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Localized HEPA Filtration

Executive Summary

Breathing air laden with particulate matter has been shown to have adverse health effects. The particulate matter of concern is PM2.5, which can easily be deposited into the lungs and transferred into the blood stream. Ultra-fine particles, in particular, are a topic of concern as COVID-19 is 0.1um; other larger aerosol droplets can still be a carrier, however. Particulate matter can also stay suspended in the air for hours on end and can be resuspended by human activity. MERV 13 filtration is the standard for dealing with PM2.5 as it captures around 90% on a single pass, but with the new focus on removing bioaerosols, the new normal will become HEPA. Portable filtration can also increase the efficacy of the air cleaning twofold by removing contaminants as close to the source as possible and delivering the clean air as close to where it is needed the most – both of which are the occupant. Our suggestion based on the current science is to utilize a portable HEPA in the two locations where we spend most of our time: where we sleep and where we work or study.

Explanation of the Science

Air cleaning by means of filtration is particularly important during the current pandemic and for general improved indoor air quality. Mechanical filtration of particles is accomplished by different mechanisms including diffusion, interception, straining, and inertial impaction. These mechanisms capture a wide variety of particulate sizes. Filters are rated by their effectiveness of removing particles and performance is presented in the graph below. The lower performing filters are rated in MERV, while the higher performing are rated as HEPA or ULPA (above MERV 16). HEPA filters capture a minimum of 99.97% of particles measuring 0.3 micrometers. The size range from 0.1- 0.3 microns has the lowest percentage of capture because the filtration mechanisms are in transition during this particle size.

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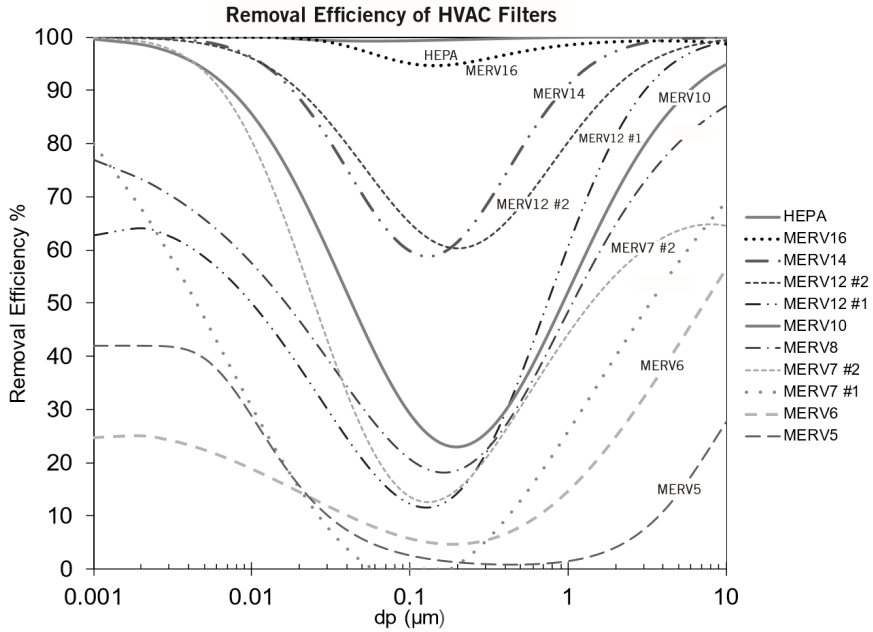
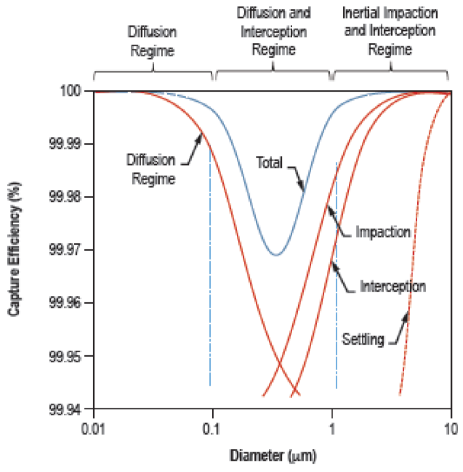
MERV and HEPA Removal Efficiencies



Source: Estimates of HVAC Filtration Efficiency for Fine and Ultrafine Particles of Outdoor Origin, Azimi et al. (2014) in Atmospheric Environment
https://www.researchgate.net/publication/265644719_Estimates_of_HVAC_filtration_efficiency_for_fine_and_ultrafine_particles_of_outdoor_origin

MERV and HEPA Removal Efficiencies



Source: Particulate Matter Filtration Design Considerations for Crew Spacecraft Life Support Systems, Agui et al. (2016) from proceedings of 46th International Conference on on Environmental Systems.https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20160009736.pdf

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There has been a recent focus on particulate matter levels and human health. Multiple studies show that increased levels of PM2.5 lead to adverse health effects (Miller and Xu 2018). The current guidance is to use MERV 13 in order to reduce PM2.5 (EPA 2018), but new research shows that MERV may not be the best metric for ultra-fine particles and PM2.5 (Azami and Zhao 2014). We have learned with the current pandemic that COVID-19 is 0.1 micrometers on its own, but often comes as a hitchhiker on other particles – this also is true for other forms of SARs. Therefore, moving from MERV 13 to HEPA for personal space filtration maximizes the potential for capture while providing other respiratory benefits through reduction in overall particulate matter (Azami and Zhao 2014). With COVID-19 and other bioaersols, we want to maximize the capture efficiency on a single pass which is why the move to HEPA is suggested. In order to get the most out of the portable HEPA, it should be located as close as possible to the occupant, where they spend most of their time, which is typically where they work and sleep. This personal filtration will help capture pollutants at the source and help with airborne disease transmission to other occupants of the building. Gas phase or combination HEPA/gas phase technologies that provide the same high capture efficiency as HEPA may also be used in place of HEPA as long as they do not lose their efficacy over time and are routinely maintained.

Mechanical filtration only occurs when particulate containing air is processed by the filter. Therefore, the more air processed, the more air cleaning that occurs. The filtration system should be set up to draw air in from the location with air that needs to be cleaned. The intake and the exhaust of the filtration system should be taken into account for various situations as pressure imbalances can cause unintended air mixing. There are downfalls to utilizing a filter that relies on the HVAC system to process air as most HVAC operate from 0% in mild weather to 40% in cooling and heating season (Cetin and Novoselac 2015) – this can be overrun by operating the system in ON. However, most HVAC systems utilize a central return with a distributed duct system which may not provide us with the filtration and clean air in the location it is needed. In addition, utilizing HVAC fans for filtration often means we are using the highest wattage fan which consumes close to 300W/ton and adds excess heat to the space. Lastly, most HVAC systems are not designed for the pressure drop caused by HEPA filtration and will negatively affect their ability to condition the space. Therefore, portable HEPA filtration units that are placed where humans spend most of their time, both in the workplace and at home, often provide the most effective and efficient filtration solution. Portable units also allow placement of the filtration as close to the source of the pollution as possible. In most cases, this is the location where people reside the longest as humans are often the source of particulate matter and their activities also responsible for the suspension and resuspension of particulate matter (Ferro et al. 2004). Even though there are downfalls to utilizing the HVAC system for high efficacy filtration, it is still recommended to put a MERV 13 filter in the system as long as the filter does not alter the performance of the system.

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PLEASE CONTACT ONE OF OUR EXPERTS TO HELP YOU IMPROVE YOUR INDOOR AIR HYGIENE

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