BENEFITS AND RISKS OF

ULTRAVIOLET RADIATION (UV)

NuAire, Inc. | 2100 Fernbrook Lane | Plymouth, MN 55447 | U.S.A. | 763.553.1270 | WWW.NUAIRE.COM

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Soon after the discovery of microorganisms, biologists began to observe that many varieties of these creatures were able to be incapacitated by exposure to sunlight. Following the discovery of the ultraviolet bandwidth in 1801, scientists attributed the sun's lethal effect to this invisible energy. Facilitated by the findings of a large body of experimental evidence collected in the decades following these initial hypotheses, contemporary scientists have determined that nearly all bacterial activity can be eradicated or at least attenuated by some wavelength of ultraviolet energy.

Due to the overwhelming diversity of microorganisms present in the environment, the resistively and rate of lysis of each species varies greatly. Generally bacteria sterilization when compared to those species whose domain is general exposure was discontinued around the early 1900's due to the development of sterilization technology utilizing chlorination and ozonation. However, there has been a general trend in industry during the last few decades towards the use of UV for germicidal purification due to its lack of toxic chemical by products.

Photochemical Background

The ultraviolet bandwidth occupies wavelengths roughly between 200 and 400 nanometers. To put into relative terms UV radiation is sandwiched between the higher energy, soft X-rays and lower energy visible light. Purification via exposure to ultraviolet radiation is unique from other types of sterilization modalities due to the fact that it does not necessarily cause death of the target organism. In those pathogens it does not directly kill, the UV radiation effectively alters the creature's genetic structure. By causing damage to the target bacteria's Deoxyribonucleic Acid (DNA), the bacteria is sterilized at the genetic level. Thus the organism is no longer able to reproduce and cause disease.

Ultraviolet Germicidal Lamps

Based on experiments which compared the effectiveness of various light sources on the survival ratio of different species of bacteria, scientists were able to determine the wavelength of ultraviolet light which produced the maximal germicidal effectiveness. This wavelength was determined to be 253.7 nm. This finding explained why sunlight is only marginally effective in the treatment of pathogens. This wavelength is far beyond the short-wave limit of solar light.

Germicidal lamps capable of emitting ► UV light at a wavelength of 253.7 nm are most effective in the treatment of pathogens.

Applying UV Sterilization to Industry

Sterilization through the utilization of ultraviolet radiation has experienced an increase in popularity in the last decade. Industry has embraced this technology due to its convenience, safety, and relative cost effectiveness. The following specific application areas are:

- Sterilization within the Food Industry
- UV Water Purification Systems
- Sterilization of Air

The Use of Ultraviolet Lights in Biological Safety Cabinets

The use of ultraviolet (UV) lights in biological safety cabinets (BSCs) has enjoyed a long history. The current version of the NSF International Standard 49 dismisses the use of UV in a BSC. The CDC and NIH, in their joint pamphlet "Primary Containment for Biohazards: Selection, Installation and Use of Biological Safety Cabinets, 2nd Ed." have taken a similar stand. ABSA [American Biological Safety Association] has, to date, made no official pronouncement. Researchers continue to request their

cabinets be outfitted with the lights and all manufacturers offer them as an option. Currently 80% - 90% of all United States Class II Type A2 Biological Safety Cabinets manufactured within the last 15 years are being shipped with Ultraviolet Germicidal Lights installed.

Objections

Several issues arise with the use of ultraviolet radiation in a biological safety cabinet. It has been argued that UV radiation puts researchers at risk from ocular damage and cancer. The UV radiation generates ozone that can damage materials within the cabinet, the radiation is ineffective at high humidity levels, the blue lamp remains the same constant blue even though the effective radiation has ceased to exist, UV radiation only kills surface bacteria, UV radiation gives the researcher a false sense of security, and the UV bulb must be cleaned weekly to prevent a drop in output.

> **"Due to the short time for UV overexposure to occur, it is recommended that neither laboratory nor maintenance personnel work in a room where UV lights are on. The CDC, NIH, and NSF agree that UV lamps are neither recommended nor required in Biological Safety Cabinets (BSC)."**
>
> Applied Biosafety. "Position Paper on the Use of Ultraviolet Lights in Biological Safety Cabinets"
>
> Jyl Burgener, Eli Lilly and Company

Even though the vast majority of our UV-equipped cabinets were using the effects of the radiation to assist with disinfecting their cabinets, users of these BSC's are also using chemical disinfectants [Isopropanol being the most common disinfectant in tissue culture areas]. Therefore, it has been argued that UV radiation is not necessary if the BSC is being properly disinfected using good aseptic techniques.

Precautions

- An individual should not expose themselves to UV radiation. Be sure the BSC is not being used with the UV light on. Most BSC's have the fluorescent light interlocked with the UV light switch with the window in the closed position for the UV light to be on.
- Wipe clean the UV lamp at least once every week or two.
- Check periodically with a UV meter to ensure the effectiveness of the radiation.
- When disposing of a spent UV lamp, dispose of it as hazardous waste.
- Beware the ozone emitted from the radiation can cause plastics/rubber to deteriorate.
- UV radiation should not take the place of wiping down the cabinet interior with a disinfectant.

Germicidal UV Lights in NuAire Equipment

NuAire is a manufacturer of everyday use laboratory equipment with over 100,000 biological safety cabinets in use worldwide.

Ultraviolet lights are not always necessary but can be found in over 80% of NuAire biological safety cabinets sold. UV lights can be useful as an added defense against contamination and to maintain work-zone sterility in addition to your routine cleaning sequence.

If you do not know your facilities' standard operating procedure (SOP) in regards to UV usage, please consult your Environmental Health and Safety Department or Biosafety Officer to confirm your SOP about operating a Biological Safety Cabinet.

References

1) Luckiesh, M, Holladay, L. L., Taylor, A. H., "Sterilization through Utilization of Ultraviolet Radiation", Solar Light Co. 1999

2) Meechan, P. J., Wilson, C., "Use of Ultraviolet Lights in Biological Safety Cabinets: A Contrarian View", Applied Biosafety, 11[4] pp., 222-227 @ ABSA 2006

3) University of Minnesota, Environmental Health and Safety, "UV Lights" June 14, 2010

4) Burgener, Jyl., "Position Paper on the Use of Ultraviolet Lights in Biological Safety Cabinets", Applied Biosafety, 11[4] pp., 228-230 @ ABSA 2006

NuAire Portable Ultraviolet Lights

NuAire offers portable UV germicidal lights, which are placed inside a biological safety cabinet providing an average intensity of 100 microwatts per centimeter (for a new tube) falling on a horizontal plane defined by the bottom of the work surface. The minimum requirement per paragraph 5.12 of NSF Standard 49 is 40 microwatts per square centimeter (ref. NSF Std. 49 June, 1976).

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