# THE ECONOMICS OF CLEAN AIR IN THE COVID-19 WORLD

Dynamic Air Quality Solutions

Richard Gillick

# DYNAMIC
# AIR QUALITY SOLUTIONS

Since 1982, Dynamic has been manufacturing award-winning air cleaning systems that improve IAQ, save energy, and reduce maintenance around the world.

From anthrax clean-ups, to the world's most valuable art collection, mission critical government facilities, and the ASHRAE headquarters… Dynamic Air Quality Solutions is able to design the right system for the job.

The Association of Energy Engineers

partner in ASHRAE Headquarters renewal

aashe
The Association for the Advancement of Sustainability in Higher Education

IAQA™
Corporate Member

International Association Museum Facility Administrators

NAFA® National Air Filtration Association

American Alliance of Museums

U.S. Green Building Council USGBC®

ASHE™
Optimizing health care facilities

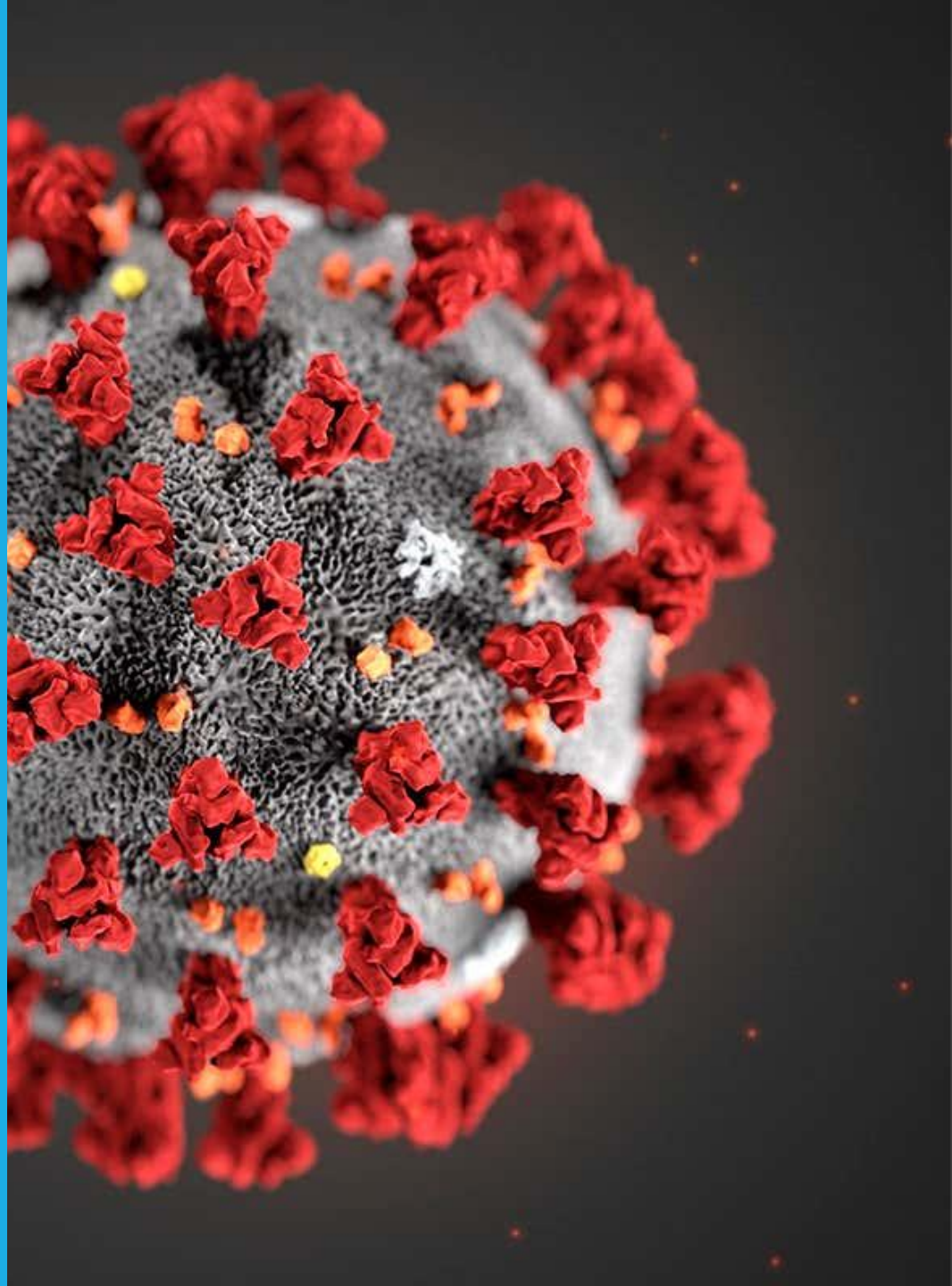
# COVID-19
## WHAT WE KNOW

COVID-19 travels through the air on droplet nuclei from sneezes, coughs, and breathing. Nuclei can range from 0.6 to 10+ micron in size, with the majority being 1-3 micron. The virus itself is 0.15 micron.

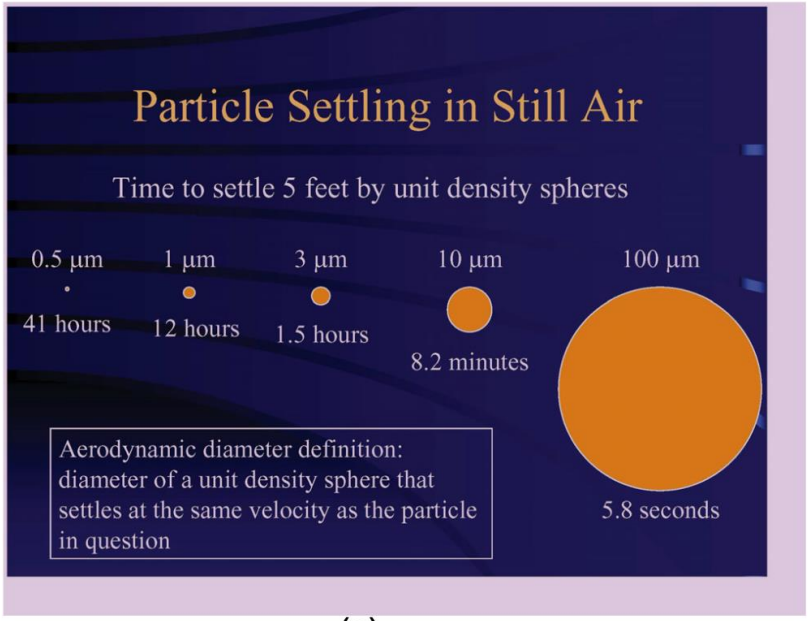
The bigger the droplet nuclei, the less time it will remain in the air before settling on a surface. Only some nuclei will make it into the HVAC system before settling.

Droplet nuclei become smaller quickly as contained moisture evaporates.

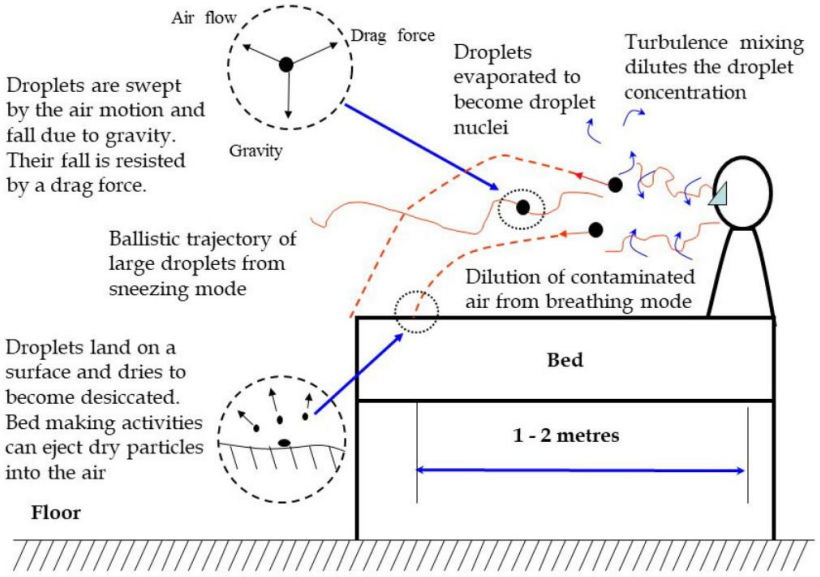
COVID-19 can live on a surface from 24 to 72 hours, depending on the material and environmental conditions.



# ASHRAE POSITION DOCUMENT ON INFECTION AEROSOLS, APRIL 2020, CONTINUED....




(a)




(b)

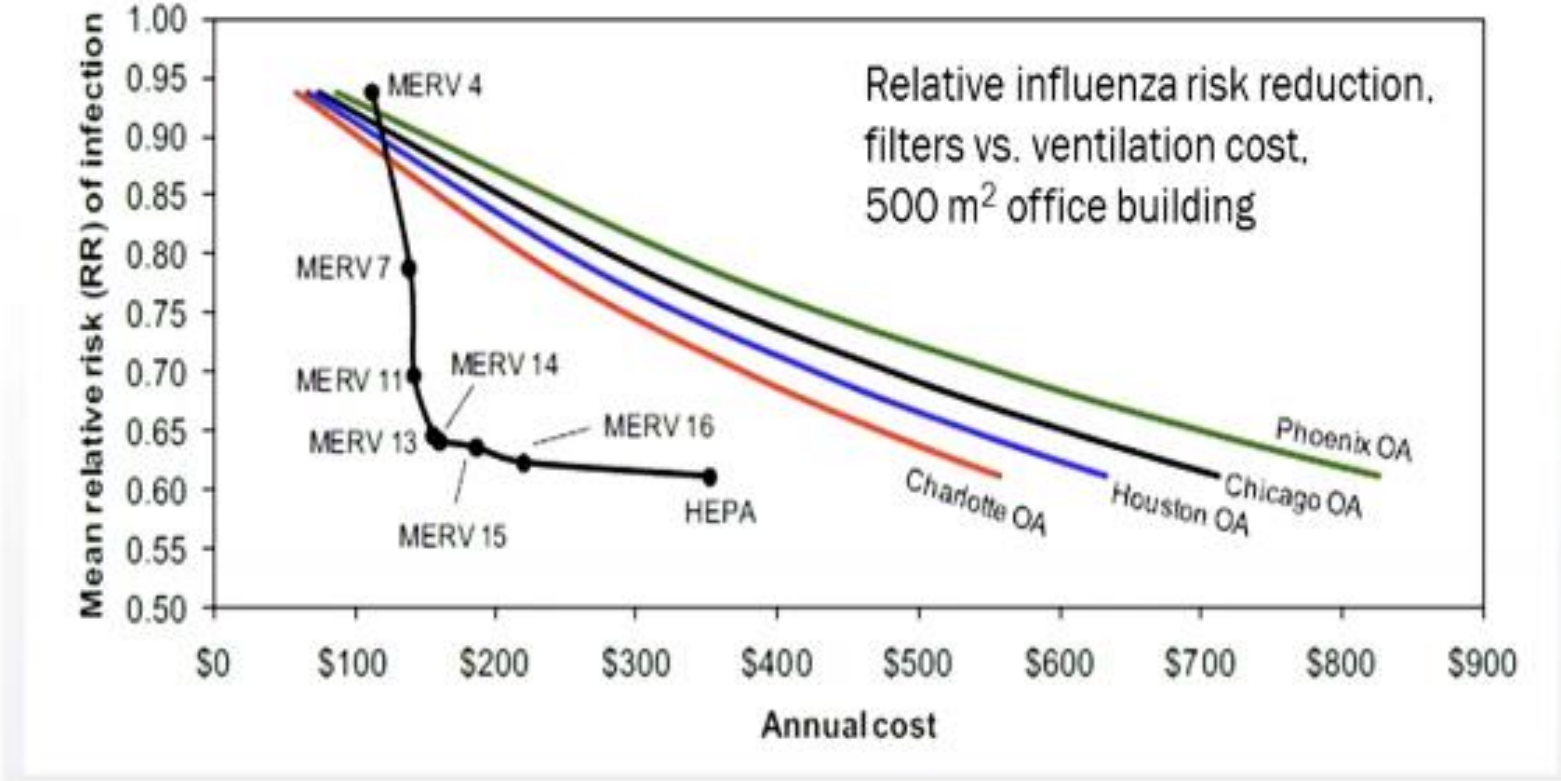
**Figure 1** (a) Comparative settling times by particle diameter for particles settling in still air (Baron n.d.) and (b) theoretical aerobiology of transmission of droplets and small airborne particles produced by an infected patient with an acute infection (courtesy Yuguo Li).

# ASHRAE
# ON INFECTIOUS DISEASE

**How do you decrease risks of spreading infectious diseases with your HVAC system?**

- High-Efficiency Air Filtration (MERV 13 or better)
- Proper ventilation and pressurization (Building / Room)
- Use of UVC Germicidal systems
- Proper Humidity Levels
- Portable Air Cleaners

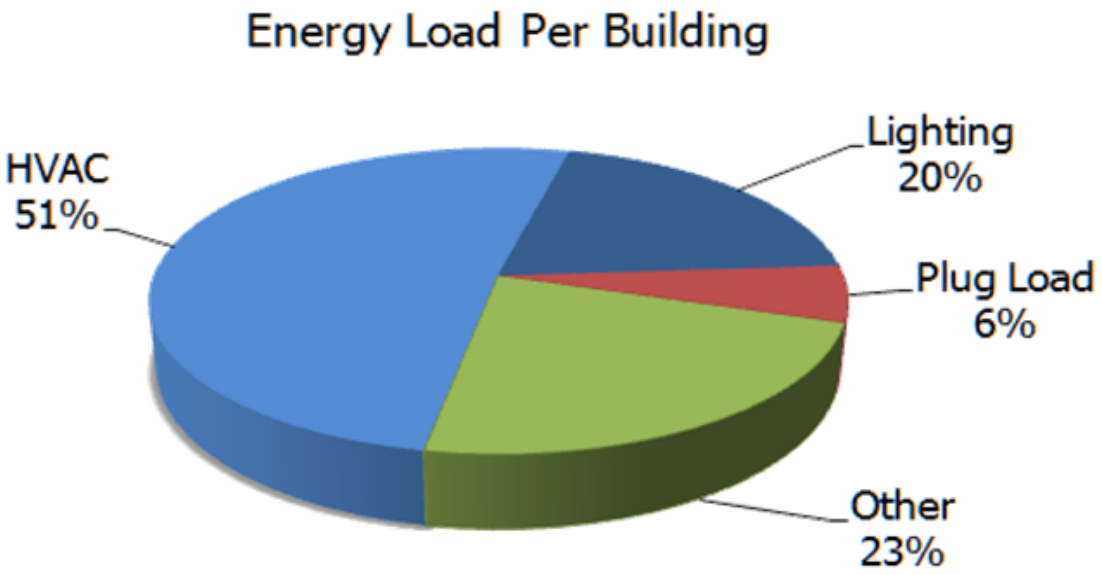
# Filtration is a lower energy way to reduce aerosol/airborne infection risk than more ventilation




# BANG FOR YOUR BUCK

# IAQ AND ENERGY

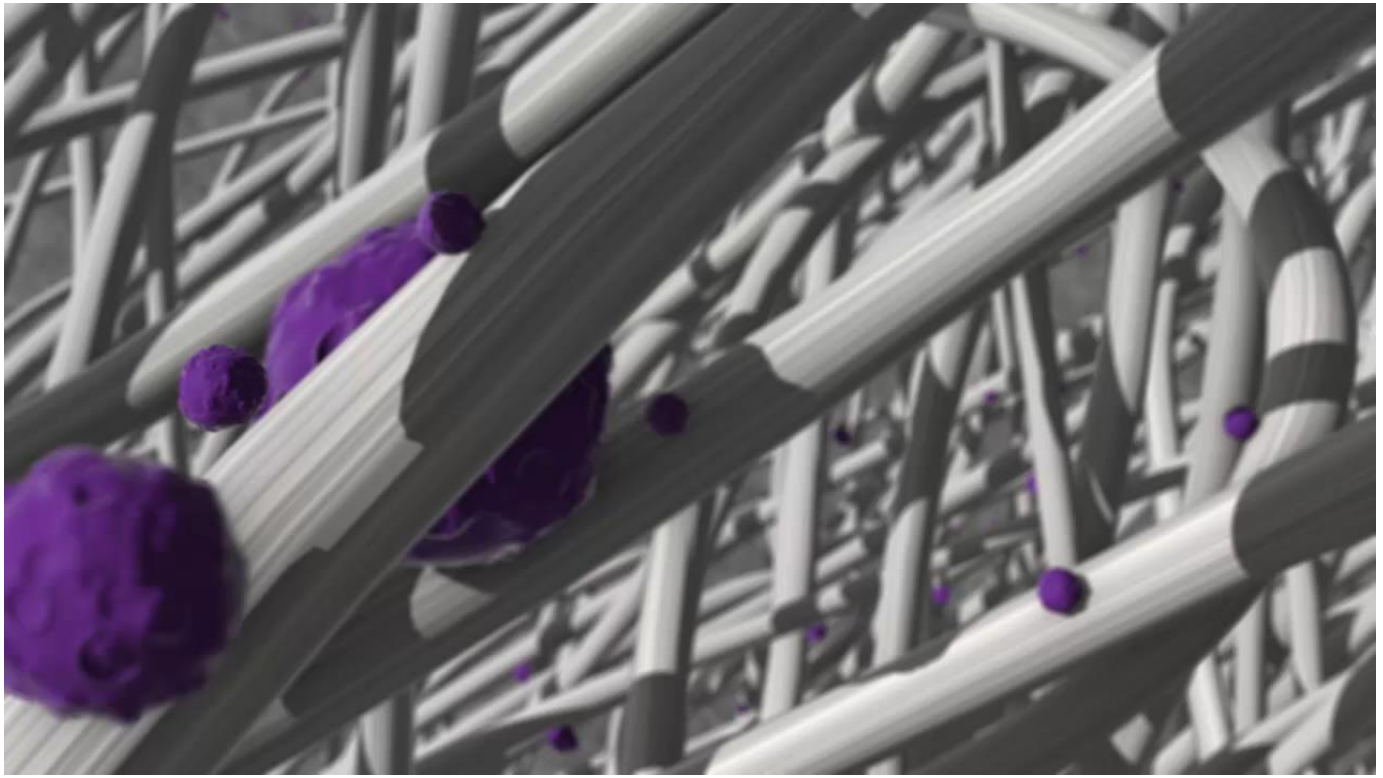
- Commercial buildings consume 40% of all energy in the US
- HVAC is over half of that
- Supply and return fans are over half of that– over 10+% of all energy!
- Over 40% of the energy in some buildings…
- 90% of the cost of filtration is energy



# PASSIVE FILTRATION

Pleats, Bags, and Cartridges Today

- Rated per MERV Parameters
- Essentially a sieve
- Trade increased efficiency
  for increased pressure drop and energy
- 90% of the cost of filtration is energy
- Upstream, face loading
- Efficiency can increase as they load



# PASSIVE FILTER RATINGS

- Pursuant to ASHRAE 52.2
- Three Size Ranges (E1-3)
- Single Pass Efficiency
- Range of Allowable $E_f$

## TABLE 3: MERV PARAMETERS

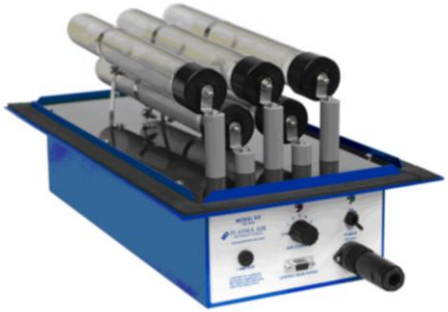
| Standard 52.2 Minimum Efficiency Reporting Value (MERV) | Composite Average Particle Size Efficiency, % in Size Range, µm | | | |
|---|---|---|---|---|
| | Range 1 (0.3-1.0) | Range 2 (1.0-3.0) | Range 3 (3.0-10.0) | Average Arrestance, % |
| 1 | n/a | n/a | $E_3 < 20$ | $A_{avg} < 65$ |
| 2 | n/a | n/a | $E_3 < 20$ | $65 \le A_{avg} < 70$ |
| 3 | n/a | n/a | $E_3 < 20$ | $70 \le A_{avg} < 75$ |
| 4 | n/a | n/a | $E_3 < 20$ | $75 \le A_{avg}$ |
| 5 | n/a | n/a | $20 \le E_3 < 35$ | n/a |
| 6 | n/a | n/a | $35 \le E_3 < 50$ | n/a |
| 7 | n/a | n/a | $50 \le E_3 < 70$ | n/a |
| 8 | n/a | $20 \le E_2$ | $70 \le E_3$ | n/a |
| 9 | n/a | $35 \le E_2$ | $75 \le E_3$ | n/a |
| 10 | n/a | $50 \le E_2 < 65$ | $80 \le E_3$ | n/a |
| 11 | $20 \le E_1$ | $65 \le E_2 < 80$ | $85 \le E_3$ | n/a |
| 12 | $35 \le E_1$ | $80 \le E_2$ | $90 \le E_3$ | n/a |
| 13 | $50 \le E_1$ | $85 \le E_2$ | $90 \le E_3$ | n/a |
| 14 | $75 \le E_1 < 85$ | $90 \le E_2$ | $95 \le E_3$ | n/a |
| 15 | $85 \le E_1 < 95$ | $90 \le E_2$ | $95 \le E_3$ | n/a |
| 16 | $95 \le E_1$ | $95 \le E_2$ | $95 \le E_3$ | n/a |

# IAQ- ARE YOUR FILTERS PERFORMING?

Hospital Data from Canada (MERV 15s performing at MERV 11)

Filter blow by and improper installation can lead to performance deficiencies.

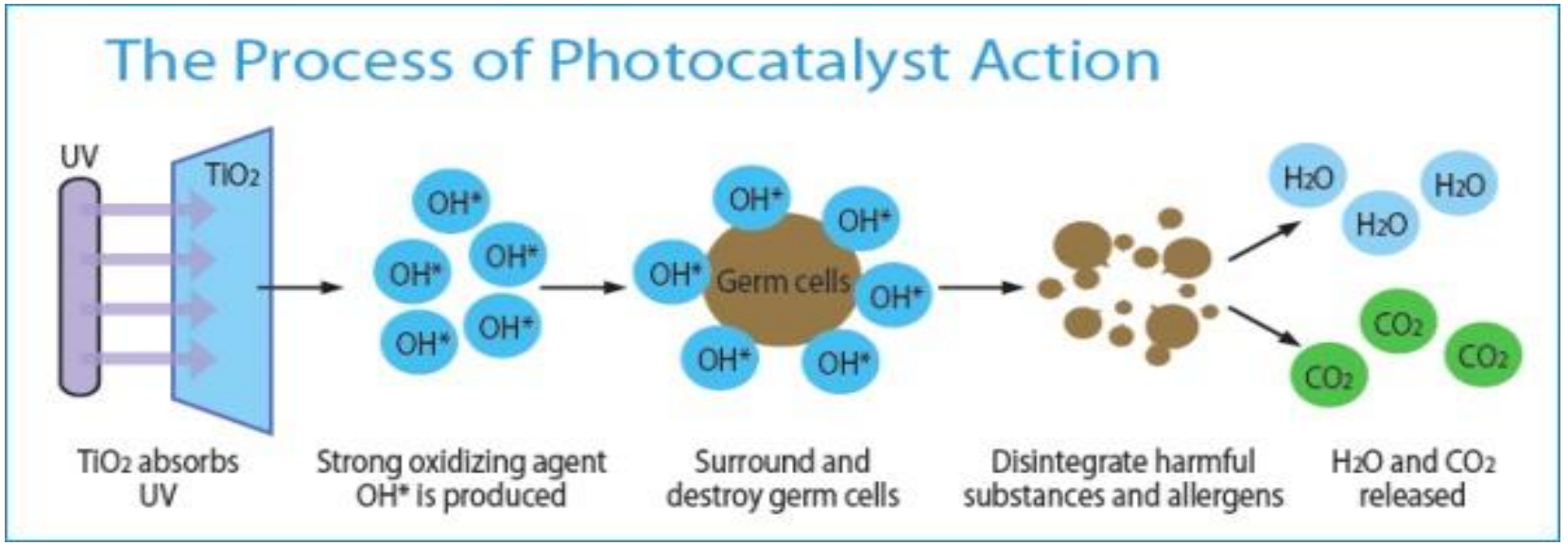
# IONIZATION CONSIDERATIONS



- Can be applied to almost any system
  - Little to no space constraints
- Electrostatic Precipitator without plates
  - Creates negative and positive ions that can break down biologicals and/or agglomerate particles
  - Does not meet building filtration requirements
- Can enhance filtration efficiency
  - Reduces maintenance interval-filter loads faster
- Agglomerated particles can come out of suspension—but land where?
  - Where do the particles/biologicals go?
- Mixed test results
  - Chamber test vs practical application in large buidling

Still Needs Filtration

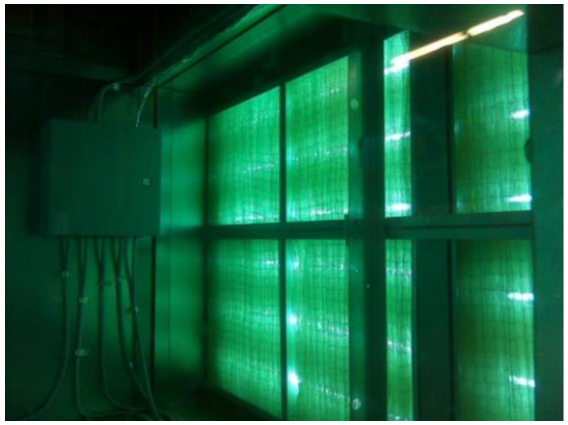
# PHOTOCATALYTIC OXIDATION (PCO)



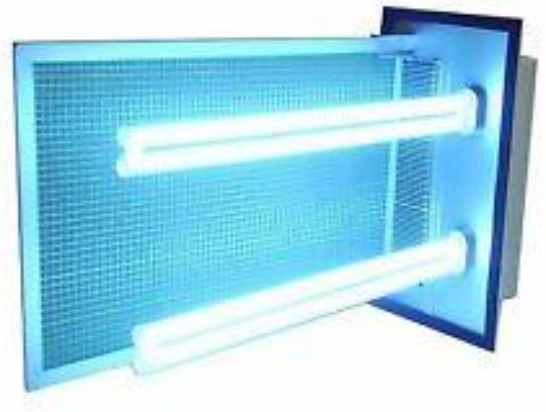

Photocatalytic Oxidation (PCO) is the process of generating free radicals (hydroxyl radicals OH molecules) by exposing a catalyst to an energy source. This process is extremely effective in destroying airborne contaminants like VOCs, bacteria, viruses, and other common pathogens. PCO can also be used for the reduction of smoke, odors and ethylene gas in food production and food storage applications.

Still Needs Filtration

# PCO CONSIDERATIONS



- Installed in AHUs, RTUs, larger ducted systems
- Can be very effective against Biologicals, VOCs, and Odors
- Requires design expertise for sizing and safety concerns
  - UV exposure
- Pressure drop added to system
- First Cost can be very expensive
- Maintenance – only works well if kept clean
  - UV Lamp periodic replacement
  - PCO panel replacement



Still Needs Filtration

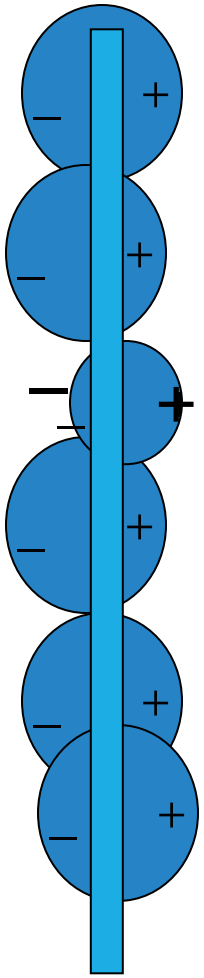
# UVC-GERMICIDAL (254 NM)

- Ultraviolet germicidal irradiation (UVGI) is a disinfection method that uses short-wavelength ultraviolet (UV-C) light to kill or inactivate microorganisms by destroying nucleic acids and disrupting their DNA, leaving them unable to perform vital cellular functions.
- According to the American Journal of Infection Control it takes 1,048 microjoules to deactivate the Sars-CoV-2 virus.
- Must be properly applied to be effective
  - Contact time, proximity, and intensity are the key variables
  - Bulbs loose 10-15% intensity every year
- Adds safety restrictions and increases energy consumption of HVAC system

Still Needs Filtration

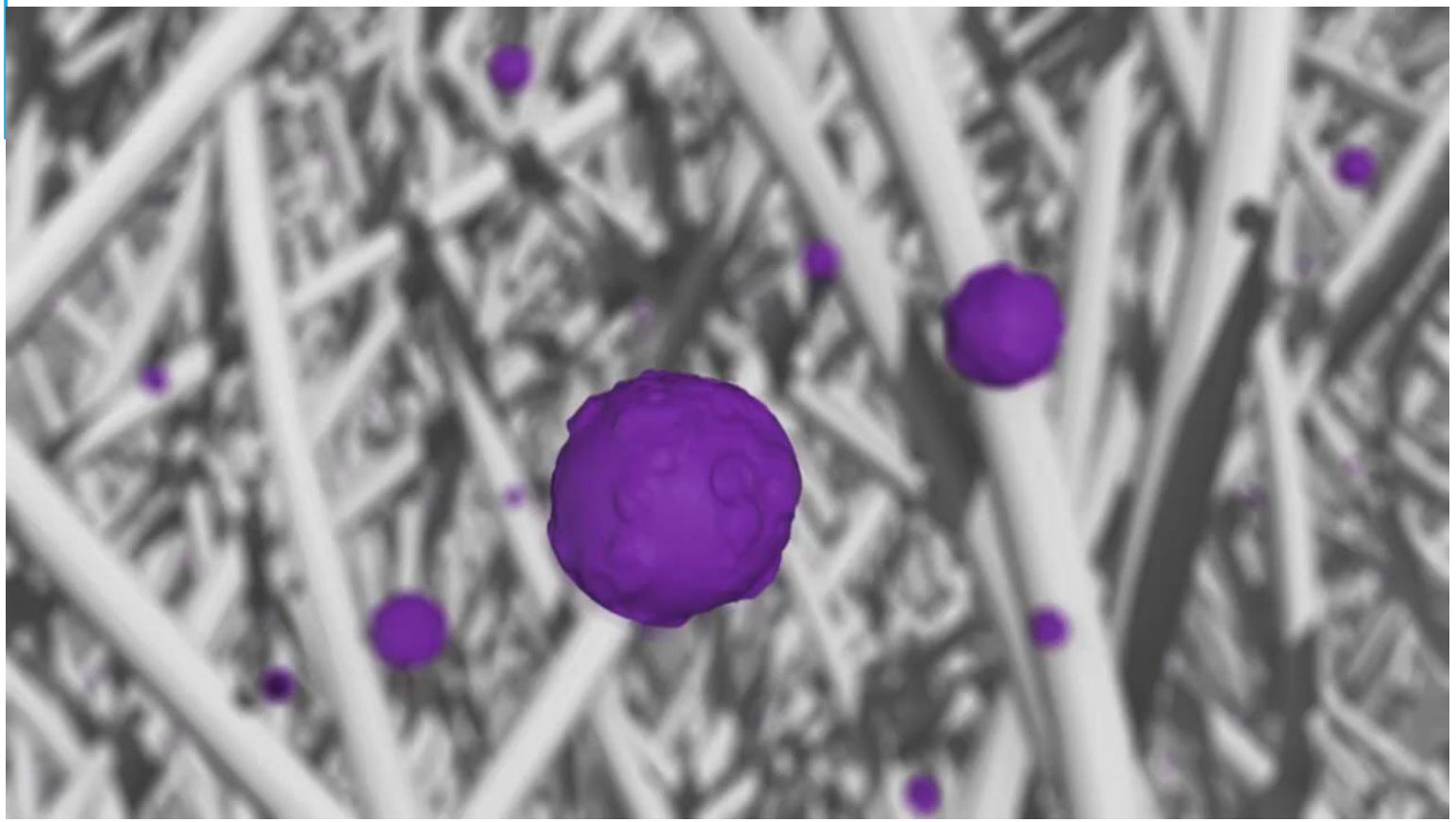
# PASSIVE-ELECTROSTATIC FILTERS

- Media fibers have induced or applied electrostatic orientation.
- Many particles have net ambient charge and/or relative charge sites.
- Charge gives it greater efficiency than comparable passive media.
- Effect is diminished as fibers become coated.
- Potential issues with 52.2 Test
  - efficiency becomes moving target
  - MERV-A rating

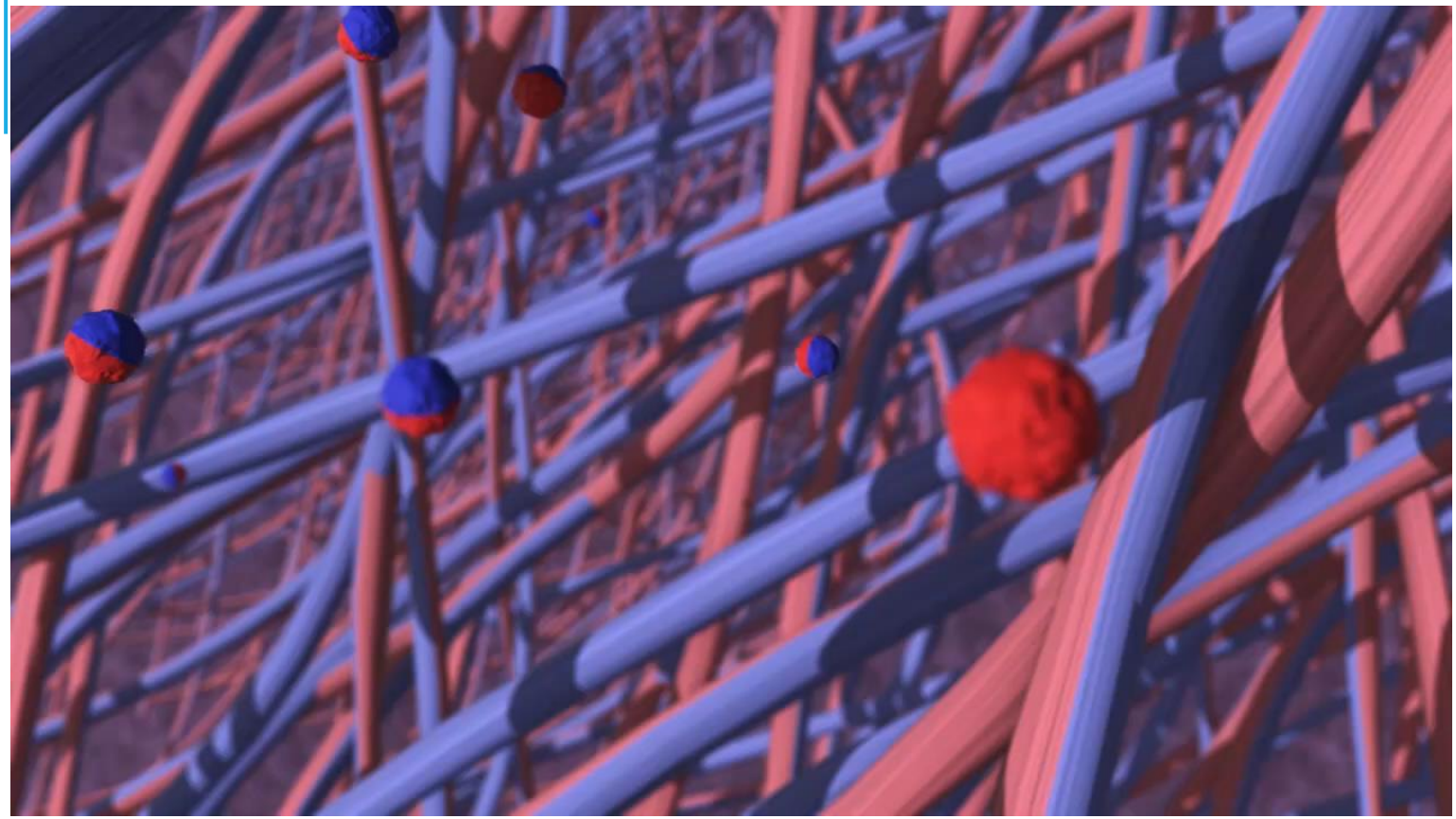


# NON-IONIZING POLARIZED MEDIA FILTER

- Combines a passive filter media with active electrostatic attraction to increase efficiency and dust holding capability
- Polarized particles agglomerate and further increase effectiveness against biologicals, VOCs, and Odors
- Some systems require more space in the AHUs or RTUs making retro fits tougher
- First cost can be expensive



# POLARIZATION & ELECTROSTATIC ATTRACTION



# PARTICLE EXCITEMENT & AGGLOMERATION

# Air Cleaning: The Intersection of IAQ, Energy, & Maintenance

- IAQ – Systems must meet requirements and be able to control particles, biologicals, and gas phase contaminants
  - Better IAQ=more protection…..but at what cost

- Energy – 90% of the cost of filtration is energy to push air through the filter

- Maintenance – a critical factor in operation and costs
  - Changeouts intervals can vary greatly

****All three have a direct effect on operation, productivity, and financial bottom lines****

# ENERGY-STANDARD DESIGN

Its all about Balance

- Managing the trade-off between more protection and cost
- Is a higher MERV/more technologies worth the energy expense?

Standard design Static Pressure for Filtration/Air Cleaning

- Pre Filters: .3-.7" Dirty
- Final Filters: 1.0-2.0" Dirty
- Additional Air Cleaning Technologies: .2-.8"

Total of 1.5"-3.5" of Static Pressure!

This large SP delta is too large to ignore in design, especially in a 24/7 environment

How do we optimize this? What if we could save just 1"?

# ENERGY-WHAT CAN 1 INCH DO?

Example: In a 60,000 cfm air handling unit saving 1" of SP

- 11.7 BHP
- 91,000 kWh/year
- $8-20K depending on kwh rate
- Approx .9 kw/hr saved per 1 square foot of space served

- Equal to:
  - 123,000 pounds of carbon
  - 107 cars not driven for one year
  - 2500 trees
- ASHRAE 90.1 design

Total Energy Footprint

- Anywhere from 3-6% total footprint reduction

Secondary Effects

- Smaller, Quieter Equipment

# MAINTENANCE
# A KEY PART OF IAQ AND BOTTOM LINE

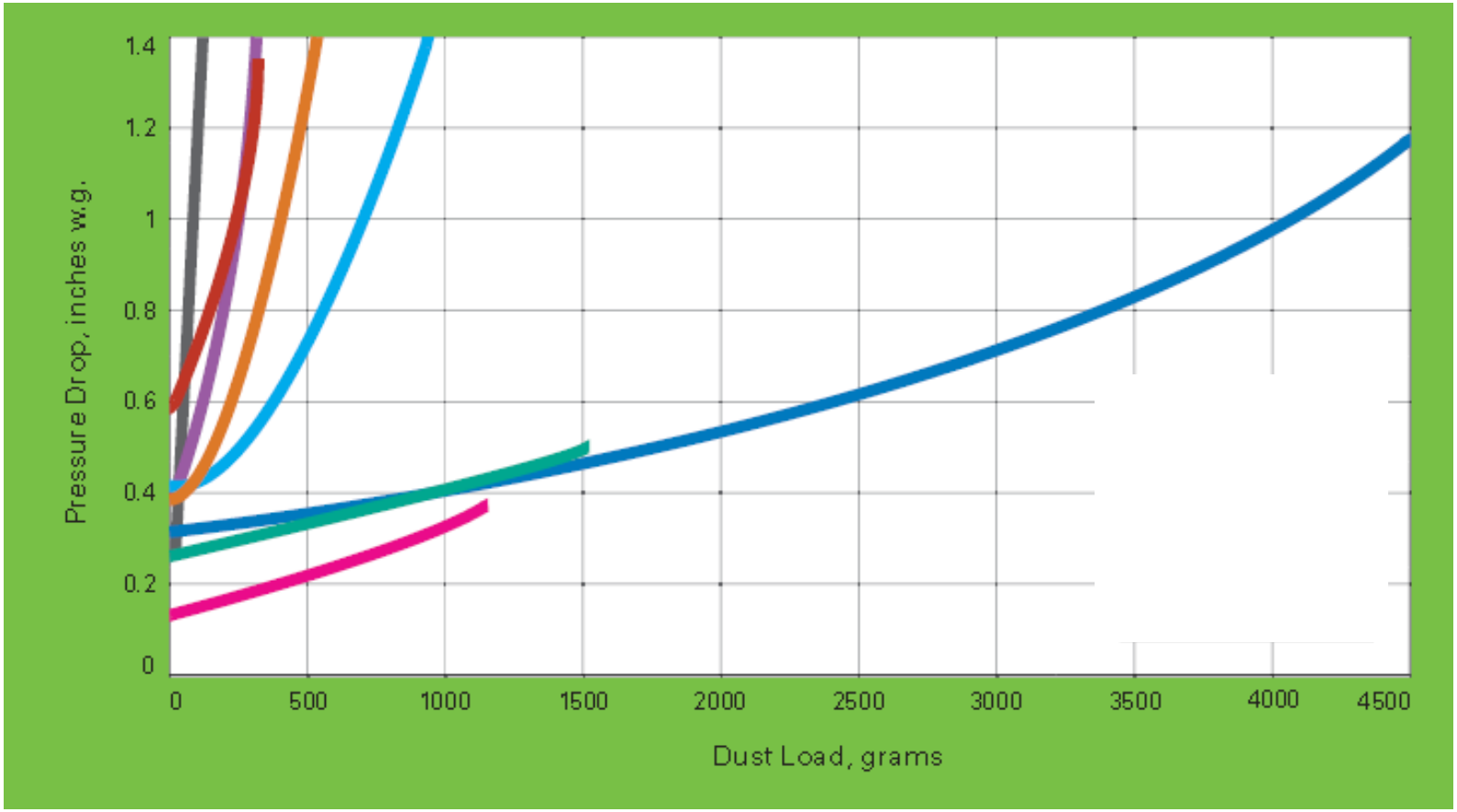
A critical part of overall IAQ is standard maintenance and upkeep

- Filters are changed at manufacturer recommended intervals
- Coils, UV Bulbs, PCO plates are all kept clean

A critical part of your design should be reducing maintenance cost as much as possible for the customer without sacrificing IAQ or energy.

- Filters range from monthly changeout to yearly changeout
- Filter may offer longer maintenance life but sacrifice IAQ or energy

# WHAT CAN YOU DO? PICK A GOOD FILTER!




****Explore Air Cleaning technologies for potential static pressure savings****

# WHAT CAN DUST HOLDING DO FOR YOU?

## Filter 1

MERV 14

Dust Holding Capacity: 500 gm

Filter Life: 6 months

Initial cost including labor: $50,000

Changeouts per year: 2

Annualized Cost: $100,000

Extended Cost over 10 years: $1,000,000

## Filter 2

MERV 14

Dust Holding Capacity: 2500 gm

Filter Life (same environment): 2.5 yrs

Initial cost including Labor: $150,000

Changeouts per year: 0.4

Annualized Cost: $60,000

Extended Cost over 10 years: $600,000

| | IAQ | Energy | Maintenance |
|---|---|---|---|
| Passive Filter (Baseline) | • Only as good as MERV<br>• HEPA/ULPA protection | • Various, all load different<br>• Higher MERV=Higher SP | • Dust Capacity Varies |
| Ionization | • **Biological/Odor Control**<br>• **Can increase filter efficiency**<br>• **Can Create Ozone**<br>• **Still need a filter**<br>• **Mixed Test Results** | • **No savings**<br>• **Usually the lowest 1st cost for air cleaning tech** | • **Can go almost anywhere**<br>• **Decreases Maintenance interval of filter**<br>• **Only works if probes are clean** |
| Polarized Media | • **Increased efficiencies for droplet nuclei, VOCs, and Biologicals**<br>• **Can perform close to HEPA in re-circ environment**<br>• **Can meet building filtration/code requirements** | • **Static Pressure savings and flatter loading curve**<br>• **Can have payback/ROI/Life Cycle Cost savings**<br>• **Higher 1st Cost** | • **Maintenance intervals increased substantially due to 360 degree loading**<br>• **Waste reduction**<br>• **Size Constraints for Install** |
| PCO | • **Biological/Odor/VOC/Gas control down to .001 um**<br>• **Performance decreases without standard cleaning**<br>• **Still need a filter** | • **Negative Savings**<br>• **Additional SP added**<br>• **Adds to 1st Cost** | • **Adds maintenance hours in addition to filter changeouts**<br>• **Requires additional Space** |
| UV | • **Biological Control**<br>• **Effective if applied properly**<br>• **Still need filtration** | • None, very little SP Add<br>• **Adds Cost** | • **Adds Maintenance Hours** |
| Passive Electrostatic Filters | • **Increased efficiencies initially, decreased efficiency over time** | • Various, will be comparable to standard passive filters | • Can extend maintenance intervals slightly due to increased initial dust holding |

# CONSIDERATIONS/BEST PRACTICES

- Focus should be on Risk Averse sustainable design
- Be diligent on the design and install of the system for proper performance
- Less Maintenance=easier upkeep and less chances for subpar performance
  - Systems will only work as designed if they are properly maintained
- Primary focus should be on life cycle cost vs first cost
  - First Cost can be mitigated with CARES Act Funding, so why not use the funds for a system that can save your building energy and maintenance dollars over its life cycle?
- Properly manage risk and liability of IAQ challenges while taking advantage of energy and maintenance saving technologies
  - Ask for Filter Test Report (ASHRAE 52.2) for performance comparison
    - Does your system offer a payback/ROI or reduced life cycle cost?
  - Think of filtration/air cleaning as an energy conservation method

# THANK YOU FOR YOUR TIME.

Please call and or email for mare information.

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