Q&A Session for

Covid-19 Protection with the Power of Ultraviolet Germicidal Irradiation

Session number: 1307682417 Date: Wed 2020-Oct-21 Starting time: 12:47 PM

from Mingchang Wang to host & presenter: Good afternoon! This is Mingchang from KW section. Thanks for orginizing this event!

It's a pleasure

October 21, 2020 1:17 PM

from John Harris to everyone: From Ahmed Aki: What is the effect of Ozone created during air purification? How can we overcome it?

This type of bulbs we use don't make significant Ozone. Please take a look:

http://www.uvresources.com/blog/the-ultraviolet-germicidal-irradiation-uv-c-wavelength/

October 21, 2020 1:29 PM

from Mingchang Wang to host & presenter: From Mingchang Wang: I was reading article from Dr. David Brenner from Columbia University about UVC-222nm, which is harmless to eye and skin. What is your take on this?

Thank you very much for pointing to this article.

http://www.columbia.edu/~djb3/papers/Germicidal%20Efficacy%20and%20Mammalian%20Skin%20Safety%20of%20222-nm%20UV%20Light.pdf

My understanding is the article says it's safe for skin not for eyes yet.

If proven to be safe to eyes as well as skin, continuous operation of far-UVC light would not require the use of cumbersome protective clothing, hoods and eye shields for the surgical staff and the patient (22, 23).

October 21, 2020 1:31 PM

from Keyan Fayaz to host (privately): How would one go about validating a UV disinfection system's log reduction against a microbe?

Great question.

In the article below, fundamentals of UV disinfection phenomena are addressed; furthermore, the essential parameters and protocols to guarantee the efficacy of the UV sterilization process in a human-safe manner are systematically elaborated. In addition, the latest updates from the open literature on UV dose requirements for incremental log removal of SARS-CoV-2 are reviewed remarking the advancements and existing knowledge gaps. This study, along with the provided illustrations, will play an essential role in the design and fabrication of effective, reliable, and safe UV disinfection systems applicable to preventing viral contagion in the current COVID-19 pandemic, as well as potential future epidemics.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7571309/

Please take a look performance validation section.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7571309/table/tbl1/?report=objectonly

October 21, 2020 1:31 PM

from Ghassan Dahman to host (privately): If certain areas are not subject to being exposed to direct rays (for example, cracks or areas behind other objects). Can diffraction contribute to have these areas being disinfected? If the high frequency of UV prevents diffraction from being enough for disinfecting such areas, how can UV-C systems be used for such cases? For example, even if you have a robot UV-C system for room disinfection, there will be significant areas within the room that are not exposed to direct rays.

Correct. This disinfection system is not efficient enough for such areas you mentioned.

October 21, 2020 1:32 PM

from jon blois to host (privately): what is the wavelength and illumance of the pin pad device?

Thanks for the question,

If you mean PIN PAD disinfection device, we used:

PL-L18W/TUV 18 watt Germicidal UV UV-C Bulb Lamp 2G11 4pin Base

https://www.amazon.ca/PL-L18W-2G11-254nm-Ultraviolet-Light/dp/B077N4F3Z9

October 21, 2020 1:34 PM

from Edmond Zahedi to host & presenter: How did you test the efficiency of the system on real pads? Also ensuring that the UVC does not damage the cover of the pads? Thank you.

Good question,

For the efficiency of the real system we use UVC meter.

For damage of pad cover it's not significant. It's light and a little heat.

October 21, 2020 1:35 PM

from Fred Scaffidi to host (privately): Is there an impact on efficacy when dealing with virus entrained in saliva?

Thank you for the question,

We considered the UV dosage a little more than it actually needed to inactivate the virus. I think as saliva includes some water, it should be test in the Lab anyways.

October 21, 2020 1:35 PM

from Tom Grubb to host (privately): Does this device create Ozine?

Thank you for the question.

Please take a look below link as well as the first question's link about Ozone free:

https://growsaver.net/en/innovation/ozone-free-vs-ozone-generating-lamps-how-can-each-help-your-grow-operation/

October 21, 2020 1:35 PM

from Kris Rupay to host (privately): You mentioned coronavirus dosage a number of times. Are you aware of any studies on the dosage required to deactivate the replication of SARS COV19 Virus?

Thank you for the question. On the time we started making the device there was not any robust research on that. There were some averaging measures available:

But there is some available like

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7571309/table/tbl1/?report=objectonly

and

https://www.researchgate.net/publication/339887436_2020_COVID-19_Coronavirus_Ultraviolet_Susceptibility

October 21, 2020 1:36 PM

from David Hisey to host (privately): Ozone - are we talking about a boiler or killing virus in an air handling unit?

We are talking about the ability of UVC light for disinfection. So boilers are an application, Yes.

October 21, 2020 1:39 PM

from Dan Gale to host (privately): What is the easiest way to estimate the spectrum of my UV-C systems (I have two) did I receive a unit that is roughly in the desired wavelength range? I'm not looking for precision. Is there a material or liquid that will change (colour) when exposed to UV-C in the range 225nm to 275nm?

Thank you for the question, yes, the device name is UV-C meter. It comes with different accuracy. There are some which have Bluetooth.

https://www.amazon.ca/MeterTo-UVC254-Light-Meter-cm%C2%B2%EF%BD%9E39-99mW/dp/B079N9ZRYG

October 21, 2020 1:42 PM

from Mingchang Wang to host & presenter: Thank you for sharing your thought. So the article is published on nature research journals. https://www.nature.com/articles/s41598-020-67211-2

Thank you so much again and it's really great.

It shows far-UVC light will show comparable inactivation efficiency against other human coronaviruses, including SARS-CoV-2.

Anyways for our PIN PAD disinfection device we needed an enclosure for effectiveness and efficiency of disinfection by UV-C light,

October 21, 2020 1:48 PM

from Terence Branch to host (privately): How effective is your UVC device in defecting masks?

Good question,

We didn't measure it. It's possible to disinfect the mask but it may need different UVC dosage. It should be test in the Lab.

October 21, 2020 1:50 PM

from David Hisey to host (privately): Have you any experience with the effect of UVC rays on Chrome tanned leather? For exmaple the production of Cr VI Hexavelat Chromium

Thank you for the question. We focused on PIN PAD devices. There is a link here:

https://www.researchgate.net/publication/287841114_Study_of_the_effect_of_temperature_relative_humidity_and_UV_radiation_on_chrome-tanned_leather_ageing

October 21, 2020 1:51 PM

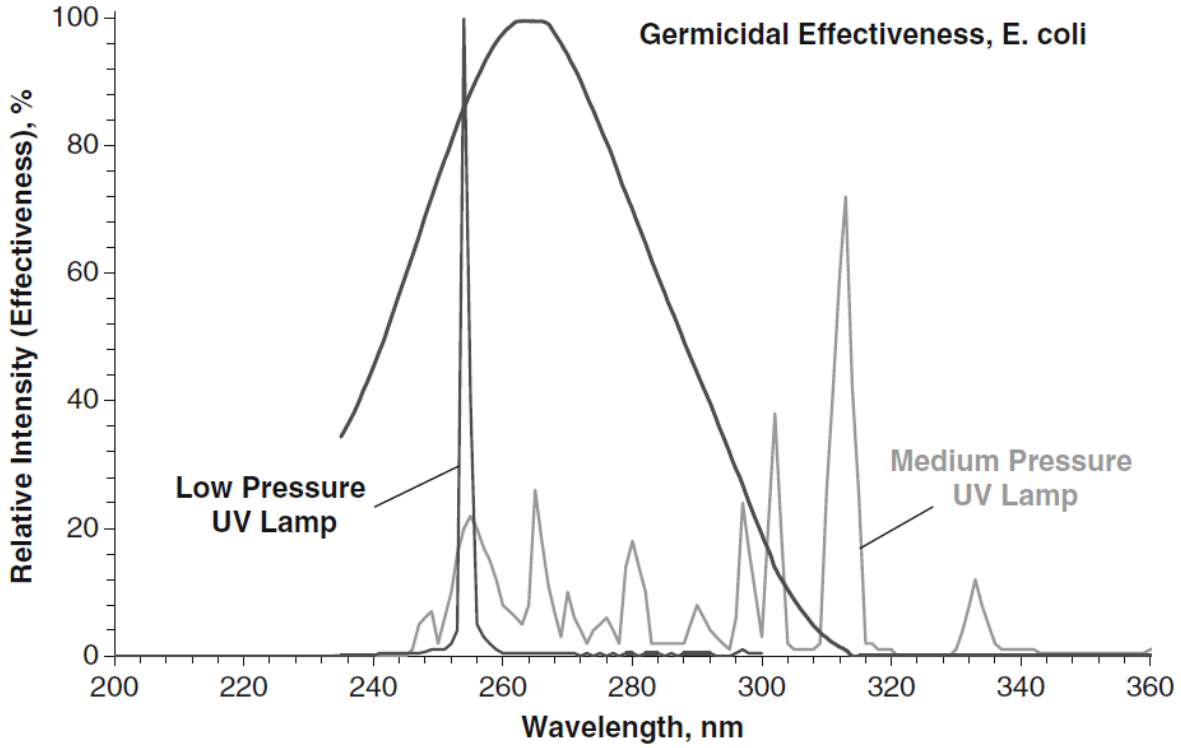
from Fred Scaffidi to host (privately): thank you.

October 21, 2020 1:51 PM

from Kris Rupay to host (privately): You mentioned UVC peak is ~254nm? Is this the peak of mercury lamps or UVC disinfection? I had thought it was closer to 265-270nm?

Thank you for the question.

The figure below shows germicidal efficiency of UV wavelengths, comparing High (or medium) and Low pressure UV lamps with germicidal effectiveness for *E. coli*. Based on data from Luckiesh (1946) and IESNA (2000)



October 21, 2020 1:51 PM

from Kris Rupay to host (privately): Any preference between Mercury Lamps or LEDs?

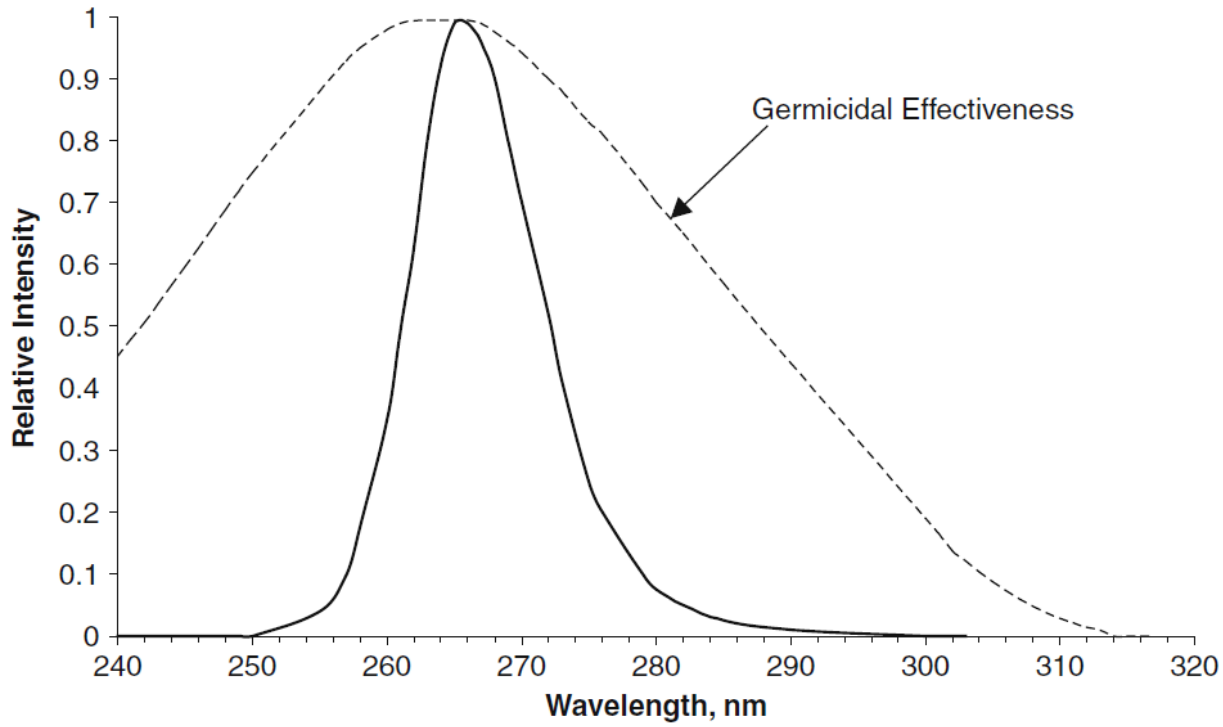
Great question,

From Ultraviolet Germicidal Irradiation Handbook page 127:

Ultraviolet light emitting diodes (LEDs) are compact light sources that come in a variety of shapes, including tiny bulb shapes, hemispherical, and flat chips (Bettles

et al. 2007). UV LEDs have certain advantages over UV lamps. They are smaller and do not require an electronic ballast for starting. UV LEDs may be located where
space does not permit regular UV lamps. Another advantage includes the fact that UV LEDs do not use the toxic heavy metal mercury. The LED is a p-n junction semiconductor lamp that emits radiation when biased in a forward direction (IES 1981). Two semiconductor materials are used to create the junction: one having an excess of electrons (negative or n-type material), and one having a shortage of electrons (positive or p-type material). Most near-UV (380–400 nm) LEDs (aka UVB LEDs) employ InGaN quantum well structures with GaN barriers, while deep-
UV LEDs (aka UVC LEDs) require AlGaN alloys with aluminum concentrations of 50% and higher (Guha and Bojarczuk 1998). Milliwatt power output levels have been achieved with deep-UV LEDs and research to produce higher power LEDs is ongoing.
Although LEDs are relatively low power (i.e. about 100 mW), they can be installed in larger arrays to produce power levels suitable for airstream disinfection.
LEDs can be modeled as point sources for analytical purposes. One advantage of UV LEDs is that they can produce UV at the optimum wavelength (about 265 nm) for germicidal effectiveness. Figure 5.5 shows one example of the spectral output of
a nominal 265 nm UV LED. Experiments on *E. coli* have confirmed that arrays of UV LEDs producing 270 nm UV can inactivate the bacteria at lower power levels than typical mercury vapor lamps (Crawford et al. 2005). UV LEDs are also available
in nominal 255 nm and other wavelengths.

The figure below shows Spectral output of a nominal 265 nm LED superimposed on the germicidal effectiveness
curve (compare with Fig. 5.1). Based on data from Seoul Optodevice Co. Ltd., Korea



October 21, 2020 1:51 PM

from Edmond Zahedi to host & presenter: Thank you, bye!

October 21, 2020 1:53 PM

from Fred Scaffidi to host (privately): Just an occupational health question: is the danger to the eye when you look directly at the UV source? Is there the same danger when dealing with UV possibly refected from surfaces?

Nice question,

Yes, but it depends of the material it reflected. Some surfaces, such as snow, sand, grass, or water can reflect much of the UV radiation that reaches them.

https://eprints.usq.edu.au/19645/2/Turner_2011_whole.pdf

October 21, 2020 1:54 PM

from John Harris to everyone: from David Hisey to host (privately): 1:36 PM

Ozone - are we talking about a boiler or killing virus in an air handling unit?

As discussed above, we were talking about the concept and the applications. We provide one case study for PIN pads.

October 21, 2020 1:59 PM

from Keyan Fayaz to host (privately): Thank you for the session!

My pleasure

October 21, 2020 1:59 PM

from Fred Scaffidi to host (privately): thank you, very interesting presentation.

My pleasure

-ahmed akl (ahmed.project123@gmail.com) - 1:14 PM

Q: What is the effect of Ozone created during air purification? How can we overcome it?

We used ozone free bulbs

-Irvin Randhawa (irvinkaurrandhawa@cmail.carleton.ca) - 1:32 PM

Q: Can you please share the UV slides with attendees if possible?

Priority: N/A-

I'll share it after patent works be done.

-Ed Shahir (sshahir@ieee.org) - 1:37 PM

Q: What is the minimum UV-C power to use for disinfection?

Priority: N/A-

Thank you for your question.

It depends what virus or bacteria you want to disinfect and on what degree of survival.

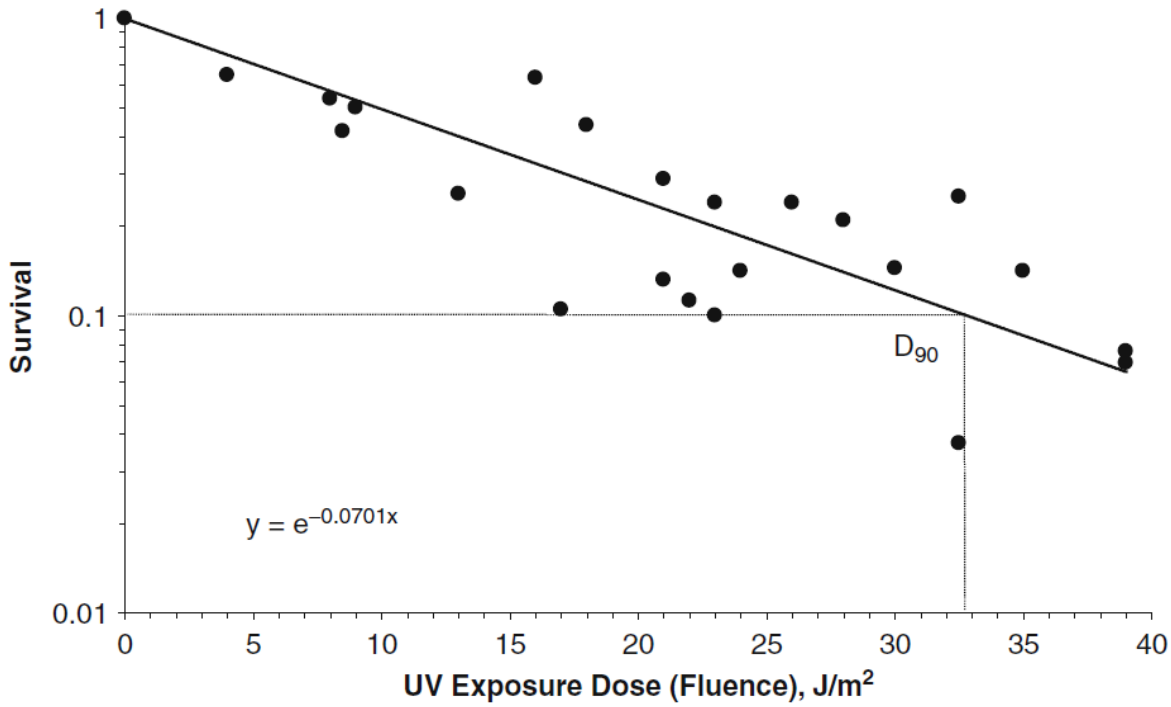


Fig. 3.1 Survival of *Corynebacterium diphtheriae* under exposure to UV irradiation. Based on data from Sharp (1939). *Line* is curve fit of the indicated exponential decay equation

So first we find the D90 (inactivate 90%) or D99 (inactivate 99%) dosage needed base on the UV constant of the Virus we want to inactivate.

Table 1: Summary of Ultraviolet Studies on Coronaviruses

Microbe	D_{90} Dose J/m²	UV k m²/J	Base Pairs kb	Source
Coronavirus	7	0.35120	30741	Walker 2007[a]
Berne virus (Coronaviridae)	7	0.32100	28480	Weiss 1986
Murine Coronavirus (MHV)	15	0.15351	31335	Hirano 1978
Canine Coronavirus (CCV)	29	0.08079	29278	Saknimit 1988[b]
Murine Coronavirus (MHV)	29	0.08079	31335	Saknimit 1988[b]
SARS Coronavirus CoV-P9	40	0.05750	29829	Duan 2003[c]
Murine Coronavirus (MHV)	103	0.02240	31335	Liu 2003
SARS Coronavirus (Hanoi)	134	0.01720	29751	Kariwa 2004[d]
SARS Coronavirus (Urbani)	241	0.00955	29751	Darnell 2004
Average	**67**	**0.03433**		

[a] *(Jingwen 2020)* [b] *(estimated)* [c] *(mean estimate)* [d] *(at 3 logs)*

And then in table below we calculated the different irradiation needed to inactivate the virus (we considered the average K here) in 30 seconds:

k: UV Constant (m2/J)	Kill%	DOSE:UV Exposure Dose (J/m2)	Exposure time (Sec)	Irradiation (W/m2)
0.03433	0.9	67.07209709	30	2.23573657
0.03433	0.999	201.2162913	30	6.707209709

And then this irradiation (W/m^2 or mW/cm^2) shows how many bulbs (Watt) with what length we need.