

Sanitization Tunnel Using Silver ION Technology

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Abstract— This paper illustrates the mechanism and importance of a fully automatic disinfection tunnel to decontaminate the external surfaces of the human body like clothes and visible body parts to protect the human body from the COVID-19 virus. These tunnels require less space and are stationed at the entrance of crowded places like airports, shops, offices, schools, hospitals, shopping malls etc. To make the tunnel highly effective against the COVID-19 virus, a two-step disinfection process has been proposed which is not only safe for the human body (unlike using chemicals like sodium hypochlorite solution which causes skin & eyes irritation) but is also cost effective. When a person enters the Chamber 1 of the tunnel, he/she gets exposed to “far-UVC radiations” of wavelength 207-222 nm. In this step the surface disinfection takes place. Once the person enters chamber 2, the fumigation of the disinfectant solution starts. This solution is a dilute mixture of “Silver Ions” and water. Both far-UVC radiations and Silver ion technology are highly effective against the COVID-19 virus and are emerging as reliable source of disinfecting agent replacing the chemicals like sodium hypochlorite which are harmful to both humans & the environment. This study will give the user an insight of both the technologies- far-UVC & Silver ion as well as play an essential role in design and mechanism of the safe disinfecting tunnel and will help in playing an important role in stopping the COVID-19 pandemic, as well as other future pandemics.

Keywords: Silver ION Technology, FAR-UVC Radiation, COVID-19, Dis-Infection Tunnel

I. INTRODUCTION

In this recent ongoing pandemic that is the coronavirus pandemic which has shook the entire world is not coming to an end rather it keeps on spreading. We have seen that this virus that is the coronavirus is spreading from human to human via droplets (that is when infected person talks, sneeze or cough), the tiny particles carry virus into air and the other person gets infected if those particles enter one's nose or mouth. From the research it is also shown that the virus can live in air for about 3 hours, 4 hours on copper surfaces, 24 hours on cardboard surfaces and the virus can live on surfaces of plastic and stainless for 2-3 days. This tells us that the if proper cleaning and sanitization is not done the spread of virus will continue increasing via air and infected surfaces. With proper dis-infection and cleaning, the spread of virus can be controlled to some level. And luckily the vaccine has also been discovered for the covid-19. So along with taking the vaccination our focus should be also on how to kill the virus that is already in the air or on the surface and also how to stop the virus from entering our homes or work places, so that we could keep those places safe as after is vaccination there is not 100 percent surety that you will not get infected again. So proper hygiene and cleanliness should be kept at home and workplace. To slow and stop the spread of virus from person to person the idea of ‘SOCIAL DISTACING’

has proven to be a great strategy, however in a country like India having average density of 382 persons per sq. km, it is exceedingly difficult to maintain social distancing. And if going to the market the rush in those places or the que formed for the shops hardly make it possible to maintain social distancing. That is why lock down was imposed. Now to make our lives somewhat same, as it was before and also at the same time to help in controlling the pandemic situation, the idea of ‘DIS-INFECTION TUNNEL’ is being used. A ‘DIS-INFECTION TUNNEL’ can perform the function of killing the virus as well as protecting the person for further infection (for a brief time) in public place. It would also make the idea of keeping the home and workplace safe from virus possible. After the lockdown is revoked and the movement of people would start this automated dis-infection tunnel working on two technologies would be effective in virus spread control. When the person would enter the tunnel first the person would be exposed to the UVC radiations, which would kill the virus present on the surface and after this the mist of silver ions would surround the body which would not only kill the virus present on the body which comes in contact with the silver ion particles, but also the silver ions will stick to body prevention from further attack from virus for some period. Both these technologies are worked upon and are proven to be effective against killing of the corona virus. The UVC radiation as well as the silver ion technology are also researched and proven to show strong bactericidal properties and also have extremely low toxicity towards animal cells and hence doesn't harm humans (if taken in low dosage). These technologies can be of foremost importance in making the places free from virus by reducing the virus spread from one place to another, by lowering contamination rate on clothes, skin and all other things which are being dis-infected in the tunnel, and hence this would be a great step in keeping our home and workplaces free from the virus as much as possible by lowering the spread of virus and also by killing the virus.

II. BACKGROUND

This paper is based on the studies and the latest findings on the processes which can be used to kill the coronavirus. The main purpose was to use two techniques together which are being studied and found to be effective against the coronavirus, to make a better way to sanitize and disinfect a person. This paper tells us that how the two techniques are being used and in what way, to sanitize a person before he/she enters a place to make the place safe from virus and also to prevent further spread of virus. The main emphasis was on the two technologies that is far-UVC radiation and silver ion technology and about their bactericidal properties, how they help in killing the virus.

III. LITERATURE SURVEY

In the month of February 2020, china started using disinfectant tunnels in the markets and outside workplaces buildings to sanitize the person, in this they use compounds

of sodium hypochlorite, whose usage can cause skin irritations and also spraying this consumes large amount of water. In June 2020, a research paper was released which enlightened everyone on the killing action of UVC radiation and this was also effective against coronavirus. But its direct exposure to human can cause damage to eyes and skin. In 2018 far-UVC light was discovered which was better UVC light of 222 nm, it had all the properties of UVC light like killing action against viruses and also it had the advantage that it can be used on human as it didn't have any side effects on animal tissue. In August 2020, Dr Avinash Kumar Agarwal, Professor, Department of Mechanical Engineering, Indian Institute of Technology (IIT) along with his team through an experiment found that far-UVC radiation are effective against coronavirus and can kill about 99.99 % of virus from the surface. From past few years research is being going on the bactericidal properties of silver ions. And during the last months of the previous year, it was found that silver ion technology was effective against coronavirus, and it can kill the virus but the proper process how it kills the virus is yet to be discovered.

IV. FUNCTIONING

The first chamber is the one where the surface disinfection takes place where UVC lamp/LEDs are present. These UVC lamp/LEDs produce far-UVC (*UVC light that have a wavelength of 222 nm*) rays which are known for their properties to kill the virus by destroying the DNA of the virus, which is great property for disinfection, especially in the medical domain. The radiation produced by the far-UVC lamp/LEDs is absorbed by the DNA or RNA and proteins of the virus and inactivates the double helix strands of DNA through formation of thymine dimers which result in cease DNA replication and hence the cell cannot replicate. And since far-UVC has an *advantage of not harming or penetrating the skin and also have no effect on eyes*, it can be used without any problem. This problem was faced if using UVC LEDs of wavelength 254 nm. This step would not result in killing the virus but it would stop the virus present on the surface to stop replicating and this would require low dose of far-UVC radiations. Now, to kill the virus for good there is Second chamber installed in the tunnel which contains the spraying mechanism for silver ions. Rather than spraying, fumigation takes place which requires a lot less chemical resulting in cost saving. Since the use of other disinfectants which use chemicals such as sodium hypochlorite or a bleaching solution which are compounds of chlorine can cause skin irritations and wastes a lot of water the *SILVER ION TECHNOLOGY* is used, as it doesn't cause harmful

effects on skin and fumigation of silver ions not only saves the water but also it enables it to reach every corner of human body. The silver NPs show great antibacterial properties. The cell membrane of bacteria has sulphur constituting proteins and sulphur having amino acids, the silver can interact with them and results in bacterial inactivation. And not only has this Ag NPs interacted with phosphorous in DNA and sulphur containing proteins inhibiting their enzymes activities. In this disinfection process the size and shape of the particle also plays a prominent role in antimicrobial activity. If the size of NPs is smaller than 200 nm, it can result in maximum permeability through membrane resulting in cell death of bacteria. And in case of shapes, the truncated triangular shape Ag NPs exhibits higher antibacterial activity. Aside from this killing action of silver ion technology, there is a whole new benefit of using this. As when we fumigate the silver ion on the body, not only it would kill the bacteria on the person but also the silver ions would stick on the person's body and would form a protective antibacterial layer on the skin. The silver ions would stay on the body for a while eliminating all known microbes. This entire system is made up of two chambers joined simultaneously to make it modular and sleek so that it doesn't take much space. And the system would work on the motion sensors, which would detect the movement of the person and according to which the spraying mechanism would start.

V. DESIGN

The tunnel is designed considering the ergonomics and easiness for human and also the floor of the tunnel is kept inclined so that excess of the disinfectant can be drained out. The base of the floor is also somewhat elevated with respect to the ground. The tunnel is being made from mild steel pipes, because of their low cost and it can be easily worked upon. The dimension of the tunnel is taken as per the average human (male) dimensions. According to the studies it is found that average dimension of a male human is: height-1740 mm and weight-65 kgs. These two along with many factors were studies upon and the dimension of the tunnel was selected, which is shown in the figure 1: The dimension of about 250 mm is left from the ground for making the elevation and also, as seen in side view, at both the sides 600mm gap is also shown, signifying the dimensions needed to make a ramp. For making the floor of the tunnel wood is selected and upon which rubber or plastic mats are placed so that the excess of disinfectant can slide. And the outer body is made up of sheet metal and is to be covered with plastic cover which is dust and water resistant.

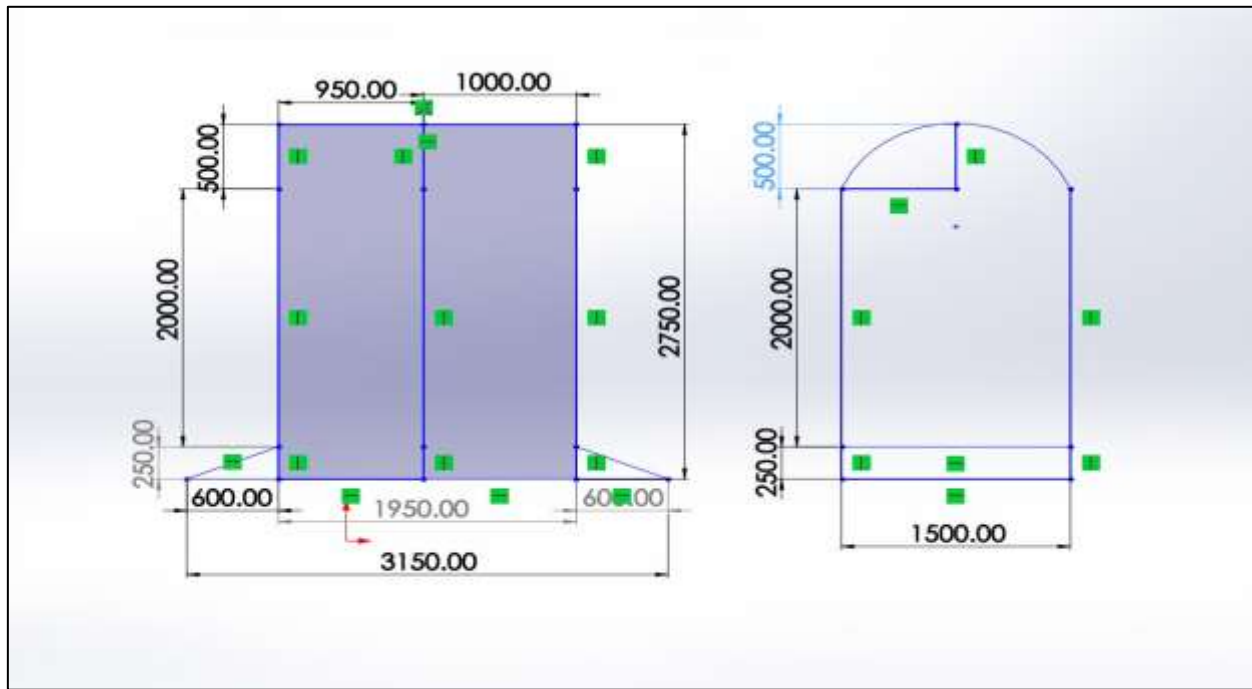


Fig. 1: Side view & Front view of the tunnel (all the length are in mm)

VI. DISINFECTANT SPRAYING MECHANISM

The spraying mechanism is divided into two parts. In the first part, the mechanism of far UV-C lights is explained and in the second part, the mechanism of Silver ion disinfectants is explained. The first chamber of the disinfectant tunnel consists of UVC light. In this chamber the surface disinfection takes place. UVC lights installation have mainly two components- far UVC Lamps/LEDs and a controller unit. We have installed overhead Ultraviolet C (far-UVC) lamps/LEDs (wavelength-222nm) which are capable of killing airborne flu viruses like corona virus, without harming human tissues. The overhead installation provides direct exposure to the body which ensures fast inactivation of virus. We have used *Low-pressure High output (HO)* lamps. The HO lamps provide higher doses and have smaller footprint. It has the potential to kill the corona virus at a much faster rates as compared to the normal UVC lamps/LEDs used in homes which takes longer time to potentially provide effective inactivation of the virus. We have used 38 Watts UV lamps/LEDs. The controller system controls the electrical output and powers the lamp to produce UVC light. The whole controller unit comprises of lamp-change timers, low-UV alarms and trouble indicator lights to which indicates when the system is not performing well. UV Lamp has a Motion Sensor. UVC lamp/LEDs, will automatically turn-off on detecting motion which saves on electricity. It has 99%-99.9% of the sterilization rate to kill bacteria, virus with high efficiency. The UV lamp/LEDs are pollution free and has minimal maintenance cost. The second chamber of the disinfectant tunnel consists of a spray mechanism for silver ion disinfectant. The various components used in the spray mechanism include, fog machine, silver ion solution, fluid tank, pipes, electrical components, and controller unit. This chamber is also fully automated. Once a sensor detects someone entering the chamber, the nozzles start spraying the disinfectant. No manual operation is required, which makes

the entire process contactless. Eventually the chances of virus spread reduces which makes the whole disinfection process more efficient. We have used *Silver Nitrate* in concentrations from 5% to 10%. This silver nitrate is diluted in water, in the ratio of 7:3 (7 parts of silver nitrate & 3 parts of water). Rather than spraying, fumigation takes place. For this application, a fog machine has been used. The fog machine breaks the disinfecting liquid (silver nitrate +water) into ultra-fine particles having size between 0.1 to 10 microns. These ultra-fine particles stay suspended in the air for a long time (3-4 hours). This suspension allows the disinfectant to spread throughout the chamber and hence increases the overall time of contact of the disinfectant with the viruses in the air. The ultra-fine particle size also makes sure that there is minimum wetting of surfaces.

VII. RESULT

Since our sanitization mechanism consist of two stages: 1 Dis-infection through UVC radiation & 2 Dis-infection through silver ions. In the first, in which the UVC radiations are concerned, the UVC radiation was found to be effectively destroying the outer protein layer of SARs-coronavirus (Severe acute respiratory syndrome coronavirus), hence inactivating the virus. And also, UVC radiation is found effective in destroying SARs-CoV-2 virus (virus causing COVID-19). Since far-UVC light is being used therefore its direct exposure would neither harm the human body nor the eyes in any manner. But if the dose duration is increases it may harm, therefore low dosage of UVC radiation would be given. When the person enters the chamber, he would be exposed to UVC radiation emitted by the UVC lamps which are present in all the directions of the human body, so that most of the body area is exposed to the radiation. And after exiting the first chamber when it would reach the second chamber, the mist of spray of silver ions would cover the whole body reaching every body part and therefore would result in not only killing the virus but also forming a

protective layer on the body so that it could be protected for some time against the virus. Since silver nanoparticles exhibit strong bactericidal properties, it would terminate the virus if present on the body, but main disadvantage of this is it would only be effective against the virus present on the surface. That is way mist is being sprayed, so that the silver ion particles could reach each and every part of the body.

VIII. SUMMARY

This paper discusses the importance and mechanism of the disinfection tunnel which is highly efficient in killing the COVID-19 virus. These disinfection tunnels are used to disinfect people from the COVID-19 virus and are installed at the entrances of public places like malls, office buildings, markets etc. The disinfection tunnel includes two chambers. In the first chamber, the person is exposed to far-UVC radiations of wavelength 222nm for a period of 20-30 sec. In the second chamber, the person is disinfected by the fumigation of silver ion solution for 20-30 sec (fumigation allows minimal use of water). The ultra-fine particles (0.1 – 10 microns) produced by the fog machine remain suspended in the air for a period and not fall to the ground immediately. This suspension of the particles ensures that the disinfectant reaches every corner of the body which eventually kills the virus. All these processes are done automatically with the help of ultra-sonic sensors when a person enters the tunnel. No manual operation is required which makes the disinfection process very efficient.

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