DOGUS UNIVERSITY

TECHNICAL REPORT:

"ANTIMICROBIAL / ANTIBACTERIAL DISINFECTION EFFECT OF 254 nm UVC RADIATION ON AIR AND SURFACES"

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This report has been prepared in order to evaluate the effect and effectiveness of UVC Radiation applied for the disinfection of air and all kinds of surfaces within the scope of the COVID-19 pandemic, which has been active recently, based on objective and the latest data. The main reference source is the Committee Report approved by the IES Standards Committee on April 15, 2020. It is indisputable that this study, which is the best known in this field as IES (Illuminating Engineering Society), has the latest and most valid data on this subject. In addition, studies supported by the United States Homeland Security Program were also examined and evaluated. In all studies, the newly published "Method of evaluating the UV dose to airborne microorganisms transiting in-duct ultraviolet germicidal irradiation devices" INTERNATIONAL STANDARD-ISO 15714, First edition, 2019-07 standard was used. In addition, recently Turkish Republic, the Ministry of Health, General Directorate of Public Health, document numbered 19020089-105.99, on "Disinfection with UVC Rays" was also taken as a basis.

In this context, the condition of 254 nm luminescent systems used in various products of LTC-Light Trade Center Company was evaluated. Here, the Company's UVCpectra Tube-Air Disinfection; UVCpectra Tower-Media Disinfection; UVCpectra Cabin Clothing Disinfection; Evaluations on UVCpectra Explorer Floor Disinfection products will be given.

Introduction

The previously known and widely used antimicrobial UVC irradiation of the COVID-19 pandemic that broke out in 2019 has brought the use and applications for disinfection. It has been observed that many infectious microorganisms are inactivated by radiation at 253.7 nm wavelength. As an effective disinfection method for a long time, UVC radiation has been used effectively in water treatment, heating-air conditioning installation and biology laboratories with shielded radiation. It is already used against the transmission of tuberculosis by air in many countries. In the USA, it is used in all kinds of environments (patient rooms) by means of autonomous mobile units in some health and medical

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institutions. Except for some extremely limited and easy to control drawbacks of UVC radiation, it is a method with proven and known disinfection efficiency and effect on both air and all kinds of surfaces.

Antimicrobial UVC Radiation

Antimicrobial UVC radiation has been proven to kill bacteria and spores of short wavelength UV rays (Radiant energy) and inactivate fungi and viruses. It has been shown that the radiation known as UVC and with a wavelength range of 200-280 nanometers provides highly effective disinfection (Figure 1)

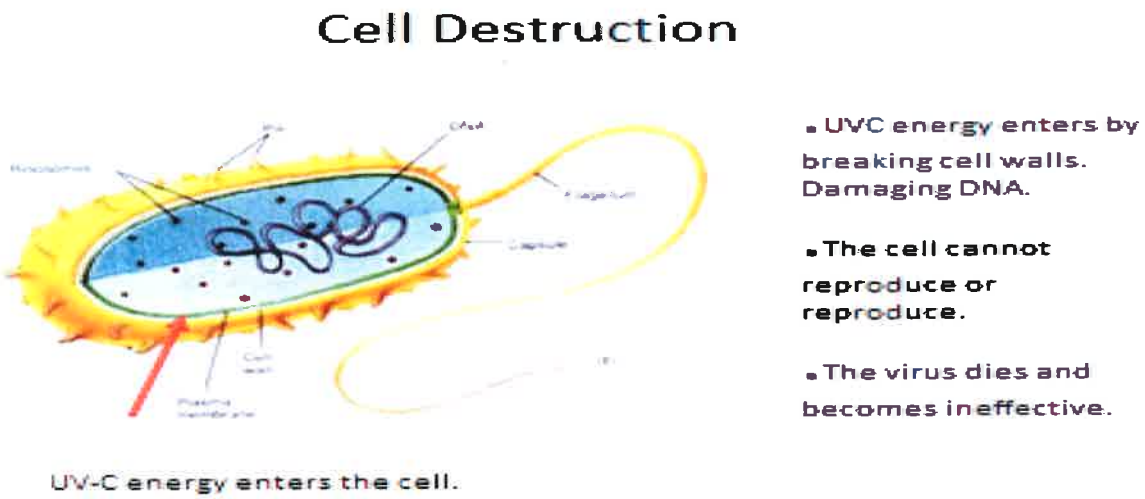

*Figure 1.**Inactivation of viral cell by 254 nm UVC Irradiation***
(https://slideplayer.com/slide/12134678/)

UVC radiation kills bacteria but renders viruses known to be non-living organisms "ineffective". Energetic UVC photons photochemically interact with the DNA and RNA molecules of a virus and this eliminates the virus / microbes from being contagious.

Does UVC Radiation Make COVID-19 Viruses "Ineffective"?

YES. It is known that the UVC light source in the range of 230-285 nm disrupts the genetic structure of microorganisms in such a way that they cannot reproduce. Although the peak point is around 265nm, the radiation at 254nm wavelength conventionally radiating from fluorescent tubes causes a very high rate (> 80%) of DNA / RNA degradation.

Is UVC radiation harmful to human health?

When UVC radiation is applied at the correct wavelength, it is an effective disinfectant. Avoid direct exposure to the eyes and skin of individuals at 254 nm wavelength. Hand disinfection is never possible with 254 nm UVC radiation. This radiation sterilizes and disinfects air and all kinds of surfaces and creates a hygienic environment at the highest level.

UVC Disinfection Application

As it is known, microbes / viruses remain in the air for minutes or even hours as droplets of 1-5 microns in size by hanging in the air (sneezing, coughing or blowing into the air by blowing from a surface). In addition to the mask, cleaning, distance, ventilation and similar measures, it has been shown and proven that the effective UVC radiation, especially the condensed air in the upper parts of the spaces, provides the highest effective disinfection.

In general, antiviral / antimicrobial UVC Lamps emit 254 nm UV radiation energy. This radiant energy stops the mutations of the virus by damaging the RNA and DNA of the virus, and thus eliminates their reproduction and contagiousness.

Due to this feature, anti-microbial UVC is most effectively used in the upper parts of the spaces. In addition, it effectively neutralizes all kinds of viruses / microbes, bacteria, spores, fungi and molds, especially COVID-19, in ventilation, air cleaning and air conditioning systems.

Use of UVC Radiation in HVAC Ventilation Units

COVID-19 passivation / activation with UVC Radiation is performed in many areas commonly used by the society, especially in hospitals, airports, subway stations, schools, cafes-restaurants, movie theaters, and so on:

1. For the control and disinfection of pathogens suspended in the air near the ceiling and rising gradually;

2. Disinfection of floors and walls with mobile UVC radiation (often autonomously with robotic systems);

3. In the disinfection of the circulating air in HVAC ventilation units of UVC Radiation (Figure 2).

*Table 1.**Use of UVC Radiation in HVAC Ventilation and Surface Disinfection (1)***

Device	Suspended in the air	Welded from the surface	On Air or Surface	According to proven data	Experimentally	Use throughout the pandemic	Always use
Mercury UVC lamp mounted in HVAC	-	-	*****	****	-	✓	✓

(*) the number of asterisks indicates the primary utility; the higher the number of stars, the more recommended

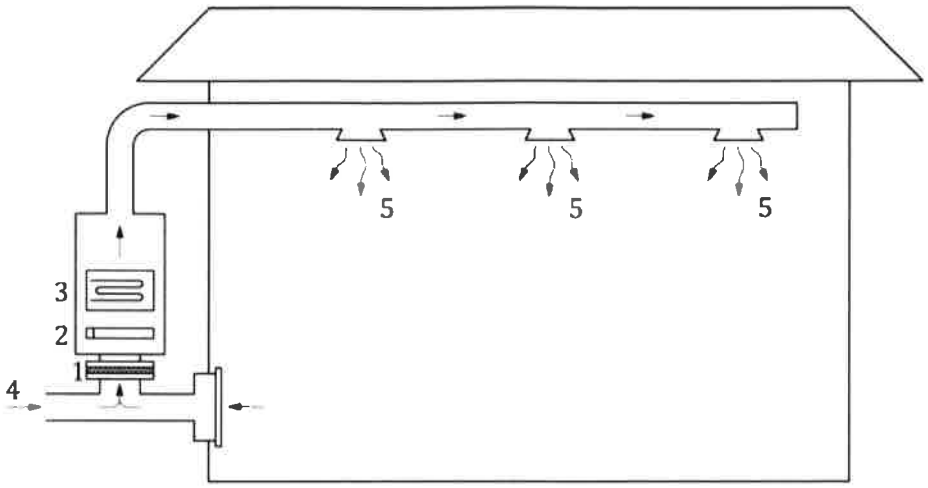

*Figure 2.**A typical HVAC with UVC Radiation system applied***

1-filter; 2-UVC lamp; 3-heating or cooling tubes; 4-fresh air; 5-Cleaned disinfected air Table

2. Advantages and Disadvantages (1)

ADVANTAGES	DİSADVANTAGES
• Suitable for all climates • Closed system • Cleans recirculated air • Keeps all surfaces in HVAC clean from all kinds of microorganisms.	• Avoid direct exposure • Costly to coat and maintain • Affects filtration • Possible material wear may occur

UVC Radiation Dose Effect

Microbial / viral activity is directly proportional to the dose / amount of radiation. The irradiation time is given by calculating the amount of radiation per square centimeter (mJ / cm^2) and the irradiation time. Disinfection efficiency and efficiency increases up to 99% with the increase of irradiation amount and duration. When this dose / amount is reduced by half, efficiency and effectiveness decrease to 90%. With a specified dose, the disinfection process is given as "single-log lethality". Practically, if these 3 or 4 "log killer" processes are implemented, the efficiency goes up to 99.99%. The calculated upper dose limit is 10.6 mJ / cm^2, but with a more precise calculation, it has been shown that this dose is 3.7 mJ / cm^2 (3). According to the results of the study conducted by

Boston University with Signify (known as Philips) to investigate the effects of UVC on the Covid19 virus, published on June 16, 2020, the dose of 5mJ / cm^2 eliminates more than 99% of the Covid19 virus. (12)

Results

It has been proven in all kinds of studies published to date that UVC radiation is effective against all types of coronavirus. Therefore, systems and applications with UVC radiation are sufficient to inactivate all types of coronavirus (3).

LTC-Light Trade Center firm products:

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The status of 254 nm luminescent systems used in various products of LTC-Light Trade Center Company was evaluated. Here, the Company's UVCpectra Tube-Air Disinfection; UVCpectra Tower-Media Disinfection; UVCpectra Cabin Clothing Disinfection; products are in question. With the use of 3 lamps in each unit, the voltage is given as 176 V with a power of 75 W and a lamp current of 0.425. UV-C radiation for 100 hours: 25/31 W.

PHILIPS TUV T5 36T5 HO 4P SE UNP / 32 was used in all the mentioned products, and the characteristics of these lamps with the commitment and certification of Philips are listed as follows: Three UVC-germicide lamps were used. UVCpectra Tube-Air Disinfection thanks to these 16 mm diameter lamps; UVCpectra Tower-Media Disinfection; UVCpectra Cabin Clothing Disinfection designs were realized. The Philips brand is committed to stable UV output, maximum disinfection assurance and high efficiency.

LTC Company provides the following qualities with Philips norms in the products developed with these UVC lamps:

- Useful lifetime: 9000 hours; (There is a 5% reduction after 9000 hours)

- System description: High output;

- Color code: TUV

- Power: 75 W / bulb;

- Lamp current: 0.8 A

-Voltage: 97 V

- UVC irradiation 100 hours: 25 W

- EAN- European Article Number / UPC- Universal Product Code: 8711500869708

PHILIPS TUV T5 36T5 HO 4P SE UNP / 32 germicide lamps are used in drinking water disinfection, waste water, swimming pools, food processing and packaging. The most important of its main areas of use is used in all kinds of spatial air and air conditioning air disinfection.

Depending on the use of PHILIPS TUV T5 36T5 HO 4P SE UNP / 32 in all product designs, LTC-Light Trade Center's UVCpectra Tube-Air Disinfection; UVCpectra Tower-Media Disinfection; UVCpectra Cabin Clothing Disinfection; As long as the standard UV dose given is applied, they are suitable commercial products that can effectively disinfect.

Another product of LTC company, **UVCpectra Explorer Floor Disinfection, includes 2 36 Watt Philips TUV PL-L 36W / 4P 1CT / 25 brand and model UVC lamps applied at a maximum distance of 60 mm to the floor. This product, which can eliminate 99% of viruses provided that it travels 60 meters per minute (5mj / cm^2), is expected to eliminate 99.99% (10mj / cm^2) of viruses at 30 meters per minute.**

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