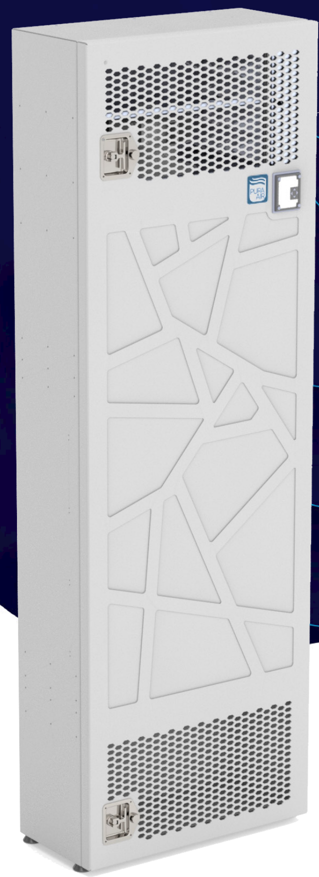
The Role of Air Purification in Your Facility's IAQ: How to Know When It Makes Sense

Air purifiers are a cost-effective way to make high traffic, high risk indoor areas more safe and more comfortable without requiring complex building retrofits. Different devices can remove different airborne particles.



AV1000

SOME OF THE TINY PARTICLES WHICH REDUCE OUR INDOOR AIR QUALITY

1. Flu and cold viruses (prior to 2019 these are one of the most costly burdens on our economy).
2. Other well known airborne viruses such as mumps, chicken pox and measles.
3. Other coronaviruses such as SARS and Covid-19.
4. Tuberculosis, whooping cough and other airborne bacteria.
5. Mould spores (which can trigger allergies, headache or other symptoms).
6. Products of incomplete combustion from cars, planes, power plants, heating (soot etc but not including NO^x and CO which are gases).
7. Smoke from both tobacco use and from wildfires.
8. Dust.
9. Animal hair and skin particles.
10. Fabric particles made from plastic or natural microscopic fibres.

Some of these are less harmful than others but often the less harmful ones are very common and can trigger long term symptoms such as fatigue, allergies or discomfort.

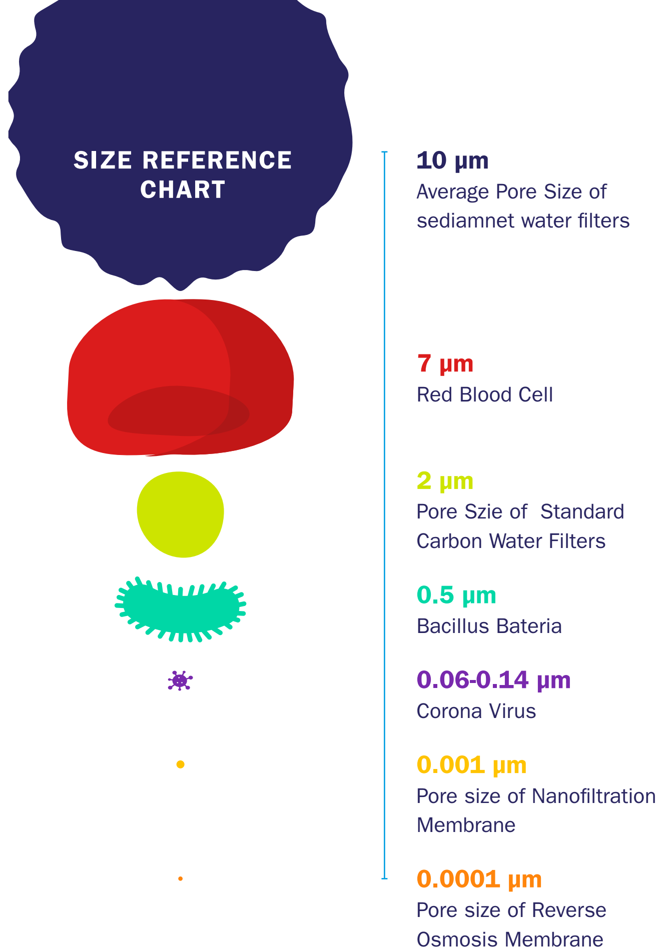
Most buildings or homes have mechanical systems for providing the fresh air we need to breathe and be comfortable. These are called Heating Ventilation and Air Conditioning (HVAC) systems. These generally supply the ventilation air to a building which is a mixture of fresh air from outdoors and reused air from indoors. Both the fresh air and the reused air are typically filtered to remove unwanted particles.

The ratio of reused to fresh air will be chosen based on the trade off between heating or cooling costs vs the desire for fresh air. If the outdoor temperature is different than the desired indoor temperature, fresh air will require energy to change its temperature. Furthermore, in some polluted large urban settings or during wildfires or sandstorms, outdoor air has its own burden of undesirable particles which can, in part, be filtered out. Indoor air has new airborne particles introduced by occupants and other activities in the building which can in part be removed by filters too.

The supply air is moved with fans and ducts to the various spaces in the building. On its way it can be heated, cooled, humidified or dried with different devices. The treatment of the air along the way and the amount of air going to different parts of the building is usually controlled by an electronic or computer system.

When supply air enters a room or building space, it usually comes through supply vents or diffusers and mixes with the air in the room, but some buildings use hallways and rooms as the pathways for air supply. To balance the incoming air, rooms often have return ducts to remove the mix of air in a room (some older buildings simply rely on cracks and leaks around the windows to allow air to escape the space). Additional sources of contamination can exist in the room (from people, cooking, and other sources) mixing with the supply air and creating complex patterns of concentrations of particles in the air. Generally ventilation is provided in an effort to fully mix in the room. Since sources of undesirable contaminants can move or vary in time, perfectly mixed air is not possible, sometimes leaving “dead” zones in a room where the air is not as well mixed.

An important concept in HVAC is called the Air Changes Per Hour (ACH), which is calculated by dividing the volume flow of supply air (in ft^3 / hour or m^3 / h) by the room volume (in ft^3 or m^3). This number indicates how many room volumes of air are supplied to the room per hour. However, the nomenclature or Air Changes deceptively implies that if you have 1 ACH, that you could expect all the air in a room to be renewed in an hour. This is not the case, because the supply air mixes with the air in the room and the return air is that mixture. If the air is perfectly mixed in the room, one air change per hour will mean after one hour, a room will have 2/3 newly supplied air and about 1/3 will be comprised of air that was there in the first place. To calculate how much air in a room has arrived in the last hour, fraction = $1- 2.72^{-ACH}$ (where ACH is an exponent on the number 2.72) So if you had 2 ACH in a room after one hour you have about 14% of the original air still in the room, with 4 ACH it is about 2%. Of course with continuous addition of new sources of contamination in a space, the equations for knowing how much air has unwanted particles is a complicated matter. In the end, we want to know how we can reduce the level of unwanted particles.



HERE’S HOW TO KNOW IF AIR PURIFICATION MAKES SENSE

We can reduce the rate of virus transmission indoors by improving Indoor Air Quality (IAQ) and providing a higher volume of fresh air to the spaces occupied by people. Human lungs continuously emit small drops of fluid; when they come from an individual with a communicable infection, these small drops are tiny and linger in the air like invisible odourless smoke and can result in transmission of infections between individuals who are separated by both time and space (somebody in a different room, or somebody who was formally in a room but is now gone, leaving no visible trace of having been there). Different viruses and bacteria behave differently and the flu, the common cold (a coronavirus) and many other diseases are known to be transmitted by air this way.

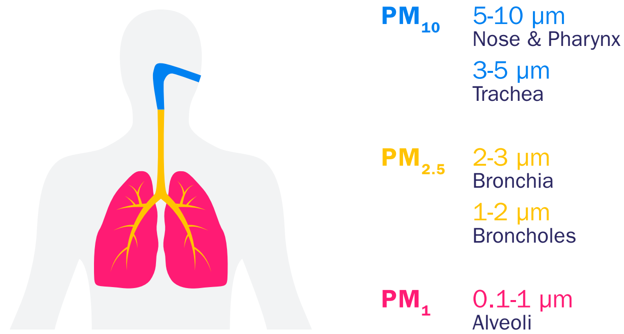
A growing majority of scientists feel there is adequate evidence to say Covid-19 is primarily transmitted by tiny aerosol particles. With that said, indoor/building technology invested in reducing flu and cold infections alone has long been recognized to justify the cost needed to improve IAQ. Improving IAQ also reduces sick time for building occupants by reducing lost time due to allergies, asthma, sick building syndrome, pollution, wild-fire smoke, and other effects of poor indoor air.

So to provide an increase in fresh air to a space or an indoor setting, the air must come from the outdoors where it may need to be heated or cooled (this can be done using heating or partially using Heat Recovery Ventilators, HRVs), or it must by reused after being purified. You can purify the air using the existing building Heating Ventilation and Air Conditioning (HVAC) system if one exists and using a high quality air filter, or you can add a system which acts alongside of the existing system.

When should you consider an air purifier over the existing HVAC system:

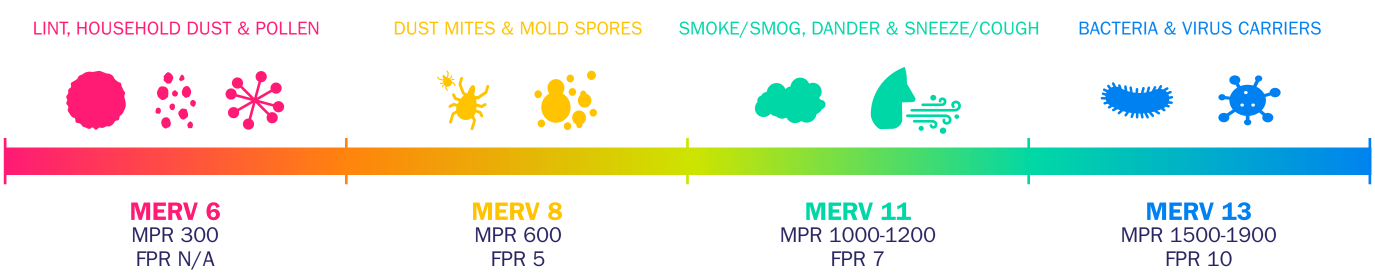
1. There is no air delivery system. This is when the building has hydronic or electric base board heaters or coolers, and there is no clean air supply.
2. The building HVAC system cannot accommodate a high-quality filter (the recommended rating for adequate filtering is MERV-13) and you don't want to renovate the whole system if it is currently providing needed comfort (temperature and humidity). This could be the case since often higher MERV rating filters are bigger and need to fit into a specific place in the air handler.
3. You have highly sensitive people (elderly or immune-compromised) in your building. A good quality air purifying system will do a better job removing infected particles from the air than most HVAC filters and can take you to a much higher level of safety if you need it.
4. You want to play it safe and have a better level of protection than what is offered by a good air filter. (similar to 3 above). This could be driven by liability or other safety policies of your organization.
5. Your risks are unevenly distributed in your building and you would like to have increased protection in specific areas which are crowded or are used intermittently where you can move or redeploy air purification (for mobile purifiers).

ISO 16890 FILTER RATINGS



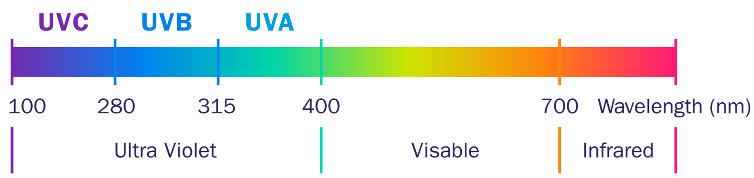
So if you are in one of the five cases above, you might be looking at the range of products and having trouble telling the difference between them. This document was prepared for Pura Air systems, but applies to all systems and is a guide for how to compare them.

1. What is the filter rating or designation? The accepted designations are MERV (minimum efficiency rating value) and HEPA (high efficiency particulate air). To be above the typical rating for a "good" HVAC system, the MERV rating should probably be above 13 or 14. That is the rating most new modern commercial buildings use if they have forced air ventilation. HEPA is a much higher rating which is used in many medical applications, however, the HEPA designation is often attributed to devices which do not actually provide this filter rating. To be a true HEPA filter, the filter medium should be scan tested and installed at the air flow rating for which it was designed. There are unreliable HEPA filter materials on the market (often originating from jurisdictions where regulations are lax) and acceptable filters which are used at unacceptable air flow rates which are outside the rated capacity for the filter medium. The best way to know what you are getting is reliable is to be advised by experts or scientists who do not have an interest in selling a specific device to you. Filters from reliable manufacturers will be labelled.



2. Is the filter susceptible to bypass? Because filters obstruct air flow, air "tries" naturally to go around the filter, like if you dam up a river and force all the water through a constriction. If you look inside the device and there is any way for air to leak around the filter, the filter is not doing nearly as good a job as its rating, because a lot of the air flow will just go around it. Because of how a filter block the air flow in a device, even a tiny crack can allow a lot of the air to simply bypass the filter. Poor construction, design or fabrication could mean a device is not doing what it should.
3. What is the air flow rate you are looking for? You will probably be estimating the increased ventilation based on the volume of air in the room(s), and the rate (in cubic feet per minute CFM or similar measure) you will deliver fresh air. You can divide the air flow rate by the volume of the space, to get a number called Air Changes. If the rate is in hours, this is called the Air Changes per Hour (or ACH). Most residential or commercial buildings with air ventilation already have systems providing 2-4 ACH. To improve on your safety, you will need to increase the amount of air changes you get in that space. However, any incremental increase in ACH provides less improvement than the last so you cannot simply increase safety without limit by increasing ACH. The amount of ACH you need, will depend on your specific setting. A dentist operatory or senior's home might need more fresh air than kindergarten class, given the different risks. Here you need to know what the target ACH is and again expertise is helpful.
4. How well is the purified air mixed into the space subject to human activity? Once fresh air is in the room, it is less effective reducing risk if it is not well mixed. Having a well-ventilated side of the room and a poorly ventilated side of the room is not a good strategy. The purifier should provide enough air speed to mix the air in the space, or you need fans in the room to do this. They air mixes a bit on its own because of the light draughts that are already in the room, but it is better to move the air around so any high concentrations of infected air are diluted with the incoming air.

THE POWER OF LIGHT TO DISINFECT



5. Will the system use ultraviolet light to kill infection? Ultraviolet light is one of the most well known and proven ways to kill bacteria and viruses. Most such systems shine or irradiate air with invisible light waves, usually at 254 nm (UV from this wavelength is called UVC light/irradiation). It is the best wavelength for killing such biological agents. Tiny viruses are most effectively eliminated by strong even light sources passing through slowly moving air passages. The rate of destruction of bacteria or viruses depends on the DOSE of UV light which goes up with increased UV light power (in Watts) and decreasing the air velocity (to kill pathogens we want lots of light and slow moving air). It works even better when the chamber where the UV light shines is reflective, so the beams can bounce back and forth through the air. Air speeding through a narrow duct with a weak UV light will do very little and good devices are able to provide numbers to show what the DOSE is.
6. Will the system use electrons or ionization energy to improve particle removal? Some air purifiers pass the air stream through a stream or field of electrons caused by a high voltage conductor. This can cause particles to become charged and cling to surfaces the same way a rubber balloon sticks to the wall at a kid's party. This way, if unsafe particles are charged, they should more rapidly settle, stick to a filter, or adhere to other solid surfaces. This is a newer technology than filters or UV systems and there is evidence to show this could be effective. Because there is no calculation to predict the effectiveness of such a strategy, it is difficult to compare how different products work and some experts have concerns that the electrical current might create unwanted byproducts.

Every Breath We Take

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