ionization equipment for control of airborne pathogens

COVID-19 has raised awareness around airborne spread of infectious particles

Federal money earmarked for ionization brought it attention

advantage is low capital cost, low operating cost, easy installation

there is a vast amount of bad information about ionization on “the internet”

reliable information is from clean room applications

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ionization is not ozonation

ozone (O_3) is a neutral molecule with 3 oxygen atoms

ozone is very effective at killing pathogens – and everything else

ASHRAE says:

Ozone (O3) is a reactive gas that can disinfect air and surfaces by killing viruses, bacteria, and fungi.

Ozone is harmful for health and exposure to ozone creates risk for a variety of symptoms and diseases associated with the respiratory tract.

ASHRAE's Environmental Health Committee issued an emerging issue brief suggesting "safe ozone levels would be lower than 10 ppb" and that "the introduction of ozone to indoor spaces should be reduced to as low as reasonably achievable (ALARA) levels."

Should only be considered for disinfection of unoccupied spaces; it should never be used in occupied spaces.

BARR

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ionization is less severe than ozone

oxygen dissociates to form ozone at 12.07 volts

most organic molecules can be altered with less than 12 volts

ions <12 electron-volts energy can destroy pathogens and not form ozone

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does it work?

- most vendors can point to a study “proving” the effectiveness
- studies show that ***given enough time***, pathogens are deactivated
- but ASHRAE, CDC and other agencies are non-committal
- maybe or maybe not – but it won’t hurt

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Sizing:

equipment should be able to maintain 1,000 to 10,000 ions/CC

rigorous calculation criteria does not exist

vendors are not helpful- only give rules of thumb

many do not have a good understanding of their own technology

best information comes from ultra-clean manufacturing, i.e. semiconductor, industry

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Theoretically: rate of generation must equal rate of decay

ions neutralize each other and react with airborne material

exponential decay $q = q0^{-\tau/t}$

- q is level of ions present
- τ is a constant representing the level of contamination, space geometry, etc. – nobody knows this value

impractical to calculate accurately because of all the unknown variables

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large “margin of error” means ion supply can be drastically oversized

levels <100,000 ions/cc have neither beneficial nor deleterious effects
(Alexander, D.D., Bailey, W.H., Perez, V. *et al.* Air ions and respiratory function outcomes: a comprehensive review. *J Negat Results BioMed* **12,** 14 (2013). https://doi.org/10.1186/1477-5751-12-14)

but be careful of ozone

selection is based on ease of installation rather than any other criteria

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do not assume that outside air can be reduced – CO2 levels will increase

ASHRAE 62.1-2016 recommends less than about 1200 ppm; other studies show measureable decline in cognitive performance at 1000 ppm (Satish et al, 2012)

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commonly used types for HVAC applications are needlepoint, and corona discharge

needlepoint produces many small ions

corona discharge produces larger ionized clusters – but fewer of them

rate of decay is very different for small ions vs large clusters

uni-polar vs bipolar:

- uni-polar more effective at reducing aerosols (Grinshpun SA, Mainelis G, Trunov M, Adhikari A, Reponen T, Willeke K. Evaluation of ionic air purifiers for reducing aerosol exposure in confined indoor spaces. Indoor Air. 2005 Aug;15(4):235-45. doi: 10.1111/j.1600-0668.2005.00364.x. PMID: 15982270.)
- bi-polar reduces deposits on surfaces – less cleaning required

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Power supply options:

- 24 VAC
- 120 / 208 VAC
- 480 VAC
- universal – anything from 24 VAC to 220 VAC

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Bismarck State College project:

- Barr sized, selected and specified inoizers for 6 buildings
- standardized on 2 models for spares commonality
- selection was based on lead time, power supply, ease of installation
- >400 units purchased & installed

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