The Impact of Filtration in HVAC Systems

Presenter

Tom Justice

Disclaimer

This presentation is not intended to be a comprehensive program covering all aspects of this topic. All technicians are encouraged to read and follow all applicable standards, codes and regulations related to this topic.

- ✓ It is the responsibility of each individual contractor to follow local building codes and licensing requirements and to work safely in accordance with OSHA guidelines.
- ✓ It is the contractor's responsibility to take proper precautions on each project to prevent cross contamination. Always take the health and safety of the building occupants into consideration before you conduct any cleaning procedures.
- ✓ All of the following tips are only general tips. They do not cover every situation and it is your responsibility to adapt these tips to the individual system you are working on.
- ✓ The Instructor is not responsible in any way for the work you perform after viewing this slide show. You are responsible for your own work.
- ✓ The views and opinions following are the instructors opinions and not necessarily the official position of the National Air Duct Cleaners Association.

What We'll Learn

- Importance of Filtration
- Different types of Filters
- Understanding Filter Performance
- Misconceptions about Filtration

The Importance of Air Filtration

Air filtration supplies the means to obtain the level of particulate cleanliness required by any definition of "air conditioning."

Air Filters are used for a variety of purposes

- Protecting the health and well-being of the occupants of the space by removal of airborne microorganisms and particles.
- Protecting the décor of occupied spaces by removing the staining portion of airborne dust.
- Reducing maintenance of building interiors by reducing the frequency of washing such items as Venetian blinds and fluorescent bulbs.

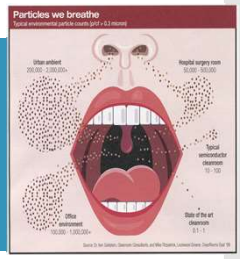
Air Filters are used for a variety of purposes

- Protecting the contents of occupied spaces including paintings, tapestries, and other items of historic or cultural value.
- Elimination of fire hazards by removing lint and other materials which might accumulate in the ductwork.
- Removing airborne bacteria from operating room air to help prevent postoperative infection.

Particulate Levels

Number of Particles

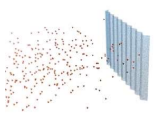
Cleanroom	1 per liter
Arctic	10,000 per liter
Ocean	100,000 per liter
Rural	1 Million per liter
City	100 Million per liter
Highway	1 Billion per liter
Tobacco Smoke	100 Billion per liter



Indoor Air Quality

"Americans on average spend close to 90% of their time indoors, where pollutants are often 2 to 5 times higher than typical outdoor concentrations." [1]

1. U.S. Environmental Protection Agency. 1987. The total exposure assessment methodology (TEAM) study: Summary and analysis. EPA/600/6-87/002a. Washington, DC.



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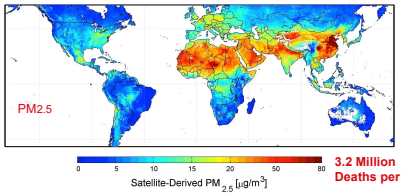
Each Day we….

- Eat roughly 1 kg of food.
- Drink about 2 kg of liquids.
- **Breathe 15 kg of air…….**
- …and inhale more than 25 million particles with each breath.

Solid Particles

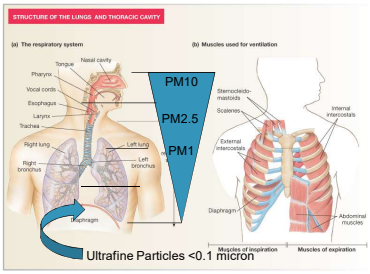
PM2.5 Exposure and Cardiovascular Mortality Worldwide



3.2 Million Deaths per Year

Mortality rate increases about 1% for every 5ug/m_3 increase in $PM_{2.5}$ *Evans J et al Env Res 2013*

Particle Deposit into the Lung



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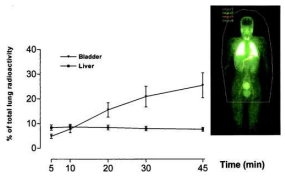

Gamma camera image shows particle accumulate in the nasal passages,

lungs, liver, and bladder in minutes

Nemmar et al., Circulation2002

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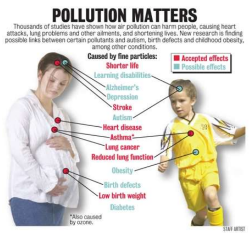
Effect of PM on Health

- Accepted effects
- Possible effects



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Estimated Deaths – Hospital Acquired Infections

90,000 People Die of Hospital-acquired Infections per year
And Costs…
$4.5 Billion Per Year

Source: Centers for Disease Control and Prevention

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Energy Consumption

Average Healthcare Facility uses 3 to 5 times more energy than the average Commercial Building.

Source: ASHRAE

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Energy Consumption

More than 2/3 of the total energy consumed by Healthcare facilities is dedicated to maintaining climate control and IAQ.

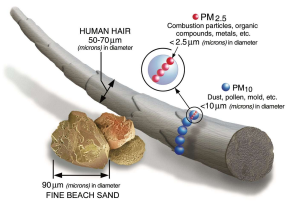
Source: ASHRAE

Filter "Rules of Thumb"

- The Static Pressure Drop across a filter increases as it "LOADS".
- The Efficiency of a mechanical filter increases as it loads with dust.
- Typically, the higher the efficiency of a square foot of media, the higher the static pressure drop.
- Charged medias almost always exhibit a lower pressure drop for similar efficiencies.
- Charged media filters almost always exhibit a loss of charge and a corresponding drop in efficiency.

Particulate Matter

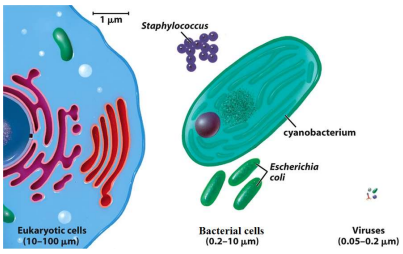
The US EPA as well as industrial hygienists have long used PM nomenclature for measuring particles in the atmosphere. This terminology is becoming more widely accepted by the HVAC industry and ASHRAE in particular.
PM stands for particulate matter (also particle pollution).



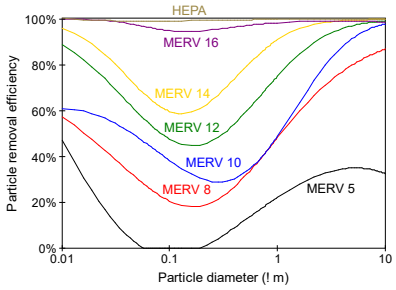
PM10 is defined as inhalable particles with diameters that are generally 10 micrometers and smaller.

PM2.5 is defined as fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller.

Typical Microorganisms

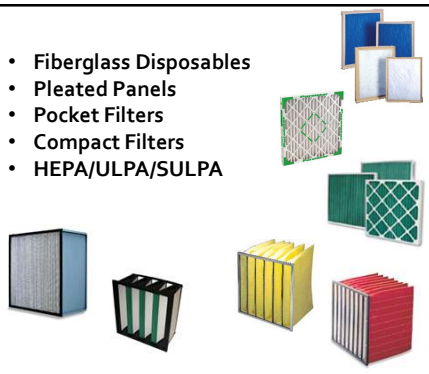


In Healthcare Facilities

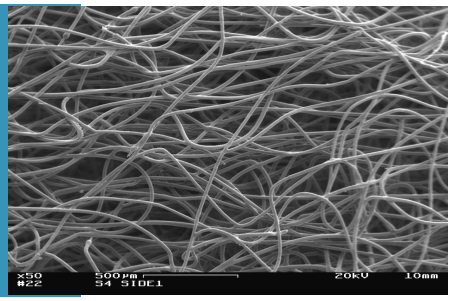


Title of Presentation

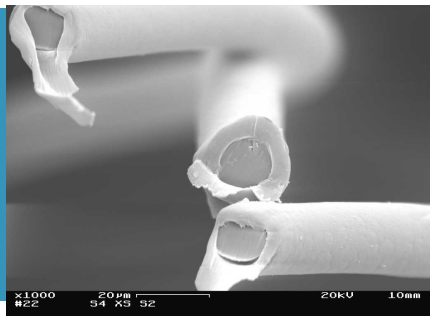
- Fiberglass Disposables
- Pleated Panels
- Pocket Filters
- Compact Filters
- HEPA/ULPA/SULPA



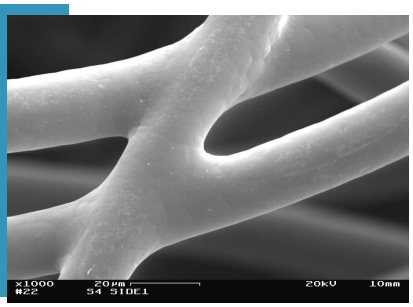
MeltBlown Media



Thermal Bonded Media



Thermal Bonded Media



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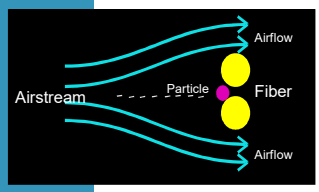
Five Mechanisms of Aerodynamic Particle Capture

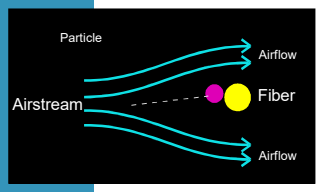
- Straining
- Impingement
- Interception
- Diffusion
- Electrostatic Attraction

Straining



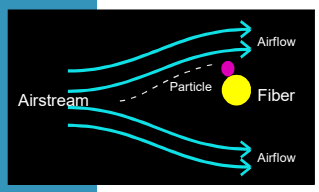
Very large particles are captured between two fibers.

Impingement



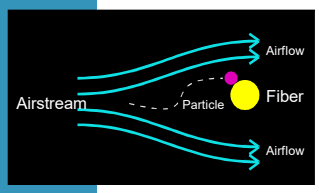
Larger particles do not move around the fiber with the airstream and are carried into the fiber due to their momentum.

Interception



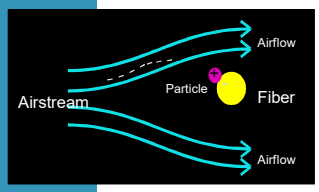
Midsize particles move along with airstream lines and contact a Fiber. Fiber and Particle size dependent

Diffusion



Smaller particles move randomly across airstream lines and contact fibers by Brownian Motion. Optimum at lower airflows.

Electrostatic Attraction



Particles are pulled to the fiber due to electrostatic attraction (charge) of the fiber, that is opposite of the particle charge.

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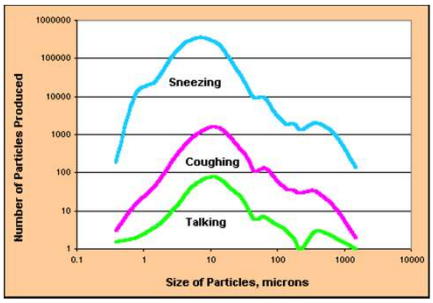
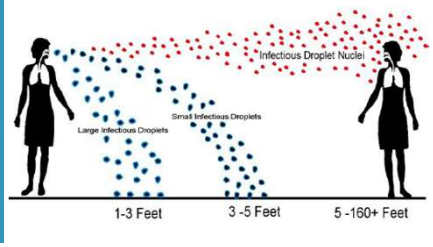
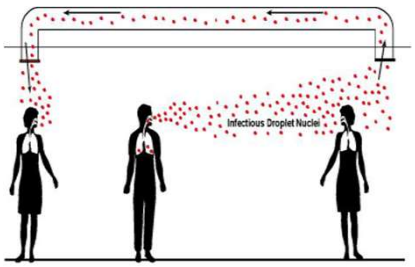
Droplet Nuclei Produced by Infected Persons



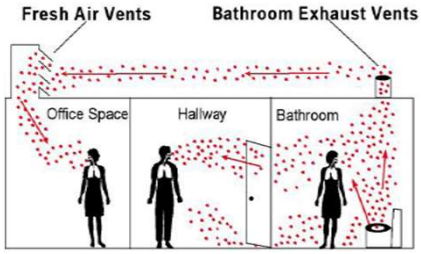
Airborne Infection



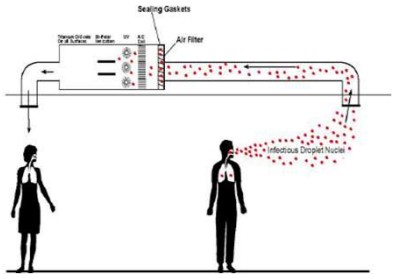
Transmission through HVAC System



Poorly Designed Outdoor Air Intake

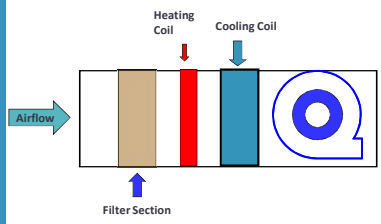


Addition of Filtration & UVGI



HVAC Equipment

HVAC Equipment

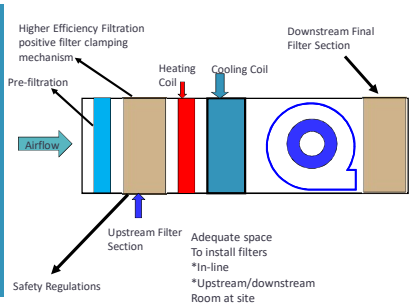


People Effects

Today

- Protect equipment from microorganism growth
- Clean air of airborne microorganisms that can cause infection
- Remove potential for cross-contamination person-to-person
- Prevent contaminant/odor introduction

System Design Considerations



Wet Filters

- 55 F @ 100% rh = 75 F @ 50% rh
- Higher Efficiency filters exhibit a higher absolute pressure drop causing the near saturated air to cross over the saturation curve.
- The effect is that the filters get wet and stay

January 2018 ASHRAE Journal
Author Stephen Duda

HVAC Equipment Rooms We've Seen (Not Yours!)

Office Areas We've Seen

Microbe growth on chilled water pipe

Damage to wallboard and tile from water damage

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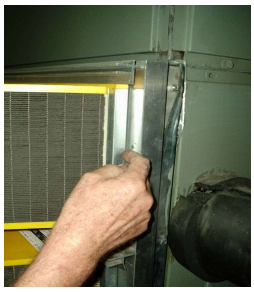

Filter Gap

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Filter Gap

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Installation Error

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Damaged Filters

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Poor Installation

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Incorrect Filter Selection

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Filter unsecured

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Improper Spacing

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Missed on Change List

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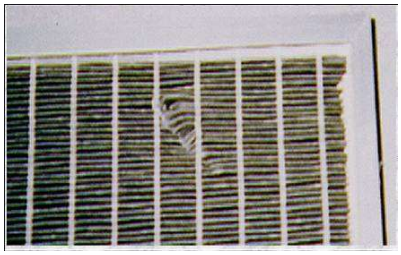

Damaged during Installation

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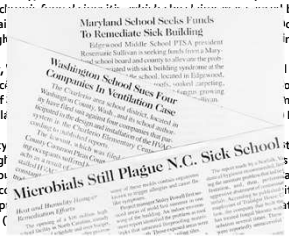
In The News!

- Orange County, Florida. A veteran teacher took disability leave as a result of c… by her school's ai… ools at levels high… inel Tribune)
- Pomeroy, … experienc… oms. Twelve of… hined that the ventila… Morning Tribune)
- University… t days apart, eigh… s including nausea, bu… ampus twice to c… ity claimed that the p… ation system. (…



Why are schools in the forefront?

- 51 million people occupy school buildings each school day (1 in 6)
  - 2.3 million teachers
  - 126,000 administrators
  - 600,000 support staff
- 110,000 schools
  - 85,000 public
  - 25,000 private

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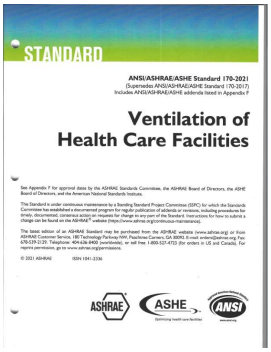
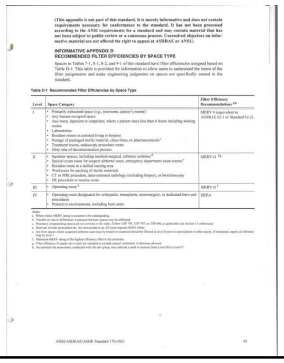
Commercial Buildings

- Buildings can make people sick
- Sick people are not productive
- Sick people do not renew their lease
- Sick people sue everybody

Revised ASHRAE Standard 170-2021



ASHRAE Standard 170-2021 Appendix D



Reference Guides

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Conclusion

- …….filters are one part of the complex residential environment and their performance can't be extrapolated from laboratory tests alone.

Jeff Siegel, University of Toronto

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Thank you for Participating!