Executive Summary

Kansas State University Testing

Biological Reduction through Photocatalysis and Ozone

研究摘要

堪薩斯州立大學實驗

光觸媒與臭氧之降低測試

Summary:

研究摘要

Testing has been performed at the Kansas State Food Science Institute in the Department of Animal Sciences & Industry, Kansas State University in Manhattan Kansas under the direction of Dr. James Marsden, Regent's Distinguished Professor of Meat Science. Kansas State is of America's foremost Universities for animal science and Dr. Marsden is known around the world as one of the top researchers and experts in food safety.

本實驗在 James Marsden 博士的指導下，於曼哈頓(Manhattan)隸屬堪薩斯州立大學動物科學暨工業學系之堪薩斯州食品科學研究所進行。堪薩斯州之大學以動物科學而聞名全美，而 Marsden 博士亦為世界頂尖的食品安全之研究員與專家。

Ten of the most deadly forms of mold, fungi, bacteria and virus were subjected to a new and innovative Photocatalytic Reactor called Radiant Catalytic Ionization (RCI). These nine organisms were placed on a piece of stainless steel inside a test chamber and the RCI cell was turned on for 24 hours. Test results showed a 24-hour reduction ranging from 96.4% to 99.9%.

十項最致命的黴菌、真菌、細菌與病毒被採用於此項創新光觸媒科技 – 又被稱為 RCI 科技 – 實驗中。將九項有機體制放於實驗槽中的不鏽鋼板上，並開啟 RCI 蜂槽座連續 24 小時。實驗結果顯示，在 24 小時內，能有效降低菌量達 96.4%至 99.9%。

This testing validates the effectiveness and speed which RCI is able to treat the indoor environment using a natural process at safe levels of oxidation.
這項實驗證實RCI能快速有效的以自然且安全的氧化作用，針對室內環境進行處理。

Discussion:

討論：

With most indoor airborne contaminants originating on surfaces, any efforts to control biological contamination in the indoor environment must address surfaces. Microorganisms such as Mold, Bacteria and Viruses thrive on surfaces in the presence of moisture, and for this reason the food industry has focused on controlling and eliminating pathogens in food contact areas.
多數室內空氣污染物乃由物體表面所引起，因此，任何室內環境生物性污染控制亦應包含物體表面。許多微生物能在潮濕的表面滋生，諸如：黴菌、細菌與病毒，因此，食物工業相當注重食物包裝區域之病源體的控制與消除。

Dr. Marsden has dedicated his life to improving food safety through understanding and controlling the spread of biological contamination. Marsden's research has recently focused on the use of advanced Photocatalysis, a technology which develops oxidizers which actively reduce airborne and surface pathogens.
瑪斯丹博士畢生致力於改善食品衛生安全，透過研究並加以控制生物性污染之擴散。馬斯單博士近期之研究著重於先進的光觸媒技術 - 一種藉由製造氧化劑有效降低空氣中與物體表面的病原體的技術。

Nine microorganisms were chosen for analysis. Three samples of each microorganism were prepared and placed on a stainless steel surface, allowing analysis at 2 hours, 6 hours and 24 hours of exposure. The test organisms included:

此項實驗共採用九種微生物。九種微生物各有三份樣本被安置於不鏽鋼表面，並分別進行2小時，6小時與24小時的處理。此實驗所採用的微生物包含：

- Staph *(Staphylococcus aureus)*
  葡萄球菌 (金黃色釀膿葡萄球菌)
- MRSA *(Methycillin Resistant Staphylococcus aureus)*
  超級病菌 (抗藥性金黃色葡萄球菌)
- E-Coli *(Escherichia coli)*
  大腸桿菌
- Anthrax family (*Bacillus* spp.)
  炭疽科 (拮抗性桿菌屬)
- Strep *(Streptococcus* spp.)
  鍊鎖狀球菌 (鏈球菌屬)
- *Pseudomonas aureuginosa*
  綠膿桿菌
- *Listeria monocytogenes*
  李斯特菌
- *Candida albicans*
  白色念珠球菌
- Black Mold *(Stachybotrys chartarum)*
  黑黴菌 (葡萄穗黴菌)

These organisms were subjected to air which was circulating through a proprietary photo catalytic reactor called Radiant Catalytic Ionization or RCI. Multiple parameters were monitored including temperature and humidity. The UV Lamp in the photo catalytic cell was positioned in the supply duct to insure there was no effect from the UVGI produced by the lamp. Understanding that Ozone is one of the oxidizers produced in this Photocatalytic process and the health concerns from exposure to excessive levels of ozone, the ozone level was monitored and never exceeded 20 parts per billion, well below EPA maximum level for continuous exposure.

上述微生物經導入空氣中，由一項獨特的光催化反應器 – 光觸媒進行處理。多種變項皆受到控制，包含溫度與溼度。光觸媒蜂槽中的UV燈置於風管，以確保此實驗不受到由燈管產生的UVGI之影響。臭氧亦爲此氧化器在此光催化過程中之產物，基於臭氧濃度對健康影響的考量，該臭氧量控制在20 ppb下，爲美國環保署所規範之安全濃度之下。

In addition to the test chamber treated with RCI and the corona discharge ozone generator, a control chamber was set up to account for natural decay of the test organisms. Because some biological pathogens die-off on their own when exposed to air, any reputable study must account for such reductions. The test results shown in the report are the reductions in viable organisms with respect to the control sample.

除了安裝了RCI與尖端放電臭氧產生器外之實驗室外，另外尚有一實驗室作為實驗中微生物自然死亡控制變項之用。因為，有些生物病原體接觸空氣即自行死亡，因此，一項周全的實驗必須將此變項含括在內。此項實驗結果之報告所顯示下降之微生物即為此控制樣本。

The test results were astounding. After 24 hours of exposure the nine organism's viability was reduced between 96.4% and 99.9%. It should be noted that the double blind study accounted for natural decay. What was even more surprising to the researchers was how fast RCI reduced the pathogens. At the 2-hour sample the average reduction was well over 80%. At the 6-hour sample the average reduction was well over 90%.

實驗結果相當驚人，在經過24小的處理，實驗中的9項微生物數量下降至96.4%與99.9%。由於此項實驗亦含括自然死亡微生物之變項，因此亦須特別註記為雙盲實驗。而令研究者更驚訝的乃是RCI降低病原體的速度，在2小時的實驗中，該樣本數量減少超過80%，而6小時的實驗樣本平均下降超過了90%。

An additional test was performed using a corona discharge ozone generator (Breeze AT) against *Candida albicans* (yeast) and *Stachybotrys chartarum* (black mold) at 50 parts per billion (the level deemed safe by the US EPA, OSHA and other international health & safety organizations). This test showed the ability of safe levels of ozone to reduce microbial contamination. It should be noted that although results showed the effectiveness of this safe level of ozone, it also showed that ozone alone is not as effective as the multiple oxidizers produced by the advanced Photocatalytic Oxidation device called RCI. One of the multiple oxidizers RCI produces is ozone but at an ozone level two to five times lower than using ozone alone.

另一項額外的實驗，是透過一部尖端放電臭氧產生器(微風型活氧機)以50 ppb之臭氧來處理白色念珠球菌與黑黴菌(此臭氧濃度為美國環保署、美國聯邦職業安全與衛生署和其他國家級健康與安全組織視為安全濃度)。此項測試顯示安全濃量的臭氧降低微生物污染的效果。需特別注意，雖然結果顯示出安全濃度的臭氧之功效，但亦同時呈現出光靠臭氧並無法取得如RCI般之效果。臭氧為RCI氧化過程中所製造的產物之一，但其所產生之臭氧濃量卻為僅靠臭氧處理之臭氧濃度的兩倍至五倍低。