White Paper (short version)

Ozone: Safety and Antimicrobial Efficacy Overview

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CERRO ZONE™
More than an air purifier.™

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Ozone (O_3) is a naturally occurring, highly reactive molecule. Historically, ozone has been used as an antimicrobial agent in a wide variety of use patterns, including the treatment of both drinking and municipal wastewater.[1-2] This capability is due to ozone's ability to oxidize organic molecules, including biomolecules present in and on microorganisms such as bacteria and viruses.[3]

Ozone was first used in water treatment in 1893, and since this time it has been used to reduce odors, promote the oxidative degradation of chemical pollutants, and to kill microorganisms.[3,4,5] Given its widespread use, ozone has been well-studied with respect to its characteristics and its ability to kill undesirable microorganisms such as potentially pathogenic bacteria and viruses.

In addition to its bactericidal activity, ozone is well-known to inactivate viruses via several mechanisms of action. The antiviral activity of ozone is thought to be largely due to oxidative degradation of the viral lipid envelope (where applicable), proteins, and nucleic acids (*i.e.,* DNA or RNA). Generally speaking, enveloped viruses are considered more vulnerable to inactivation by ozone or other chemicals than non-enveloped viruses.[6,7] Nevertheless, the available scientific literature indicates that both enveloped and non-enveloped viruses are susceptible to inactivation by ozone.

Ozone-based air purifying devices, which pass contaminated air through an ozone treatment chamber and then past a catalytic ozone scrubber, have also demonstrated virucidal efficacy. For example, the CerroZone mobile air purification device was recently tested and found capable of reducing the population of aerosolized MS2 virus by 99% following a single pass-

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[1] Dev Kumar, G., Mishra, A., Dunn, L., Townsend, A., Oguadinma, I. C., Bright, K. R., & Gerba, C. P. (2020). Biocides and Novel Antimicrobial Agents for the Mitigation of Coronaviruses. Frontiers in microbiology, 11, 1351. https://doi.org/10.3389/fmicb.2020.01351

[2] Foarde, K. K., D. W. VanOsdell, & Steiber. R. S. (1997). Investigation of Gas-Phase Ozone as a Potential Biocide. Applied Occupational and Environmental Hygiene, 12(8):535-542.

[3] United States Environmental Protection Agency. (1986). Air Quality Criteria for Ozone and Other Photochemical Oxidants, Volume 1.

[4] Dyas, A., Boughton, B. J., Das, B. C. (1983). Ozone Killing Action Against Bacterial and Fungal Species; Microbiological Testing of a Domestic Ozone Generator. J Clin Pathol. 36(10):1102-4. doi: 10.1136/jcp.36.10.1102.

[5] United States Environmental Protection Agency. (2018). Residential Air Cleaners: A Technical Summary.

[6] Rutala, W.A. et al. (2019). Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008. Update: 2019. United States Centers for Disease Control and Prevention. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/

[7] Grignani, Elena, et al. "Safe and effective use of ozone as air and surface disinfectant in the conjuncture of Covid19." Gases 1.1 (2021): 19-32.

through treatment (treatment residence time of 1.2 seconds). Although the CerroZone device also incorporates a filter which could potentially trap viral particles, comparative testing with non-ozonating units indicated that the vast majority of viral reduction observed was due to ozone treatment. The CerroZone device was also subjected to simulated use testing to evaluate its ability to reduce populations of aerosolized MS2 virus in a sealed treatment chamber measuring 9.1 ft x 9.1 ft x 7.0 ft (total volume = 579.7 ft^3). Results indicated a 99% reduction in active MS2 virus counts following a 30 minute treatment time.[8]

The CerroZone device is intended to be effective at inactivating the SARS-CoV-2 virus when used in accordance with its labeled instructions for use. Non-enveloped MS2 virus is anticipated to be more resistant to ozone treatment than the enveloped SARS-CoV-2 virus and its present (e.g. delta, omicron) and future variants.

[8] Aerosol Research and Engineering Laboratories Report "Efficacy of the CerroZone Device Against Aerosolized MS2 Bacteriophage at Various UV Intensity Levels." Olathe KS. 2021.