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Ozonizer

Ozone generator

Team

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The COVID-19 virus is transmitted through the air and has high resistance on the surface of materials to which it adheres. This requires strict cleaning protocols in places where infected patients are treated, in order to guarantee the protection of medical personnel and non-infected patients.

Ozone is a strong oxidizing agent that takes minutes to break down viruses. Although there is no data yet regarding its effectiveness against Covid-19, ozone's effectiveness in killing SARS was 99% in just minutes of exposure. Ozone has been recommended by the WHO as a reliable and efficient disinfecting agent that, being a gas in its natural state, can quickly cover the entire volume of a room.

The application of ozone extends to all closed spaces that require a deep clean prior to being reused. For example, resuscitation rooms, surgery and endoscopy wards, ambulances, emergency treatment cubicles, and waiting rooms for patients not infected with COVID, among others. In all these cases, cleaning times would be reduced to 20 minutes.

Today, an ambulance that transports a critically ill patient with COVID-19 today between 2 and 3 hours to become available as a deep clean must be carried out by medical personnel, usually with the application of quaternary ammonium. Using the proposed solution would reduce the disinfection time to 20 minutes, allowing the ambulance to be operational again.

Ozone (O_3) is a strong oxidant that has been classified by the WHO as the most efficient disinfectant for all types of microorganisms. During the 2003 SARS epidemic, ozone disinfection was successfully used to purify environments contaminated with SARS-Cov-1, which is a member of the coronavirus family.

Ozone is formed by the ionization of oxygen (O_2) and is found naturally in the stratosphere in concentrations of 10 to 20 ppm. Ozone is naturally produced by UV radiation that breaks an oxygen molecule, generating two oxygen atoms which are highly unstable and quickly combine

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with another oxygen molecule. This natural process can be replaced by a strong ionizing discharge.

Our solution proposes to apply the corona effect to generate the ionization of the air through a discharge at high voltage. The corona effect occurs when the electric field charge is high enough to generate electrical conduction in a region, but low enough not to generate an electric arc. In the air, the crown effect generates ozone and nitric oxide (NO). Today, this is the most commonly used method of producing ozone.

The equipment is designed to produce around 1 gram per hour of ozone and would operate for 20 minutes, enough to reach a final concentration of 2.27 ppm of ozone in a room with a volume of 120 m3 (considering an air density of 1.22 kg. per m3, the weight of the air would be 146.4 kg.). This concentration is well above the required since viruses are generally known to deactivate with concentrations above 0.6 ppm of ozone and exposure times of 20 minutes.

The equipment will be made with a high voltage source used in neon electronic transformers (8 kV, 60 W), an electrode made with glass tubes, a stainless steel mesh used in screens (very common in the agricultural industry), a fan small 12 or 220 V, and a timer. The system requires a built-in timer to set the auto on/off time to prevent it from staying on for long periods. Finally, all the components go inside a portable box of approximately 30 cm x 40 cm x 50 cm, weighing less than 5 kg. The equipment has already been manufactured and is operating stably. It continues to optimize the operation to maximize ozone generation and define prototyping details.

Level of progress of the solution

The electrical circuit has already been assembled with the components and the prototype is working stably at laboratory level. The current stage is the measurement of the amount of ozone generated and the necessary adjustments to make generation more efficient. It is also necessary to add further elements, such as timer, fans, and other minor elements. We are now in a position to move towards packaging, the validation of use in hospitals to arrive at a minimum viable product that can subsequently be mass produced quickly.

Barriers and risks associated with the solution and its potential mitigations

The greatest risk associated with the proposed solution is that ozone is an irritant and is harmful to humans in high concentrations over long periods of time. The troposphere contains a concentration between 0.02 and 0.06 ppm, which does not harm humans. As the concentration of ozone in the air increases, it causes discomfort and can even damage the respiratory system. The FDA defines a maximum concentration of ozone in residential areas as 0.05 ppm. The Japan Society for Occupational Health (JSOH) establishes a maximum concentration of ozone exposure of 0.1 ppm as standard, while the Chinese Health Commission also establishes a maximum concentration of 0.1 ppm. The mitigation is that the design will include a timer with a maximum operating time of 30 minutes so that the equipment switches itself off. Since the ozone concentration required for disinfection is greater than the maximum allowed for personnel, once the equipment is turned off, the site must be ventilated. This is the same in all existing ozonizers. In addition, the medical personnel who will use it will receive a training course and a user manual.

Another risk associated with operation is that the equipment suffers overloads or short circuits. The design of the equipment will be completed in such a way to minimize the possibilities of short circuits and/or fires, according to the applicable safety regulations.

Potential for replicability and scalability of the solution

The current equipment has been completely designed and assembled in the laboratories of the School of Engineering of the Pontificia Universidad Católica de Chile. The critical components have been selected to ensure their purchase locally and the assembly of a first batch would be carried out on a secure production line at the facilities of DICTUC SA, a subsidiary of the university. Since it is expected that the requirement for these devices will be much higher, national companies that are in a position to replicate the design will be contacted. Informal contacts and commitments have been established with a company that has experience in building equipment that uses similar electronics.

In terms of markets, we estimate that each hospital could require at least ten ozonizers.

The main components are stainless steel 10 wire mesh, regular glass tubes of two diameters and 30 cm long, a power source, cables, and a plastic box.

Technical and/or scientific evidence to support the solution

Elvis & Ekta, Ozone therapy: A clinical review
J Nat Sci Biol Med. 2011 Jan-Jun; 2(1): 66–70.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3312702/

Wng et al. 2018. Differential removal of human pathogenic viruses from sewage by conventional and ozone treatments
Int J Hyg Environ Health. 2018 Apr; 221(3): 479–488.
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7106402/

Hudson et al. 2009 Development of a Practical Method for Using Ozone Gas as a Virus Decontaminating Agent
The Journal of the International Ozone Association
Volume 31, 2009 - Issue 3
https://www.tandfonline.com/doi/full/10.1080/01919510902747969?src=recsys

A Plausible "Penny" Costing Effective Treatment for Corona Virus - Ozone Therapy
Journal of Infectious Diseases and Epidemiology
DOI: 10.23937/2474-3658/1510113
Pub Date: March 06, 2020
https://clinmedjournals.org/articles/jide/journal-of-infectious-diseases-and-epidemiology-jide-6-113.php?jid=jide

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