Summarizing Indoor Air Quality Improvement Methods

By Jeffrey Kling P.E.

Hopefully this information finds you in good health and it serves you well. Indoor air quality (IAQ) is an always increasing concept which blends human health considerations, particulate control, and occupancy requirements. Within building environments, the management of indoor air quality is often reliant on centralized air systems as designed by licensed mechanical engineers. This applied engineering science can support surgical suites, migrate the smell of popcorn, capture off gases, and control carbon-dioxide levels. IAQ can also support the health of the building occupants, aiding productivity and reducing health risks. Hospitals and health care facilities have targeted code requirements for indoor air quality, but other building occupancies need only comply with minimal air filtration and fresh air requirements. Owners and managers interested in ways to improve their own occupancies should understand the various options that can improve indoor air quality.

Passive filtration, active filtration, increased ventilation, and other methods have all been examined in detail by the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE). As ASHRAE references and associated with death rates reported by the World Health Organization, reduction in exposure rates to particles smaller than 2.5 microns is proportional to the substantial health benefits of filtration.

https://www.ashrae.org/File%20Library/About/Position%20Documents/Filtration-and-Air-Cleaning-PD.PDF

https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

Passive particulate filtration or mechanical filtration can be located centrally as well as spread throughout a facility. ASHRAE 52.2 provides the testing method and ASHRAE 62.1 recommends a minimum of MERV 6. MERV 13 units provide average filtration rates of the smallest particle size range with an arguably acceptable amount of energy consumption to achieve. High Efficiency Particle Absorbing (HEPA) filter or MERV 17+ will filter 99% of particles 0.3 microns and larger. Particulate filters require replacement when loaded and increasing filtration will increase electrical consumption. Filter boxes are often modified and relocated as a modification to existing systems. Filtration of any particle is completely dependent on how the air is captured and moved through the air handling filtration system. Portions of any facility based on the configuration can have drastically reduced air change over rates.

A list of notable particle size ranges:
Viruses 0.0005 – 0.3 microns
Bacterial 0.3-60 microns
Mold 10-30 microns
Fumes 0.01-50 microns
Hair 25-100 microns

Table E-1 Application Guidelines

Std. 52.2 Minimum Efficiency Reporting Value (MERV)	Application Guidelines: Typical Controlled Contaminant	Typical Applications and Limitations	Typical Air Filter/Cleaner Type
16	**0.30 to 1.0 µm Particle Size**	Hospital inpatient care	**Bag Filters**
	All bacteria	General surgery	Nonsupported (flexible) microfine fiberglass or synthetic
15	Most tobacco smoke	Smoking lounges	media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
	Droplet nuclei (sneeze)	Superior commercial	**Box Filters**
14	Cooking oil	buildings	Rigid style cartridge filters 150 to 300 mm
	Most smoke		(6 to 12 in.) deep may use lofted (air laid) or paper (wet laid)
13	Insecticide dust		media.
	Copier toner		
	Most face powder		
	Most paint pigments		
12	**1.0 to 3.0 µm Particle Size**	Superior residential	**Bag Filters**
	Legionella	Better commercial	Nonsupported (flexible) microfine fiberglass or synthetic
11	Humidifier dust	buildings	media. 300 to 900 mm (12 to 36 in.) deep, 6 to 12 pockets.
	Lead dust	Hospital laboratories	**Box Filters**
10	Milled flour		Rigid style cartridge filters 150 to 300 mm
	Coal dust		(6 to 12 in.) deep may use lofted (air laid) or paper (wet laid)
9	Auto emissions		media.
	Nebulizer drops		
	Welding fumes		
8	**3.0 to 10.0 µm Particle Size**	Commercial buildings	**Pleated Filters**
	Mold	Better residential	Disposable, extended surface, 25 to 125 mm
7	Spores	Industrial workplaces	(1 to 5 in.) thick with cotton-polyester blend media,
	Hair spray	Paint booth inlet air	cardboard frame.
6	Fabric protector		**Cartridge Filters**
	Dusting aids		Graded density viscous coated cube or pocket filters,
5	Cement dust		synthetic media.
	Pudding mix		**Throwaway**
	Snuff		Disposable synthetic media panel filters.
	Powdered milk		
4	**>10.0 µm Particle Size**	Minimum filtration	**Throwaway**
	Pollen	Residential	Disposable fiberglass or synthetic panel filters
3	Spanish moss	Window air conditioners	**Washable**
	Dust mites		Aluminum mesh, latex coated animal hair, or foam rubber
2	Sanding dust		panel filters
	Spray paint dust		**Electrostatic**
1	Textile fibers		Self charging (passive) woven polycarbonate
	Carpet fibers		panel filter

Note: A MERV for other than HEPA/ULPA filters also includes a test airflow rate, but it is not shown here because it has no significance for the purposes of this table.

Active particulate filtration, Electronic filtration, Sorbent Air cleaners, Photocatalytic Oxidation, and Ultraviolet (UV-C) filtration has seen a variety of products introduced to the market. Current and future opportunities will likely become the market preference due to escalating cost comparisons. These products require more initial cost, reduced continued maintenance costs, with testing showing similar results to mechanical filtration. These devices provide opportunities residentially through minimal space and system modification needs.

- Sorbent Air cleaners – commonly known as a carbon filter to capture unwanted odors or chemicals. New products are reporting carbon dioxide capture. Maintenance is critical when the filter is loaded and begins rejecting the absorbed gases back into the airstream.
- Photocatalytic Oxidation (PCO) – utilizes ultraviolet activation of hydroxyl ions which oxidizes contaminants. Utilized for pure air delivery. Reactive area contained within the air handling system.
- Ultraviolet (UV-C) – designed to a provide the optimum disinfecting light wavelength without producing ozone. Utilized for pure air delivery. Reactive area contained within the air handling system or within an unoccupied room for sterilization.
- Electronic filtration – Electrically charges ions attach to particles which then precipitate from the air onto plates, filter media, or surfaces within the space. Can generate ozone and should be tested to UL 867 compliance. Systems' third party tested to verify pathogen reduction rates. Products can provide ions to an occupied space to improve reactive efficiencies.
- Portable units – used for room filtration. Seen as energy, cost, and maintenance intensive, but may be reasonable for smaller facilities.

Included for reference only and does not constitute an endorsement:

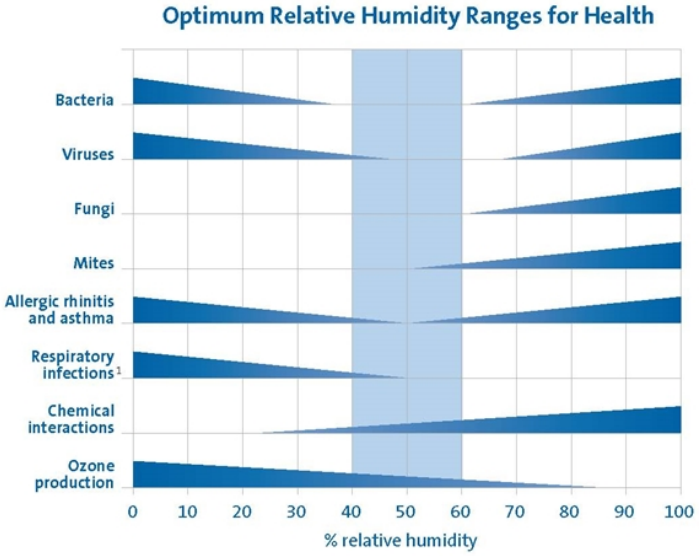
PCO and UV-C product: https://www.uvdi.com/hvac/air-purification/

Needle Point Electronic Air Filtration : https://www.prnewswire.com/news-releases/indoor-air-quality-technology-company-global-plasma-solutions-responds-to-coronavirus-301019802.html

Ion Tube Generation Electronic Air Filtration : https://pdfs.semanticscholar.org/02fe/8020010cff61e31ccdbb485a6f92884abaae.pdf

Increased ventilation is commonly considered an alternative to advanced filtration methods. Increased ventilation serves to dilute contaminants within the occupied spaces and is dependent upon capture rate and efficiency. ASHRAE provides guidance to increase or reduce ventilation when compared to filtration methods. The cost of ventilation rates and filtration methods must be compared to provide guidance. Increased ventilation is only as good as the outdoor air source, air turnover rate, and capture efficiency within the building.

Indoor humidity control has been studied and correlated to human's ability to resist communicable disease. The body's immune system is shown to function at an ideal level when relative humidity levels are between 40-60%. Humidity control will additionally benefit the facility's electronic components and finishes. Existing building envelopes will determine how much humidification can be provided without condensing water vapor.



[1]Insufficient data above 50% RH.

E.M. Sterling, Criteria for Human Exposure to Humidity in Occupied Buildings, 1985 ASHRAE.

Research studies

https://www.ghp-news.com/2019-new-study-dry-air-is-flu-s-best-friend/

https://www.condair.com/m/0/breatheeasy-wp-drtaylor-final-web-v102016.pdf

Conclusions and recommendations involve the consideration of one or multiple air cleaning methods with humidification. Engage a registered professional mechanical engineer to evaluate the existing construction and provide cost analysis assistance to aid any decision. Be cautious with new technology and request third party testing verification. Convey the appropriate information to the occupants so they understand how the indoor environment is being improved.

ASHRAE has provided additional informative guidance for building owners and operators that should be considered.

https://www.ashrae.org/news/ashraejournal/guidance-for-building-operations-during-the-covid-19-pandemic

Hopefully this information has been of a benefit. Thank you,

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