQuest RCI cell and EcoQuest Breeze AT ozone generators reduced microbial populations on stainless steel surfaces within 2 h under ambient conditions, with greater reductions associated with longer exposure times. The RCI cell was more effective than the Breeze AT ozone generator at reducing microbiological populations at shorter exposure times of 2 and 6 h. This study demonstrated that the low levels of oxidative gases produced by the RCI cell have the potential to be an effective surface disinfectant tool for use in food processing, sick building remediation and health care applications.

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Electrostatic Air Cleaners - UL 867

1 Scope

1.1 These requirements cover electrostatic air cleaners rated at 600 volts or less, intended to remove dust and other particles from the air and intended for use in accordance with the National Electrical Code, ANSI/NFPA 70.

1.2 These requirements do not cover electrostatic air cleaners for use in hazardous locations or to clean atmospheres defined as hazardous by the National Electrical Code, ANSI/NFPA 70.

1.3 These requirements do not cover air cleaners intended to remove particles other than dust and other particles normally found in heating and ventilating systems.

1.4 Requirements for the installation of duct-type electrostatic air cleaners are included in the Standards of the National Fire Protection Association for Installation of Air Conditioning and Ventilating Systems, NFPA 90A; and for Installation of Warm Air Heating and Air Conditioning Systems, NFPA 90B.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

UL 867 references these Standards: 4 * 44 * 50 * 62 * 73 * 83 * 94 * 224 * 310 * 486A * 486B * 489 * 496 * 498 * 506 * 510 * 512 * 514A * 514B * 514C * 746A * 746B * 746C * 746D * 796 * 810 * 817 * 873 * 900 * 917 * 969 * 1004 * 1012 * 1054 * 1059 * 1097 * 1413 * 1446 * 2111 * .