

Disinfecting Passenger Lift using UV Light during COVID-19

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Abstract— At present the elevator/lift is an essential necessity in hospital emergencies, shopping centre, multi storey buildings and residential apartment. During a day there are many people using the lift so there are chances of being infected from other people's using the same lift. Recently COVID-19 outbreak is an example of such kind of infection. Therefore, there is an acute requirement for proper disinfection/sanitization of passenger lift to prevent the spread of such harmful diseases. In Passenger lift people are transported between floors at reasonably quick speeds and the control systems are often designed to give the most economical distribution of passengers throughout the building. In today's occupied life, everyone needs an easy and convenient way to reach their destination, the elevator route is one of such way to get to the place early but due to prevailing conditions of pandemic using elevators is more prone to get infected. One of such solution to the above-mentioned problem can be use of UVC for disinfection. This paper illuminates about sanitization using UVC light in smart passenger lift to make it more feasible for human usage.

Keywords— Passenger Lift, Disinfection, development, UVC light, Benefits

I. INTRODUCTION

An elevator/lift is a type of cable-assisted hydraulic cylinder machine that vertically transports people as well as goods between floors of a building in an efficient and time-consuming manner. As these lifts transport individuals, they should meet specific standards and caliber to ensure that they are secure. Elevators are a standard part of any tall commercial or residential building. Due to the cause of rapid population growth of the cities and multistoried building, the need of elevators is being increased and hence the elevator has been one of the important tools of everyone's daily life. In the US each year elevators make 18 billion passenger trips and each elevator carries an average of 20,000 passengers per year. Elevators carry 40 times more bacteria than public toilet seats according to a study by the University of Arizona [1].

During 2020, the outbreak of COVID-19 in China, where 84,000 people have been infected and 4,600 have died [2]. In this present scenario there is a necessity to disinfect the passenger lift/elevator from these viruses. One such solution to the above-mentioned problem can be the use of UV light rays.

The disinfection properties of ultraviolet lighting are been used in destroying micro-organism. The Corona Virus can also be made inactive by using the Ultraviolet light. This paper emphasizes on disinfect/ sanitization of passenger lift using Ultraviolet light.

II. DEVELOPMENT OF LIFTS

The first lift to be invented is mentioned by Roman architect Vitruvius who reported Archimedes to have built in 236 BC. In 1743, King Louis XV commanded the construction of passenger lift called 'flying chair'. It was installed outside the king's balcony which was operated by hand. In 1793, the first screw drive lift was designed by Ivan Kulibin and was installed in the Winter Palace. In the 19th century after industrialization steam-powered lift were fabricated to move immense capacity of goods in factories. Sir William Armstrong in 1846 invented the hydraulic crane for the motive of loading cargo into ships. The Equitable Life Building, New York had the first passenger lift in the year 1870 and the opening of electric lift was introduced by Werner von Siemens in 1880. The foremost hydraulic lift with push buttons (without a driver) was operated in 1894 along with this Paris Universal Exhibition had its first lift operated in 1900. In 2000, the first vacuum elevator was offered commercially in Argentina and since then more lifts are installed and advanced technologies are been adopted [3].

III. CLASSIFICATION OF LIFTS

Lifts (or elevators) have become an essential part of everyday life, particularly, for those who work or live in high-rise buildings. There are many various types of lift which can be used in different applications, serving distinct purposes. Some kind of them includes building lift, capsule lift, hydraulic lift, pneumatic elevator, passenger lift, freight elevator, cable driven, residential elevators, machine room-less elevator.

A. Hydraulic Elevator

A hydraulic elevator is a power-driven by a piston that moves within a cylinder. The piston movement can be done by pumping hydraulic oil to the cylinder. The piston lifts the lift cab easily, and the oil can be controlled by an electrical valve. All the current hydraulic pumps are designed with a mechanical Y-delta starter otherwise solid-state contractor.

For the power supply of motor as well as building, solid-state starters are superior. Because the windings stay longer as well as there is no voltage drop across the building power supply [4].

Simple Hydraulic Mechanism

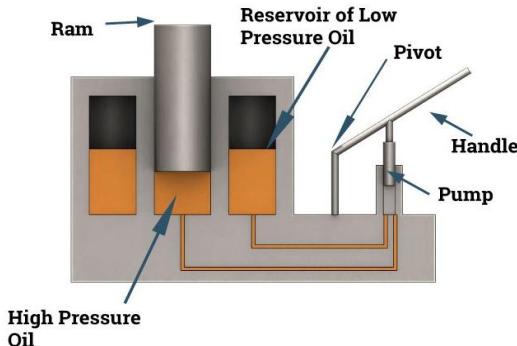


Fig. 1. Hydraulic Elevator

[Source- <https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcR6xpJS4-GfLGHGOGGgezuGGh8fgooTnyPpAw&usqp=CAU>]

B. Pneumatic Elevator

The pneumatic elevator can be designed with an external cylinder, and the cylinder is a crystal clear self-supporting cylinder. This cylinder includes modular sections to fit effortlessly into one by one. The top of this tube is designed with steel material that ensures tight air shutting by suction valves as well as inlets. A lift car runs within the cylinder, & the head unit on the top cylinder surface consists of valves, controllers, and turbines for controlling the elevator movements. Pneumatic elevators are very easy to fit, operate as well as maintain when compared with the traditional elevators. These are used in existing homes because of their solid design. The main benefits of using these elevators include solid design & smooth, speed and flexibility, energy efficient and very safe.

This elevator represents as a new concept derived and evolved from the pneumatic-vacuum elevator as the idea of vacuum air is changed by the pressed air. The electro-pneumatic elevator is capable of transporting people between floors without using any cables, counter weight, or pulleys.

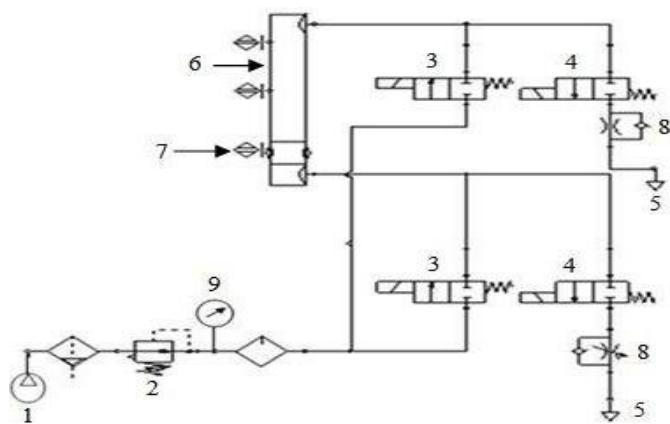


Fig. 2. Pneumatic Elevator
[Source- <https://www.researchgate.net/>]

C. Capsule Lift

Capsule lift or elevators are used in prestigious buildings, which can be called as decoration of a building because they improve the building's beauty as well as carries life into it. The main features of this elevators mainly include design, and travel comfort is best. The interior design of these lifts is attractive with a large glass panel for viewing. The ultramodern design of these lifts offers a cosmic zone travel experience for the passengers. These lifts are consistent and inexpensive with the least maintenance.

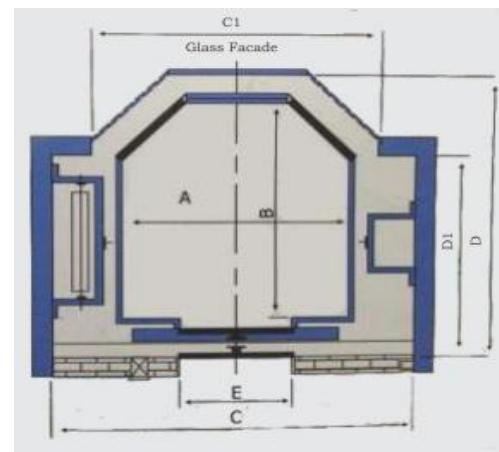


Fig. 3. Capsule Lift

[Source- <https://www.spaceelevators.org/images/capsule-elevator.jpg>]

D. PASSENGER LIFT

This type of lift has entirely included a lift car that moves vertically in a specially equipped lift shaft. Passengers are travelled between the floors in the building at quick speed. The control systems in the lift frequently designed to offer the most economical sharing of passengers all over the building. These lifts are very space efficient which are used in existing buildings where space is at a best.

The main advantages of using passenger lift give a very comfort traveling among different floors, particularly space efficient, fully fixed shaft, small construction works, and no level loadings on the building.



Fig. 4. Passenger Lift
[Source- https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQefKAzB99KFXT1Ii_DKlcrmMNI CKbAx058Dg&usqp=CAU]

E. FREIGHT LIFTS

In the world of elevators, these lifts are workhorses. These are very useful for transporting materials, goods in warehouses, manufacturing industries, shopping malls, seaports, etc. This type of elevator is separated into classes, to describe their load capacity as well as application. These lifts are strong in nature, and they are specially manufactured by engineers.



Fig. 5. Freight Lift

[Source-https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcS_cB-nDk7hOJR7aAanNFiIHxjdqsIIXuBiEQ&usqp=CAU]

IV. NEED TO GENERATE NEW TECHNOLOGIES FOR DISINFECTION

Recently Covid-19 outbreak worldwide is an example of infectious disease. During this period there is new technology advancement are in demand. UVC based technologies are helpful to control the spread of viruses and bacteria, also used in water purification etc. Many countries have developed new technologies based on UVC light to detect or destroy these viruses. Recently China has developed the UV light-based robots for clinical purposes [5]. Light earth industry has also developed the UVC Germicidal Lamp. These lamps offer 30% to 60% higher output at a spectral output of 254 nm and are ozone-free. Standard low-pressure mercury UVC germicidal lamps made of synthetic or natural quartz glass have spectral output at 254 nm and 185 nm and are ozone-generating.

The radiation of UVC tube light for sterilization has an intense bactericidal action. Microorganisms such as viruses, bacteria, yeasts and spores are effectively inactivated without the addition of chemicals [6]. The international company uv-technik ltd. has developed UV air disinfection / odor treatment. This involves microorganisms floating freely within the air of a room being treated by UVC radiation. This is far more effective than the conventional means for disinfecting air which are generally ineffective. UVC Air disinfection will lead to a substantial reduction of airborne organisms present within a room. The process for UVC air disinfection essentially involves air being forced by natural convection into the irradiated region of a uv disinfection device. The result is that the danger of airborne infection, which is a factor in many illnesses, is considerably reduced

[7]. Therefore, the UVC light is also useful for disinfecting passenger lift/elevator.

V. What is UV light

Electromagnetic radiation comes from the sun and transmitted in waves or particles at different wavelengths and frequencies. This broad range of wavelengths is known as the electromagnetic (EM) spectrum. The spectrum is generally divided into seven regions in order of decreasing wavelength and increasing energy and frequency. The common labels are radio waves, microwaves, infrared (IR), visible light, ultraviolet (UV), X-rays and gamma-rays.

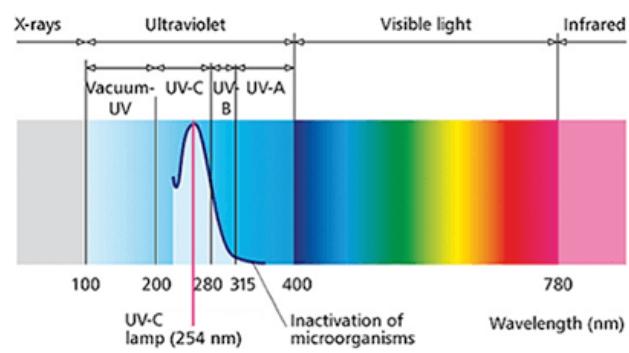


Fig. 6. Electromagnetic Spectrum
 [Source-https://www.intl-lighttech.com/sites/default/files/uv_spectrum_2_2.png]

In which ultraviolet light (UV) is a type of naturally present electromagnetic radiation that is in sunlight and actually makes up approximately 10% of the total light generated by the sun. UV light is electromagnetic energy with wavelengths shorter than visible light but longer than x-rays.

Ultraviolet (UV) light falls in the range of the EM spectrum between visible light and X-rays. It has frequencies of about 8×10^{14} to 3×10^{16} cycles per second, or hertz (Hz), and wavelengths of about 380 nanometers (1.5×10^{-5} inches) to about 10 nm (4×10^{-7} inches). UV is further classified into three categories according to its wavelength

- UVA, or near UV (315–400 nm)
- UVB, or middle UV (280–315 nm)
- UVC, or far UV (180–280 nm)

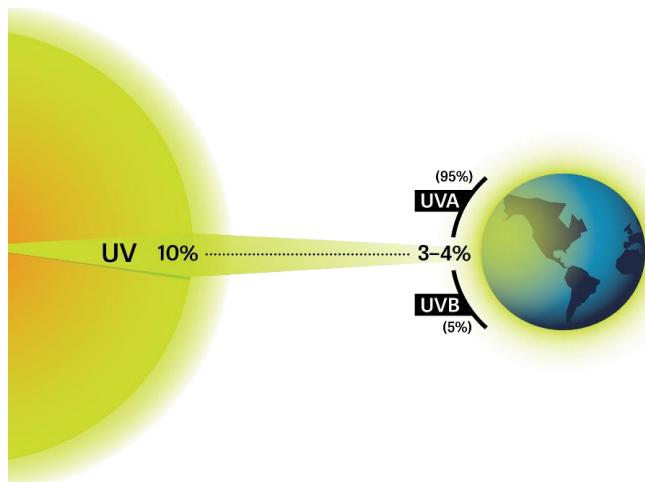


Fig. 7. Ultraviolet Rays [Source-https://klaran.com/templates/yootheme/cache/uv_sunlight_3-ad25cf2.png]

Most natural UV light is generated by the sun with about ten percent of sunlight being UV and only about three to four percent penetrating the atmosphere to reach the ground. Of the UV radiation that reaches the earth, 95 percent is UVA and five percent is UVB.

No measurable UVC from the sun reaches the earth's surface. Because of the spectral sensitivity of DNA, only the UVC region demonstrates significant germicidal properties.

VI. Keeping Elevators clean using UV light

In current scenario, where people are struggling against covid pandemic and the key to safety is social distancing the above mentioned UVC technology can be used or is in use in smart passenger lift.

From urban high rises carrying cabs filled with workers, to hospitals, universities, apartment buildings, airports and more, elevators ferry some 20,000 passengers of different age groups each day to their vertical destinations [8].

In addition to the numerous touch points found in elevators, from handrails to call buttons, elevators are small, enclosed spaces where germs can easily lurk on surfaces and in the air. Individuals belonging to old age group and children along with those having weak immune system are more prone to get infected within a passenger lift. Frequent cleaning of elevator cabs is time consuming and costly. With new social distancing measures that limit the number of riders in an elevator, taking elevators offline for cleaning would further delay people getting where they need to be.



Fig. 8. By touching the Call Buttons a person can get infected.

[https://www.intl-lighttech.com/sites/default/files/2020-09/elevator_call_buttons_1.png]

UV-C lights bind the power of the sun and disinfect by disturbing the molecular bonds that hold together microbial genetic material or proteins. Ultra Violet light has been used extensively for more than 40 years in disinfecting drinking water, waste water and hospitals against hundreds of bacteria and viruses including COVID-19 related viruses – SARS-COV-1 and MERS-COV. When biological organisms are exposed to deep UV light in the range of 200nm to 300nm it is absorbed by DNA, RNA and proteins.

Absorption by proteins can lead to rupture of cell walls and death of the organism. Absorption by DNA or RNA

(specifically by thymine bases) is known to cause inactivation of the DNA or RNA double helix strands through the formation of thymine dimers. If enough of these dimers are created in DNA, the DNA replication process is disrupted, and the cell cannot replicate.

Cells that cannot replicate, cannot infect.

It is widely accepted that it is not necessary to kill pathogens with UV light, but rather apply enough UV light to prevent the organism from replicating. The UV doses required to prevent the replication are orders of magnitude lower than required to kill, making the cost of UV treatment to prevent infection commercially viable.

A. Working of UV light in Passenger Lift

In Passenger lift the UV light technology can be used to disinfect the viruses. The UV light mechanism is disabled in the presence of humans and once the passenger lift is vacant it starts to work. During this process the doors of passenger lift gets locked so no person can enter or use the lift as its harmful for human being so this is to be followed strictly.

The UVC light comes with the backup of sensors which helps in their working like infrared rays sensor, motion sensors, thermal sensors etc.

The UV light activated when the infrared system detects no human presence inside the lift. Cleaning the area with penetrating UV rays and killing all virus and bacteria inside both floating and on surfaces.

B. Benefits of UV Disinfection

In addition to being effective at killing germs, there are several other advantages to using UV light for anti-microbial applications. First, UV light disinfection can be done with little or no human intervention. Most UV light disinfection systems are either permanently mounted fixtures, or a robotic apparatus that can be deployed by remote control. In an elevator, occupancy sensors can detect whether or not people are present inside the cabin, and turn the disinfecting lights on when the cab is empty. This can allow for cleaning any time the elevator is not in use. Unlike fogs or ozone, UV light does not need time for the air to clear of fumes or odors in order for the area to be safe for people. Neither does it leave a residue or harsh smell like with chemical cleaners. Once the light is off, the hazard is gone. In short, UV light can provide an effective, efficient disinfection process free from after-effects.

As every coin has two faces so along with the advantages the side effects of using UVC light also comes in role. Like with all things, UV disinfection does have some drawbacks that users should be aware of. First, UV light is extremely hazardous to humans and cannot be performed in any instance where a person might be directly exposed without protective equipment. UVC exposure can at the least cause skin and eye irritations, and at the worst, burns, cancer and blindness. Disinfection of a surface requires a clear line of sight to the UV source, so areas that are shadowed will not be treated. UVC light can also be damaging to inanimate materials and surfaces. All UVC systems will likely require some kind of maintenance. Reflectors may need cleaning and lamps will need eventual replacing. UVC systems can be a

costly investment but can pay back quickly by offsetting the need for manual cleaning.

C. LATEST UVC LIGHT TECHNOLOGY ADVANCEMENT IN THE PASSENGER LIFT

Some corporations have already developed the UVC light concept in Passenger lift to destroy viruses. For example, the Ashla System is using Ultraviolet Rays (UV-C) Technology to create smart elevators that kill coronavirus and 100s of other viruses (shown in Fig.9.). UV-C light which has been proven to kill the virus after just 10 minutes of contact [9].



Fig. 9. Disinfecting Passenger Lift

[<https://www.Send2Press.com/300dpi/20-0430s2p-ashla-flowchart-300dpi.jpg>]

The Light tech system uses a light meter for the light measurement of UVC light (shown in Fig.10.). Light measurement devices allow users to quickly, easily, and safely validate the performance of their system. Good light measurement systems will further simplify the process through features such as auto-ranging [10].



Fig.10. Light Meter used in working of UV light

[<https://www.intl-lighttech.com/blog/keeping-elevators-clean-uv-disinfection>]

Likewise, Schindler system also uses the UVC light mechanism. They use it to sanitize surfaces in cabin cars like button panels and handrails, Schindler UV Clean Car employs the germicidal properties of UV-C ultraviolet rays [11].

VII. CONCLUSION

In present scenario the need of sanitization is very essential and the passenger lift/elevator being the most used space requires more hygiene. One of the methods used to clean passenger lift is explained in this paper and is Disinfection of passenger lift using UV light. UV light is electromagnetic energy with wavelengths shorter than visible light but longer than x-rays. In Passenger lift the UV light technology can be used to disinfect the viruses. The UV light mechanism is disabled in the presence of humans and once the passenger lift is vacant it starts to work. UV light does not need time for the air to clear of fumes or odors in order for the area to be safe for people. Neither does it leave a residue or harsh smell like with chemical cleaners. Also, many corporations have already started to use UV light for disinfecting the passenger lift.

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