

UV, mercury lamp and ozone disinfection principle

1. Understanding of ultraviolet rays and antivirus principles

Ultraviolet (Ultra Violet, UV) is very common. It is light with a wavelength of 100 to 400 nm in sunlight. According to different wavelength bands, it can be divided into UVA, UVB, UVC and vacuum UV. Among them, the UVA wavelength range is 315-400 nm, the UVB wavelength range is 280-315nm, and the UVC wavelength range is 200-280nm.

1.1 Principles of UV disinfection

The UVC band has the characteristics of short wavelength and high energy. It can penetrate the cell membrane and cell nucleus of organisms, cause damage to DNA, and destroy the molecular structure of microorganisms (bacteria, viruses and other pathogens) in a short time. By destroying the DNA and RNA of microorganisms to prevent their reproduction, it can achieve high-efficiency and rapid broad-spectrum sterilization effects, such as bacterial propagules, spores, viruses, fungi, etc., so as to sterilize water, air and surface of objects, making cells unable to regenerate. Among them, the ultraviolet output with 265nm as the center band can be quickly absorbed by bacteria, which is an effective sterilization method.

1.2 Advantages of UVC antivirus

High-efficiency sterilization: The sterilization effect of ultraviolet rays on bacteria and viruses is generally completed within a few seconds, almost transiently, and the sterilization and disinfection capacity is 600 to 3000 times greater than that of chlorine.

Broad-spectrum sterilization: UV technology has the highest broad-spectrum sterilization among all current sterilization technologies. It can kill almost all bacteria and viruses with high efficiency.

More thorough sterilization: the combined use of ultraviolet rays and ozone (UVC+O3) can exert a more powerful and thorough sterilization power. Ultraviolet rays irradiate the air and the surface of objects in a straight line to achieve strong sterilization; ozone penetrates into all corners of the room with the air to completely kill indoor bacteria.

Complete environmental protection: The ultraviolet light emits ultraviolet rays for sterilization and disinfection. The ultraviolet rays irradiate the oxygen in the air to

紫外線，汞燈及臭氧殺毒原理

一、紫外線認識及殺毒原理

紫外線(Ultra Violet, UV)很常見，它是陽光中波長 100 至 400 nm 的光線，根據不同波段可分為 UVA、UVB、UVC 及真空 UV。其中 UVA 波長範圍 315-400 nm，UVB 波長範圍 280-315nm,UVC 波長範圍 200-280nm。

1.1 紫外線殺毒原理

UVC 波段具有波長短、能量高特點，能穿透生物的細胞膜和細胞核，對 DNA 造成損傷，短時間內破壞微生物機體(細菌、病毒等病原體)細胞中分子結構。通過破壞微生物的 DNA 和 RNA 阻止其繁殖，實現高效快速的廣譜殺菌效果，如細菌繁殖體、芽胞、病毒、真菌等，從而對水、空氣和物體表面進行殺菌消毒，使細胞無法再生。而其中，265nm 為中心波段的紫外輸出能快速被細菌吸收，是有效的殺菌手段。

1.2 UVC 殺毒優點

高效率殺菌：紫外線對細菌、病毒的殺菌作用一般在幾秒內完成，幾乎是暫態發生，殺菌消毒能力比氯大 600~3000 倍。

殺菌廣譜性：紫外線技術在目前所有的消毒技術中，殺菌的廣譜性是最高的。它對幾乎所有細菌、病毒都能高效率殺滅。

殺菌更徹底：紫外線與臭氧結合使用(UVC+O3)，能夠發揮更強大更徹底的殺菌消毒威力。紫外線直線照射空氣、物體表面，達到強力殺菌消毒；臭氧隨空氣滲透到室內各角落，徹底殺滅室內細菌。

完全環保：由紫外線燈發出紫外線照射進行殺菌消毒，紫外線照射空氣中的氧氣生成臭氧，臭氧強氧化殺滅細菌病毒，整個殺菌過程均無需添加任何化學藥劑，真正達到完全環保。

不存在抗藥性：紫外線或臭氧均是直接破壞細菌病毒細胞中的 DNA、RNA、蛋白質等，致細胞直接死亡並無法繁殖複製，不存在抗藥性。而

generate ozone, and the ozone is strongly oxidized to kill bacteria and viruses. The entire sterilization process does not need to add any chemicals, truly achieving complete environmental protection.

There is no drug resistance: ultraviolet light or ozone directly destroys the DNA, RNA, protein, etc. in the bacterial virus cell, causing the cell to die directly and unable to reproduce, and there is no drug resistance. The sterilization of other chemical agents will cause the bacteria and viruses to become resistant, and the sterilization effect of the chemical agent will be invalid.

No secondary pollution: Ultraviolet rays and ozone cause the direct death of bacteria and viruses without any other chemical pollutants; meanwhile, ozone is converted into oxygen at room temperature for 15-30 minutes (ozone half-life) without any residual secondary pollution.

1.3 Disadvantages of UVC antivirus

The main part of human body damage caused by UVC ultraviolet rays is the eyes and bare skin. Short-term high-intensity irradiation can burn eyes and skin, and long-term high-intensity irradiation can even cause skin cancer.

The penetration of UVC is extremely weak, and ordinary transparent glass, clothes, plastic, dust, etc. can be completely blocked. Therefore, wearing glasses (if you don't have glasses, avoid looking directly at the ultraviolet light) and covering your bare skin as much as possible, you can protect your eyes and skin from UVC ultraviolet rays.

1.4 UVC antivirus application

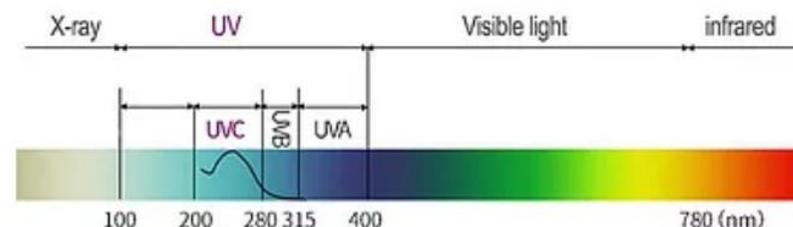
The main parameter to measure the sterilization efficiency is the radiation dose received by the bacteria (radiation dose (mJ/cm²) = radiation time (s) * deep ultraviolet radiation intensity (mW/cm²), the greater the radiation dose, the higher the sterilization efficiency. Data It is shown that with only 30mW/cm² UVC ultraviolet radiation intensity, almost 100% of most bacteria can be killed in one second, and the effect is very significant, which can be widely used in the field of medical and health. In personal health and family hygiene In the field, ultraviolet light can be used for disinfection of water cups and chopsticks, air purification and sterilization, killing worms, sterilization and deodorization of footwear and socks, and sterilization of baby bottles.

其他化學藥劑滅菌，會使細菌病毒產生抗藥性，而造成該化學藥劑滅菌效果失效。

無二次污染：紫外線、臭氧致使細菌病毒直接死亡，沒有其他任何化學污染物產生；同時臭氧常溫下 15~30 分鐘(臭氧半衰期)轉化成氧氣，無任何殘留的二次污染。

UVC LED disinfection 99.99% sterilization rate

Irradiation with a wavelength of 260-280nm and physical sterilization can destroy the DNA or RNA of bacteria and microorganisms, and lose the ability to survive and reproduce.



1.3 UVC 殺毒缺點

UVC 紫外線對人體傷害的主要部位是眼睛、裸露的皮膚，短期高強度照射可灼傷眼睛及皮膚，長期高強度照射嚴重的甚至會造成皮膚癌。

UVC 紫外線穿透力極弱，普通透明玻璃、衣服、塑膠、塵埃等均能完全阻擋。因此戴著眼鏡(如無眼鏡則避免眼睛直視紫外線燈)、把衣服儘量遮住裸露皮膚，就能保護眼睛與皮膚避免受 UVC 紫外線的傷害。

1.4 UVC 殺毒應用

衡量滅菌效率的主要參數是細菌接受到的照射劑量 (照射劑量(mJ/cm²) =照射時間 (s) *深紫外線輻照強度(mW/cm²)，照射劑量越大，消毒效

2. The principle and application of deep ultraviolet LED antiviral

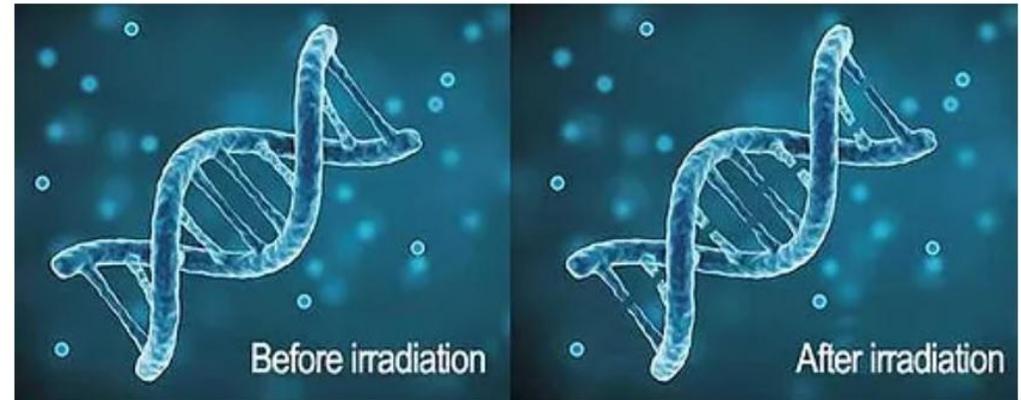
Deep ultraviolet LED (UVC LED) is: a sterilizing ultraviolet diode, and the way that LED emits UVC has performance advantages such as safety, environmental protection, compactness, high efficiency, and low consumption. The UVC LED used in our products emits deep ultraviolet rays with a wavelength of 260~280nm. Deep ultraviolet rays can damage the DNA or RNA molecular structure of the genetic material in microorganisms, causing bacteria to fail to reproduce or even inactivate, thereby achieving the purpose of sterilization.

2.1 Advantages of deep ultraviolet LED sterilization

Compared with other sterilization methods such as ozone method and ultraviolet mercury lamp sterilization method, deep ultraviolet LED sterilization has many advantages:

- 1) Efficient sterilization, the UVC segment ultraviolet light emitted by the deep ultraviolet LED generally kills bacteria and viruses within a few seconds. The traditional water sterilization methods such as ozone and other methods generally require 20 minutes to 1 hour to reach the deep ultraviolet sterilization efficiency. ;
- 2) Extensive bactericidal properties. Because bacteria, virus antigens and other microorganisms are not resistant to ultraviolet light, deep ultraviolet light can kill almost all bacteria and viruses with high efficiency, and deep ultraviolet LED sterilization technology can also be used in To a certain extent, inhibit the growth of some higher aquatic organisms, such as algae, bloodworms, and paramecium.
- 3) Safety and environmental protection (without mercury). Compared with the mercury-excited ultraviolet lamps currently on the market, the most obvious advantage of deep ultraviolet LED devices is that the germicidal light source does not contain mercury. Mercury is a heavy metal substance, commonly known as mercury. It can evaporate. Mercury vapor and mercury compounds are highly toxic (chronic). In the sterilization process of traditional ultraviolet mercury lamp germicidal lamps, once the lamp tube is broken, it will cause serious water pollution. Deep ultraviolet LED devices are a safe and reliable device. Contains heavy metals, simple operation, safe and reliable operation.
- 4) Energy saving, long life and low maintenance cost. Deep ultraviolet LED sterilizers are gradually replacing the common mercury lamp ultraviolet sterilizers on the market.

率越高。數據顯示，僅以 30mW / cm² 的 UVC 紫外輻照強度，一秒鐘即可對絕大部分細菌實現近乎 100%的殺滅，效果非常顯著，可廣泛應用於醫療衛生領域。在個人健康和家庭衛生領域，紫外光可用於水杯碗筷消毒、空氣淨化除菌、殺滅瞞蟲、鞋襪殺菌除臭、嬰兒奶瓶消毒等，用武之地簡直不可勝數。



二、深紫外 LED 殺毒原理及應用

深紫外 LED (UVC LED) 就是：殺菌紫外線二極體，而 LED 發出 UVC 的方式，具有安全、環保、小巧、高效、低耗等性能優勢。我司產品所用 UVC LED 發出波長 260~280nm 的深紫外線，深紫外線能破壞微生物體內遺傳物質 DNA 或者 RNA 分子結構，導致細菌無法繁殖甚至失活，從而達到殺菌消毒的目的。

2.1 深紫外 LED 殺菌優勢

相比於其他殺菌方法如臭氧法及紫外汞燈殺菌法，深紫外 LED 殺菌有諸多優勢：

- 1) 高效殺菌性，深紫外 LED 所發出的 UVC 段紫外光對細菌、病毒殺滅作用一般在幾秒以內，傳統水殺菌方法如臭氧等方法，達到深紫外殺菌效率一般需要 20 分鐘至 1 小時；

One of the important reasons is that ultraviolet LEDs have low power consumption and are very energy-efficient. The power of deep ultraviolet LEDs is about One-tenth of the mercury lamp, this ratio greatly saves costs;

5) Small size, flexible design, convenient installation, deep ultraviolet LED device, small size, and flexible design of its sterilization device, which can be used in small spaces where traditional ultraviolet mercury lamps cannot be used.

3. the principle of mercury lamp disinfection

The mercury lamp disinfection is actually a kind of low-pressure mercury. The low-pressure mercury lamp uses a lower mercury vapor pressure (<10-2Pa) to be modified to emit ultraviolet waves. There are two main emission spectral lines: one is 253.7nm wavelength; The other has a wavelength of 185nm, both of which are invisible to the naked eye. The wavelength of 250nm-260nm can play a very good sterilization effect, so the ultraviolet light with the wavelength of 253.7nm passes through the glass tube wall and is transmitted to achieve the purpose of ultraviolet sterilization.

The ultraviolet germicidal lamp tube is made of quartz glass. The mercury lamp is divided into three types according to the mercury vapor pressure in the lamp tube after lighting and the difference in the ultraviolet output intensity: low pressure low intensity mercury lamp, medium pressure high intensity mercury lamp And low-pressure high-intensity mercury lamps. The sterilization effect is determined by the radiation dose received by the microorganisms. At the same time, it is also affected by the output energy of ultraviolet rays, which is related to the type of lamp, light intensity and use time. As the lamp ages, it will lose 30%-50% of its intensity .

Mercury lamp sterilization is currently a more widely used sterilization method. But mercury is highly toxic. Mercury can evaporate at room temperature. Mercury vapor and mercury compounds are highly toxic (chronic). In the sterilization process of traditional ultraviolet mercury lamp germicidal lamps, once the lamp tube is broken, it will cause serious water pollution and poor control. Will have serious consequences.

4. The principle of ozone disinfection

At room temperature, ozone gas is a lavender gas with a special fishy smell, and its solubility increases as the temperature decreases. Because ozone has strong oxidizing properties, it exhibits outstanding effects of sterilization, disinfection, and degradation of

2) 廣泛殺菌性，由於細菌、病毒抗原體等微生物對紫外光不具有可抗性，因此深紫外光對幾乎所有細菌和病毒都能高效率殺滅，並且深紫外 LED 殺菌技術，還能在一定程度上抑制一些較高等的水生生物生長，如藻類、紅蟲、草履蟲等。

3) 安全環保（不含汞），深紫外 LED 器件相對於目前市場上的汞激發紫外燈最明顯優勢在於其殺菌光源不含汞，而汞是一種重金屬物質，俗稱水銀，汞在常溫下即可蒸發，汞蒸氣和汞化合物有劇毒（慢性），傳統紫外汞燈殺菌燈在殺菌過程中，一旦燈管破裂，將引起嚴重的水質污染，而深紫外 LED 器件是一種安全可靠的裝置，不含重金屬，操作簡單、運行安全可靠。

4) 節能、壽命長、維護成本低，深紫外 LED 殺菌器正逐漸取代市場上普遍的汞燈紫外殺菌器，重要原因之一是紫外 LED 功耗較低，十分節能，深紫外 LED 功率大約是汞燈十分之一，這一比率大大節省了成本；

5) 體積小、設計靈活、安裝方便，深紫外 LED 器件，體積小，其殺菌裝置設計靈活，可以應用在傳統紫外汞燈無法應用的狹小空間。

三、汞燈殺毒原理

汞燈殺毒實際上是屬於一種低壓汞，低壓汞燈是利用較低汞汽壓 (<10-2Pa)被做化而發出紫外波，其發光譜線主要有兩條：一條是 253.7nm 波長；另一條是 185nm 波長，這兩條都是肉眼看不見的紫外線。250nm-260nm 波長能起到很好的殺菌作用，因此波長 253.7nm 的紫外線穿過玻管壁透射出來，實現紫外線殺菌的目的。

紫外線殺菌燈燈管是由石英玻璃製成，汞燈根據點亮後的燈管內汞蒸氣壓的不同和紫外線輸出強度的不同，分為三種：低壓低強度汞燈、中壓高強度汞燈和低壓高強度汞燈。殺菌效果是由微生物所接受的照射劑量決定的，同時，也受到紫外線的輸出能量，與燈的類型，光強和使用時間有關，隨著燈的老化，它將喪失 30%-50%的強度。

汞燈殺菌是目前使用比較廣泛的殺菌方式。但是汞含有劇毒，汞在常溫下即可蒸發，汞蒸氣和汞化合物有劇毒（慢性），傳統紫外汞燈殺菌燈在殺菌過程中，一旦燈管破裂，將引起嚴重的水質污染，控制不好會產

pesticides. It is an efficient and broad-spectrum fungicide. Ozone can also kill hepatitis viruses, cold viruses, etc. Ozone diffuses quickly and evenly in the air, disinfecting without dead ends. Its shortcomings: the sterilization time is longer, generally should reach 50-60min; in addition, if the surface of the items to be disinfected has water, the disinfection effect of ozone will be weakened.

However, when the concentration is too high, the decomposition time of ozone is prolonged, the ozone that is not completely decomposed has a great smell, and it has greater damage to the human respiratory tract, nervous system, and immune system.

Ozone is a strong oxidant, and the sterilization process is a biochemical oxidation reaction. There are three forms of ozone sterilization:

1. Ozone can oxidize and decompose the enzymes necessary for the degradation of glucose inside the bacteria, inactivate the enzymes necessary for cell activities, and inactivate the bacteria.
2. Directly interact with bacteria and viruses, destroy their organelles, DNA and RNA, destroy the metabolism of bacteria and cause the death of bacteria.
3. Through the cell membrane tissue, invade into the cell, acting on the lipoprotein of the outer membrane and the lipopolysaccharide inside, changing the cell permeability, leading to cell lysis and death.

4.1 Ozone effect

1. Sterilization: Ozone can quickly kill bacteria, molds, yeasts, viruses and other microorganisms in the air and water. When the ozone concentration in the water is 0.05ppm, keep it for ten minutes, and the killing rate of bacteria is more than 99%.
2. Detoxification: The environment is full of various substances harmful to the human body, such as carbon monoxide, pesticides, heavy metals, fertilizers, organic matter, odor, pigments, etc. After ozone treatment, these toxic substances will be decomposed into harmless substances to the human body .
3. Keeping healthy products fresh: Using ozone sterilizers in food production can reduce the chance of food spoilage and extend the shelf life of food. Using ozone in health products such as medicines and cosmetics can also extend the shelf life of food.
4. Bleaching: Ozone has a strong bleaching effect and can be used for laundry, food, and wastewater treatment.
5. Deodorization: Ozone has super oxidizing properties, which can quickly decompose

生的的嚴重後果。

四、臭氧消毒原理

在室溫下，臭氧氣是一種呈淡紫色的、有特殊魚腥味的氣體，隨著溫度的降低而溶解度增加。由於臭氧具有強氧化性，呈現出突出的殺菌、消毒、降解農藥的作用，是一種高效廣譜殺菌劑。臭氧還可以殺滅肝炎病毒、感冒病毒等，臭氧在空氣中彌漫快而均勻，消毒無死角。其缺點：殺菌時間較長，一般應達到 50~60min；另外，如果待消毒的物品表面有水，會使臭氧消毒作用減弱。

但濃度過高時，臭氧的分解時間延長，沒有完全分解的臭氧氣味很大，而且對於人的呼吸道、神經系統、免疫系統具有的較大的傷害。

臭氧是一種強氧化劑，滅菌過程屬生物化學氧化反應。臭氧滅菌有以下 3 種形式：

1. 臭氧能氧化分解細菌內部降解葡萄糖所需的酶，使細胞活動必需的酶失去活性，使細菌滅活死亡。
2. 直接與細菌、病毒作用，破壞它們的細胞器和 DNA、RNA，使細菌的新陳代謝受到破壞，導致細菌死亡。
3. 透過細胞膜組織，侵入細胞內，作用於外膜的脂蛋白和內部的脂多醣，改變細胞通透性，導致細胞溶解、死亡。

4.1 臭氧作用

- 1、殺菌消毒：臭氧可迅速殺滅空氣、水中的細菌、黴菌、酵母菌及病毒等微生物，水中臭氧濃度在 0.05ppm 時，保持十幾分鐘，對細菌的殺滅率在 99% 以上。
- 2、解毒：環境中到處充滿各種對人體有害的物質，如一氧化碳、農藥、重金屬、化肥、有機物、臭味、色素等，經臭氧處理後，這些有毒物質都會分解成對人體無害的物質。
- 3、健康產品保鮮：在食品生產中使用臭氧消毒機，可減少食品腐敗變質的機率、延長食品保質期，在藥品、化妝品等健康產品中使用臭氧，也可起到延長食品保質期。
- 4、漂白：臭氧具有很強的漂白作用，可用於洗衣、食品、廢水處理。
- 5、除臭：臭氧具有超強氧化性，可快速分解不良氣味中的物質，從而消

the substances in the bad smell, thereby eliminating the peculiar smell.

4.2 Which is better, ozone disinfection or ultraviolet disinfection?

Ultraviolet disinfection and ozone disinfection actually have their own characteristics. Ozone disinfection has a strong oxidizing effect. It does not produce excess by-products like ultraviolet rays. It oxidizes the enzymes inside the bacteria and destroys its metabolism and eventually leads to death. Ozone itself is a gas, which can fill the entire space with almost no dead ends. However, ozone disinfection is the same as ultraviolet disinfection, and the penetrating power of sterilization is not strong. If you want to achieve the best results, it takes about 30-60 minutes, otherwise it will not be thorough enough, and various fungi and pathogens will be revived in a short time. After the sterilizer is turned off, it should be closed for 30 minutes, so that the effect will be the best. The principle of ultraviolet sterilization is to destroy the structure of DNA (deoxyribonucleic acid) in the body through ultraviolet radiation to bacteria, viruses and other microorganisms, causing them to die or lose their activity immediately.

In summary, if we combine ultraviolet rays and ozone to perform loop antivirus, the effect will be more reliable than a single antivirus method.

除異味。

4.2 臭氧消毒和紫外線消毒哪個更好？

紫外線消毒和臭氧消毒其實各有特點，臭氧消毒具有很強的氧化作用，它和紫外線一樣都不會產生多餘的副產物，通過氧化細菌內部的酶，破壞其新陳代謝最終導致死亡。臭氧本身為氣體，能夠瀰漫整個空間，幾乎是沒有死角。不過，臭氧消毒和紫外線消毒一樣，滅菌的穿透力都不強。如果想要達到最佳效果，需要 30-60 分鐘左右，不然會不夠徹底，短時間內會讓各種真菌、病原體死灰復燃。消毒機關閉以後，還應該密閉 30 分鐘，這樣效果才會達到最理想。而紫外線殺菌原理是通過紫外線對細菌、病毒等微生物的照射，以破壞其機體內 DNA(去氧核糖核酸)的結構，使其立即死亡或喪失活性。